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Brief Communication

The Changing Face of Cancer Surgery During Multiple Waves of COVID-19

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Abstract

COVID-19 has had a detrimental effect on the provision of cancer surgery, but its impact beyond the first 6 months of the pandemic remains unclear. We used data on 799 220 cancer surgeries performed in Ontario, Canada, during 2018-2021 and segmented regression to address this knowledge gap. With the arrival of the first COVID-19 wave (March 2020), mean cancer surgical volume decreased by 57%. Surgical volume then rose by 2.5% weekly and reached prepandemic levels in 8 months. The surgical backlog after the first wave was 47 639 cases. At the beginning of the second COVID-19 wave (January 2021), mean cancer surgical volume dropped by 22%. Afterward, surgical volume did not actively recover (2-sided $P = .25$), resulting in a cumulative backlog of 66 376 cases as of August 2021. These data urge the strengthening of the surgical system to quickly clear the backlog in anticipation of a tsunami of newly diagnosed cancer patients in need of surgery.

Like many time-sensitive and potentially lifesaving procedures, cancer surgeries were dramatically reduced by hospitals worldwide during the first wave of COVID-19 (1,2). Treatment delays are associated with worse quality of life and even lower survival in some cases (2,3). We examined the weekly volume of cancer surgical procedures from January 2018 to August 2021, along with COVID-19–related hospitalizations, to demonstrate how the surgical system has responded to 2 distinct waves of COVID-19 and to assess if a full recovery of surgical volume has occurred (1).

This retrospective population-based cohort study was based in Ontario, Canada, where permanent residents are insured under a universal health-care system (4). Administrative datasets were linked using unique encoded identifiers and analyzed at ICES, a nonprofit research institute legalized by section 45 of Ontario's Personal Health Information Protection Act to collect and analyze health care and demographic data, without consent, for health system research. The use of the data in this study is approved by ICES' Privacy and Legal Office and, therefore, does not require review by a research ethics board. Records of cancer surgical procedures and hospitalizations were aggregated by week using hospital-matched procedure codes from the Canadian Institute for Health Information (1).

Three COVID-19 periods were defined relative to Ontario's 2 declared provincial states of emergency (5): prepandemic (January 7, 2018, to March 14, 2020), the first wave of COVID-19 (March 15, 2020, to January 9, 2021), and the combined second and third wave of COVID-19 (January 10, 2021, to August 28, 2021). Comparisons of patient characteristics were carried out between periods, where a standardized mean difference exceeding 0.1 indicated a statistically significant difference (6). Segmented negative binomial regression models were used to quantify the weekly surgical volume trend (slope) within each period and the change in mean volume (intercept) at the beginning of each COVID-19 wave. General and standard parameterizations were used to provide a fulsome depiction of the surgical trend. Surgical backlog was computed at the end of both waves as the difference between the observed and predicted (had there been no pandemic) volume over all weeks of that wave (7). A cumulative backlog was also calculated as the total missed cases from March 15, 2020, to August 28, 2021. Regression analyses were 2-sided using a P value less than .05 to

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indicate statistical significance. Analyses were performed on SAS Enterprise Guide 7.15 (SAS Institute, Cary, NC, USA).

We observed 799 220 cancer surgical procedures over the study period (mean [standard deviation] age = 56.6 [17.0] years; n = 492 590 [61.6%] women and n = 306 630 [38.4%] men). In the prepandemic period, Ontario hospitals performed an average of 237 545 cancer surgeries annually or 19 524 procedures monthly. These numbers dropped to 179 789 and 14 777, respectively, during the first COVID-19 wave and recovered slightly back to 207 955 and 17 093 during the second wave. A higher proportion of cancer surgeries was performed urgently (ie, patient was admitted to hospital via the emergency department or arrived at hospital by ambulance) during the first wave than in prepandemic (28 220 [19.0%] vs 74 277 [14.3%]; standardized mean difference = 0.13); otherwise, patient characteristics were identical throughout the 3 periods (Table 1).

In the first week of the first COVID-19 wave, mean cancer surgical volume declined by 57% compared with the week prior (Supplementary Tables 1 and 2, available online). Cancer surgical volume then increased consistently by 2.5% (rate ratio [RR] = 1.025, 95% confidence interval = 1.02 to 1.03; $P < .001$) each week and reached prepandemic levels 8 months later. The surgical backlog after the first wave was 47 639 cases in total, or 1108 cases in each week. At the beginning of the second COVID-19 wave, mean cancer surgical volume dropped by 22%. Afterward, surgical volume did not show any weekly growth (RR = 0.995, 95% confidence interval = 0.99 to 1.00; $P = .25$), resulting in a cumulative backlog of 66 376 cases 6.5 months later or an additional backlog of 18 737 cases after the end of the first wave. This means during the second wave, hospitals performed 568 fewer cancer surgeries per week. The cumulative backlog was equivalent to 28% of the prepandemic annual surgical volume or 3.4-fold of the prepandemic monthly volume. Overall, cancer surgical volume was inversely associated with COVID-19–related hospitalizations (Figure 1).

At the start of 2 COVID-19 waves, cancer surgeries were ramped down across patient populations to preserve capacity for rising COVID-19–related hospitalizations. Cancer surgical volume was found to decrease by a smaller extent during the first week of the second COVID-19 wave than that of the first wave, but unlike the first wave, surgical volume did not actively recover. This led to a considerable additional backlog even with declining COVID-19–related hospitalizations. On a positive note, we observed the weekly surgical backlog reduce by half during the second wave. Because surgical volume did not rise on a weekly basis over this period, this improved weekly backlog likely reflects a further reduction in the demand for cancer surgery as activities of cancer screening, diagnosis, staging, and symptom assessment continued to be negatively impacted by the pandemic (7-9). As such, our findings suggest that to tackle an anticipated tsunami of new cancer (and noncancer) patients requiring surgery, there is an urgent need to direct hospital resources to strengthen the surgical system. Data from this analysis can be used to inform microsimulation models to quantify how much extra capacity is required to minimize the long-term repercussions especially to prevent excessive cancer mortality (10).

This analysis has limitations. Although a rise in COVID-19–related hospitalizations and a drop in cancer surgical volume around April 2021 was noted, we did not examine a distinct third COVID-19 wave. This is because we only captured the first half time period of this wave (11) and, therefore, had only 19 weekly data points to estimate a new segment in the regression model. Future research with more recent data needs to incorporate more pandemic-related milestones including the strategic reopening of the province and the discovery of the Omicron subvariants in the analysis. We also did not examine cancer staging because these data take at least 3 years in our cancer registry to accrue. With staging data, we would be able to quantify how much the observed shift in surgery utilization can be attributed to the potential stage migration during the pandemic (12,13).

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Table 1. Distribution of sociodemographic, clinical, and hospital characteristics for cancer surgical procedures performed during the 3 COVID-19 periods in Ontario, Canada

Variable	Patients by COVID-19 period, No. (%)[a]			Standardized mean difference		
	Prepandemic (n = 519 346)	First wave (n = 148 264)	Second wave (n = 131 610)	First wave vs prepandemic	Second wave vs prepandemic	Second vs first wave
Age, mean (SD), y	56.39 (16.92)	56.90 (17.23)	56.89 (17.23)	0.03	0.03	0
Sex						
Men	196 838 (37.9)	58 444 (39.4)	51 348 (39.0)	0.03	0.02	0.01
Women	322 508 (62.1)	89 820 (60.6)	80 262 (61.0)	0.03	0.02	0.01
Rural score[b]						
0-9, less rural	340 434 (65.6)	96 649 (65.2)	85 436 (64.9)	0.01	0.01	0.01
10-30	93 990 (18.1)	26 912 (18.2)	24 507 (18.6)	0	0.01	0.01
31-50	55 720 (10.7)	16 274 (11.0)	14 196 (10.8)	0.01	0	0.01
51-70	15 700 (3.0)	4422 (3.0)	3880 (2.9)	0	0	0
≥71, more rural	7183 (1.4)	2165 (1.5)	1864 (1.4)	0.01	0	0
Immigrants[c]	77 172 (14.9)	21 131 (14.3)	19 031 (14.5)	0.02	0.01	0.01
Material deprivation[d]						
1, least deprived	114 056 (22.0)	33 277 (22.4)	29 407 (22.3)	0.01	0.01	0
2	108 543 (20.9)	30 863 (20.8)	27 660 (21.0)	0	0	0
3	100 053 (19.3)	28 394 (19.2)	25 174 (19.1)	0	0	0
4	96 108 (18.5)	27 287 (18.4)	24 154 (18.4)	0	0	0
5, most deprived	95 860 (18.5)	27 058 (18.2)	23 906 (18.2)	0.01	0.01	0
Region						
Toronto	37 593 (7.2)	10 778 (7.3)	9608 (7.3)	0	0	0
Central	153 648 (29.6)	43 325 (29.2)	37 143 (28.2)	0.01	0.03	0.02
East	133 431 (25.7)	37 706 (25.4)	33 088 (25.1)	0.01	0.01	0.01
North	39 042 (7.5)	11 342 (7.6)	10 244 (7.8)	0	0.01	0.01
West	155 632 (30.0)	45 113 (30.4)	41 527 (31.6)	0.01	0.03	0.02
Elixhauser grouping[e]						
0	73 842 (14.2)	21 321 (14.4)	18 576 (14.1)	0	0	0.01
1	44 736 (8.6)	13 882 (9.4)	11 624 (8.8)	0.03	0.01	0.02
2	28 076 (5.4)	8547 (5.8)	7448 (5.7)	0.02	0.01	0
≥3	37 579 (7.2)	11 746 (7.9)	9836 (7.5)	0.03	0.01	0.02
No hospitalization	335 113 (64.5)	92 768 (62.6)	84 126 (63.9)	0.04	0.01	0.03
Cancer type[f]						
Breast	38 557 (7.4)	11 470 (7.7)	10 607 (8.1)	0.01	0.02	0.01
Colorectal	83 853 (16.1)	26 241 (17.7)	22 989 (17.5)	0.04	0.04	0.01
Endocrine	14 053 (2.7)	4209 (2.8)	3507 (2.7)	0.01	0	0.01
Esophagus	2093 (0.4)	595 (0.4)	516 (0.4)	0	0	0
Genitourinary	37 403 (7.2)	11 978 (8.1)	10 228 (7.8)	0.03	0.02	0.01
Gynecological	111 377 (21.4)	28 111 (19.0)	25 256 (19.2)	0.06	0.06	0.01
Head and neck	27 504 (5.3)	6915 (4.7)	6658 (5.1)	0.03	0.01	0.02
Hepatobiliary	63 284 (12.2)	19 853 (13.4)	17 027 (12.9)	0.04	0.02	0.01
Lung	10 299 (2.0)	3168 (2.1)	2590 (2.0)	0.01	0	0.01
Lymphoma	941 (0.2)	298 (0.2)	246 (0.2)	0	0	0
Prostate	22 684 (4.4)	6417 (4.3)	5214 (4.0)	0	0.02	0.02
Sarcoma (bone)	20 029 (3.9)	6290 (4.2)	5195 (3.9)	0.02	0	0.01
Sarcoma (soft tissue)	3795 (0.7)	983 (0.7)	834 (0.6)	0.01	0.01	0
Stomach	14 363 (2.8)	3841 (2.6)	4016 (3.1)	0.01	0.02	0.03
Other	69 111 (13.3)	17 895 (12.1)	16 727 (12.7)	0.04	0.02	0.02
Nonteaching hospital	382 747 (73.7)	107 557 (72.5)	96 464 (73.3)	0.03	0.01	0.02
Urgent[g]	74 277 (14.3)	28 220 (19.0)	22 885 (17.4)	0.13	0.08	0.04

[a]We defined 3 COVID-19 periods based on the 2 times Ontario declared state of emergency amid rising infection cases. As such, the prepandemic period was from January 7, 2018, to March 14, 2020; the first wave of the pandemic was from March 15, 2020, to January 9, 2021; and the second wave of the pandemic was from January 10, 2021, to August 28, 2021. Missing data were found for rural score (1.3%) and material deprivation (1.0%) that did not differ by COVID-19 period (standardized mean differences < 0.02).

[b]We used the Rurality Index for Ontario version 2008 (rio2008) to define rurality. This measure is computed using the latest census data and accounts for the size and density of population in a neighborhood, travel time to the nearest basic referral center, and travel time to the nearest advanced referral center.

[c]Individuals who immigrated to Ontario between January 1985 and May 2017 were identified from the Immigration, Refugee and Citizenship Canada Permanent Resident Database (with data from that period).

[d]Material deprivation was computed using the latest census data and obtained from the Ontario Marginalization Index database. This composite measure of socioeconomic status encompasses the proportion of a population that is without a high school diploma, lone-parent families, receiving government transfer payments, unemployed, low income, and living in dwellings in need of major repair.

[e]The Elixhauser comorbidity index was computed using hospital administrative data during a 5-year look-back window from the date of cancer surgery.

[f]Cancer type refers to the cancer surgical site determined from hospital procedural code. "Other" includes melanoma, ophthalmologic, paraneoplastic neurological syndromes, central nervous system, and skin cancers.

[g]A surgical procedure is considered urgent if a patient was admitted to hospital via the emergency department or if the patient arrived at hospital by ambulance.

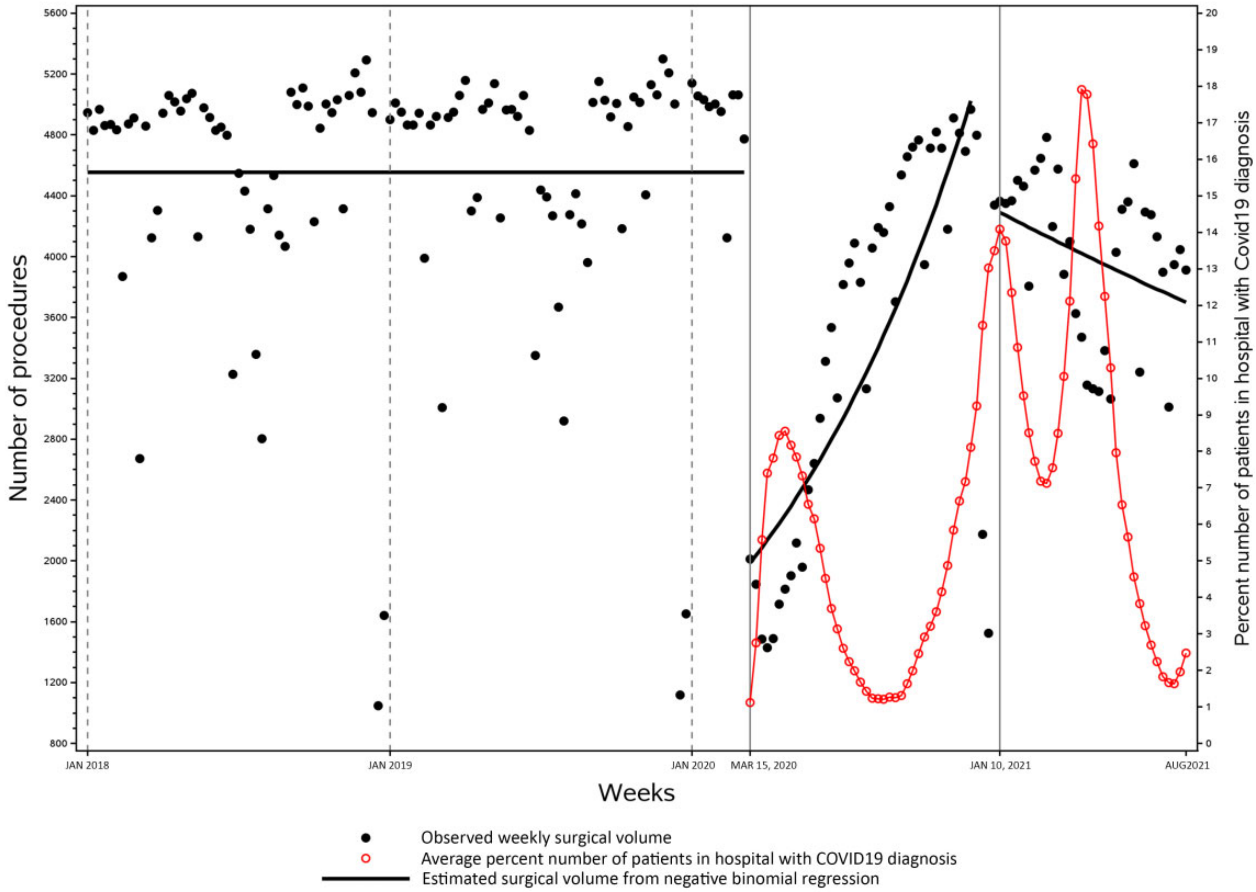

Figure 1. Weekly cancer surgical volume and the proportion of hospitalizations related to COVID-19 in Ontario, Canada, during January 7, 2018, to August 28, 2021. COVID-19–related hospitalizations included patients who were admitted to hospital because of a laboratory-confirmed COVID-19 diagnosis as the most responsible diagnosis and those who got infected with COVID-19 during the hospital stay. During the week of November 8-14, 2020 (ie, week 35 since the start of the first wave of COVID-19), cancer surgical volume has returned to prepandemic levels. As of August 28, 2021, there was a surgical backlog of 66 376 missed cases.

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Data Availability

The dataset from this study is held securely in coded form at ICES. While legal data sharing agreements between ICES and data providers prohibit ICES from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS (email: das@ices.on.ca). The full dataset creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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