

# Time-to-Incision for Hip Fractures in a Canadian Level-1 Trauma Centre: Are We Respecting the Guidelines?



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## ABSTRACT

### Background

Surgical intervention within 48 hours is recommended for hip fractures in the elderly in order to reduce post-operative complications and lower mortality rates. The purpose of this retrospective study is to explore the causes of surgical delays for acute geriatric hip fractures.

### Methods

This is a retrospective cohort study involving a total of 109 consecutive geriatric patients who sustained proximal femur fractures (“hip fractures”), who subsequently underwent definitive fixation. Clinical, demographic, and direct costing data were extracted via a modern system and electronic medical records on a centralized data warehouse. Surgical delays and length of stay were analyzed according to clinical variables.

### Results

The established benchmark of a time-to-surgery of less than 48 hours was respected for 63 (57.8%) patients. Patients on oral anticoagulant (ACO) waited significantly longer, on average 58 hours compared to 44 for non-anticoagulated patients ( $p = .007$ ). Patients with higher ASA scores waited significantly longer ( $p = .0018$ ). More importantly, patients treated within 48 hours were discharged significantly earlier, on average after 10 days compared to 16 days for patients who waited more than 48 hours before receiving surgical treatment ( $p = .003$ ), regardless of the pre-operative waiting time.

### Conclusion

Fewer than 60% of patients received surgery within the 48-hour benchmark after being admitted for an acute hip fracture in a Level-1 trauma centre. Patients with more comorbidities waited longer and stayed longer in the hospital after surgery. Implementing strategic, evidence-based changes should be done using this data to improve care of this vulnerable population.

**Key words:** orthopaedics, traumatology, hip fractures, wait times, geriatric orthopaedics

## INTRODUCTION

Prompt surgery for proximal femoral fractures (“hip fractures”) in the elderly has been associated with reduced mortality risk and fewer post-operative complications.<sup>(1-12)</sup> As a result, in 2005 Canadian authorities established a benchmark<sup>(13)</sup> of 48 hours from time to admission to definitive surgical treatment of acute hip fractures. Despite clear guidelines, variability of their application has been observed across the provinces.<sup>(14)</sup> In addition, surgical hip fracture repair data from Quebec have historically been excluded from national reports due to variation in data definitions<sup>(15)</sup> and a lack of accessibility. There was an impression among the senior authors that the current standards as they relate to surgical management timing and protocols for these patients were not being applied. This retrospective cohort study involving acute hip fracture care sought to elucidate reasons for delay in care and define areas for strategic improvements in this vulnerable population.

The primary objective of this study was to evaluate the wait times of patients from the time of presentation at the emergency department to the incision time in the operating room. This period is defined as the time-to-incision (TTI). The secondary objectives included the assessment of several factors shown<sup>(4,16-19)</sup> to influence surgical delays including patients’ demographics, anticoagulation status, comorbidities, and timing of presentation at the emergency room. Lastly, we evaluated the impact of surgical delays on post-operative length of stay (LOS).

## METHODS

This is a retrospective cohort study of 109 consecutive patients treated surgically for acute hip fracture at the Montreal

General Hospital, a Level-1 trauma centre receiving over 10,000 trauma patients annually. The institution is one of the three tertiary trauma care centres in Quebec (population 8.6 million). The orthopaedic surgery division shares operating room resources with other surgical specialties. On weekdays, one operating room is dedicated to traumatic orthopaedic cases and an emergency room is available after 5:00 pm but is shared with other surgical specialties. An institution-specific tool categorizes patients needing surgical attention into categories. Category 1 patients are the sickest and their condition is deemed life-threatening. Category 2 refers to limb threatening injuries that should be treated within 4 to 6 hours. Orthopaedic trauma patients are often Category 3. Multiple orthopaedic groups are forced to petition for OR time for “walking wounded” patients.<sup>(18)</sup> Surgeons are relied upon to assign their patients to the appropriate category.

### Participants

All patients over 60 years of age who had surgery for an acute proximal femoral fracture over an 11-month window were included. Patients aged less than 60 years old, polytrauma cases, and patients managed non-surgically were excluded from this study. The research protocol included acquisition of patient demographics, past medical history, injury characteristics, time of presentation to the ED, time of admission, time of intervention, complications from surgery, type of anaesthesia, and discharge date.

Data were extracted primarily via a modern Project Portfolio Management (PPM) system (Power Health Solutions, Adelaide, Australia). This centralized database is secured and managed by the McGill University Health Centre (MUHC) Data Warehouse. The PPM enables prompt extraction of data including itemized direct and indirect costs per episode of care, procedure codes, adverse events, and precise temporal data. Digitalizing data entry adds precision and efficiency to data collection, compared to onerous manual extraction from patient charts. Complementary data were extracted manually via the electronic medical record system. The study was approved by the local ethics board.

### Variables Collected

#### Demographics

Demographic data recorded included patient’s age, gender, comorbidities, the American Society of Anesthesiologists (ASA) classification,<sup>(20)</sup> and the classification of injury. The Charlson Comorbidity Index (CCI)<sup>(21)</sup> was calculated. An institution-specific emergency room categorization was also recorded. The classification of each patient is first established by the triage nurse in the emergency department according to the five levels of priority. This classification is distinct from the surgical priority, which is selected by the surgeon based on various criteria.

Anticoagulation status of patients is defined as the current use of any anticoagulation agent at the time of presentation at the emergency room. Timing of presentation at the emergency room was classified into four blocks (A = Weekday 7:00 a.m. to

3:59 p.m., B = Weekday 4:00 p.m. to 11:59 p.m., C = Weekday 12:00 a.m. to 06:59 a.m., D = Weekend). The post-operative length of stay is defined as the duration (in days) each patient was on the inpatient unit after surgical intervention.

#### Study Treatments

All patients included in the study elected either for a definitive fixation or arthroplasty depending on their fracture characteristics and classification. Fixation was performed either using a sliding hip screw (DHS, Synthes, Paoli, PA), Centro-medullary nail (TFN, Synthes, Paoli, PA) or in situ cannulated screws (Synthes, Paoli, PA). Other patients underwent total hip or hemiarthroplasty. General anaesthesia (GA) or spinal were used to induce anaesthesia during the procedure. The start and end time of the intervention was noted by the nursing team in the institutional OR software (Opera OR system, GE Healthcare, Chicago, IL). Perioperative blood loss volume was recorded. Any complications during and after the intervention were carefully recorded.

#### Post-operative Protocol

Participants all followed an institution-specific hip fracture post-operative protocol, comprised of adapted multimodal analgesia, early ambulation with physiotherapy, adequate thromboprophylaxis, geriatric medicine assessment, delirium prevention, and medical optimization. This institutional protocol was introduced in 2017—well before the data collection period. The discharge date was recorded and collected via PPM with the help of the Data Warehouse team.

#### Statistical Analysis

Data were coded, stored, and analyzed via PRISM Version 8 (GraphPad, San Diego, CA). Unpaired Student’s *t*-tests were used to compare outcomes between two groups. One-way ANOVA tests were performed when comparing three groups. Subanalyses were performed without outliers; more than six days of TTI. Statistical significance level was set at  $p < .05$  and confidence interval at 95%. Continuous variables are presented as mean (CI 95% inferior: superior).

## RESULTS

### Subject Demographics (Table 1, Figure 1)

One hundred and nine patients (72 females and 37 males) were included in the study. Mean age of all subjects was 80 years old. Fifty-three (48.6%) patients sustained a right hip fracture and 56 (51.4%) had a fracture of their left hip. No patient had an American Society of Anesthesiologists (ASA) classification of 1. Fourteen (12.7%) patients were classified as ASA 2; 82 (75.2%) ASA 3; 13 (11.9%) ASA 4; no patient had an ASA score of 5. As for the calculated Charlson Comorbidity Index (CCI), 63 (57.8%) of patients were classified as CCI between 0 and 5; 45 (41.3%) patients had a CCI score between 6 and 10, and 1 (1%) patient had a CCI between 11 and 15. No patient had a CCI score of more than 15. Out of the 109 patients, 39 (35.8%) patients were on oral anticoagulants at the time of presentation in the emergency room. Twenty-seven patients

TABLE 1.  
Baseline characteristics of participants

Characteristic	n (% of total)
Sample Size	109
Age , mean (SD), yr	80.1 (9.6)
Gender	
Female	72 (66.1)
Male	37 (33.9)
ASA Score	
1	0 (0)
2	14 (12.7)
3	82 (75.2)
4	13 (11.9)
5	0 (0)
Charlson Comorbidity Index	
0– 5	63 (57.8)
6– 10	45 (41.3)
11– 15	1 (1.0)
>15	0 (0)
Emergency Triage Priority	
1	6 (5.5)
2	27 (24.8)
3	35 (32.1)
4	35 (32.1)
5	6 (5.5)
Procedure Done	
SHS	33 (30.3)
CMN	28 (25.7)
CRPP	12 (11.0)
Arthroplasty	36 (33.0)
Timing of ER Presentation	
Weekday 7AM to 3:59PM	37 (33.9)
Weekday 4PM to 11:59PM	45 (41.3)
Weekday 12AM to 06:59AM	6 (5.5)
Weekend	21 (19.3)
Injury Side	
Right	53 (48.6)
Left	56 (51.4)
Anesthesia Type	
Spinal	50 (45.8)
General	59 (54.1)
Anticoagulated	
Yes	39 (35.8)
No	70 (64.2)
Discharge Location	
Home	27 (24.8)
Acute care/rehabilitation	57 (52.3)
Long-term care facility	20 (18.3)
Deceased	5 (4.6)

were discharge home (24.8%), 57 (52.3%) to a rehabilitation centre, 20 (18.3%) to a long-term care facility, and 5 (4.6%) patients died during their stay at the hospital.

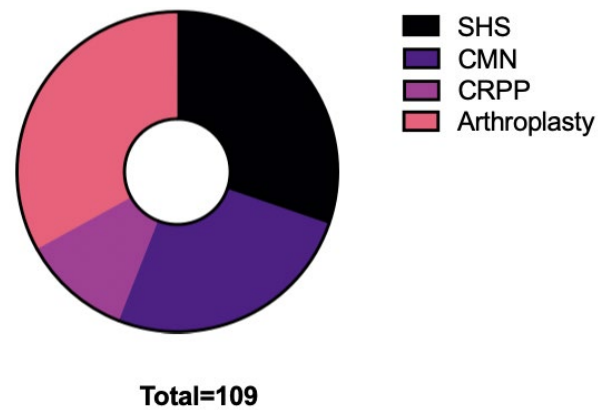


FIGURE 1. Procedures distribution

**Time-to-Incision (TTI) (Table 2, Figure 2)**

The average operative delay from time of presentation at the emergency department was 55 hours (46 to 63) with a median of 44 hours. Out of the 109 patients, 63 (57.8%) were operated within the 48-hour benchmark recommended by authorities. Forty-five patients (41.3%) were not operated within the recommended delay. Only 15 patients (13.7%) were able to undergo surgical intervention within 24 hours.

Patients on oral anticoagulants (ACO) waited an average of 58 hours (median 51) compared to 44 hours (median 38) for patients not anticoagulated ( $p = .007$ ). ASA class 2 patients waited an average of 51 hours, ASA class 3 patients waited on average 47 hours, and those with ASA class 4, 63 hours ( $p = .17$ ).

Patients who presented to the emergency department on a weekday between 7:00 a.m. and 3:59 p.m. waited an average of 59 hours; patients who presented between 4:00 p.m. and 11:59 p.m. waited on average 47 hours; those who entered the emergency between 12:00 a.m. and 6:59 a.m. waited an average of 44 hours; and finally those who presented during the weekend waited an average of 67 hours. One-way ANOVA did not reveal a significant difference in waiting times between groups ( $p = .356$ ). Subanalysis of delays in patients who presented on weekdays compared to a weekend presentation using Student’s  $t$ -test did not reveal a significant difference ( $p = .60$ ). In addition, when comparing weekdays to weekend ER presentation, there were no differences observed in the odds of respecting the 48h benchmark (OR 0.93, 0.43 to 2.09). No statistical difference was observed based on the choice of anaesthesia technique, either general sedation or spinal anaesthesia ( $p = .42$ ).

**Length of Stay (LOS) (Table 3, Figure 3)**

As explained in the methodology section, we defined the length-of-stay by the duration of hospitalization from the end of the surgical intervention until discharge. The overall average length of stay was 12.5 (10.5; 14.5) days, with a median of 9.9 days. A significant difference ( $p = .001$ ) was observed based on the ASA classification in relation to the length of stay (LOS). Patients with ASA 2 had a length of

TABLE 2.  
Time-to-Incision (TTI) analysis

Variables	n (%)	Mean (hrs)	Median (hrs)	95% CI	p value
Overall TTIA	109 (100)	54.9	43.8	46.1 to 63.8	N/A
Within 48 hrs	63 (57.8)	32.9	33.9	30.1 to 35.7	
Within 24 hrs	15 (13.7)	18.2	18.3	16.2 to 20.3	
ACO					.007
yes	38 (35.8)	58.1	50.5	49.3 to 66.9	
no	68 (64.2)	43.7	37.6	37.6 to 49.8	
ASA Classification					.17
2	14 (13.2)	50.8	40.3	27.2 to 74.4	
3	81 (76.4)	46.7	43.0	42.0 to 51.3	
4	11 (10.4)	62.7	61.07	37.1 to 88.3	
ER Presentation					.60
Weekday	86 (81.1)	48.2	43.4	42.3 to 53.6	
Weekend	20 (18.9)	51.7	41.6	36.1 to 67.3	
Anaesthesia Type					.42
General	49 (46.2)	51.1	47.3	43.3 to 59.0	
Spinal	57 (53.4)	46.9	41.1	40.1 to 53.8	

<sup>a</sup>All subjects included for global TTI analysis.

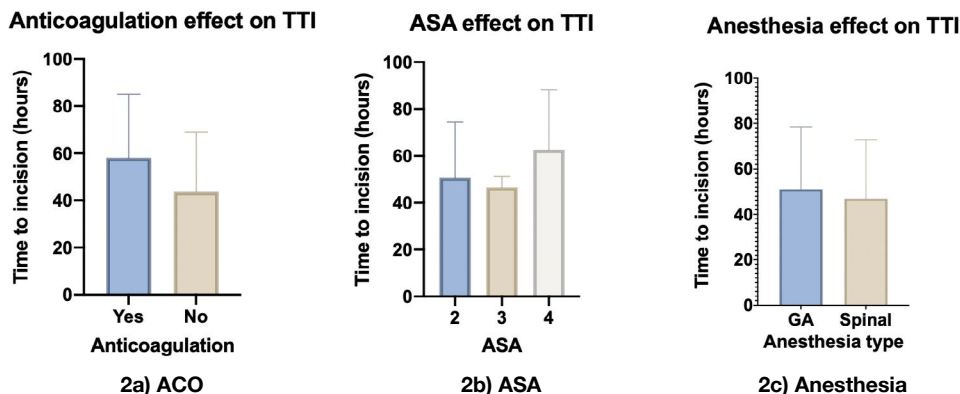


FIGURE 2. TTI assessment

stay of 9.0 days; the LOS for patients with ASA class 3 was 11.6 days, and those with ASA class 4, 21.9 days. Moreover, patients treated within 48 hours were discharged significantly earlier, on average after 10.0 days compared to 15.9 days for patients who waited more than the recommended delay ( $p = .003$ ). No significant difference was observed based on the anaesthesia type and the average length of stay. Patients who were anesthetized under general anaesthesia were discharged on average 13.4 days after their intervention compared to 11.7 days for patients with spinal block ( $p = .39$ ). Finally, one-way ANOVA revealed no significant difference on the length of stay based on the procedure type ( $p = .11$ ). Patients who underwent surgical fixation with dynamic hip screw stayed in hospital on average 12.2 days after surgery; 16.2 days for patients treated with titanium fixation nail; 8.0 days for closed reduction and percutaneous pinning (CRPP); and 11.4 days for patients who underwent hip arthroplasty ( $p = .11$ ). Patients

discharged home stayed on average 9.1 days in the hospital, 10.9 days for those transferred to a rehabilitation centre, and 19.6 days for patients requiring placement to a long-term care facility ( $p = .0007$ ).

## DISCUSSION

This study aimed at providing in-depth analysis of wait times for acute management of proximal femoral fractures at a Level-1 trauma centre. The purpose of the observational study was to evaluate procedure efficacy to enable comparison with other provinces and national guidelines. The most important finding of this study was the poor adherence with the established benchmark of a time-to-surgery of less than 48 hours for hip fractures. Only 63 (58%) patients received surgery within the benchmark. As mentioned above, some studies have suggested that patients operated within 24 hours

TABLE 3.  
Post-operative length of stay (LOS)

Variables	Mean (days)	Median (days)	95% CI	p value
Overall LOS	12.5	9.9	10.5 to 14.5	N/A
Intervention within 48 hrs	10.0	8.3	8.4 to 11.5	.003
Intervention delayed (> 48 hrs)	15.9	12.5	11.9 to 20.0	
ASA Classification				
2	9.0	9.1	6.2 to 11.7	.001
3	11.6	9.5	9.5 to 13.7	
4	21.9	16.6	12.6 to 31.3	
Procedure Type				
SHS	12.2	9.4	8.9 to 15.5	.11
CMN	16.2	11.5	10.9 to 21.5	
CRRP	8.0	5.7	3.5 to 12.5	
Arthroplasty	11.4	10.0	8.3 to 14.4	
Anaesthesia Type				
General	13.4	10.7	10.2 to 16.7	.40
Spinal	11.7	9.4	9.2 to 14.2	
Discharge Location				
Home	9.1	7.6	6.4 to 11.8	.0007
Acute care/rehabilitation centre	10.9	9.5	9.3 to 12.5	
Long-term care facility	19.6	13.0	11.1 to 28.1	

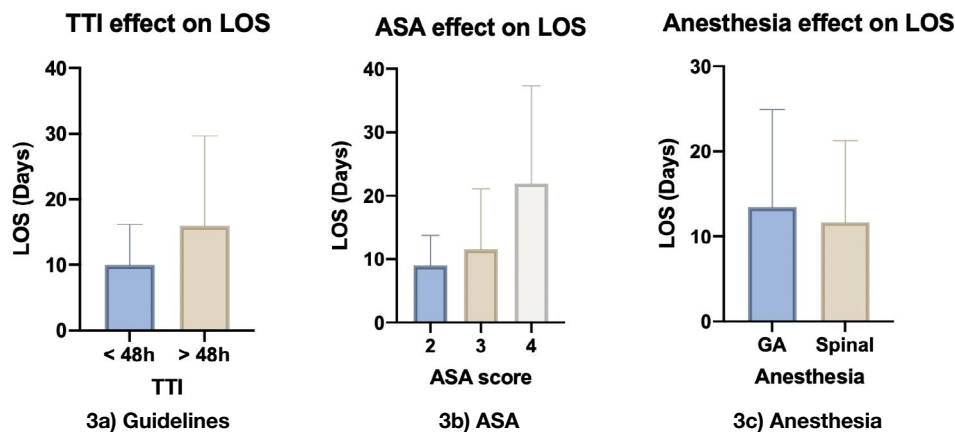


FIGURE 3. LOS assessment

could benefit from lower mortality risks and post-operative complications. At our institution, only 15 (14%) patients were treated within 24 hours. Among the plausible explanations for non-adherence to the guidelines, the high volume of trauma patients received for care at a Level-1 trauma centre might be responsible for the delays. With limited operating room time availabilities, evening priority is often given to a case more urgent from another surgical specialty, for example general surgery, neurosurgery, or thoracic surgery. The priority is decided based on an institution-specific tool that categorizes patients needing surgical attention. Increasing dedicated orthopaedic trauma room access beyond 3:30PM could significantly increase the adherence to guidelines. For example, patients who cannot have their surgical procedure during Day 1 are only being treated at Day 2 at 7:30AM. This automatically

increases surgical delays an additional eight hours. If the first case on Day 2 is already scheduled or represents an orthopaedic emergency (open fracture, compartment syndrome), then the patient would be delayed into the afternoon on Day 2.

Another explanation for the non-adherence with guidelines is the special management required for anticoagulated patients. When a patient is on oral anti-coagulation therapy, the management team (composed of an orthopaedic surgeon, an internal medicine physician, and an anesthesiologist) faces a point of decision. Often, a decision is made to hold the anticoagulant and delay the surgical intervention to safely perform spinal anaesthesia. Although some studies<sup>(22-26)</sup> have suggested spinal anaesthesia to be safer than general anaesthesia during hip fracture repair, it is still a subject of debate and generally left to the choice of the anaesthetist at the time of the

surgery. Other studies<sup>(27-32)</sup> have demonstrated non-superiority of using regional anaesthesia compared to general anaesthesia. In summary, the decision to delay surgery to perform spinal anaesthesia in an anticoagulated patient might not be the ideal solution, as delaying surgery is itself associated with high mortality risks and increased post-operative complications such as pulmonary infections, heart failure, and urinary tract infections.<sup>(33)</sup> In this cohort, and as seen in the literature, no significant difference in the length-of-stay was observed between patients who underwent surgical fixation under general anaesthesia compared to spinal anaesthesia ( $p = .40$ ).

This study also underlines the trend that the most comorbid patients tend to wait more before receiving surgical intervention. ASA class 2 patients waited an average of 51 hours compared 63 hours for patients classified as ASA 4 ( $p = .17$ ). In contrast, Yeoh & Fazal,<sup>(34)</sup> presented a cohort of 249 patient treated surgically for a femoral neck fracture, and ASA class 2 patients waited 34 hours, while the delay was 43 hours for ASA class 3 and 61 hours for ASA class 4 patients. This finding reveals the importance of process optimization in patients with multiple comorbidities and severe systemic diseases. It would be ideal for those patients to be prioritized and operated on early. The odds of being operated within 48 hours were 4.00 (0.8503 to 17) in favour of ASA 2 compared to ASA 4. Most (71%) patients with ASA class 2 were operated within 48 hours compared to only 39% for patients with ASA class 4. It is presumed that a larger sample size would have yielded statistical significance. The timing of presentation at the emergency department did not seem to influence significantly delay to surgery. Most patients (41.3%) presented on weekdays between 4:00 p.m. and 11:59 p.m. This result is unexpected, as it was previously predicted by Yeoh and Fazal that patients presenting during the weekends would wait longer due to reduced operating room availabilities and lower hospital staffing.<sup>(14,35,36)</sup> This finding suggests a problem of access to early surgery consistent throughout the week, or a limitation generated by a sample size bias.

In our study, patients who underwent surgical fixation with CRPP stayed in hospital on average 8.0 days after surgery, 11.4 days for patients who underwent hip arthroplasty, 12.2 days for DHS fixation, and 16.2 days for patients treated with TFN. Although patient comorbidities and perioperative complications certainly contribute to the duration of the post-operative stay, fracture severity and its associated surgical indications also appear to play a role. Indeed, CRPP is frequently performed for Garden 1 valgus impacted femoral neck fractures. This stable pattern and minimal surgical burden permit rapid mobilization. Furthermore, DHS is usually utilized for stable pertrochanteric fractures, whereas TFN is indicated for unstable fracture patterns. This variance could also be held accountable for a longer rehabilitation.

The location of discharge appears to influence the post-operative length of stay. On average, patients requiring placement into a long-term care facility stayed 19.6 days in the hospital before being discharged, a significant difference compared to the post-operative length of stay for other discharge

locations ( $p = .0007$ ). This finding suggests that placement of patients into a long-term care facility remains an obstacle for early discharge. A subanalysis was performed to compare the post-operative length of stay of patients discharged home compared to those awaiting transfer to a rehabilitation centre, which revealed no statistical difference between the two groups ( $p = .220$ ). As a result, transfer to a rehabilitation centre does not seem to have delayed significantly the post-operative length of stay in this hip fracture cohort.

Lastly, not only did patients with more comorbidities wait longer to undergo surgical intervention, but they also stayed longer in the hospital prior to discharge. Patients with an ASA classification of 2 stayed an average of 9.0 days before being discharged compared to 21.9 days for ASA class 4 patients, a significant difference ( $p = .001$ ). Most importantly, a positive correlation was observed between adherence to the 48-hour benchmark and the length of stay. Patients treated within 48 hours were discharged on average 10.0 days after their intervention compared to 15.9 days for other patients ( $p = .003$ ). This association is reinforcing the importance of early intervention.<sup>(37)</sup> Besides being exposed to higher mortality risks and post-operative complications, patients who were not operated on within the benchmark time have a hospital stay on average five days longer. Considering the high use of resources of patients on the hospital wards, delaying interventions appears deleterious from financial standpoints. Similarly, prolonged hospitalization is associated with an increased risk of hospital-acquired infections and deconditioning.<sup>(38-42)</sup> Efforts should be sought to prevent delays in surgical intervention for acute hip fracture patients. Academic centres may benefit from quality improvement initiatives to optimize the process and flow of patients presenting with proximal femoral fractures. Ultimately, providing orthopaedic departments with additional resources including more operating room time, a designated multidisciplinary activation code for suspected hip fractures, and an understanding of the medical complexity of these patients, might help reduce health-care system wastes while improving outcomes.

There are limitations in this study that could be addressed in future research. Small sample size might have exacerbated the impact of outliers in the data. However, subgroup analyses were performed and excluded outliers. Data were drawn from a single institution with the intention to challenge existing conditions in one centre. Although this limitation can restrict generalized conclusions, institution-specific data should be encouraged to disseminate for interinstitution comparisons and internal quality improvement initiatives. This original study is retrospective, which might be a potential source of selection bias in the composition of this cohort.

This study revealed suboptimal adherence to already established<sup>(13)</sup> national guidelines for management of patients with acute hip fractures. Immediate actions should be taken to address the prolonged delays in surgical intervention. To propose adequate and impactful solutions, a dedicated quality improvement project is recommended to increase the number of patients at our institution being treated within the

benchmark of 48 hours after hip fracture. As demonstrated by Bhattacharyya *et al.* in 2006,<sup>(43)</sup> a dedicated orthopaedic trauma operating room that is available six days per week until 5:00 p.m. reduces the number of delayed surgeries and improves operating room flow. Unravelling current OR time restraints would enable the health-care team to carry out more operative cases and therefore reduce delays. Other institutions have designed a dedicated code for hip fractures called “Code Hip”, which streamlines the flow of hip fracture patients from their entry into the emergency room until discharge after surgical treatment.<sup>(44)</sup> Such initiatives should be considered to initiate a culture of operating hip fractures as Category 2 in less than 24 hours and underline the importance of a rapid surgical stabilization of these injuries. Moreover, in-depth analyses of the economic impact of delaying hip fracture interventions will be performed by our group to provide additional insight on the potential benefits of improving the management of these cases.

## CONCLUSION

To our knowledge, this is the first observational study to be published on the adherence with national guidelines for acute hip fracture management in the Quebec province. In a Level-1 trauma centre, fewer than 60% of patients received surgery within the 48-hour benchmark after being admitted for an acute hip fracture. Patients with highest comorbidities waited longer and stayed longer in the hospital after surgery. Moreover, patients not treated within 48 hours stayed in the hospital after their surgery on average five more days compared to patients treated within the benchmark. In response to this meaningful update, immediate actions should be taken to improve the management of this vulnerable population at high risk of mortality and post-operative complications.

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Not applicable

## CONFLICT OF INTEREST DISCLOSURES

We have read and understood the Canadian Geriatrics Journal’s policy on conflicts of interest disclosure and declare none.

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