Cancellations and delays of emergent orthopedic operations at a Canadian level 1 trauma centre

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Background: Day-of surgery cancellation (DOSC) is considered to be a very inefficient use of hospital resources and results in emotional stress for the patient. To examine opportunities to minimize the incidence of preventable cancellations — an indicator of quality of care — we assessed the incidence of and reasons for DOSCs over 3 months among inpatients and outpatients at a trauma orthopedic service.

Methods: This was a prospective study of 2 cohorts of patients, inpatients and outpatients, scheduled for emergent orthopedic surgery at a Canadian tertiary level 1 trauma centre from Jan. 1 to Mar. 31, 2020. Patient demographic characteristics, injury characteristics, delays until surgery and reasons for DOSCs were recorded.

Results: A total of 185 patients (100 males and 85 females with a mean age of 54 yr) were included in the study. There were 98 outpatients and 87 inpatients. Seventy-five (40%) of the scheduled procedures in the outpatient group and 34 (30%) of those in the inpatient group were cancelled. In both groups, more than 85% of the cancellations were because of prioritization of a more urgent orthopedic or nonorthopedic surgical case. The average operative delay for the outpatient group was 11.4 days, compared to 3.8 days for the inpatient group ($p < 0.001$).

Conclusion: High DOSC rates were observed among both outpatients and inpatients. The main reason for delaying surgery was prioritization of a more urgent surgical case. Providing the orthopedic trauma service with a dedicated OR opened 6 days per week, along with extended hours of OR services to 1700 daily, might be effective at minimizing DOSCs.

Contexte : Les annulations de chirurgie le jour même (ACJM) sont considérées comme une utilisation très inefficace des ressources, sans compter qu'elles entraînent souvent un stress émotionnel chez le patient. Pour explorer les moyens de réduire l'incidence des annulations évitables, un indicateur de la qualité des soins, nous avons mesuré l'incidence des ACJM et leurs motifs sur une période de 3 mois chez des patients hospitalisés ou non, dans un centre de traumatologie orthopédique.

Méthodes : Il s'agit d'une étude prospective de 2 cohortes de patients, hospitalisés et non hospitalisés, qui devaient subir une intervention orthopédique urgente dans un centre de traumatologie canadien de niveau 1 entre le 1er janvier et le 31 mars 2020. Les caractéristiques démographiques des patients, les caractéristiques des lésions, les reports de chirurgie et les motifs des ACJM ont été consignés.

Résultats : En tout, 185 patients (100 hommes et 85 femmes, âgés en moyenne de 54 ans) ont été inclus dans l'étude qui comptait 98 patients non hospitalisés et 87 patients hospitalisés. Soixante-quinze (40 %) des interventions prévues dans le groupe hospitalisé et 34 (30 %) dans le groupe non hospitalisé ont été annulées. Dans les 2 groupes, plus de 85 % des annulations ont été attribuées à la priorisation de cas plus urgents de chirurgie, orthopédique ou autre. Le report moyen des interventions dans le groupe de patients non hospitalisés a été de 11,4 jours, contre 3,8 jours dans le groupe de patients hospitalisés ($p < 0{,}001$).

Conclusion : Des taux élevés d'ACJM ont été observés chez les patients hospitalisés et non hospitalisés. Le principal motif du report des chirurgies était la priorisation de cas plus urgents. Mettre à la disposition du service de traumatologie orthopédique un bloc opératoire dédié ouvert 6 jours sur 7 et prolonger les heures de fonctionnement des blocs opératoires à 1700 par jour pourrait réduire efficacement les ACJM.

An estimated 312.9 million surgical procedures are performed every year around the globe, making surgery one of the costliest domains in health care.[1] In 2012, Canadian surgeons performed more than 2.3 million procedures.[1] Day-of surgery cancellation (DOSC) is considered to be a very inefficient use of resources. Costs associated with preparing the patient for surgery are wasted when the scheduled surgery is cancelled or postponed. In addition, before surgery, there is a list of requirements for patients. They must follow a strict fasting regimen to decrease the risk of pulmonary aspiration during their procedure.[2] They need to prepare psychologically for the event, which often results in stress and anxiety. Also, they must make family arrangements, arrange for transport to and from hospital, or take time off work.

The literature suggests that most DOSCs are preventable.[3] Scheduling problems, including underestimation of the time needed per operation and hospitals' tendency to restrict surgeons from working beyond daytime hours, are factors recognized as preventable causes of DOSC. Academic centres try to minimize the incidence of preventable cancellations, an indicator of quality of care and management.[4] Moreover, publicly funded Canadian hospitals are financed by global annual budgets, which may result in hospital managers' preferring to cancel overbooked procedures rather than use overtime resources.

To examine opportunities to minimize the incidence of preventable cancellations, we assessed the incidence of and reasons for DOSCs over 3 months among inpatients and outpatients at a trauma orthopedic service. Based on the mechanism of injury, comorbidities and urgency to intervene, patients seen by the service are either discharged home (outpatients) or admitted to the orthopedic surgical ward (inpatients). We hypothesized that the number of interventions performed would be equivalent between the outpatient and inpatient groups. We expected that DOSC rates would be higher among the outpatients, also known as the "walking wounded," since their condition usually requires less urgent surgical intervention. We also hypothesized that the average delay to surgery would be 7 days for all injuries combined in the outpatient group (e.g., 7–10 d for those with an ankle fracture, 5–10 d for those with a distal radius fracture). We hypothesized that inpatient surgery would be performed in a more timely fashion than outpatient surgery.

Methods

This was a prospective cohort study of patients undergoing surgery at a Canadian tertiary level 1 trauma centre. All patients scheduled for emergent orthopedic surgery at our institution from Jan. 1 to Mar. 31, 2020, were included. The study was stopped after Mar. 31 owing to the COVID-19 pandemic. The research protocol included acquisition of patient demographic characteristics, injury characteristics, delays from injury to surgery and reasons for DOSCs. The study was approved by the McGill Research Ethics Board (F1–42387).

To identify opportunities for improvement, a multidisciplinary discussion occurred among orthopedic staff, residents and a business consultant. Three factors engendering high DOSC rates were identified. First, the orthopedic trauma service at our institution functions without any centralized booking system to schedule operations. Orthopedic staff and residents are responsible for scheduling. Second, restrictions imposed by the hospital's administration and culture limit the operating room (OR) schedule to 0730 to 1530. To prevent the team from working after hours, OR managers are often forced to cancel the last case of the day. Third, no OR is dedicated to the orthopedic trauma service after hours or on weekends. Cases scheduled at these times compete with all surgical services for OR access.

Our institution has a high annual volume of emergent orthopedic procedures. Collaboration among residents, staff and administrative support is constantly required. To facilitate scheduling for the orthopedic trauma service, the study team designed an integrated method using the Airtable platform. Once an operation is performed, the patient's data are transferred and kept for 1 year in an archived log. One observer (J.M.) used this platform to record daily operative delays, cancellation rates and reasons for cancellation. Owing to the high volume of urgent procedures, the daily operative list of the orthopedic trauma service is often variable, especially after hours and on weekends.

It was established that DOSCs are usually caused by an orthopedic emergency, a nonorthopedic emergency (e.g., exploratory laparotomy, craniectomy), an OR time constraint, a change in treatment plan, inappropriate preoperative preparation, a medical limitation, an administrative barrier and patient no-show. In an orthopedic emergency, a patient with an orthopedic injury is prioritized over the scheduled case on the operative list. A common example would be an older patient with a hip fracture who presents overnight after the schedule has been prepared. Given standard-of-care guidelines indicating prompt surgery (< 48 h) in such cases, the last orthopedic operation scheduled for the next day will often be cancelled in order to perform the hip fracture surgery, considering that, by 1530, OR resources will no longer be available.

In a nonorthopedic emergency, priority is given to a case from another surgical specialty, such as general surgery, neurosurgery or thoracic surgery. An institution-specific tool groups patients needing surgical attention into 3 categories. Those in category 1 are the sickest, and their condition is deemed life-threatening. Open fractures and compartment syndrome are classified as category 2

(limb-threatening) injuries that can wait 4–6 hours. Outpatients with orthopedic trauma and inpatients in need of urgent care are commonly classified as being in category 3.

Cancellation of cases to prevent the OR from running after hours (after 1530 on weekdays) is considered to be due to OR time constraints. A change in treatment plan occurs when a case needs to be reoriented toward nonoperative management owing to the patient's profile and injury pathoanatomy. Noncompliance with preoperative fasting instructions can result in cancellation. Medical complications and inappropriate perioperative anticoagulation management are classified as medical limitations. Occasionally, patients from out of province are not covered by medical insurance and opt to proceed with the surgery in their home province or country. These cases meet administrative barriers and therefore are cancelled. Finally, a no-show occurs when a patient does not present on the day of the intended surgery.

Statistical analysis

We performed statistical analysis using PRISM version 8 (GraphPad). We compared the outpatient and inpatient groups using unpaired Student *t* tests for patient demographic characteristics, delays to surgery and rates of cancellation. We performed 1-way analysis of variance when comparing multiple groups within the outpatient population. We reported continuous variables as mean and 95% confidence interval (CI). Statistical significance was set at $p < 0.05$.

Results

A total of 185 patients (100 males and 85 females with a mean age of 54 yr [95% CI 50.9–57.1 yr]) were included in the study (Table 1). There were 98 outpatients and 87 inpatients. There was a statistically significant difference in age between the 2 groups ($p < 0.001$).

In all, 227 procedures were performed over the study period, with the most common being for hip fracture (36 [15.9%]), ankle fracture (35 [15.4%]) and distal radius fracture (29 [12.8%]) (Table 2).

There were 75 DOSCs in the outpatient group (Table 3). Of the 98 patients, 57 (58%) had their procedure cancelled at least once; 11 patients (11%) had their procedure cancelled twice, 2 patients (2%) had their procedure cancelled 3 times, and 1 patient (1%) had their procedure cancelled 4 times. The average number of cancellations per patient was 1.3. The ratio of cases performed versus booked was 0.6, meaning that, of all scheduled procedures, 40% were cancelled the day of the intended surgery. The most common reason for cancellation of outpatient procedures was orthopedic emergency (47 cases [63%]) (Table 4).

Table 1. Age and gender of patients scheduled for emergent orthopedic surgery, Jan. 1 to Mar. 31, 2020

Characteristic; group	No. (%) of patients*
Age, mean (95% CI), yr	
All patients	54.0 (50.9–57.1)
Inpatients	63.3 (58.6–68.0)
Outpatients	45.7 (42.5–49.0)
Gender	
All patients	
Male	100 (54.0)
Female	85 (45.9)
Inpatients	
Male	46 (52.9)
Female	41 (47.1)
Outpatients	
Male	54 (55.1)
Female	44 (44.9)

CI = confidence interval.
*Except where noted otherwise.

There were 34 DOSCs in the inpatient group (Table 3). Of the 87 patients, 24 (28%) had their procedure cancelled at least once; 1 patient (1%) had their procedure cancelled twice, 3 patients (3%) had their procedure cancelled 3 times, and 1 patient (1%) had their procedure cancelled 4 times. The average number of cancellations per patient was 1.4. The ratio of cases performed versus booked was 0.7. Orthopedic emergency (16 cases [47%]) was the main reason for cancellation of inpatient procedures (Table 4).

Delays until surgery

The average delay from the time of injury to surgery was 11.4 days (95% CI 10.1–12.8 d) for the outpatient group, compared to 3.8 days (95% CI 2.9–4.7 d) for inpatients ($p < 0.001$) (Table 5). The average delay for outpatients with a distal radius fracture and those with an ankle fracture, and for inpatients with a hip fracture and those with a tibial diaphyseal fracture are presented in Table 5.

Discussion

The most important finding of this study was the high frequency of DOSCs among outpatients scheduled for emergent orthopedic surgery at our institution from Jan. 1 to Mar. 31, 2020. The ratio of performed to scheduled operations was 0.6 in this group, meaning that 40% of all scheduled procedures were cancelled the day of the intended intervention. More than half of patients (58%) had their procedure cancelled at least once; some patients had their procedure cancelled as many as 4 times, which may have resulted in considerable physical, psychologic and emotional stress. Before the day of the scheduled surgery,

Table 2. Procedure count

Procedure	No. (%) of procedures *n* = 227
Hip fracture	36 (15.9)
Ankle fracture	35 (15.4)
Distal radius fracture	29 (12.8)
Tibial shaft fracture	14 (6.2)
Tibial plateau fracture	13 (5.7)
Calcaneus fracture	8 (3.5)
Clavicle fracture	7 (3.1)
Pelvic ring injury	6 (2.6)
Femur shaft fracture	6 (2.6)
Distal femur fracture	6 (2.6)
Olecranon fracture	5 (2.2)
Distal humerus fracture	5 (2.2)
Proximal humerus fracture	5 (2.2)
Achilles tendon rupture	5 (2.2)
Ulnar shaft fracture	5 (2.2)
Acetabulum fracture	4 (1.8)
Proximal humerus fracture dislocation	4 (1.8)
Pilon fracture	3 (1.3)
Removal of hardware	3 (1.3)
Maisonneuve fracture	3 (1.3)
Midfoot fracture	3 (1.3)
Patella fracture	3 (1.3)
Perilunate dislocation	3 (1.3)
Radial head fracture	2 (0.9)
Distal biceps rupture	2 (0.9)
Scaphoid fracture	2 (0.9)
Septic arthritis	2 (0.9)
Galeazzi fracture	1 (0.4)
Pectoralis major tear	1 (0.4)
Quadriceps tendon rupture	1 (0.4)
Compartment syndrome	1 (0.4)
Talus fracture	1 (0.4)
Patellar tendon rupture	1 (0.4)
Capitellum fracture	1 (0.4)
Chronic elbow dislocation	1 (0.4)

Table 3. Day-of surgery cancellation rates

Variable	Outpatients *n* = 98	Inpatients *n* = 87
No. of patients without cancellations	41	63
No. of patients with cancellations	57	24
No. of procedures cancelled	75	34
Mean no. of cancellations/patient	1.3	1.4
Cases done/booked	0.6	0.7

patients treated on an outpatient basis were called at home and asked to adopt a strict fasting regimen. Most cancellations were announced to patients while they were waiting in hospital the day of their scheduled surgery, and a few patients were informed of the cancellation while waiting at home; in both cases, the cancellation resulted in unnecessary fasting and possible emotional stress.

Table 4. Reasons for surgery cancellation

Group; reason	No. (%) of cases
Inpatients (*n* = 34)	
Orthopedic emergency	17 (50)
Nonorthopedic emergency	14 (41)
Change in treatment plan	2 (6)
Noncompliance with preoperative fasting instructions	1 (3)
Outpatients (*n* = 75)	
Orthopedic emergency	47 (63)
Nonorthopedic emergency	19 (25)
Operating room time constraint	6 (8)
Patient no-show	2 (3)
Administrative barrier	1 (1)

Table 5. Delays until surgery

Group; subgroup	Mean delay (95% CI), d
Inpatients	
Overall	3.8 (2.9–4.7)*
Hip fracture	1.8 (1.3–2.4)
Tibial diaphyseal fracture	2.8 (1.9–3.7)
Outpatients	
Overall	11.4 (10.1–12.8)
Distal radius fracture	13.2 (10.7–15.6)
Ankle fracture	11.0 (9.0–12.9)

CI = confidence interval.
*$p < 0.001$ for difference between inpatients and outpatients.

In comparison, an observational study at a Swedish university hospital showed that 24% of patients (outpatients and inpatients) scheduled for an emergent orthopedic operation had their surgery cancelled at least once.[5] Canada's health care system differs in many ways from the decentralized and competitive system in Sweden, where privately and publicly funded hospitals coexist.[5] Nonetheless, we observed more than twice as many DOSCs as Caesar and colleagues[5] at 1 institution in Sweden.

Another important finding of the present study was that the majority of DOSCs (63%) in the outpatient group were due to prioritization of a more urgent orthopedic case. We suspect that most of these orthopedic emergencies consisted in new patients presenting to the emergency department and patients admitted on the orthopedic ward (inpatients) who required more urgent intervention. Given the severity of their injuries and the presence of comorbidities, as well as the desire to free up beds in our crowded system, admitted patients are often given priority over patients awaiting surgery at home (outpatients). Nonorthopedic emergencies accounted for 25% of DOSCs in the outpatient group, and OR time constraints for 8%. This latter reason for cancellation has been identified as being preventable with tailored, multidisciplinary and innovative strategies.[6,7]

The average operative delay for outpatients with distal radius fractures was 13.2 days and that for patients with

ankle fractures was 11.0 days. Although the timing of surgery for closed ankle fractures is a matter of debate, delayed intervention has been associated with more challenging anatomic reduction, higher health care system costs and possible increased risk of wound complications.[8] In addition, Carr and colleagues[9] reported that patients who had their surgery postponed perceived their condition to be deteriorating while waiting. These patients often reported extreme levels of stress, disappointment and anger.[9] Moreover, there is an economic impact for society owing to the loss of additional working days.[10] Resource use in residents, staff or secretaries answering calls from patients or their families, rescheduling of clinic and surgical times, involvement of the hospital ombudsmen and fear of medicolegal repercussions makes the system less efficient.

In the inpatient group, the ratio of cases performed versus planned was 0.7. Most cancellations (48%) were due to prioritization of an orthopedic case, followed by prioritization of a nonorthopedic case (42%). The latter would not have occurred if an OR had been dedicated to the trauma orthopedic service. The mean operative delay for the inpatient population overall was 3.8 days; the mean delay for patients with hip fractures was 1.8 days. American Academy of Orthopaedic Surgeons guidelines recommend a time to surgery of less than 48 hours for hip fracture, as this time frame is associated with a lower mortality rate and fewer perioperative complications.[11]

To ensure that delayed cases are performed, residents and staff are often pressured to operate after hours. Bhattacharyya and colleagues[12] found that orthopedic trauma cases performed after 1700 required more OR time and resulted in a greater risk of complications for the patient. The absence of a dedicated OR after hours and on weekends is thought to be the root cause of prolonged delays and high DOSC rates at our institution. From Monday to Thursday, orthopedic trauma ORs are fully staffed from 0730 until 1530. During these periods, inpatient cases are usually prioritized since they represent more urgent and complex injuries. This results in cancellation of multiple outpatient procedures, which are then tentatively rescheduled for the weekend. However, no OR is dedicated to the orthopedic trauma service on weekends. As a result, these outpatient cases must frequently be cancelled again. A vicious cycle develops as the number of patients on the waitlist for the following week starts to rise.

Various strategies should be considered to prevent numerous surgery cancellations in academic centres in order to deliver optimal care to all patients. Some of the interventions proposed in the literature to be effective at minimizing DOSCs may be beneficial to our institution. Bhattacharyya and colleagues[12] reported that a dedicated orthopedic trauma OR that was available until 1700, 6 days per week, reduced the number of delayed procedures and improved OR flow. Solving current OR time restraints would enable the health care team to carry out all operative cases on the week list rather than the current necessity of performing surgery after hours. Currently, OR lists are often overbooked to avoid finishing the day early and thereby wasting precious OR time. Overbooking ensures that a case is always available if a cancellation does occur, but this may result in numerous cancellations. A 1-year prospective study similar to the present study could help design a prediction model for patient flow in the overall trauma service. This model would empower the hospital's administration with a framework to better allocate resources according to monthly predictions of injury volume, which could help avoid the need to overbook the OR list.

Limitations

Our study is subject to recall bias. Although scheduled operations were already being recorded by the orthopedic trauma service on the electronic platform, DOSCs were not previously documented routinely. Therefore, the trauma resident on duty (J.M.) had to instruct his colleagues on reporting daily cancellations on the platform. Having a single resident rigorously overseeing the data ensured that the same methodology was used for the entire study period. Cancellations were recorded every day during the 3-month study period by a single observer. If any underreporting errors occurred, they would most likely have been systematic between the 2 patient groups and would therefore not have decreased the validity of the findings. However, underreporting may have resulted in underestimation of the number of the cancellations if other residents forgot cases that were cancelled.

The data were collected during the winter in Canada, when there is usually an increased incidence of outdoor falls and subsequent ankle and wrist fractures. As these patients are often treated on an outpatient basis, the outpatient cohort might have been larger than the annual average. Also, we observed higher rates of DOSCs for the outpatient group than the inpatient group. Therefore, overestimation of the annual incidence of DOSCs cannot be excluded. Repeating the study in the summer might have yielded different results.

The study was stopped at the onset of the COVID-19 pandemic. Although a larger number of participants would have been preferable, we do not expect that the trend would have been significantly different from that observed if more participants had been included in the study.

Conclusion

From Jan. 1 to Mar. 31, 2020, there were 109 DOSCs of interventions for trauma at our institution. A high rate of cancellations was observed among both inpatients and outpatients. The main reason for delaying surgery was prioritization of another orthopedic trauma case. Providing the

orthopedic trauma service with a dedicated OR opened 6 days per week, along with extended hours of OR services to 1700 daily, could be effective at minimizing DOSCs. A cost–benefit analysis of extending OR hours in an attempt to reduce length of hospital stay and loss of working days is warranted. Ultimately, reducing DOSCs would improve overall patient satisfaction and substantially help reduce waste of health care system resources. In the end, the goal is to provide safe, effective, patient-centred, timely, efficient and equitable care to all patients.

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Competing interests: Mitchell Bernstein reports institutional research support from NXTSENS Microsystems and consulting fees from Smith & Nephew, NuVasive and Orthofix. He is a member of the Executive Board of the Limb Lengthening and Reconstruction Society. Edward Harvey reports grants or contracts from the Canadian Institutes of Health Research (CIHR), the US Department of Defense and the Natural Sciences and Engineering Research Council of Canada. He holds many patents outside the submitted work. He is a member of the Institute of Musculoskeletal Health and Arthritis Advisory Board, CIHR, and has played a leadership role for the Orthopaedic Trauma Association. He holds stock in MY01 and NXTSENS Microsystems, and has received equipment for performance of preclinical models from MY01. No other competing interests were declared.

Contributors: M. Bernstein, G. Berry, J. Montreuil and R. Reindl designed the study. M. Bernstein acquired the data, which M. Bernstein, A. Denis and E. Harvey analyzed. A. Denis, G. Berry and J. Montreuil wrote the manuscript, which M. Bernstein, E. Harvey and R. Reindl critically revised. All authors gave final approval of the article to be published.

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