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Original Article

Neurosurgical Operative Cancellations in Canada: A Multicentre Retrospective Cohort Study

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ABSTRACT: ***Introduction:*** Operative cancellations adversely affect patient health and impose resource strain on the healthcare system. Here, our objective was to describe neurosurgical cancellations at five Canadian academic institutions. ***Methods:*** The Canadian Neurosurgery Research Collaborative performed a retrospective cohort study capturing neurosurgical procedure cancellation data at five Canadian academic centres, during the period between January 1, 2014 and December 31, 2018. Demographics, procedure type, reason for cancellation, admission status and case acuity were collected. Cancellation rates were compared on the basis of demographic data, procedural data and between centres. ***Results:*** Overall, 7,734 cancellations were captured across five sites. Mean age of the aggregate cohort was 57.1 ± 17.2 years. The overall procedure cancellation rate was 18.2%. The five-year neurosurgical operative cancellation rate differed between Centre 1 and 2 (Centre 1: 25.9%; Centre 2: 13.0%, $p = 0.008$). Female patients less frequently experienced procedural cancellation. Elective, outpatient and spine procedures were more often cancelled. Reasons for cancellation included surgeon-related factors (28.2%), cancellation for a higher acuity case (23.9%), patient condition (17.2%), other factors (17.0%), resource availability (7.0%), operating room running late (6.4%) and anaesthesia-related (0.3%). When clustered, the reason for cancellation was patient-related in 17.2%, staffing-related in 28.5% and operational or resource-related in 54.3% of cases. ***Conclusions:*** Neurosurgical operative cancellations were common and most often related to operational or resource-related factors. Elective, outpatient and spine procedures were more often cancelled. These findings highlight areas for optimizing efficiency and targeted quality improvement initiatives.

RÉSUMÉ : Annulations d'interventions neurochirurgicales au Canada : une étude de cohorte rétrospective multicentrique. ***Introduction :*** Les annulations d'interventions chirurgicales ont des conséquences négatives sur la santé des patients et pèsent sur les ressources des systèmes de santé. Notre objectif est ici de décrire les annulations d'interventions neurochirurgicales dans cinq établissements universitaires canadiens. ***Méthodes :*** Le *Canadian Neurosurgery Research Collaborative* a effectué une étude de cohorte rétrospective après avoir récupéré des données portant sur l'annulation d'interventions neurochirurgicales dans cinq établissements universitaires canadiens, et ce, au cours de la période allant du 1er janvier 2014 au 31 décembre 2018. Des données démographiques et d'autres données portant sur le type de d'intervention envisagée, la raison de l'annulation, l'état de santé des patients au moment de l'admission et l'acuité des cas ont été recueillies. Quant aux taux d'annulation, ils ont été comparés entre eux sur la base de données démographiques, de données liées aux interventions et de données concernant les établissements. ***Résultats :*** Au total, 7 734 annulations ont été enregistrées dans cinq établissements. L'âge moyen des patients de notre cohorte générale était de 57,1 ± 17,2 ans. Le taux général d'annulation des interventions était de 18,2 %. Le taux d'annulation des interventions neurochirurgicales au cours d'une période de cinq ans différait entre les établissements 1 et 2 (établissement 1 : 25,9 % ; établissement 2 : 13,0 %, p = 0,008). Notons que les patients de sexe féminin ont moins souvent subi une annulation d'intervention. Les interventions électives, ambulatoires et visant la colonne vertébrale ont été celles qui ont été le plus souvent annulées. Les motifs d'annulation comprenaient des facteurs liés au chirurgien (28,2 %), à un cas plus grave (23,9 %), à l'état de santé du patient (17,2 %), à d'autres facteurs (17,0 %), à la disponibilité des ressources (7,0 %), à un retard dans la salle d'opération (6,4 %) et à des facteurs liés à l'anesthésie (0,3 %). Lorsqu'on les regroupe entre eux, les motifs d'annulation sont liés aux patients dans 17,2 % des cas, au personnel dans 28,5 % des cas et aux interventions ou aux ressources dans 54,3 % des cas. ***Conclusions :*** Les annulations d'interventions neurochirurgicales étaient fréquentes et le plus souvent liées à des facteurs opérationnels ou en lien avec les ressources disponibles. Les interventions électives, ambulatoires et visant la colonne vertébrale ont été celles qui ont été le plus

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souvent annulées. Ces résultats mettent donc en évidence des aspects dont l'efficacité peut être optimisée ainsi que des initiatives ciblées d'amélioration de la qualité.

Keywords: Health services research; neurosurgery; quality of care; spinal surgery

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Introduction

Surgical cancellations are a cause of inconvenience and patient dissatisfaction.[1] Patients also report post-operative complications to a greater extent after a cancelled outpatient procedure.[2] While standard of care is often considered unimpacted when rescheduling cancelled procedures, there is mounting evidence to support a negative association between patient's physical well-being, psychological health and longer duration waiting for surgery.[3,4] Neurosurgical patients are particularly vulnerable given the relatively invasive nature, high complexity, propensity for acute decline and some procedures being performed under awake conditions. This may result in a high degree of pre-operative anticipatory patient anxiety and a resultant reduction in postoperative HRQoL.[3,4]

Previously reported neurosurgical cancellation rates range between 4% and 20%.[1,2,5] A survey study by Koh et al. indicated that 83.5% of cancellations were reported as due to administrative or facility reasons.[1] These findings are similar to those reported in the broader surgical literature.[1,7–16] Other factors relevant to procedural cancellation include pre-anaesthetic workup, comorbidity optimization, type of surgery and surgeon-specific factors.[17] Canada faces challenges with the burden of surgical cancellations due to the nature of a single-payer social health care system, particularly with regards to inefficient use of operating room time and limited opportunity to utilize time with an alternative case.

To date, no prior studies have examined the nature of neurosurgical procedural cancellations across Canadian institutions. As such, here we aimed to address this knowledge gap and identify any factors associated with procedure cancellations. Identifying causative factors may provide an opportunity for targeted quality improvement initiatives aimed at improving efficiency and optimizing the care of neurosurgical patients.

Methods

The Canadian Neurosurgery Research Collaborative (CNRC)[18–21] performed a cross sectional, multicentre retrospective cohort study of operative cancellations at five Canadian academic neurosurgical centres. Sites included were Dalhousie University, University of Alberta, Western University, University of Calgary and McMaster University. Research Ethics Board approval was waived by the lead site for being a quality improvement initiative. Health record departments were consulted at each site to compile neurosurgical operative cancellations from January 1, 2014 to December 31, 2018. Deidentified data collected pertaining to each cancelled case included patient age, sex, procedure name, reason for cancellation, admission status (outpatient or inpatient), emergency status (elective or emergency) and American Surgical Association (ASA) score.

Each case was reviewed by two team members (MM, ARP) and coded for neurosurgical subspecialty focus area and stratified into procedural categories: cranial, spine, peripheral nerve, endovascular, miscellaneous, or not provided. Miscellaneous procedures included those that did not specifically fit into one of the aforementioned categories. Finally, reasons for cancellation were reviewed and clustered according to the following groups: (1) patient-related; (2) staffing-related; (3) operational or resource-related factors; and (4) reason not provided or assigned. Patient-related factors included new acute illness, inclement weather precluding transportation to hospital, comorbidity status, expiry, patient not fasting or could not be contact on the day of surgery. Staffing-related factors included reasons for cancellation provided by the surgeon (i.e., surgeon overbooked slate, surgeon called to emergency) or reasons provided by anaesthesia (i.e., anaesthesia unavailable, further pre-operative investigations required, patient did not meet anaesthetic candidacy requirements). Operational and resource-related factors included bed availability constraints, cancellations due to higher acuity cases booked on the emergency slate, rooms running late, or other miscellaneous factors (i.e., patient surgery postponed due to unavailable equipment).

Five-year case cancellation rates were determined for two neurosurgical centres for which total annual case counts were obtainable. A χ^2 test was performed to assess for differences between groups. Historical data pertaining to the proportion of Canadian neurosurgical operative cases completed per anatomic region (i.e., cranial, spine, peripheral nerve, miscellaneous) was determined using data reported recently by the CNRC.[5] In order to determine if cases for a given anatomic region were disproportionately cancelled, we compared the actual proportion of operative cancellations to the historical proportion of surgical cases in Canada by anatomic region. Given that case type and reason for case cancellation were reviewed and arbitrated by two independent team members, an interrater Cohen's kappa statistic was calculated to evaluate degree of agreement.

Statistical analysis was completed using SPSS 21.0 (IBM, Chicago, IL) software. Parametric data were compared by one-way ANOVA. Non-parametric data were compared by Mann–Whitney U test for non-parametric quantitative data and by χ^2 test for qualitative data. Interrater reliability was expressed as Cohen's kappa statistic.

Results

Across all five sites, 7,734 total neurosurgical cancellations were recorded. Cancellations were categorized by surgical centre, with 1,225 cancellations at Centre 1, 893 cancellations at Centre 2, 187 cancellations at Centre 3, 3,887 cancellations at Centre 4 and 1,542 cancellations at Centre 5. Total completed case counts were only available for centres 1 and 2. The five-year rate of neurosurgical cancellations differed between Centre 1 and 2 (Centre 1: 25.9%; Centre 2: 13.0%, $p = 0.008$; Table 1). Overall, the combined cancellation rate for the two centres was 18.2%.

Demographics, procedural data and reasons for cancellation are presented in Table 2. The mean age was 57.1 ± 17.2 years. Sixty-three per cent of cancellations were observed in patients between the age of 50–79 years. Cancelled patients were 44.9% female. Approximately, two-thirds of cancellations were outpatients (Table 2). Cancelled cases were 74.2% elective and 25.8% emergency. The mean ASA score for all study patients was

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Table 1. Cancellations, total cases and cancellation percentage at two Canadian centres. Yearly cancellation rates were compared by Mann–Whitney *U* test

	Centre 1			Centre 2			
	Cancellations	**Total Cases**	**% Cancelled**	**Cancellations**	**Total Cases**	**% Cancelled**	
2014	259	600	30.2	217	1108	16.4	
2015	219	695	24.0	203	1137	15.2	
2016	256	718	26.3	125	1188	9.5	
2017	246	745	24.8	198	1233	13.8	
2018	245	751	24.6	150	1339	10.1	
TOTAL	1225	3509	**25.9**	893	6005	**13.0**	$p = 0.008$

Table 2. Demographic and procedural data pertaining to neurosurgical operative cancellations across five Canadian academic centres

	***n* = 7734**
Age (mean ± SD)	57.1 ± 17.2
0–9 (%)	50 (1.2)
10–19 (%)	48 (1.1)
20–29 (%)	220 (5.0)
30–39 (%)	398 (9.1)
40–49 (%)	571 (13.1)
50–59 (%)	940 (21.6)
60–69 (%)	992 (22.8)
70–79 (%)	834 (19.1)
80–89 (%)	289 (6.6)
90–99 (%)	17 (0.4)
100+ (%)	0
Not provided	3375
Sex	
Female (%)	3322 (44.9)
Male (%)	4073 (55.1)
Not provided	339
Admission status	
Inpatient (%)	2808 (37.9)
Outpatient (%)	4595 (62.1)
Not provided	331
Emergency status	
Elective (%)	4693 (74.2)
Emergency (%)	1629 (25.8)
Not provided	1412
ASA (mean ± SD)	2.99 ± 0.79
Location (%)	
1	1225 (16.4)
2	893 (11.5)
3	187 (2.4)
4	3887 (49.9)
5	1542 (19.8)
Procedure type (%)	
Spine	3068 (47.7)
Cranial	1820 (28.3)
Peripheral nerve	234 (3.6)
Endovascular	134 (2.1)
Miscellaneous	1169 (18.2)
Not provided	1309
Subspecialty (%)	
Oncology	928 (14.4)
Vascular	416 (6.5)
Functional	519 (8.1)
Peripheral nerve	234 (3.6)
Spine	3052 (47.7)
General	1204 (18.7)
Epilepsy	70 (1.1)
Not provided	1311
Reason for cancellation (%)	
Resource availability*	478 (7.0)
Higher acuity case	1633 (23.9)
Room running late	440 (6.4)
Patient condition	1177 (17.2)
Other	1163 (17.0)
Surgeon reason	1933 (28.2)
Anaesthesia reason	19 (0.3)
Not provided	891
Clustered reason for cancellation (%)	
Patient factor	1177 (17.2)
Staff factor	1952 (28.5)
Operational and resources	3714 (54.3)
Not provided	891

*Resource availability: Examples include no post-operative inpatient bed (e.g., ward or intensive care unit) available or elective time no longer available.

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2.99 ± 0.79. Regarding type of procedure, spine cases were most often cancelled (47.7%), followed by general neurosurgery (18.7%), oncology (14.4%), functional (8.1%), vascular (6.5%), peripheral nerve (3.6%) and epilepsy (1.1%). Cohen's kappa statistic for interrater reliability pertaining to arbitration of case type data was 0.998 ± 0.0001 for procedure type and 0.996 ± 0.001 for subspecialty focus. Reason for cancellation was most often due to

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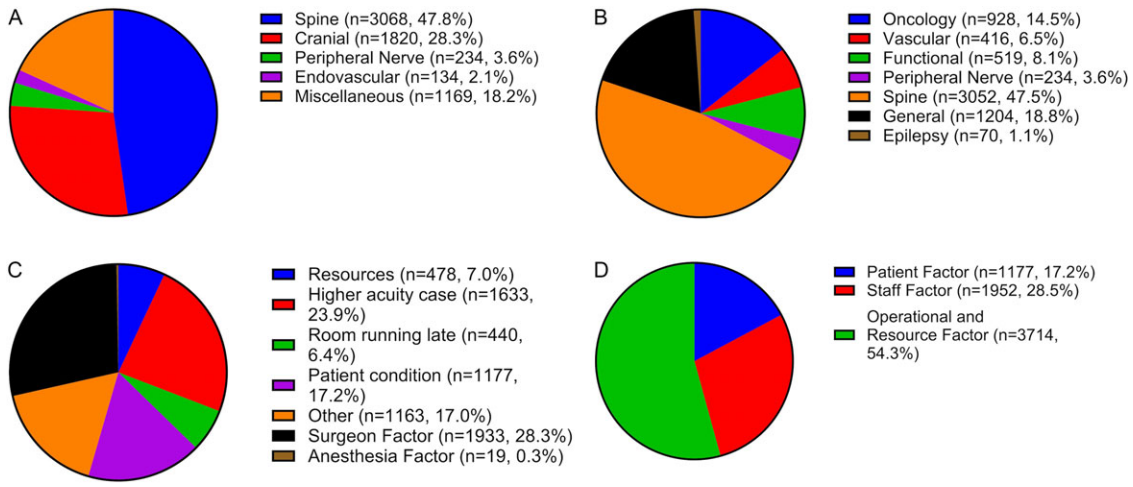

Figure 1. Graphical representation of (***a***) surgical cancellations by case type, (***b***) surgical cancellations by subspecialty, (***c***) rationale for surgical cancellations and (***d***) high-level categories of reasons for cancellation.

surgeon-related factors (28.2%), followed by cancellation for a case of higher acuity (23.9%), patient condition (17.2%), other miscellaneous factors (17.0%), resource factors including lack of bed availability (7.0%), cancellation secondary to a prior case running late (6.4%) and anaesthesia factors (0.3%). When clustered, the reason for cancellation was patient-related in 17.2%, staff-related in 28.5% and operational or resource-related in 54.3% of cases (Fig. 1). Cohen's kappa statistic was 1.00 ± 0.0001 for both reason for cancellation and clustered reason for cancellation.

A comparison of procedural cancellations across centres is presented in Table 3. Differences were identified between the five centres in mean patient age, age distribution stratified by decade, admission status (i.e., inpatient versus outpatient), case acuity (i.e., emergency versus elective), procedure type, subspecialty focus, reason for cancellation and ASA scores. There were more outpatient than inpatient cancellations at Centres 1, 3 and 4. There more spine cancellations than cranial cancellations at Centre 1, 4 and 5. The most common reasons for operative cancellations were related to patient condition at Centres 3 and 5, surgeon-related factors at Centre 4, higher case acuity taking priority at Centre 2 and miscellaneous (other) and Centre 1. Upon clustering, reasons for cancellation revealed operational and resource-related factors were the most common reason for cancellations at all sites except Centre 4, where staff-related factors were most common.

Comparison of the proportion of operative cancellations to the historical proportion of neurosurgical cases completed in Canada per anatomic region, indicated a disproportionately high rate of spine cases ($p < 0.00001$; Table 4). Information pertaining to the number of times a procedure was cancelled and duration of surgical delay after cancellation was only available at select centres (Supplementary Table 1). At Centre 2, 15.7% of cancelled cases were cancelled at least once prior. The average delay to surgery following cancellation was 19 ± 26.1 days at Centre 3 and the average time from placement on the surgical waitlist to cancellation was 5 ± 7.7 months at Centre 4. Author's did not receive funding from any sources to support this work.

Discussion

Here, we present the first multicentre review of neurosurgical operative cancellations in Canada. The current work provides several insights into the nature of neurosurgical cancellations.

The rate of neurosurgical operative cancellations reported in the literature widely ranges 4%–20%.[1,2,5] Herein, the combined cancellation rate for Centres 1 and 2 was 18.2%. The only prior study including data on Canadian neurosurgical operative cancellations is from a medium-sized neurosurgical centre in Kingston, Ontario.[1] They reported 265 procedural cancellations and 1,271 cases successfully completed over a four-year period, yielding a cancellation rate of 16.9%. A comparison of institutional data entry and coding methods would be helpful to assess for differences in the accuracy of recording and coding of operative cancellations. Disparity in data capture, entry and coding may at least partly explain the observed difference in cancellation rates. Centre 1 had a higher cancellation rate for spine and outpatient procedures. These findings are in keeping with the overall trend observed across all five participating Centres. It also aligns with the disproportionately higher than expected rate of spine procedure cancellations based on historical Canadian neurosurgical case frequencies.[22]

For the combined cohort, patients most often cancelled were male, outpatients and on the elective surgical list. Patients in their fifth to eight decades of life comprised the majority of cancelled patients. This trend likely reflects the overall demographic composition of adult neurosurgical patients. Given that the reasons for operative cancellations may be disparate between centres, and in an effort to avoid masking differences in site-specific reasons underlying cancellations, we presented data stratified according by centre (Table 3). We also identified differences in age, admission status, acuity status, ASA grade, procedure type, subspecialty of operation and reason for cancellation between neurosurgical centres. The lack of demographic data on the overall patient populations undergoing electively booked neurosurgical procedures at these centres limits the ability to comprehensively evaluate case cancellation on a demographic basis and produce meaningful statistical comparisons, which should be the subject of future work.

In terms of subspecialty focus, the most commonly cancelled cases were spine (47.7%), followed by general neurosurgery (18.7%) cases. Oncology, vascular, functional, peripheral nerve and epilepsy cases were underrepresented in the cancellation figures. These findings are in keeping with prior literature suggesting that cancer operations are less frequently cancelled.[10] This also likely reflects the urgency of oncologic procedures and provincial or

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Table 3. Demographics and surgical data by centre. Parametric data are compared by one-way ANOVA, non-parametric data are compared by χ^2 test

	Centre 1 ($n = 1225$)	Centre 2 ($n = 893$)	Centre 3 ($n = 187$)	Centre 4 ($n = 3887$)	Centre 5 ($n = 1542$)	*p*-Value
Age (mean ± SD)	59.1 ± 15.5	57.8 ± 15.8	57.2 ± 18.7	51.6 ± 20.7	58.6 ± 15.9	**<0.001**
0–9 (%)	1 (0.1)	0 (0.0)	0 (0.0)	49 (5.8)	0 (0.0)	**<0.001**
10–19 (%)	4 (0.4)	4 (0.4)	3 (1.6)	26 (3.1)	11 (0.7)	
20–29 (%)	45 (5.0)	43 (4.8)	15 (8.1)	48 (5.7)	69 (4.5)	
30–39 (%)	58 (6.5)	81 (9.1)	19 (10.2)	85 (10.1)	155 (10.1)	
40–49 (%)	113 (12.6)	141 (15.8)	25 (13.4)	117 (13.9)	175 (11.3)	
50–59 (%)	199 (22.2)	183 (20.5)	32 (17.2)	178 (21.1)	348 (22.6)	
60–69 (%)	225 (25.1)	208 (23.3)	39 (21.0)	182 (21.6)	338 (21.9)	
70–79 (%)	192 (21.5)	175 (19.6)	30 (16.1)	109 (12.9)	328 (21.3)	
80–89 (%)	49 (5.5)	56 (6.3)	21 (11.3)	47 (5.6)	116 (7.5)	
90–99 (%)	9 (1.0)	2 (0.2)	2 (1.1)	2 (0.2)	2 (0.1)	
100+ (%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Not provided (*n*)	330	0	1	3044	0	
Sex						0.593
Female (%)	385 (43.0)	406 (45.4)	84 (45.2)	1736 (44.7)	711 (46.3)	
Male (%)	510 (57.0)	487 (54.5)	102 (54.8)	2151 (55.3)	823 (53.7)	
Not provided	330	0	1	0	8	
Admission status						**<0.001**
Inpatient (%)	415 (46.4)	493 (55.2)	68 (36.6)	599 (15.4)	1233 (80.0)	
Outpatient (%)	480 (53.6)	400 (44.8)	118 (63.4)	3288 (84.6)	309 (20.0)	
Not provided	330	0	1	0	0	
Emergency status						**<0.001**
Elective (%)	0	510 (57.1)	0	2913 (74.9)	1270 (82.4)	
Emergency (%)	0	383 (42.9)	0	974 (25.1)	272 (17.6)	
Not provided	1225	0	187	0	0	
ASA (mean ± SD)	N/A	2.6 ± 0.7	3.2 ± 0.6	N/A	3.2 ± 0.8	**0.02**
Procedure type (%)						**<0.001**
Spine	623 (50.9)	285 (31.9)	47 (25.5)	1433 (55.5)	680 (44.2)	
Cranial	358 (29.2)	326 (36.5)	85 (46.2)	431 (16.7)	620 (40.3)	
Peripheral nerve	16 (1.3)	10 (1.1)	2 (1.1)	196 (7.6)	10 (0.6)	
Endovascular	51 (4.2)	0 (0.0)	1 (0.5)	82 (3.2)	0 (0.0)	
Miscellaneous	176 (14.4)	272 (30.5)	49 (26.6)	442 (17.1)	230 (14.9)	
Not provided	1	0	3	1303	2	
Subspecialty (%)						**<0.001**
Oncology	215 (17.6)	131 (14.7)	33 (17.9)	155 (6.0)	394 (25.6)	
Vascular	79 (6.5)	94 (10.5)	12 (6.5)	201 (7.8)	30 (1.9)	
Functional	130 (10.6)	53 (5.9)	32 (17.4)	235 (9.1)	69 (4.5)	
Peripheral nerve	16 (1.3)	10 (1.1)	2 (1.1)	196 (7.6)	10 (0.6)	
Spine	623 (50.9)	284 (31.8)	47 (25.5)	1426 (55.2)	672 (43.6)	
General	152 (12.4)	314 (35.2)	47 (25.5)	329 (12.7)	362 (23.5)	
Epilepsy	9 (0.7)	7 (0.8)	11 (6.0)	40 (1.5)	3 (0.2)	
Not provided	1	0	3	1305	2	
Reason for cancellation (%)						**<0.001**
Resources*	175 (14.7)	67 (7.5)	16 (8.6)	34 (1.1)	186 (12.1)	
Higher acuity case	228 (19.1)	513 (57.7)	38 (20.4)	501 (16.5)	353 (22.9)	

(*Continued*)

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Table 3. Demographics and surgical data by centre. Parametric data are compared by one-way ANOVA, non-parametric data are compared by χ^2 test (*Continued*)

	Centre 1 ($n = 1225$)	Centre 2 ($n = 893$)	Centre 3 ($n = 187$)	Centre 4 ($n = 3887$)	Centre 5 ($n = 1542$)	*p*-Value
Room running late	9 (0.8)	52 (5.8)	36 (19.4)	101 (3.3)	242 (15.7)	
Patient condition	138 (11.5)	80 (9.0)	66 (35.5)	405 (13.4)	488 (31.6)	
Other	633 (53.0)	28 (3.1)	15 (8.1)	385 (12.7)	102 (6.6)	
Surgeon reason	6 (0.5)	148 (16.6)	14 (7.5)	1596 (52.6)	169 (11.0)	
Anaesthesia reason	5 (0.4)	1 (0.1)	1 (0.5)	10 (0.3)	2 (0.1)	
Not provided	31	4	1	855	0	
Clustered reason for cancellation (%)						**<0.001**
Patient factor	138 (11.6)	80 (9.0)	66 (35.4)	405 (13.3)	488 (31.6)	
Staff factor	11 (0.9)	149 (16.8)	15 (8.1)	1606 (53.0)	171 (11.1)	
Operational and resources	1045 (87.5)	660 (74.2)	105 (56.5)	1021 (33.7)	883 (57.3)	
Not provided	31	4	1	855	0	

*Resources: Examples include no post-operative inpatient bed (e.g., ward or intensive care unit) available or elective time no longer available.

Table 4. Statistical comparison of proportion of cancelled cases to historical case record. Statistical analysis performed by χ^2 test

	Cranial	Spine	Peripheral nerve	Miscellaneous
Case proportion (%) (Tso et al, 2017)[22]	50.6	32.5	3.4	13.5
Cancelled case proportion (%)	28.8	49.0	3.7	18.5
χ^2 statistic				299.9
p-value				**<0.00001**

health authority wait time benchmarks. We assessed for differences in the proportions of cancelled cases, compared to historical procedure rates (previously published by Tso *et. al* (2017)),[22] stratified by anatomical region (i.e., cranial, spine and peripheral nerve). The cancellation rate for spine procedures was disproportionately higher than expected based on historical case frequency. These data imply that patients undergoing spinal operations may be more at risk of cancellation than those undergoing other procedures.

The most frequent reasons for surgical cancellation in the study population were operational and resource-related, which specifically included post-operative bed availability (e.g., ward or high acuity), administrative reasons, more urgent case booked on emergency slate, surgeon's operative slate running late and other related factors. This falls in line with the earlier work by Koh *et al.*,[1] who demonstrated that neurosurgical cancellations in their cohort were largely due to operational or resource-related factors (89.4%). Rates of operative cancellations for all surgical specialties in the literature range from 0.037% to 16.7%.[8–17] Specific surgeon practices,[8] caregiver preference.[8] insufficient pre-operative assessment,[9,16] type of surgery,[10] wait times,[11] patient no-show,[12] operating room resources,[12] operating room management,[13] country of cancellation[14] and lack of financial clearance[14] have all been identified as barriers precluding planned surgical care.

Regional health care delivery method likely plays a role in operative cancellations. Neurosurgical care often takes place at tertiary or quaternary settings due to specialty-specific resource constraints, such as requirement for high acuity beds after certain procedures, neuroscience-trained nursing staff, multidisciplinary subspecialty support and a variety of other infrastructure factors. This adds a further layer of complexity for patients travelling from rural communities or those distant from neurosurgical centres, as last-minute cancellations affect this population disproportionately. Canada is a single-payer social health care system and financial clearance for surgery does not generally play a role, although as indicated above, travel costs for surgical intervention are covered by patients and their families.

From the perspective of countries serviced under other healthcare insurance climates, rates of cancellation in 2003–2004 at a hospital in the USA (16.5%) and in Norway (14.6%)[14] were grossly similar to the current study, so it remains unclear if there is an effect imposed by the insurance system. Hospitals functioning in similar single-payer social healthcare systems, such as the United Kingdom, Italy, New Zealand, may see similar rates of cancellation as compared to countries such as the USA that largely function in a private health insurance ecosystem. Further evaluation of operative cancellations in other countries would assist in answering this question.

While our study spans years in the pre-COVID era, the COVID-19 pandemic has made surgical cancellations, surgical wait times and surgical backlog a pressing global issue. COVID-19 testing and cancellation algorithm vary by region and have had various effects on different types of surgery.[23–25] Further evaluation of surgical cancellations in the post-COVID era is warranted in order to develop strategies to mitigate cancellations and prevent worsening of surgical waitlists.

Limitations

A primary study limitation was the lack of total completed case counts for three of five participating sites, at least partially attributable to a complex data collection process employed in a national, multicentre, resident-led study. Furthermore, we did not have access to institutional data entry and coding methods for documenting neurosurgical operative cancellations. The decision to broadly categorize cancellations (e.g., cranial, spine, peripheral nerve) was also primarily based on lack of granularity in data coding at the respective participating centres (e.g., surgery for a lumbar spinal fusion for degenerative spondylolisthesis was not

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differentiated from neurological compromise from a lumbar spinal abscess). While there is a considerable difference in the overall number of cancelled cases at each centre, this largely reflects the size of the participating centres and variability in their annual case volume. Four of five participating sites in this study were small-medium size and therefore these results may not be generalizable to larger academic centres. For this reason, cancellation rate was provided only for two sites with total annual case booking data. Case coding across sites was not standardized as Canadian national standards for coding neurosurgical operative cancellations do not exist.

Conclusion

The current study represents the first Canadian multicentre evaluation of neurosurgical operative cancellations. The overall rate of neurosurgical cancellation was 18.2%. We identified factors related to neurosurgical cancellations; cases more often cancelled included, spine, elective and outpatients, respectively. The most common reasons for cancellation pertain to administrative and operational factors. In addition, points of variability between centres are highlighted that merit further investigation. Future data analysis of interprovincial administrative databases may provide the granularity required to describe and address such a multi-factorial and complex challenge in health care delivery.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/cjn.2024.265.

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