Degenerative spinal conditions requiring emergency surgery: an evolving crisis in a publicly funded health care system

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Background: Surgery for degenerative spine pathologies is typically performed on a scheduled basis; however, worsening symptoms may warrant emergency surgery. An increasing number of patients requiring emergency surgery has been observed (22.6% in 2006 to 34.8% in 2019). We sought to compare the outcomes of patients who received scheduled surgery and those who required emergency surgery.

Methods: All patients treated between Jan. 1, 2006, and Dec. 31, 2019, were included. Retrospective comparisons were made between patients who were scheduled (elective) for surgery and those requiring emergency surgery, patients who were scheduled for surgery and those who decompensated while on the surgical waitlist and patients who presented as de novo emergencies and those who decompensated while on the surgical waitlist.

Results: Among the 6217 patients with degenerative pathologies, 4654 (74.9%) patients were scheduled (elective) for surgery and 1563 (25.1%) were patients requiring emergency surgery. Compared with patients who were scheduled, patients requiring emergency surgery had a longer length of stay (LOS) in hospital (5.1 d, interquartile range [IQR] 2.7–11.2 v. 3.6 d, IQR 1.3–6.4, $p < 0.001$) and lower rate of home discharge (78.6% v. 94.2%, $p < 0.001$). Patients requiring emergency surgery were 1.34 times more likely to have any adverse events (95% confidence interval [CI] 1.06–1.68, $p = 0.01$). When compared with patients who were scheduled for surgery, those who decompensated while on the surgical waitlist had longer LOS (7.0 d, IQR 3.3–15.0 v. 3.6 d, IQR 1.3–6.4, $p < 0.001$), less home discharge (77.6% v. 94.2%, $p < 0.001$) and were 2.5 times more likely to have any adverse events (95% CI 1.5–4.1, $p < 0.001$). Patients who decompensated had a 2.1 times higher risk of having any adverse events than patients who presented as de novo emergencies (95% CI 1.2–3.6, $p < 0.001$).

Conclusion: We observed worse perioperative outcomes for patients requiring emergency surgery for degenerative spinal conditions than for patients who were scheduled for surgery. Patients who decompensated while on the surgical waitlist had the worst outcomes.

Contexte : Le traitement chirurgical des pathologies dégénératives de la colonne vertébrale est généralement planifié; l'aggravation des symptômes peut toutefois justifier une opération d'urgence. On constate d'ailleurs qu'un pourcentage croissant de patients ont besoin d'une telle intervention (22,6 % en 2006 comparativement à 34,8 % en 2019). Nous avons cherché à comparer les issues des patients ayant subi une intervention planifiée avec celles des patients nécessitant une opération d'urgence.

Méthodes : Tous les patients traités entre le 1er janvier 2006 et le 31 décembre 2019 ont été inclus. Nous avons établi des comparaisons rétrospectives entre les patients allant subir une intervention planifiée (non urgente) et ceux ayant besoin d'une opération d'urgence, entre les patients allant subir une intervention planifiée et ceux ayant subi une décompensation alors qu'ils étaient sur une liste d'attente, et entre les patients nécessitant une opération urgente pour une pathologie de novo et ceux ayant subi une décompensation alors qu'ils étaient sur une liste d'attente.

Résultats : Parmi les 6217 patients présentant des pathologies dégénératives, 4654 (74,9 %) allaient subir une intervention planifiée (non urgente) et 1563 (25,1 %) avaient besoin d'une opération d'urgence. Comparativement aux premiers, ces derniers restaient plus longtemps à l'hôpital (5,1 jours [écart interquartile (EI) 2,7–11,2] c. 3,6 jours [EI 1,3–6,4], $p < 0,001$) et présentaient un taux de congé plus faible (78,6 % c. 94,2 %, $p < 0,001$). Ils étaient 1,34 fois plus susceptibles d'être victimes d'un

événement indésirable (intervalle de confiance [IC] de 95 % 1,06–1,68, p = 0,01). Comparativement aux patients pour lesquels une intervention était prévue, ceux ayant subi une décompensation alors qu'ils étaient sur une liste d'attente restaient plus longtemps à l'hôpital (7,0 jours [EI 3,3–15,0] c. 3,6 jours [EI 1,3–6,4], p < 0,001), présentaient un taux de congé plus faible (77,6 % c. 94,2 %, p < 0,001) et étaient 2,5 fois plus susceptibles de subir un événement indésirable (IC de 95 % 1,5–4,1, p < 0,001). Les patients ayant subi une décompensation présentaient un risque 2,1 fois plus élevé d'être victimes d'un événement indésirable, comparativement aux patients nécessitant une opération urgente pour une pathologie de novo (IC de 95 % 1,2–3,6, p < 0,001).

Conclusion : Nous avons observé des issues périopératoires moins favorables chez les patients ayant besoin de se faire opérer d'urgence pour des pathologies dégénératives de la colonne vertébrale, comparativement à ceux pour lesquels une intervention était prévue. Les patients ayant subi une décompensation alors qu'ils étaient sur une liste d'attente présentaient les pires issues.

Older age demographics have increased the demand for spinal surgery, creating an ever-increasing burden for the health care system.[1] This is especially true for degenerative spinal pathologies such as disc herniations, spinal stenosis, spondylolisthesis and myelopathy. This is most pronounced in publicly funded health care systems with limited resources and access to care.[2,3] In a previous study, we identified that the proportion of patients treated for degenerative pathology has steadily increased on average by 1.3% per year from 2006 to 2019.[4] Meanwhile, the proportion of patients presenting emergently with 'elective' conditions has increased at a faster pace, on average by 3.2% per year during the same time frame.[4] In 2006, 22.6% of patients with degenerative pathologies were treated emergently, compared with 34.8% in 2019. From 2006 to 2019, 29.7% of patients with degenerative pathologies were treated emergently. This observed increase has been more pronounced than other diagnostic categories, such as spinal oncology or spinal deformity.

Whether there are any clinical consequences of treating patients with degenerative pathologies on an emergency basis compared with them being scheduled for surgery before decompensation is unknown.[5] This is an important question to answer given the higher complication rates and mortality in emergency spine surgeries for all pathologies.[6–11] Charest-Morin and colleagues[12] found that nonelective spine surgery performed after-hours was associated with an increased risk of perioperative adverse events, length of stay (LOS) in hospital and possibly death.

We sought to compare baseline characteristics, surgical details and early perioperative outcomes between patients with degenerative spine conditions who underwent emergency and those who underwent scheduled surgery. We also performed subanalyses on patients who presented as de novo with a degenerative condition that required emergency surgery, and on patients who were booked for elective surgery and who deteriorated, or decompensated, while on the surgical waitlist.

Methods

Patient population

We conducted a retrospective analysis of prospectively collected data on consecutive patients who underwent surgery, emergency or scheduled, for degenerative cervical, thoracic or lumbar spinal conditions between Jan. 1, 2006, and Dec. 31, 2019. Our institution is a level 1 trauma centre and quaternary academic teaching centre in a major metropolitan area. The study centre serves a population of 5.1 million people.[13] As the COVID-19 pandemic affected all aspects of hospital operations in 2020 and 2021, in particular the performance of elective surgeries, we chose not to include data from 2020 and 2021. Research ethics board approval was obtained.

The degenerative diagnostic categories or pathologies included in this study were disc herniation, myelopathy, degenerative spondylolisthesis and degenerative spinal stenosis based on our centre's database. Patients were excluded if they had a primary diagnosis of cancer, deformity, trauma or infection. Patients treated on an emergency basis presented to the institutional emergency department or were transferred from a peripheral hospital. Patients already scheduled for surgery had previously been assessed in an outpatient clinic after referral by a primary care physician and deemed appropriate for surgical management.

Data collection and covariates

Age, sex, diagnostic subcategory, admission status, spinal segment involved (cervical, thoracic or lumbar), use of instrumentation, total operative time, adverse events, LOS and discharge disposition were collected in the centre's database.

Intraoperative and postoperative adverse events were collected using the Spine Adverse Event Severity System (SAVES), version 2.[14] As a prospective, spine-specific, surgeon-led, perioperative adverse event identification and

reporting system, SAVES was developed and validated in Canada, has been used in more than 100 peer-reviewed publications and is the adverse event reporting system of the Canadian Spine Outcomes Research Network. Electronic medical records of all emergency admissions were reviewed to identify if patients had already been on a waitlist for spinal surgery. Any missing data are shown in tables, with differing denominators in some categories.

Statistical analysis

Descriptive statistics were used for all variables, overall and by type of admission. Unadjusted comparisons were made using χ^2 test for proportions and Wilcoxon signed-rank test for means. Baseline characteristics were compared, as well as surgical factors and postoperative outcomes. Adverse events were compared as a continuous variable (mean number of adverse events per patient) and dichotomous variables (having had any adverse events). Multivariable logistic regression models were fit to compare the proportions of having had any adverse event by group (emergency v. scheduled), adjusted for age and diagnostic categories. Missing data were omitted and the complete case analysis or listwise deletion method was followed. A p value less than 0.05 (2-tailed) was considered statistically significant. All statistical analyses were performed using SAS version 9.4 (SAS Institute).

Results

A total of 6217 patients were included in the analysis: 2348 (37.8%) patients with disc herniation, 2383 (38.3%) patients with degenerative spinal stenosis, 1416 (22.8%) patients with degenerative spondylolisthesis and 70 (1.1%) patients with myelopathy (Table 1). Scheduled or elective cases (scheduled group) involved 4654 (74.9%) patients who were scheduled for surgery. Emergency cases (emegency group) involved 1563 (25.1%) patients requiring emergency surgery, of which there were 2 subgroups: patients presenting de novo to the emergency department (1349 [86.3%]) and patients who decompensated while on the surgical waitlist (214 [13.7%]).

Scheduled compared with all emergency surgeries

Patients requiring emergency surgery were younger than patients who were scheduled for surgery (53.9 yr, standard deviation [SD] 16.9 v. 56.0 yr, SD 15.4, $p < 0.001$). The emergency group had more patients with lumbar disc herniation than the scheduled group (55.7% v. 31.8%, $p < 0.001$). Patients requiring emergency surgery were more likely to have surgery in the cervical (23.5% v. 18.4%, $p < 0.001$) and thoracic (6.5% v. 3.9%, $p = 0.001$) regions, whereas patients who were scheduled for surgery were more likely to have surgery in the lumbar region (80.0% v. 73.8%, $p < 0.001$). Patients requiring emergency surgery had a shorter mean operative time (2.5 h ± SD 3.0 v. 3.0 h ± SD 3.1, $p < 0.001$) and less commonly received instrumentation (51.0% v. 70.0%, $p < 0.001$). In contrast, patients who were scheduled for surgery had a higher proportion of spinal stenosis (39.6% v. 34.6%, $p < 0.001$) and degenerative lumbar spondylolisthesis (27.6% v. 8.3%, $p < 0.001$). Both groups were similar in terms of sex and proportion of patients with myelopathy (1.0% v. 1.4%, $p = 0.267$).

Table 1. Scheduled group compared with overall emergency group — patient characteristics and surgical factors

Characteristic	Total *n* = 6217	Scheduled group *n* = 4654	Overall emergency group *n* = 1563	*p* value
Age, mean ± SD	54.9 ± 15.8	56.0 ± 15.4	53.9 ± 16.9	< 0.001
Male, no. (%)	2936/6217 (47.2)	2255/3848 (58.6)	681/1174 (58.0)	0.73
Diagnosis, no. (%)				
Disc herniation	2348/6217 (37.8)	1478/4654 (31.8)	870/1563 (55.7)	< 0.001
Myelopathy	70/6217 (1.1)	48/4654 (1.0)	22/1563 (1.4)	0.27
Degenerative spondylolisthesis	1416/6217 (22.8)	1286/4654 (27.6)	130/1563 (8.3)	< 0.001
Degenerative spinal stenosis	2383/6217 (38.3)	1842/4654 (39.6)	541/1563 (34.6)	< 0.001
Spinal segment involved, no. (%)				
Cervical	901/4604 (19.6)	667/3609 (18.5)	234/995 (23.5)	< 0.001
Thoracic	207/4604 (4.5)	142/3609 (3.9)	65/995 (6.5)	< 0.001
Lumbar	3621/4604 (78.7)	2887/3609 (80.0)	734/995 (73.8)	< 0.001
Instrumentation used, no. (%)	1508/2283 (66.1)	1267/1810 (70.0)	241/473 (51.0)	< 0.001
Operative time, h, mean ± SD	—	3.0 ± 3.1	2.5 ± 3.0	< 0.001
Length of stay, d, median (IQR)	—	3.6 (1.3–6.4)	5.1 (2.7–11.2)	< 0.001
Discharged home, no. (%)	5615/6217 (90.3)	4386/4654 (94.2)	1229/1563 (78.6)	< 0.001
Placed on surgical waitlist, no. (%)	—	—	214/1563 (13.7)	—

IQR = interquartile range; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

Table 2. Scheduled group compared with overall emergency group — postoperative outcomes

Outcome	Scheduled group	Overall emergency group	*p* value
Adverse events per patient, mean ± SD	0.3 ± 0.7	0.4 ± 0.8	0.03
Risk of having any adverse events adjusted for age and diagnosis OR (95% CI)	1.00 (Ref.)	1.79 (1.40–2.30)	< 0.001
Types of adverse events, no. (%)			
Surgical site infections	12/1633 (0.7)	8/653 (1.2)	0.32
Systemic infections including urinary tract infections	104/1647 (6.3)	76/655 (11.6)	< 0.001
Neuropathic pain	203/1647 (12.3)	99/655 (15.1)	0.08
Delirium	115/1647 (7.0)	59/655 (9.0)	0.11
Dural tear	198/1610 (12.3)	60/612 (9.8)	0.10
Pneumonia	24/1647 (1.5)	25/655 (3.8)	0.001
Dysphagia	18/1647 (1.1)	16/655 (2.4)	0.02
Deep vein thrombosis	0/263 (0.0)	2/103 (1.9)	0.08
Pulmonary embolism	5/263 (1.9)	3/103 (2.9)	0.69
Neurologic deterioration	15/263 (5.7)	6/103 (5.8)	> 0.99
Cord injury	0/226 (0.0)	0/59 (0.0)	NA
Nerve root injury	3/226 (1.3)	0/59 (0.0)	0.61
CSF leak meningocele	4/262 (1.5)	0/103 (0.0)	0.33
Hematoma	6/263 (2.3)	2/103 (1.9)	> 0.99
Wound dehiscence	6/263 (2.3)	4/103 (3.9)	0.48
Hardware malposition	28/226 (12.4)	1/59 (1.7)	0.01
Massive blood loss/transfusion	12/226 (5.3)	1/59 (1.7)	0.31

CI = confidence interval; CSF = cerebrospinal fluid; NA = not applicable; OR = odds ratio; Ref. = reference; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

Patients requiring emergency surgery had a longer LOS (5.1 d, interquartile range [IQR] 2.7–11.2 v. 3.6 d, IQR 1.3–6.4, $p < 0.001$), less home discharge (78.6% v. 94.2%, $p < 0.001$) and higher mean number of adverse events per patient (0.4 ± 0.8 v. 0.3 ± 0.7, $p = 0.03$) (Table 2). Patients requiring emergency surgery were 1.79 times more likely to have any adverse events when controlled for age and diagnosis (95% CI 1.40–2.30, $p < 0.001$) and were more likely to experience systemic infections, including urinary tract infections (11.6% v. 6.3%, $p < 0.001$), pneumonia (3.8% v. 1.5%, $p = 0.001$) and dysphagia (2.4% v. 1.1%, $p = 0.02$). Patients requiring emergency surgery showed a trend toward more postoperative neuropathic pain (51.1% v. 12.3%, $p = 0.08$) and deep venous thrombosis (1.9% v. 0.0%, $p = 0.08$).

Scheduled compared with emergency surgery, decompensated subgroup

Among emergency patients, 214 (13.7%) patients had already been on a surgical waitlist and had decompensated acutely (Table 3). Patients who were scheduled for surgery and those in the decompensated group requiring emergency surgery were similar in terms of age (56.0 yr, SD 15.4 v. 57.1 yr, SD 16.7, $p = 0.20$) and sex (48.5% v. 55.2% male, $p = 0.37$). Patients who decompensated were more likely to have a diagnosis of myelopathy (3.3% v. 1.0%, $p = 0.01$) and were less likely to have degenerative spondylolisthesis (20.1% v. 27.6%, $p = 0.02$) than patients who were scheduled for surgery. They were also more likely to have surgery in the thoracic region (9.7% v. 3.9%, $p = 0.001$) and less likely to have surgery in the lumbar region (80.0% v. 71.0%, $p = 0.004$). Total operative time was similar between the 2 groups. More patients who were scheduled for surgery received instrumentation (70.0% v. 59.3%, $p = 0.04$).

Patients who decompensated had a longer median LOS (7.0 d, IQR 3.3–15.0 v. 3.6 d, IQR 1.3–6.4, $p < 0.001$) and were less frequently discharged home (77.6% v. 94.2%, $p < 0.001$). They had a higher mean number of adverse events than patients who were scheduled for surgery (0.6 ± 0.9 v. 0.3 ± 0.7, $p < 0.001$) (Table 4). Patients who decompensated were 2.86 times more likely to have any adverse events when adjusting for age and diagnosis (95% CI 1.69–4.84, $p < 0.001$) and had more surgical site infections (5.8% v. 0.7%, $p = 0.003$), systemic infection including urinary tract infections (18.8% v. 6.3%, $p = 0.001$) and pneumonia (8.7% v. 1.5%, $p = 0.001$).

Emergency surgery in de novo compared with decompensated subgroups

Patients who presented with de novo emergencies were younger than patients who decompensated (53.2 yr, SD 16.9 v. 57.1 yr, SD 16.7, $p = 0.004$) and a greater proportion had disc herniation (58.9% v. 35.5%, $p < 0.001$) (Table 5). Conversely, a greater proportion of patients who decompensated had myelopathy (3.3% v. 1.1%, $p = 0.02$), degenerative spondylolisthesis (20.1% v. 6.5%, $p < 0.001$) and spinal stenosis (41.1% v. 33.6%, $p < 0.04$).

Table 3. Scheduled group compared with decompensated group — patient characteristics and surgical factors

Characteristic	Scheduled group *n* = 4654	Decompensated group *n* = 214	*p* value
Age, mean ± SD	56.0 ± 15.4	57.1 ± 16.7	0.20
Male, no. (%)	2255/4654 (48.5)	106/192 (55.2)	0.37
Diagnosis, no. (%)			
Disc herniation	1478/4654 (31.8)	76/214 (35.5)	0.26
Myelopathy	48/4654 (1.0)	7/214 (3.3)	0.01
Degenerative spondylolisthesis	1286/4654 (27.6)	43/214 (20.1)	0.02
Degenerative spinal stenosis	1842/4654 (39.6)	88/214 (41.1)	0.67
Spinal segment involved, no. (%)			
Cervical	667/3609 (18.5)	43/186 (23.1)	0.12
Thoracic	142/3609 (3.9)	18/186 (9.7)	0.001
Lumbar	2887/3609 (80.0)	132/186 (71.0)	0.004
Instrumentation used, no. (%)	1267/1810 (70.0)	51/86 (59.3)	0.04
Operative time, h, mean ± SD	3.0 ± 3.1	3.0 ± 3.1	0.62
Length of stay, d, median (IQR)	3.6 (1.3–6.4)	7.0 (3.3–15.0)	< 0.001
Discharged home, no. (%)	4386/4654 (94.2)	166/214 (77.6)	< 0.001

IQR = interquartile range; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

Table 4. Scheduled group compared with decompensated group — postoperative outcomes

Outcome	Scheduled group	Decompensated group	*p* value
Adverse events per patients, mean ± SD	0.3 ± 0.7	0.6 ± 0.9	< 0.001
Risk of having any adverse events adjusted for age and diagnosis, OR (95% CI)	1.00 (Ref.)	2.86 (1.69–4.84)	< 0.001
Adverse events, no. (%)			
Surgical site infections	12/1633 (0.7)	4/69 (5.8)	0.003
Systemic infections including urinary tract infections	104/1647 (6.3)	13/69 (18.8)	0.001
Neuropathic pain	203/1647 (12.3)	11/69 (15.9)	0.46
Delirium	115/1647 (7.0)	7/69 (10.1)	0.33
Dural tear	198/1610 (12.3)	10/64 (15.6)	0.44
Pneumonia	24/1647 (1.5)	6/69 (8.7)	0.001
Dysphagia	18/1647 (1.1)	1/69 (1.5)	> 0.99
Deep vein thrombosis	0/263 (0.0)	0/20 (0.0)	NA
Pulmonary embolism	5/263 (1.9)	0/20 (0.0)	> 0.99
Neurologic deterioration	15/263 (5.7)	1/20 (5.0)	> 0.99
Cord injury	0/226 (0.0)	0/15 (0.0)	NA
Nerve root injury	3/226 (1.3)	0/15 (0.0)	> 0.99
CSF leak meningocele	4/263 (1.5)	0/20 (0.0)	> 0.99
Hematoma	6/263 (2.3)	0/20 (0.0)	> 0.99
Wound dehiscence	6/263 (2.3)	1/20 (5.0)	0.40
Hardware malposition	28/226 (12.4)	0/15 (0.0)	> 0.99
Massive blood loss or transfusion	12/226 (5.3)	1/15 (6.7)	> 0.99

CI = confidence interval; CSF = cerebrospinal fluid; NA = not applicable; OR = odds ratio; Ref. = reference; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

Operative time was longer for patients who decompensated (3.0 h v. 2.4 h, $p = 0.03$). Similarities between the subgroups included spinal segment involved, the use of instrumentation, LOS and proportion of patients discharged home.

Patients who decompensated had a higher mean number of adverse events than those with de novo emergencies (0.6 ± 0.9 v. 0.4 ± 0.8, $p = 0.002$) (Table 6). When adjusted for age, they were 1.81 times more likely to have an adverse event (95% CI 1.04–3.13, $p = 0.03$). Patients who decompensated had more surgical site infections (5.8% v. 0.7%, $p = 0.006$) and pneumonia (8.7% v. 3.2%, $p = 0.04$).

Discussion

We examined the consequences of the growing number of patients with degenerative spinal pathologies requiring emerg-ency surgery. With an aging population and growing obstacles to accessing timely surgical intervention, the demand for surgical treatment for degenerative spinal

Table 5. De novo emergency group compared with decompensated group — patient characteristics and surgical factors

Characteristic	De novo group *n* = 1349	Decompensated group *n* = 214	*p* value
Age, mean ± SD	53.2 ± 16.9	57.1 ± 16.7	0.004
Male, no. (%)	575/982 (58.6)	106/192 (55.2)	0.42
Diagnosis, no. (%)			
Disc herniation	794/1349 (58.9)	76/214 (35.5)	< 0.001
Myelopathy	15/1349 (1.1)	7/214 (3.3)	0.02
Degenerative spondylolisthesis	87/1349 (6.5)	43/214 (20.1)	< 0.001
Degenerative spinal stenosis	453/1349 (33.6)	88/214 (41.1)	0.04
Spinal segment involved, no. (%)			
Cervical	191/809 (23.6)	43/186 (23.1)	0.92
Thoracic	47/809 (5.8)	18/186 (9.7)	0.07
Lumbar	602/809 (74.4)	132/186 (71.0)	0.36
Instrumentation used, no. (%)	190/387 (49.1)	51/86 (59.3)	0.10
Operative time, h, mean ± SD	2.4 ± 2.9	3.0 ± 3.1	0.03
Length of stay, d, median (IQR)	4.9 (2.4–10.6)	7.0 (3.3–15.0)	0.85
Discharged home, no. (%)	1063/1349 (78.8)	166/214 (77.6)	0.72

IQR = interquartile range; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

Table 6. De novo emergency group compared with decompensated group — postoperative outcomes

Outcome	De novo group	Decompensated group	*p* value
Adverse events per patient, mean ± SD	0.4 ± 0.8	0.6 ± 0.9	0.002
Risk of having any adverse events adjusted for age, OR (95% CI)	—	1.81 (1.04–3.13)	0.035
Adverse events, no. (%)			
Surgical site infections	4/584 (0.7)	4/69 (5.8)	0.006
Systemic infections including urinary tract infections	63/586 (10.8)	13/69 (18.8)	0.07
Neuropathic pain	88/586 (15.0)	11/69 (15.9)	0.86
Delirium	52/586 (8.9)	7/69 (10.1)	0.82
Dural tear	50/548 (9.1)	10/64 (15.6)	0.12
Pneumonia	19/586 (3.2)	6/69 (8.7)	0.04
Dysphagia	15/586 (2.6)	1/69 (1.5)	0.72
Deep vein thrombosis	2/83 (2.4)	0/20 (0.0)	> 0.99
Pulmonary embolism	3/83 (3.6)	0/20 (0.0)	0.61
Neurologic deterioration	5/83 (6.0)	1/20 (5.0)	> 0.99
Cord injury	0/44 (0.0)	0/15 (0.0)	NA
Nerve root injury	0/44 (0.0)	0/15 (0.0)	NA
CSF leak meningocele	0/83 (0.0)	0/20 (0.0)	NA
Hematoma	2/83 (2.4)	0/20 (0.0)	> 0.99
Wound dehiscence	3/83 (3.6)	1/20 (5.0)	> 0.99
Hardware malposition	1/44 (2.3)	0/15 (0.0)	> 0.99
Massive blood loss or transfusion	0/44 (0.0)	1/15 (6.7)	0.25

CI = confidence interval; CSF = cerebrospinal fluid; NA = not applicable; OR = odds ratio; SD = standard deviation.
Differing denominators indicates missing data for some patients in some categories.

pathology is increasing. In a previous report, we identified an increasing number of patients presenting each year for emergency surgery with degenerative cervical, thoracic and lumbar pathologies.[4] Our results show a novel finding: that patients presenting for emergency surgery to treat degenerative spinal pathologies have worse perioperative outcomes than patients who were scheduled for surgery for the same conditions. Further, patients who decompensated while on a surgical waitlist have even worse outcomes than those treated in a scheduled fashion and those presenting as de novo emergencies. Our diagnosis-specific results suggest that efforts should first target wait times from referral to consultation (T1 wait time) in patients with lumbar disc herniation and wait times from consultation to surgery (T2 wait time) in patients with myelopathy, degenerative spondylolisthesis and degenerative spinal stenosis.

We identified worse perioperative outcomes, including LOS and adverse events, in patients requiring emergency surgery than in patients who were scheduled for surgery. This is consistent with the findings of studies from other surgical specialties. In a study of 15 160 patients undergoing noncardiac surgery, delayed operating room access was associated with increased risk of in-hospital death, longer LOS and higher costs.[15] That study also showed increased surgical site infections or infection of other systems consistently in all comparisons. Surgical site infections represent a major burden for surgical patients and health care institutions with protracted LOS, readmission, higher intensive care unit admissions, mortality and consequently, higher costs.[16] Patients with degenerative spinal disease seem at particular risk as no notable association between emergency surgery and infection was found in similar oncology and trauma studies.[17–20] Our finding of worse outcomes in patients requiring emergency surgery is even more striking considering that the emergency group had a greater proportion of simpler surgical cases, with more disc herniations (55.7% v. 31.8%) and less instrumentation (51.0% v. 70.0%). Our results support increasing scheduled surgery resources to reduce morbidity and costs that are largely preventable in patients with degenerative pathologies.

Our study also identified that patients who decompensated while on a waitlist had worse early postoperative outcomes than both patients who were scheduled for surgery, and those with de novo emergencies. Adjusting for age, patients who decompensated had 2.5 times the risk of having any adverse event than patients who were scheduled for surgery and 2.1 times the risk than those with de novo emergencies. Patients who decompensated had longer LOS and were discharged home less frequently. To our knowledge, this has not been previously reported in degenerative spinal surgery.

Longer wait times for planned cardiac surgical revascularization leads to the deterioration of a patient's condition and a less favourable clinical outcome.[21] Prolonged wait-times for elective laparoscopic cholecystectomy are associated with an increase in morbidity of 14% with a consequentially preventable increase in health care costs.[22] Our findings of worse perioperative outcomes for patients who decompensated compared with patients who presented with de novo emergencies should specifically incentivize Canadian health care policy-makers to expand elective surgical resources. This should diminish the risk of decompensation while on a waitlist, improve outcomes and decrease costs.

Our results show that patients with lumbar disc herniation are an especially underserved population as they were the only diagnostic group in which more patients were treated emergently than scheduled for surgery (55.7% v. 31.8%, $p < 0.001$). Also, more patients presented with de novo emergencies than decompensated emergencies (58.9% v. 35.5%, $p < 0.001$). This implicates T1 wait times as the most valuable target for improvement in the management of patients with disc herniation. In contrast, more patients with myelopathy deteriorated while on a waitlist and needed to be treated emergently compared with presenting as de novo emergencies (3.3% v. 1.1%, $p = 0.02$). This suggests that efforts should first be directed toward T2 wait times in patients with myelopathy.

The financial effects of patients decompensating while on a surgical wait list and presenting emergently has not been assessed in spinal surgery. However, a study of 500 000 patients to determine costs in surgery for abdominal aortic aneurysm repair, coronary artery bypass graft and colon resection reported that, if a modest 10% of the weighted estimate of emergency procedures would have been performed electively, the cost benefit would have been nearly $1 billion.[23] Future cost analysis in spinal surgery should compare the cost of increasing resources for scheduled surgeries to the cost of performing emergency surgeries in patients who decompensated, with its associated poorer outcomes and morbidity cost.

Limitations

Although this study provides useful insight, our findings have to be interpreted in the context of the study design. It is possible that patients requiring emergency surgery have more severe disease, making outcomes worse than those of patients treated electively. However, this seems unlikely given their younger age. Referral patterns for surgery may vary widely owing to several factors such as region, age, comorbidities and health care provider networks. For instance, in the United States, patients have different odds of emergency surgery depending on the state.[23] This study was retrospective in design and therefore, some information is missing. However, the large sample size of this study diminishes the possibility that results would have differed without missing data. Long-term postoperative clinical outcomes were not assessed as they were not available in the database. This can be assessed with a future study.

Conclusion

We observed worse perioperative outcomes for patients with degenerative spinal disease presenting emergently than for patients who were scheduled for surgery. Patients who decompensated while already on a surgical waitlist had the worst outcomes. Highly granular data are required to appropriately target improvement in T1 and T2 wait times, as highlighted by our analysis of lumbar disc and myelopathy populations. Future cost analysis should compare the cost of increasing resources for scheduled surgeries to the cost of performing emergency surgeries in patients who decompensated, with associated poorer outcomes and morbidity cost.

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