Original Article

The effect of the COVID-19 pandemic on hospital admissions and outpatient visits in Ontario, Canada

Steven Habbous[1,2], Anna Lambrinos[1], Stephen Petersen[1], Erik Hellsten[1]

[1]Ontario Health (Strategic Analytics), [2]Department of Epidemiology and Biostatistics, Western University, London, Ontario, Canada

Address for correspondence:
Dr. Steven Habbous, Ontario Health, 525 University Avenue, Toronto, Ontario, Canada.
E-mail: steven_habbous@hotmail.com

Submission: 17-10-2022
Revised: 05-12-2022
Accepted: 08-12-2022
Published: 25-04-2023

Abstract:

INTRODUCTION: The wave-over-wave effect of the COVID-19 pandemic on hospital visits for non-COVID-19-related diagnoses in Ontario, Canada remains unknown.

METHODS: We compared the rates of acute care hospitalizations (Discharge Abstract Database), emergency department (ED) visits, and day surgery visits (National Ambulatory Care Reporting System) during the first five "waves" of Ontario's COVID-19 pandemic with prepandemic rates (since January 1, 2017) across a spectrum of diagnostic classifications.

RESULTS: Patients admitted in the COVID-19 era were less likely to reside in long-term-care facilities (OR 0.68 [0.67–0.69]), more likely to reside in supportive housing (OR 1.66 [1.63–1.68]), arrive by ambulance (OR 1.20 [1.20–1.21]) or be admitted urgently (OR 1.10 [1.09–1.11]). Since the start of the COVID-19 pandemic (February 26, 2020), there were an estimated 124,987 fewer emergency admissions than expected based on prepandemic seasonal trends, representing reductions from baseline of 14% during Wave 1, 10.1% in Wave 2, 4.6% in Wave 3, 2.4% in Wave 4, and 10% in Wave 5. There were 27,616 fewer medical admissions to acute care, 82,193 fewer surgical admissions, 2,018,816 fewer ED visits, and 667,919 fewer day-surgery visits than expected. Volumes declined below expected rates for most diagnosis groups, with emergency admissions and ED visits associated with respiratory disorders exhibiting the greatest reduction; mental health and addictions was a notable exception, where admissions to acute care following Wave 2 increased above prepandemic levels.

CONCLUSIONS: Hospital visits across all diagnostic categories and visit types were reduced at the onset of the COVID-19 pandemic in Ontario, followed by varying degrees of recovery.

Keywords:

Admissions, COVID-19, emergency department, healthcare utilization, hospital visits

At the onset of the COVID-19 pandemic in Ontario, in order to reserve capacity for the expected surge of patients requiring respiratory support, nonemergency surgeries across a spectrum of indications were postponed.[1] To reduce the risk of infection, virtual care options were implemented and nonurgent services like cancer screening were temporarily suspended.[2-4] In addition, healthcare avoidance due to fears of contracting COVID-19 may have reduced the number of patients seeking care in a hospital setting.[5-7]

At the onset of the COVID-19 pandemic, a near-universal reduction in healthcare utilization was reported across the globe, including surgical admissions, medical admissions, and emergency department (ED) visits.[8-12] However, like many other jurisdictions, Ontario experienced multiple "waves" of surging and receding COVID-19 incidence, with each wave occurring under a different set of contextual factors including public health policies, behavioral modifications, changing

Access this article online

Quick Response Code:

Website: www.thoracicmedicine.org

DOI: 10.4103/atm.atm_376_22

How to cite this article: Habbous S, Lambrinos A, Petersen S, Hellsten E. The effect of the COVID-19 pandemic on hospital admissions and outpatient visits in Ontario, Canada. Ann Thorac Med 2023;18:70-8.

population immunity, and differing COVID-19 variants. Estimating changes in healthcare utilization by wave and diagnostic category may help to inform the measures of incidence, gauge the extent of recovery across the health system to prepandemic patterns, and inform future pandemic response decision-making.

In this study, we (1) Assessed differences in patient and admission characteristics over time; and (2) Compared the rates of hospital visits across an array of encounter types and diagnosis categories.

Methods

In this retrospective study, we examined hospital admissions and hospital outpatient episodes beginning January 1, 2017 in Ontario, Canada. Admissions were captured from the Discharge Abstract Database (DAD) until March 25, 2022 and hospital outpatient visits were captured from the National Ambulatory Care Reporting System (NACRS) until May 27, 2022 (most recent data available for complete weekly counts). Data were extracted on August 25, 2022.

Hospital admissions

Hospital admissions were resolved into episodes of care to avoid double-counting. An inpatient episode of care included admissions occurring within 6 h of previous discharge or admissions occurring within 12 h of previous discharge but with evidence of a transfer (e.g., "transfer to" from the prior admission or a "transfer from" for the current admission).[13,14] We revised this definition such that planned admissions (readmit code 1) within 1 week after the previous discharge were classified as belonging to the previous episode.

Admission episodes were categorized as emergency admissions if the admission that started the episode was assigned entry code = "E" (admitted via the ED), admission category = "U" (emergent/urgent), or the patient was transferred from an ED (institution from type = emergency). The nonemergency admission episodes were categorized as surgical (main patient service 30–49) or medical (all other patient service codes). Admissions were also classified according to whether the patient arrived by ambulance (yes or no) a proxy for acuity and by time of admission as overnight (10 pm to 6 am) or during the day (7 am to 9 pm).

Outpatient visits

Outpatient visits were also resolved into episodes: An outpatient visit starting within 6 h since the patient left the ED (or within 6 h of the disposition date/time if the date/time the patient left the ED was missing), then that visit was considered the same episode as the previous NACRS record. We restricted our analyses to ED visits (ambulatory care type starts with "10," "11," or "12") and day surgeries (ambulatory care type starts with "2") using the NACRS record that started the episode. We considered all same-day surgeries as elective, although a small number (anecdotally <5%) are believed to be emergency surgeries. ED visits were considered to have resulted in an admission if the discharge disposition (any record during the episode) was "06" or "07".

Exclusion criteria

Patients were excluded if their episodes of care could not be resolved. To allow for some uncertainty in administrative data collection, admissions occurring within 72 h before the previous discharge (e.g., negative time since the previous discharge) were considered part of the prior admission. Patients with any admission starting >72 h before the previous discharge were omitted since it was unclear whether these admissions belonged to the same episode as prior admissions or whether this was a result of data quality issues. Patients were also excluded if their admission or discharge dates or times were missing, since episodes of care could not be ascertained. Similar exclusions were applied to outpatient visits, but 24 h was used instead of 72.

Patients were excluded if they had a death date before admission or could not be linked to the Registered Persons Database (RPDB), the source of vital statistics and demographic information in the province.

Covariates and data sources

Admissions and outpatient hospital visits were categorized based on International Classifications of Diseases, 10th revision (ICD-10) diagnostic codes [eTable S1]. There are up to 25 diagnostic codes for a single hospital admission and up to 10 diagnostic codes for a single outpatient hospital visit. Unless otherwise stated, we considered all of them to be relevant.

Patient demographic characteristics include age and sex at admission. Age was calculated using the date of birth from the RPDB. Patient postal code (from RPDB) was linked to the 2016 Canada Census through the Postal Code Conversion File (PCCF + v7) to ascertain rurality and neighborhood-level marginalization indices.[15] To further measure a patient's socioeconomic status, patients were classified as residing in group living, supportive housing, or transitional housing if they had any hospital admission 12 months prior with a transfer to/from "G" or "H." A patient was classified as residing in a long-term care facility if, within 12 months prior to and including admission, they had either (1) A physician claim from the Ontario Health Insurance Plan starting with "W"; or (2) Any hospital admission with a transfer code of "4" (transfer to/from a long-term care facility

with 24-h nursing). To ascertain prior medical history, we searched DAD and NACRS 12 months prior to diagnosis to estimate the Charlson comorbidity score using ICD-10 codes.[16] The same ICD-10 codes were included during the admission episode if the diagnostic code was type = "1" (preadmit comorbidity). Comorbidity score was retained as a continuous variable.

We defined an admission episode related to COVID-19 if, at any time during the admission (DAD, NACRS, and the Ontario Laboratory Information System, OLIS) or within 2 weeks prior (NACRS and OLIS), the ICD-10 code U07/U072 (DAD or NACRS) was present or if there was a COVID-19-positive PCR or rapid antigen test in OLIS.

Statistical methods

For every trend analysis, we created forecasting models on the weekly number of visits (admissions or ED visits) using linear regression with covariates for year (general trend), month (seasonal variation), and holiday weeks that may affect volumes (Christmas, New Years, Canada Day, and Labor Day) [eTables S2 and S3]. Forecasts were made on visits between January 1, 2017 and February 29, 2020 (the prepandemic period) and extrapolated until the end of the study period (March 25, 2022 for admissions and May 27, 2022 for outpatient visits). To quantify the extent to which visits in the COVID-19 era were different from expected, the difference between the weekly number of observed (actual counts) and expected (forecasted counts) visits was calculated. These residuals were regressed on time period using wave 0 (prepandemic) as the referent. Beta coefficients with standard errors (SE) were reported, which represent the number observed that are greater (positive beta) or fewer (negative beta) than expected during each wave relative to the pre-COVID-19 era (wave 0). For contextualization of absolute differences between observed and expected, the percent difference was calculated as the residual divided by the expected number of visits ×100%.

We used multivariable logistic regression to compare the admissions during the COVID-19 era (all waves) and the pre-COVID-19 era, reporting odds ratios (OR) with 99% confidence intervals (CI). The primary variable of interest was the COVID-19 wave. All models were adjusted for age at admission, sex, rurality, neighbourhood-level residential instability, material deprivation, dependency, and ethnic concentration, residence in long-term care, residence in some supportive housing, Charlson comorbidity, arrival by ambulance, urgent admission, overnight admission, length of stay, most responsible diagnosis, and month of admission. Unless otherwise stated, P values were not adjusted for multiple comparisons. $P < 0.05$ was considered statistically significant for the residual analysis of weekly rates (hundreds of records) and < 0.01 for analyses on the level of admissions (millions of records).

All analyses were conducted using the Statistical Analysis Software version 9.4 (SAS Institute; Cary, NC, USA) using data holdings at Ontario Health as a prescribed entity (health card numbers used for linkage were pseudonymized prior to analysis). Research ethics approval was not required.

Results

Between January 2017 and December 2019, there was a mean 12,851 (standard deviation [SD] 465) emergency admissions, 5973 (SD 283) medical nonemergency admissions, and 2663 (SD 503) surgical admissions. For outpatient activity, there was a mean 112,132 (SD 4897) ED visits and 21,670 (SD 4267) day surgery visits. Of these, a total 55,200/3,572,915 (1.5%) of day-surgeries and 1,784,073/18,419,318 (9.7%) of ED visits were directly admitted to hospital.

Admissions in the COVID-19 era versus the pre-COVID-19 era

Excluding admissions related to COVID-19, admission episodes in the COVID-19 era were less likely to comprise patients residing in a long-term care facility (OR 0.71 [0.70–0.72]), more likely to comprise patients residing in supportive housing (OR 1.15 [1.13–1.16]), more likely to consist of ambulance arrivals (OR 1.21 [1.20–1.21]), more likely to include at least one hospital transfer (OR 1.14 [1.13–1.16]), and less likely to consist of surgical admissions (OR 0.89 [0.88–0.90]) [Table 1]. Although statistically significant ($P < 0.0001$ for all), the magnitude of these differences was small (standardized differences <0.08 for all). The most responsible diagnosis had the largest difference (standardized difference 0.15), with the greatest reduction observed for respiratory system diagnoses (OR 0.50 [0.49–0.51]) compared with pregnancy or childbirth.

Hospital visits over time

At the onset of the COVID-19 pandemic, there was a sudden decline in emergency admissions, medical admissions, and surgical admissions [Figure 1a]. Compared with the expected number of admissions per week due to year-over-year changes, seasonal variability, and holiday weeks, during wave 1 we observed a mean −1850 (95% CI: −2081, −1612) fewer emergency admissions (14.1% reduction), −450 (95% CI: −538, −363) fewer medical admissions (7.5% reduction), and −1160 (95% CI: −1361, −958) fewer surgical admissions (41.7% reduction) [Table 2]. Over the course of the first 5 waves, this translated to a total 124,987 fewer emergency admissions,

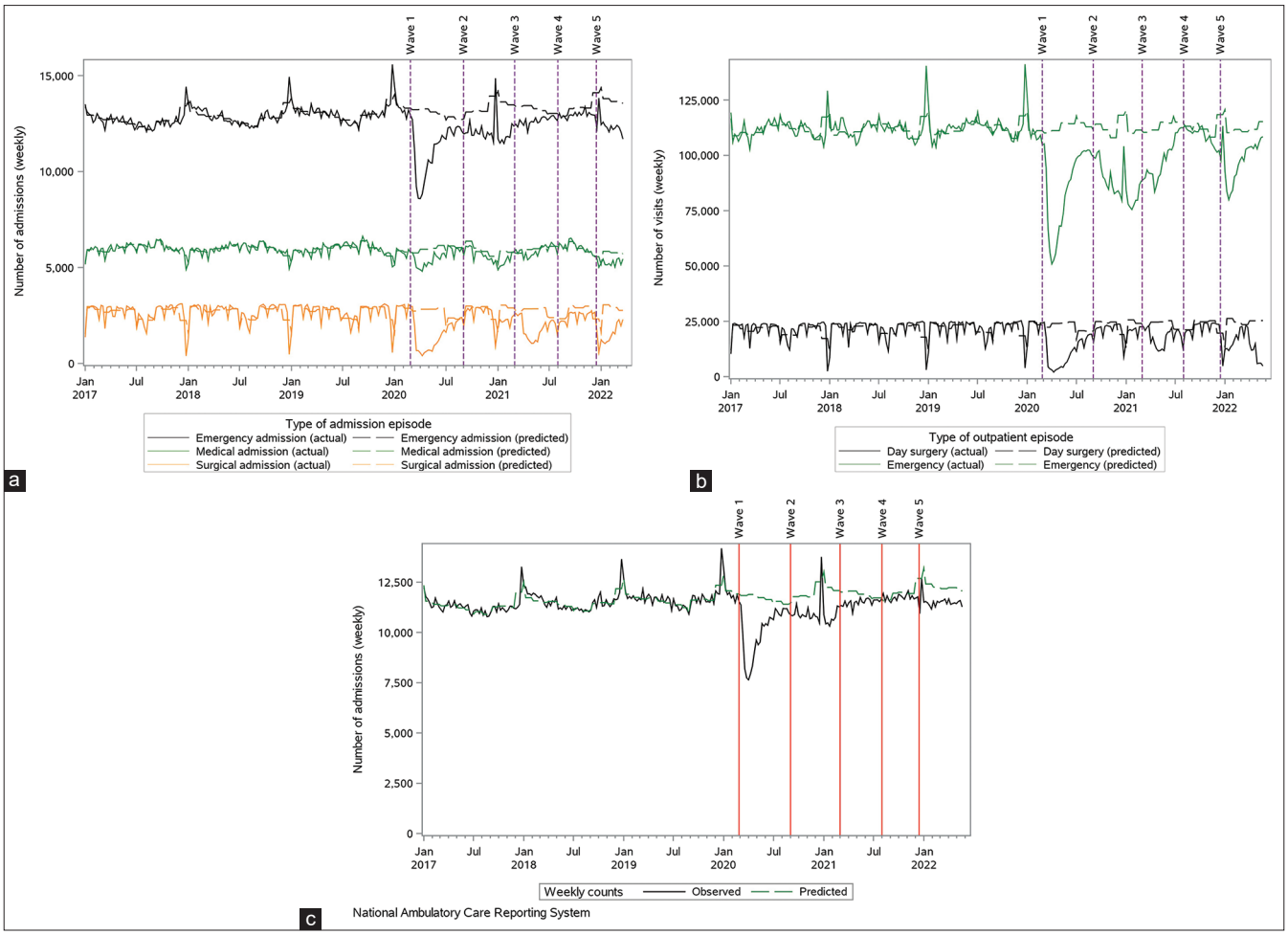

Figure 1: Weekly counts of (a) Hospital admission episodes from the DAD by type of admission. (b) Outpatient episodes from the NACRS by type of visit; and. (c) The number of ED visits with a discharge disposition direction to inpatient. DAD: Discharge abstract database, NACRS: National ambulatory care reporting system, ED: emergency department

27,616 fewer medical admissions, and 82,193 fewer surgical admissions. Emergency admissions recovered partially during Wave 2 (−10.1% of expected), further by Wave 3 (−4.6% of expected) and Wave 4 (−2.4% of expected), but dropped again during Wave 5 (−10.3% of expected). Surgical admissions were more volatile, fluctuating between the 41.7% reduction in Wave 1 to a 10.9% reduction in Wave 2, a 32.8% reduction in Wave 3, a 9.6% reduction in Wave 4, and another reduction by 43.7% in Wave 5. In contrast, medical admissions were more stable, gradually returning to baseline by wave 4 (+1.2%, P = 0.16) and exhibited reductions only at the onset of pivotal COVID-19 waves (waves 1 and 5).

ED visits followed a similar trajectory as emergency admissions (2 million fewer ED visits during the study period) [Figure 1b]. Similarly, day surgeries mirrored surgical admissions (total reduction of 667,919 fewer day surgery visits over the study period) [Figure 2a]. ED visits resulting in admission remained below baseline levels [Figure 1c].

Emergency admission and emergency department visits by diagnostic code classification

Emergency admission episodes were classified according to the presence of diagnostic codes (no restriction on most responsible diagnosis) at any point in the admission episode and compared with expected values [eFigure Set 1]. Relative to prepandemic levels, the number of weekly admissions declined across all diagnostic code groupings in Wave 1 [Figure 2b]. The smallest reduction was observed for mental health and addictions (MHAs) (129 fewer emergency admissions/week, −5.3%) and the greatest reduction was observed for diagnoses related to the respiratory system (563 fewer emergency admissions/week; −20.6%) [eTable S4]. Over waves 2–4, percent differences in emergency admissions approached expectations quicker for some diagnostic categories (e.g., nervous system disorders, genitourinary system disorders, injuries/poisoning), more slowly for others (e.g., infections/parasites, eye/ear disorders), while others remained below expectations (e.g., skin conditions and perinatal conditions). In contrast,

Table 1: Characteristics of admissions over time

	Pre-COVID era (*n*=2,420,943, 54%)[a]	COVID era (*n*=2,063,582, 46%)[b]	OR (99% CI)[b]	*P*	Standardized difference
Patient characteristics					
Age	50.3 (SD 29.5)	49.6 (SD 29.7)	1.02 (1.01-1.02)	<.0001	-0.0206
Male vs female	1,058,724 (43.7%)	896,260 (43.4%)	1.03 (1.02-1.03)	<.0001	-0.0060
LTC residence	88,944 (3.7%)	57,242 (2.8%)	0.71 (0.70-0.72)	<.0001	-0.0510
Supportive housing	85,306 (3.5%)	82,053 (4.0%)	1.15 (1.13-1.16)	<.0001	0.0248
Charlson comorbidity index	0.70 (SD 1.65)	0.68 (SD 1.64)	0.99 (0.99-1.00)	<.0001	-0.0124
Rural versus urban	307,756 (12.8%)	258,593 (12.6%)	1.00 (0.99-1.01)	0.98	0.0053
Most unstable	607,694 (25.6%)	524,723 (25.9%)	1.05 (1.04-1.06)	<.0001	0.0072
Most deprived	515,619 (21.7%)	435,658 (21.5%)	0.97 (0.96-0.98)	<.0001	0.0061
Most dependent	601,522 (25.3%)	493,244 (24.4%)	0.92 (0.92-0.93)	<.0001	0.0265
Highest ethnic concentration	558,118 (23.5%)	483,003 (23.9%)	0.98 (0.97-0.99)	<.0001	0.0118
Admission characteristic					
Ambulance arrival	688213 (28.4%)	634068 (30.6%)	1.21 (1.20-1.22)	<.0001	0.0462
Overnight admission	841,688 (34.8%)	707,434 (34.3%)	0.99 (0.98-0.99)	<.0001	-0.0102
Length of episode (days)	6.49 (SD 17.9)	6.26 (SD 13.2)	1.00 (1.00-1.00)	<.0001	-0.0145
Use of critical care	276,660 (11.4%)	232,185 (11.3%)	1.03 (1.02-1.04)	<.0001	-0.0056
Hospital transfers[c]	90,886 (3.8%)	87,276 (4.2%)	1.14 (1.13-1.16)	<.0001	0.0243
Admission category					
Medical admission	666,055 (27.5%)	608,158 (29.5%)	1.0 (ref)	<.0001	0.0752
Surgical admission	300,696 (12.45)	210,836 (10.2%)	0.89 (0.88-0.90)		
Emergency admission	1,454,192 (60.1%)	1,244,588 (60.3%)	1.03 (1.02-1.04)		
Most responsible diagnosis					
Cancer (metastatic)	18,353 (0.8%)	17,267 (0.8%)	0.91 (0.88-0.94)		
Cancer (primary)	100,288 (4.1%)	88,983 (4.3%)	0.91 (0.90-0.93)		
Cardiovascular disease	257,377 (6.7%)	112,081 (5.4%)	0.78 (0.77-0.80)		
Congenital disorder	15,016 (0.6%)	13,198 (0.6%)	0.97 (0.92-1.00)		
Digestive system	233,699 (9.7%)	213,144 (10.3%)	0.87 (0.86-0.88)		
Endocrine disorder	68,274 (2.8%)	60,413 (2.9%)	0.85 (0.83-0.86)		
Eye or ear	8,745 (0.4%)	6,552 (0.3%)	0.71 (0.68-0.74)		
Genitourinary	119,099 (4.9%)	96,162 (4.7%)	0.78 (0.76-0.79)		
Infections or parasites	75,495 (3.1%)	58,416 (2.8%)	0.71 (0.69-0.72)		
Injury or poisoning	173,824 (7.2%)	153,749 (7.5%)	0.80 (0.79-0.81)		
Mental health and addictions	63,483 (2.6%)	64,987 (3.2%)	0.94 (0.92-0.96)		
Musculoskeletal	161,000 (6.7%)	112,081 (5.4%)	0.74 (0.72-0.75)		
Nervous system	42,539 (1.8%)	36,550 (1.8%)	0.80 (0.78-0.82)		
Other diagnosis	77,244 (3.2%)	65,010 (3.2%)	0.83 (0.81-0.84)		
Perinatal condition	100,016 (4.1%)	99,670 (4.8%)	1.08 (1.07-1.10)		
Pre-cancers	50,250 (2.1%)	41,514 (2.0%)	0.82 (0.81-0.84)		
Pregnancy or childbirth	492,291 (20.3%)	463,238 (22.5%)	1.0 (ref)	<.0001	0.1490
Respiratory disease	203,379 (8.4%)	109,341 (5.3%)	0.50 (0.49-0.51)		
Skin disorder	23,695 (1.0%)	20,102 (1.0%)	0.79 (0.77-0.80)		
Some abnormal lab result	118,847 (4.9%)	103,486 (5.0%)	0.79 (0.78-0.80)		

[a]Episode start dates were restricted to occur between February 26, 2017 and February 26, 2020 (pre-COVID era) or February 26, 2020 and February 26, 2022 (COVID era) to account for seasonal variability. [b]odds ratio (OR) and 99% confidence interval (CI) adjusted for all variables shown, in addition to month. [c]an in-hospital transfer occurred of >1 hospital admission record contributed to the same admission episode. Admission episodes were restricted to episodes without known or suspected COVID-19 infection

emergency admissions related to MHAs surpassed anticipated levels by 5.2% during Wave 2, 8.2% during Wave 3, and 9.2% during Wave 4. The return to baseline was either slowed or reversed during Wave 5 across all diagnostic categories.

ED visits across all diagnostic categories declined during Wave 1 [eTable S4 and eFigure Set 2], least for primary cancers (−10.7%) and most for respiratory diagnoses (−45.1%), infections/parasites (−36.4%), and eye/ear disorders (−31.3%) [Figure 2c]. Reductions in day surgery visits [eFigure Set 3] were more drastic, particularly for eye/ear disorders (−59.9%), respiratory system disorders (−56.2%), and disorders of the skin (−51.6%).

Respiratory system subclassification

Through waves 1–5, there were 23,785, 18,746, and 10,691 fewer emergency admission episodes associated

Table 2: Observed versus expected number of weekly hospitalizations and outpatient hospital visits over time

Wave of COVID-19	Weeks/wave[a]	Regression of residuals[b]		Residual percent[c]	Total difference[d]
	n	Beta (SE)	*P*	%	*n*
Emergency admissions (surgical or medical)					
Wave 0	164	0 (ref)	-	0.02	-
Wave 1	27	-1850.1 (117.8)	<.0001	-14.06	-49,953
Wave 2	26	-1360.4 (119.8)	<.0001	-10.07	-35,370
Wave 3	22	-614.4 (128.8)	<.0001	-4.59	-13,517
Wave 4	19	-328.4 (137.5)	0.02	-2.40	-6,240
Wave 5	14	-1421.9 (158.0)	<.0001	-10.30	-19,907
					-124,987
Medical admissions					
Wave 0	164	0 (ref)	-	0.00	-
Wave 1	27	-450.4 (44.9)	<.0001	-7.53	-12,161
Wave 2	26	-316 (45.6)	<.0001	-5.37	-8,216
Wave 3	22	-107.2 (49.1)	0.03	-1.78	-2,358
Wave 4	19	74.1 (52.4)	0.16	1.23	1,408
Wave 5	14	-449.2 (60.2)	<.0001	-7.77	-6,289
					-27,616
Surgical admissions					
Wave 0	164	0 (ref)	-	-0.02	-
Wave 1	27	-1159.9 (102.8)	<.0001	-41.7	-31,317
Wave 2	26	-320.2 (104.5)	0.002	-10.9	-8,325
Wave 3	22	-914.0 (112.4)	<.0001	-32.8	-20,108
Wave 4	19	-277.1 (120.0)	0.02	-9.6	-5,265
Wave 5	14	-1227.0 (137.9)	<.0001	-43.7	-17,178
					-82,193
ED visits (NACRS)					
Wave 0	164	0 (ref)	-	0.01	-
Wave 1	27	-27830.4 (1557.4)	<.0001	-24.71	-751,421
Wave 2	26	-25283.8 (1582.9)	<.0001	-22.46	-657,379
Wave 3	22	-15072.0 (1702.6)	<.0001	-13.36	-331,584
Wave 4	19	-3767.1 (1817.2)	0.04	-3.28	-71,575
Wave 5	22	-14775.5 (1669.6)	<.0001	-13.12	-206,857
					-2,018,816
Day surgery					
Wave 0	164	0 (ref)	-	0.49	-
Wave 1	27	-11433.6 (914.7)	<.0001	-48.46	-308,707
Wave 2	26	-2446.7 (929.7)	0.009	-9.12	-63,614
Wave 3	22	-6042.6 (1000.0)	<.0001	-24.66	-132,937
Wave 4	19	-1193.0 (1067.3)	0.26	-4.21	-22,667
Wave 5	22	-9999.6 (980.6)	<.0001	-40.03	-139,994
					-667,919

[a]Weekly duration of the wave from the start of the wave until the start of the next wave or the most recent data available wave 5). Approximate dates for COVID-19 waves in Ontario were March 11, 2020 (wave 1), September 30, 2020 (wave 2), March 1, 2021 (wave 3), August 1, 2021 (wave 4), and November 1, 2021 (wave 5). [b]beta coefficient (standard error, SE) represent the mean weekly difference between observed and expcted hospital visits. [c]calculated as the residual divided by the expected number of visits x100%. [c]calculated as the mean weekly difference between observed and expected multiplied by the number of weeks

with chronic lower respiratory disease, influenza or pneumonia, or acute upper respiratory infection, respectively [eTable S5 and eFigure 1a]. Reductions were also observed for ED visits. In contrast, there was an increase in emergency admissions over the study period involving interstitial disease (+2054), surgical complications (+1966; e.g., related to mechanical ventilation), or other respiratory diseases (+1683) that was not mirrored by increases in ED visits [eTable S5].

Circulatory system sub-classification

Through waves 1–5, there 16,991 fewer emergency admissions and 28,774 fewer ED visits involving pericarditis, endocarditis, or other heart diseases. In contrast, there were 13,579 more admissions but 14,147 fewer ED visits associated with hypertensive disease. Similarly, there were 3480 more admissions but 8749 fewer ED visits associated with pulmonary disease [eTable S6 and eFigure 1b].

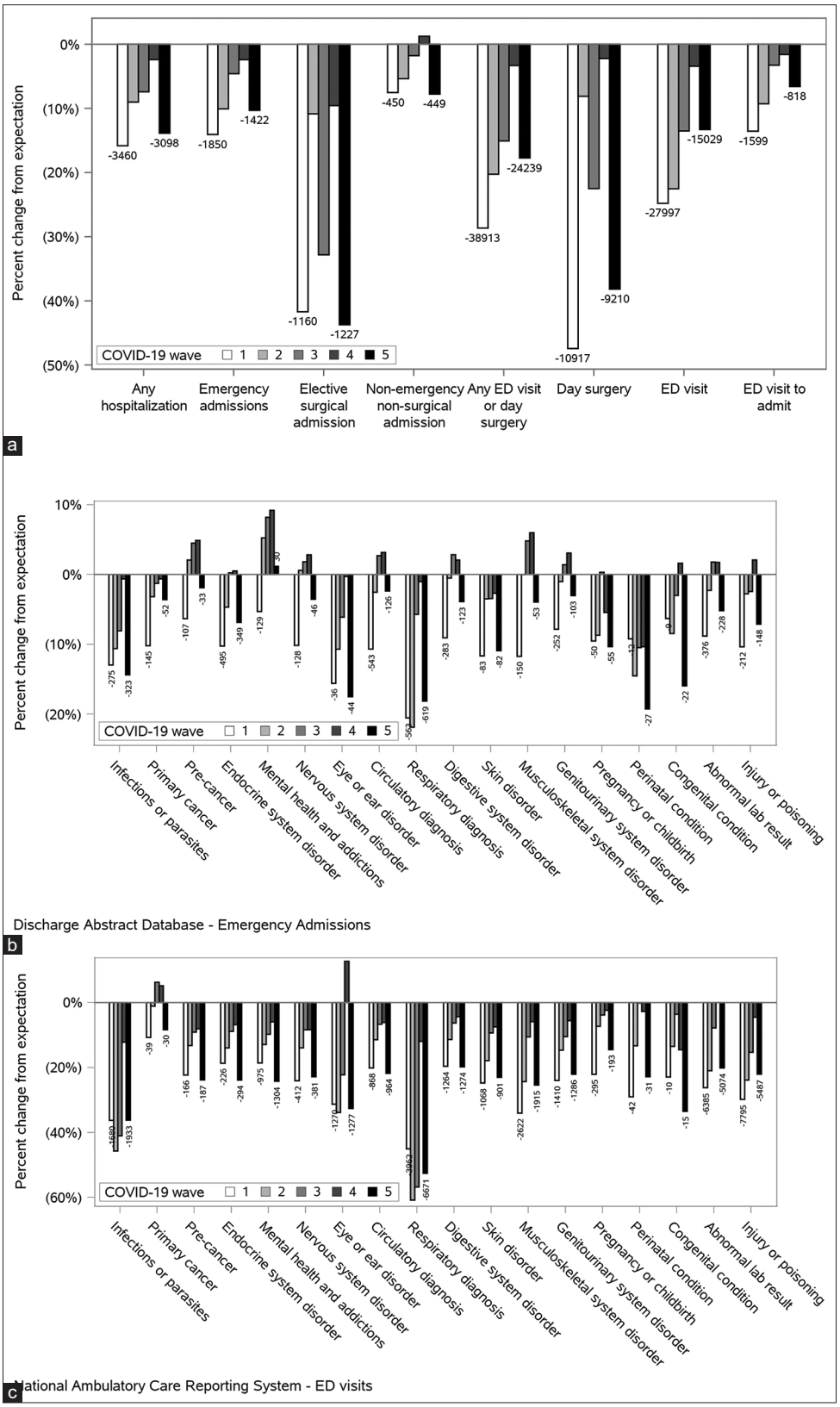

Figure 2: Percent of expected weekly rate of hospital visits (a) Emergency admissions by diagnosis classification. (b) And ED visits by diagnosis classification. (c) Percent was calculated as a proportion of the expected baseline number off weekly visits. The numbers on the bars indicate the absolute change in weekly visits from baseline for context. ED: Emergency department

Mental health and addictions sub-classification

For MHA sub-classifications, net increases between waves 1–5 were associated primarily with psychoactive substance use, which includes alcohol, opioids, cannabinoids, sedative or hypnotics, cocaine, etc., (5526 excess emergency admissions). There were 4807 excess emergency admissions related to known physiological conditions (e.g., Alzheimer's and dementia), 2702 excess emergency admissions related to mood (affective) disorders, and 1104 excess emergency admissions related to physiological disturbances (e.g., eating disorders and nonorganic sleep disorders) [eTable S7 and eFigure 1c]. ED visits decreased across all classifications, however, with the exception of those related to physiological disturbances.

Cancer diagnostic codes

For oncology sub-classifications, changes in emergency admissions and ED visits were small during the study period. The greatest reductions in emergency admissions were observed for secondary malignancies (−3844), followed by the cancers of the respiratory system (−1743), colorectal cancers (−1221), hematologic malignancies (−1216 fewer admissions), and breast cancer (−974) [eTable S8 and eFigure 1d].

Discussion

We found that all types of hospital visits were reduced at the onset of the COVID-19 pandemic in Ontario. While emergency admissions, medical admissions, and ED visits approached expected levels by Wave 4, resumption of surgical activity remains below prepandemic levels.

Some indicators of severity (e.g., ambulance arrivals, emergency admissions, and use of critical care) suggest admitted patients were more acute during the COVID-19 era.[8] However, selective reductions in surgical activity likely explain part of the relative increase in urgent admissions. Furthermore, we did not observe a higher rate of patients being admitted following an ED visit. It is possible that many patients who previously would have been admitted may instead be managed in primary care.[17] In addition, lower waiting room census and changing hospital policy during the COVID-19 pandemic may play a larger role than changes in patient acuity on determining who is admitted.[18] Regardless of the reasons behind the reduced rate of admissions and ED visits, it is possible that some of these patients may engage the healthcare system in the future with a more advanced stage of illness.

For some diagnosis categories, a reduction in hospital encounters may be driven by a true reduction in incidence. For example, the effect of pandemic restrictions on transmission of influenza and respiratory syncytial virus may explain the large reductions in respiratory system-related hospital visits.[19] For other diagnosis categories, a reduction in hospital encounters may be driven by detection bias, whereby due to hospital avoidance, more mild conditions may be missed. For other diagnostic categories, such as MHA, the COVID-19 pandemic has been demonstrated to increase the burden of MHA agnostic of age.[20-23] A more detailed examination of MHA in Ontario is warranted. Finally, there remains a group of diagnostic codes that were associated with more admissions but without a concomitant rise in ED visits. These diagnoses may be directly attributable to exacerbations caused by COVID-19 (e.g., interstitial disease, respiratory surgical complications, other respiratory diseases, hypertensive disease, and pulmonary disease).

While some degree of reductions in surgical activity was planned, it remains to be seen if longer-term patient outcomes are worse among those who had their surgery deferred.[24] The greatest reductions in day surgery activity were associated with digestive system disorders, eye/ear disorders, and precancers. The greatest reductions in surgical admissions were associated with musculoskeletal disorders and the endocrine system. Understanding specific operations that contribute most to the backlog is crucial for surgical recovery planning.

Limitations

One limitation of the present work is the lack of data on the severity of illness. Although we adjusted for comorbidity, age, and indicators of acuity, it is likely still only partially measured. In the outpatient setting, our study focused on ED visits and day surgery visits because these have mandated reporting in NACRS. Except oncology clinics, renal dialysis clinics, and cardiac catheterization laboratories, all other outpatient visits may be differentially reported by hospital. A further limitation is the potential inaccuracy of estimating comorbidity. As a result of reduced hospital utilization, population-level measures of incidence of disease that rely on hospital data (e.g., Charlson comorbidity score) may be subject to bias due to the COVID-19 pandemic. Comorbidity may therefore be underestimated for patients admitted in the COVID-19 era. Despite these limitations, one strength of this work is that it is population-based and includes data by disease classifications and hospital encounter types across the different waves of the COVID-19 pandemic. These findings are exploratory in nature and valuable toward hypothesis generation.

Conclusions

Emergency admissions, ED visits, and surgical activity have declined since the start of the COVID-19 pandemic in Ontario. For many diagnostic classifications, hospital visits

returned to baseline levels by Wave 4 before declining again at the onset of the fifth surge (Omicron B.1.1.529 wave).

Data source acknowledgements

Parts of this material are based on data and information compiled and provided by the Canadian Institute of Health Information (CIHI) and the Ministry of Health (MOH). However, the analyses, conclusions, opinions, and statements expressed herein are those of the author, and not necessarily those of CIHI or MOH.

We acknowledge support of the MOH in this report. All views expressed are those of the authors of this report and do not necessarily reflect those of Ontario or the Ministry.

Data availability statement

Ontario Health is prohibited from making the data used in this research publicly accessible if it includes potentially identifiable personal health information and/or personal information as defined in Ontario law, specifically the Personal Health Information Protection Act and the Freedom of Information and Protection of Privacy Act. Upon request, data de-identified to a level suitable for public release may be provided.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Wang J, Vahid S, Eberg M, Milroy S, Milkovich J, Wright FC, *et al*. Clearing the surgical backlog caused by COVID-19 in Ontario: A time series modelling study. CMAJ 2020;192:E1347-56.
2. Haldane V, Zhang Z, Abbas RF, Dodd W, Lau LL, Kidd MR, *et al*. National primary care responses to COVID-19: A rapid review of the literature. BMJ Open 2020;10:e041622.
3. Walker MJ, Meggetto O, Gao J, Espino-Hernández G, Jembere N, Bravo CA, *et al*. Measuring the impact of the COVID-19 pandemic on organized cancer screening and diagnostic follow-up care in Ontario, Canada: A provincial, population-based study. Prev Med 2021;151:106586.
4. Dinmohamed AG, Cellamare M, Visser O, de Munck L, Elferink MA, Westenend PJ, *et al*. The impact of the temporary suspension of national cancer screening programmes due to the COVID-19 epidemic on the diagnosis of breast and colorectal cancer in the Netherlands. J Hematol Oncol 2020;13:147.
5. Cho H, Kwon J. Pandemic and hospital avoidance: Evidence from the 2015 Middle East respiratory syndrome outbreak in South Korea. Econ Lett 2021;203:109852.
6. Splinter MJ, Velek P, Ikram MK, Kieboom BC, Peeters RP, Bindels PJ, *et al*. Prevalence and determinants of healthcare avoidance during the COVID-19 pandemic: A population-based cross-sectional study. PLoS Med 2021;18:e1003854.
7. Czeisler ME, Kennedy JL, Wiley JF, Facer-Childs ER, Robbins R, Barger LK, *et al*. Delay or avoidance of routine, urgent and emergency medical care due to concerns about COVID-19 in a region with low COVID-19 prevalence: Victoria, Australia. Respirology 2021;26:707-12.
8. Moynihan R, Sanders S, Michaleff ZA, Scott AM, Clark J, To EJ, *et al*. Impact of COVID-19 pandemic on utilisation of healthcare services: A systematic review. BMJ Open 2021;11:e045343.
9. Rennert-May E, Leal J, Thanh NX, Lang E, Dowling S, Manns B, *et al*. The impact of COVID-19 on hospital admissions and emergency department visits: A population-based study. PLoS One 2021;16:e0252441.
10. Ojetti V, Covino M, Brigida M, Petruzziello C, Saviano A, Migneco A, *et al*. Non-COVID diseases during the pandemic: Where have all other emergencies gone? Medicina (Kaunas) 2020;56:1-10.
11. Kruizinga MD, Peeters D, van Veen M, van Houten M, Wieringa J, Noordzij JG, *et al*. The impact of lockdown on pediatric ED visits and hospital admissions during the COVID19 pandemic: A multicenter analysis and review of the literature. Eur J Pediatr 2021;180:2271-9.
12. Ambulatory Care Sensitive Conditions | CIHI. Available from: https://www.cihi.ca/en/indicators/ambulatory-care-sensitive-conditions. [Last accessed on 2022 May 26].
13. Canadian Institute for Health Information. Indicator Library: General Methodology Notes — Clinical Indicators, February 2023. Ottawa, ON: CIHI; 2023.
14. Sheehan KJ, Sobolev B, Guy P, Bohm E, Hellsten E, Sutherland JM, *et al*. Constructing an episode of care from acute hospitalization records for studying effects of timing of hip fracture surgery. J Orthop Res 2016;34:197-204.
15. Matheson FI, Dunn JR, Smith KL, Moineddin R, Glazier RH. Development of the Canadian Marginalization Index: A new tool for the study of inequality. Can J Public Health 2012;103:S12-6.
16. Dobbins TA, Creighton N, Currow DC, Young JM. Look back for the Charlson Index did not improve risk adjustment of cancer surgical outcomes. J Clin Epidemiol 2015;68:379-86.
17. Vilafranca Cartagena M, Tort-Nasarre G, Romeu-Labayen M, Vidal-Alaball J. The experiences of patients with diabetes and strategies for their management during the first COVID-19 lockdown: A qualitative study. BMC Nurs 2022;21:124.
18. Gorski JK, Batt RJ, Otles E, Shah MN, Hamedani AG, Patterson BW. The impact of emergency department census on the decision to admit. Acad Emerg Med 2017;24:13-21.
19. Stamm P, Sagoschen I, Weise K, Plachter B, Münzel T, Gori T, *et al*. Influenza and RSV incidence during COVID-19 pandemic-an observational study from in-hospital point-of-care testing. Med Microbiol Immunol 2021;210:277-82.
20. Jones EA, Mitra AK, Bhuiyan AR. Impact of COVID-19 on mental health in adolescents: A systematic review. Int J Environ Res Public Health 2021;18:2470.
21. Meherali S, Punjani N, Louie-Poon S, Abdul Rahim K, Das JK, Salam RA, *et al*. Mental health of children and adolescents amidst COVID-19 and past pandemics: A rapid systematic review. Int J Environ Res Public Health 2021;18:3432.
22. Shillington KJ, Vanderloo LM, Burke SM, Ng V, Tucker P, Irwin JD. Ontario adults' health behaviors, mental health, and overall well-being during the COVID-19 pandemic. BMC Public Health 2021;21:1679.
23. Xiong J, Lipsitz O, Nasri F, Lui LMW, Gill H, Phan L, *et al*. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. J Affect Disord 2020;277:55-64.
24. Habbous S, Tai X, Beca JM, Arias J, Raphael MJ, Parmar A, *et al*. Comparison of use of neoadjuvant systemic treatment for breast cancer and short-term outcomes before vs. during the COVID-19 era in Ontario, Canada. JAMA Netw Open 2022;5:e2225118.