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Research

Demographic characteristics, acute care resource use and mortality by age and sex in patients with COVID-19 in Ontario, Canada: a descriptive analysis

Stephen Mac MBiotech, Kali Barrett MD, Yasin A. Khan MD, David M.J. Naimark MD, Laura Rosella PhD, Raphael Ximenes PhD, Beate Sander PhD

Abstract

Background: Understanding resource use for coronavirus disease 2019 (COVID-19) is critical. We conducted a descriptive analysis using public health data to describe age- and sex-specific acute care use, length of stay (LOS) and mortality associated with COVID-19.

Methods: We conducted a descriptive analysis using Ontario's Case and Contact Management Plus database of individuals who tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Ontario from Mar. 1 to Sept. 30, 2020, to determine age- and sex-specific hospital admissions, intensive care unit (ICU) admissions, use of invasive mechanical ventilation, LOS and mortality. We stratified analyses by month of infection to study temporal trends and conducted subgroup analyses by long-term care residency.

Results: During the observation period, 56 476 individuals testing positive for SARS-CoV-2 were reported; 41 049 (72.7%) of these were younger than 60 years, and 29 196 (51.7%) were female. Proportion of cases shifted from older populations (> 60 yr) to younger populations (10–39 yr) over time. Overall, 5383 (9.5%) of individuals were admitted to hospital; of these, 1183 (22.0%) were admitted to the ICU, and 712 (60.2%) of these received invasive mechanical ventilation. Mean LOS for individuals in the ward, ICU without invasive mechanical ventilation and ICU with invasive mechanical ventilation was 12.8 (standard deviation [SD] 15.4), 8.5 (SD 7.8) and 20.5 (SD 18.1) days, respectively. Among patients receiving care in the ward, ICU without invasive mechanical ventilation and ICU with invasive mechanical ventilation, 911/3834 (23.8%), 124/418 (29.7%) and 287/635 (45.2%) died, respectively. All outcomes varied by age and decreased over time, overall and within age groups.

Interpretation: This descriptive study shows use of acute care and mortality varying by age and decreasing between March and September 2020 in Ontario. Improvements in clinical practice and changing risk distributions among those infected may contribute to fewer severe outcomes.

Understanding local epidemiology and resource use implications of coronavirus disease 2019 (COVID-19) is critical to inform mitigation strategies throughout the pandemic. Appropriate allocation of acute care resources for all patients and the ability to use tailored public health measures to minimize adverse effects resulting from broad restrictions are key concerns.[1–3]

Population-level studies in Ontario to date describe several aspects of the first wave, including age- and sex-specific descriptive studies for testing; cases and outcomes up to May 26, 2020;[4] hospital admissions up to June 17, 2020 (preprint);[5] mortality using cremation data in a time series up to June 30, 2020 (preprint);[6] and prediction tools using cases up until May 15, 2020.[7] However, as the COVID-19 pandemic evolves, current data on health outcomes and use of acute care resources across stages of the pandemic are warranted.

The objective of our study was to describe the demographic characteristics of individuals testing positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Ontario between Mar. 1 and Sept. 30, 2020, and to provide estimates of age- and sex-specific use of acute care resources in patients with COVID-19 (hospital admission, intensive

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Correspondence to: Stephen Mac, sm.mac@mail.utoronto.ca

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care unit [ICU] admission and invasive mechanical ventilation), length of stay (LOS) and mortality.

Methods

Design and setting

We conducted a descriptive analysis using administrative data collected from Ontario's Case and Contact Management Plus (CCMplus) database. Ontario is the most populous province in Canada, and its residents are eligible for universal health care through the Ontario Health Insurance Plan.

Data sources

CCMplus is Ontario's province-wide population-based data set on all individuals who test positive for SARS-CoV-2 in Ontario (74 715 individuals between Jan. 23 and Oct. 30, 2020).[8] CCMplus includes individual-level data on demographic characteristics (e.g., age, sex and region), epidemiology (e.g., likely acquisition), patient characteristics (e.g., comorbidities), use of acute care resources (e.g., hospital admission, ICU admission and invasive mechanical ventilation), health outcomes (e.g., mortality) and long-term care (LTC) residency. Given the evolving nature of the data set, including addition of variables over time, our analysis was limited to outcomes of interest using fields considered complete by the data set custodian, including cumulative cases and deaths. All variables used for this analysis are described in Appendix 1, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1.

Participants

We accrued incident laboratory-confirmed COVID-19 cases between Mar. 1 and Sept. 30, 2020, and followed these individuals until Oct. 30, 2020, ensuring at least 30 days of follow-up. Accrual was based on the "accurate episode date" (episode date) field in CCMplus, the earliest date available in CCMplus of the case created, case reported, symptom onset and specimen date. Given that 94% of all cases require up to 14 days for the episode date to be completed (Appendix 2, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1), and time from episode date to hospital admission is about 8 days, we accrued cases only until Sept. 30, 2020, to allow for at least 30 days of follow-up.

Outcomes

We examined use of acute care resources (hospital admission, ICU admission and invasive mechanical ventilation), LOS at each level of acute care, and mortality. Outcomes are examined overall, by age and sex, by specific comorbidities, by LTC residence status and by month based on episode date. We considered 3 comorbidities — diabetes and immunocompromised and renal conditions — which were previously identified as conditions that increase risk of mortality among patients with COVID-19.[7] Per the CCMplus data entry guide, diabetes was checked for individuals who self-reported they had been diagnosed with diabetes. Immunocompromised was checked if a person was less capable of battling infections because of an immune response that was not properly functioning. This can be brought about by illness and disease or by medication and treatment. Renal conditions was checked if an individual had a condition in which the kidneys malfunctioned.[9]

Statistical analysis

We used a complete case analysis approach for missing data. We describe overall acute care use by 10-year age groups, sex and month based on accurate episode date. Proportion outcomes are calculated as follows: hospital admissions based on reported infections, ICU admissions based on number of hospital admissions, and invasive mechanical ventilation based on the number of ICU admissions. We assumed that individuals who were recorded as "intubated" received invasive mechanical ventilation.

Mortality and LOS were estimated by acute care level: ward (i.e., admitted to hospital but did not receive ICU care or invasive mechanical ventilation), ICU (i.e., required ICU care but no invasive mechanical ventilation) and ventilation (i.e., required invasive mechanical ventilation). Mortality was estimated based on LTC residency and by hospital admission status. For mortality and LOS, we included only individuals with resolved outcomes (i.e., resolved, fatal) and complete hospitalization data. We assigned death to the highest level of care (i.e., related to the severity of the disease). For example, if an individual was admitted to hospital, we did not differentiate whether this individual died during or after their hospitalization. Overall mortality was analyzed by month based on episode date.

All data were handled and analyzed in Microsoft Excel 2016. Detailed information on data manipulation and cleaning is included in Appendices 3, 4 and 5, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1. Results are reported following the RECORD statement for observational studies.[10]

Ethics approval

We obtained research ethics board approval from the University of Toronto.

Results

On Oct. 30, 2020, there were 74 715 cumulative individuals with laboratory-confirmed SARS-CoV-2 infection, of which 4 were excluded owing to missing age and 18 235 did not meet the accrual period (66 preaccrual and 18 169 post-accrual), resulting in a total of 56 476 individuals from Mar. 1 to Sept. 30, 2020, included in this analysis. A total of 36 073 (63.9%) patients were between the ages of 20 and 59 years, 9847 (17.4%) were aged 70 years and older, and 29 196 (51.7%) were female. Excluding LTC residents, there were 4426 (8.8%) individuals aged 70 years and older. Among LTC residents, 5421 (86.6%) were aged 70 years and older, and 4010 (64.0%) were female. All case characteristics are summarized in Table 1.

Figure 1 shows total cases by age group over time overall (Figure 1A) and excluding LTC residents (Figure 1B). As the

Table 1: Demographic characteristics of individuals testing positive for SARS-CoV-2 between Mar. 1 and Sept. 30, 2020*

Age range, yr	All individuals, no. (%) *n* = 56 476			Excluding LTC, no. (%) *n* = 50 215			Only LTC individuals, no. (%) *n* = 6261		
	Male	Female	Other	Male	Female	Other	Male	Female	Other
0–9	790 (1.4)	753 (1.3)	10 (< 1)	790 (1.6)	753 (1.5)	10 (< 1)	–	–	–
10–19	1738 (3.1)	1661 (2.9)	24 (< 1)	1738 (3.5)	7101 (14.1)	24 (< 1)	–	10 (< 1)	–
20–29	5936 (10.5)	5450 (9.7)	48 (< 1)	10 405 (20.7)		48 (< 1)	15 (< 1)		–
30–39	4484 (7.9)	4087 (7.2)	38 (< 1)		4077 (8.1)	38 (< 1)		10 (< 1)	–
40–49	3635 (6.4)	4075 (7.2)	36 (< 1)	3617 (7.2)	4054 (8.1)	35 (< 1)	18 (< 1)	21 (< 1)	6 (< 1)
50–59	3776 (6.7)	4487 (7.9)	21 (< 1)	3699 (7.4)	4395 (8.8)	21 (< 1)	77 (1.2)	92 (1.5)	
60–69	2849 (5.0)	2714 (4.8)	17 (< 1)	2522 (5.0)	2450 (4.9)	12 (< 1)	327 (5.2)	264 (4.2)	
70–79	1693 (3.0)	1639 (2.9)	20 (< 1)	1198 (2.4)	1036 (2.1)	15 (< 1)	495 (7.9)	603 (9.6)	79 (1.3)
≥ 80	2091 (3.7)	4330 (7.7)	74 (< 1)	857 (1.7)	1320 (2.6)		1234 (19.7)	3010 (48.1)	
Total	26 992 (47.8)	29 196 (51.7)	288 (< 1)	24 826 (49.4)	25 186 (50.2)	203 (< 1)	2166 (34.6)	4010 (64.0)	85 (1.4)

Note: LTC = long-term care, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
*Some age group frequency and proportions are aggregated to avoid small cells. "Other" was defined as unknown sex at the time patient information was entered into the Case and Contact Management Plus data set.

pandemic progressed, the proportion of total cases in patients aged 60 years and older decreased from a high (6585, 45.9%) in April to the lowest (1671, 12.5%) in September, and the proportion of total cases from younger populations (age 10–39 yr) increased from a low (3558, 24.8%) in April to a high (7887, 58.8%) in September. This trend was still evident when excluding LTC residents (Figure 1B). Starting in June, the age group 20–39 years accounted for the greatest proportion of reported cases, with the proportion of cases in the age group 20–29 years increasing April (1606, 11.2%) to September (4143, 30.9%).

There was a decreasing proportion of patients with comorbidities over time. In March, 10.7% (640 of 5977) of all patients had diabetes versus 4.2% (567 of 13 419) in September, and cases in patients who were immunocompromised or had renal conditions decreased from 2.8% and 3.4% (170 of 5977, and 203 of 5977, respectively) in March to 0.8% and 0.7% (105 of 13 419, and 96 of 13 419, respectively) in September.

Acute care resource use

Hospital admission and ICU admission by age and sex are summarized in Figure 2 (all data in Table 2). Overall hospital admission was 9.5% (5383 patients), with males having a slightly higher proportion of hospital admission (10.7%, 2886 patients) than females (8.5%, 2489 patients). The proportion of all reported patients with COVID-19 requiring hospital admission decreased over time, from a high in March at 20.5% (1226 patients) to 3.0% (402 patients) by the end of September. This trend is apparent for all age groups, among older adults (70–79 yr: 47.3%, 390 patients, dropping to 17.7%, 71 patients; ≥ 80 yr: 37.8%, 253 patients, dropping to 28.0%, 99 patients), and also in younger age groups (40–49 yr: 13.1%, 124 patients, dropping to 2.0%, 34 patients). On average, individuals were admitted to hospital 7.8 days after their episode date (7.9 d from symptom onset). Hospital admissions are summarized in Appendix 6, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1.

Analysis of the 3 included comorbidities (Table 3) showed that the proportion of hospital admission decreased from March to September for patients with diabetes (42.0%, 269 patients, to 13.6%, 77 patients), patients who were immunocompromised (32.9%, 56 patients, to 12.4%, 13 patients), patients with renal conditions (53.7%, 109 patients, to 36.5%, 35 patients) and individuals with 2 or more of these conditions (61.3%, 68 patients, to 46.8%, 22 patients). However, proportion of ICU admissions were similar or increased in the same period.

Overall, 22.0% (1183) of hospitalized patients required admission to the ICU, with males being more likely to require ICU care (26.2%, 756) than females (17.1%, 425). ICU admission was highest for patients between the ages of 50 and 69 years for males (37.3%, 410) and females (28.4%, 205). Invasive mechanical ventilation was required for 60.2% (712) of patients with COVID-19 admitted to the ICU. Admissions to the ICU and invasive mechanical ventilation were highest in March at 32.5% (398 hospitalized patients) and 67.6% (269 ICU patients), respectively, and decreased over the course of the pandemic to 20.6% (83 hospitalized patients) and 42.2% (35 ICU patients), respectively, in September. ICU admissions and invasive mechanical ventilation are summarized in Table 2 (Appendix 7, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1, shows the monthly breakdown).

Crude odds ratios (ORs) and 95% confidence intervals (CIs) for men not residing in LTC aged 70 years or older compared with those younger than 70 years were 13.48

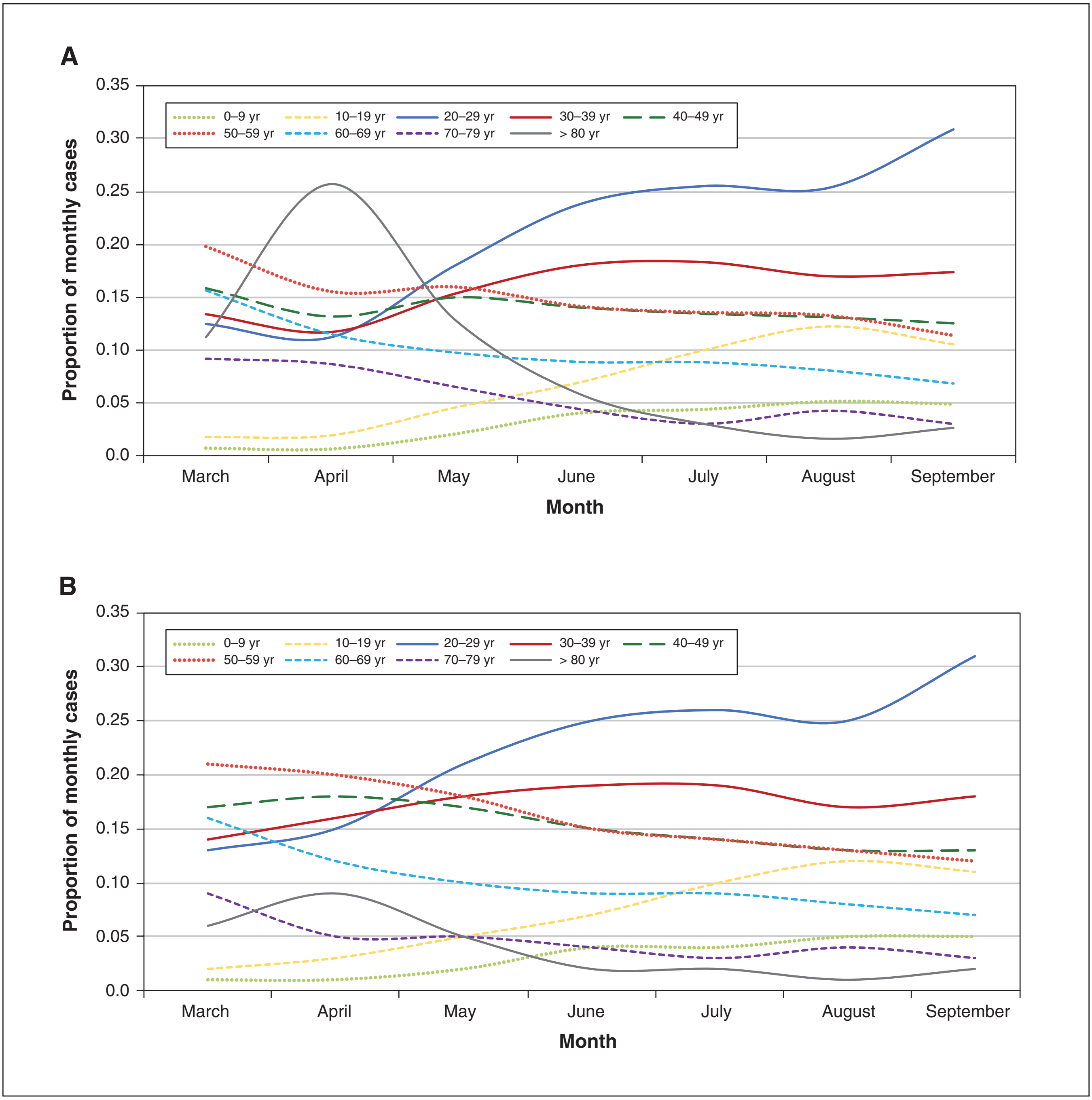

Figure 1: Distribution of individuals testing positive for severe acute respiratory syndrome coronavirus 2 by age group from Mar. 1 to Sept. 30, 2020. (A) The distribution of cases by age groups including long-term care (LTC) residents. (B) The distribution of cases when LTC residents were excluded from the analysis.

(95% CI 12.18–14.92) for hospitalization, 0.52 (95% CI 0.44–0.63) for ICU admission among those hospitalized and 0.92 (95% CI 0.66–1.28) for need for invasive mechanical ventilation after ICU admission. For women not residing in LTC aged 70 years or older compared with those younger than 70 years, crude ORs were 12.76 (95% CI 11.50–14.16) for hospitalization, 0.51 (95% CI 0.40–0.64) for ICU admission among those hospitalized and 0.73 (95% CI 0.47–1.13) for need for invasive mechanical ventilation after ICU admission. All ORs by sex and LTC status are presented in Appendix 8, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1.

Length of stay

The mean LOS for those admitted to the ward was 12.8 days. Individuals who required ICU care had an average LOS of 14.6 days (8.5 d in the ICU, 1.9 d in the ward pre-ICU and 4.2 d post-ICU). Individuals requiring invasive mechanical

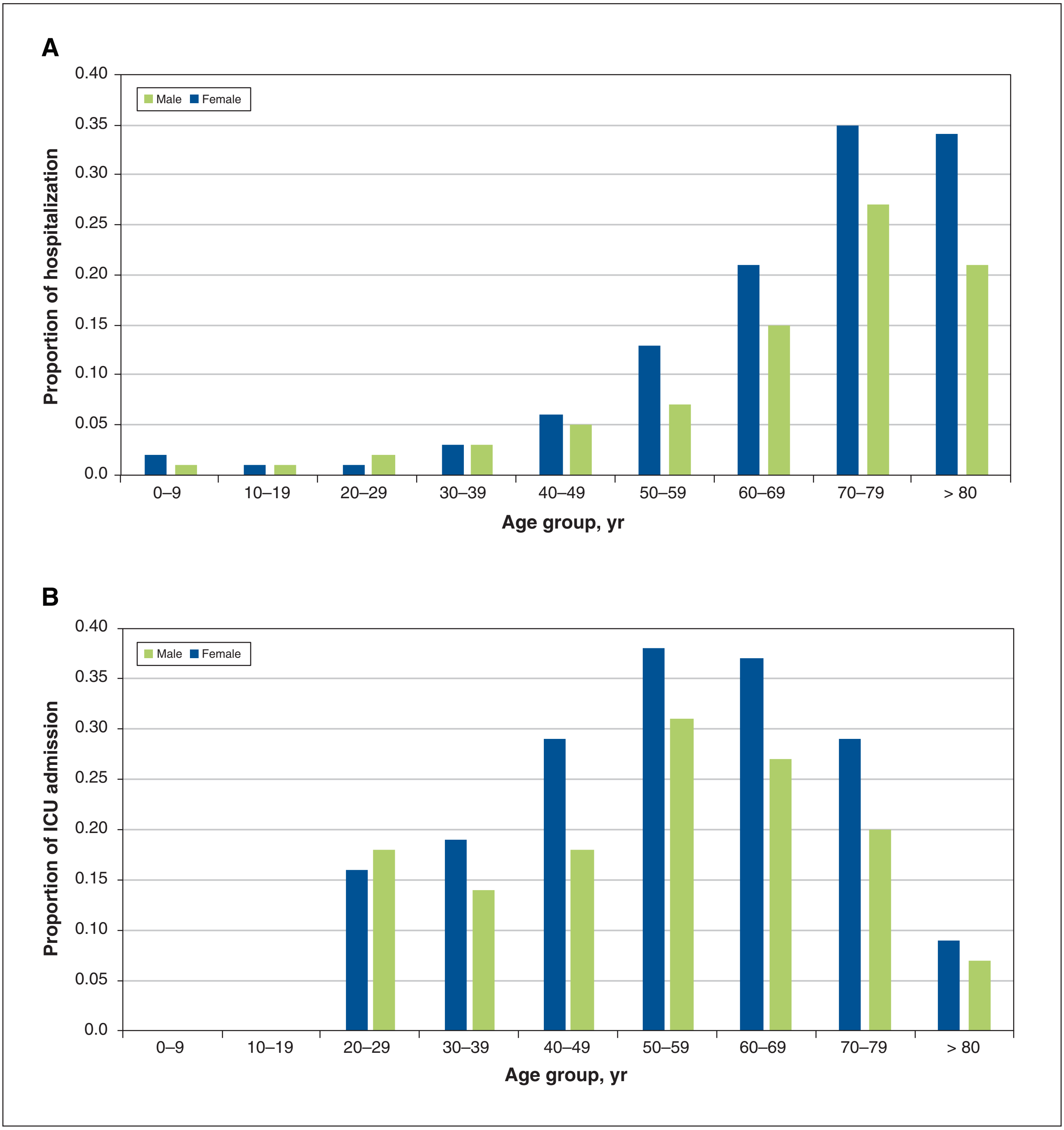

Figure 2: Use of acute care resources by age and sex for (A) hospitalization and (B) intensive care unit (ICU) admissions after initial hospitalization. "Others" group for all, and ages 0 to 9 and 10 to 19 for panel B are not shown owing to small cells.

ventilation had an average LOS of 29.7 days (20.5 d in the ICU with invasive mechanical ventilation, 1.2 d in the ICU pre- or postventilation, 1.6 d in the ward pre-ICU and 6.3 d post-ICU care). Of the 1183 individuals requiring ICU care (with or without invasive mechanical ventilation), 469 (39.6%) stayed in the ward before ICU admission for 1 day or longer (mean LOS of 4.1 d).

The mean LOS by month for each of the 3 levels of acute care overall and with LTC residents excluded is presented in Table 4. The number of days spent in the ward for individuals not requiring ICU admission decreased from an average of 16.2 in May to 7.7 days in September. Similarly, the LOS for ICU patients who required invasive mechanical ventilation decreased from an average of 21.5 days in April to 14.4 days in September.

Table 2: Hospital admission, ICU admission and use of ventilation by age and sex among individuals testing positive for SARS-CoV-2 between Mar. 1 and Sept. 30, 2020*†

Age range, yr	Hospital admission, no. (%) n = 5383			ICU and hospital admission, no. (%) n = 1183			IMV and ICU admission, no. (%) n = 712		
	Male	Female	Other	Male	Female	Other	Male	Female	Other
0–9	12 (1.5)	8 (1.1)	8 (2.8)	19 (17.3)	17 (14.9)	NR	10 (52.6)	9 (52.9)	NR
10–19	21 (1.2)	18 (1.1)							
20–29	77 (1.3)	88 (1.6)							
30–39	140 (3.1)	119 (2.9)		27 (19.3)	17 (14.3)		16 (59.3)	7 (41.2)	
40–49	235 (6.5)	185 (4.5)		68 (28.9)	34 (18.4)		41 (60.3)	21 (61.8)	
50–59	497 (13.2)	327 (7.3)		188 (37.8)	100 (30.6)		120 (63.8)	62 (62.0)	
60–69	602 (21.1)	394 (14.5)		222 (36.9)	105 (26.6)		136 (61.3)	72 (68.6)	
70–79	589 (34.8)	440 (26.8)		169 (28.7)	86 (19.5)		106 (62.7)	51 (59.3)	
≥ 80	713 (34.1)	910 (21.0)		63 (8.8)	66 (7.3)		26 (41.3)	33 (50.0)	
Total	2886 (10.7)	2489 (8.5)	8 (2.8)	756 (26.2)	425 (17.1)	NR	455 (60.2)	255 (60.0)	NR

Note: ICU = intensive care unit, IMV = invasive mechanical ventilation, NR = not reported owing to small cell, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
*Some age group frequency and proportions are aggregated to avoid small cells. “Other” was defined as unknown sex at the time patient information was entered into the Case and Contact Management Plus data set.
†Proportion of hospitalization is calculated as number of hospitalizations per number of cases within respective group. Proportion of ICU admission is given as number of ICU admissions per number of hospitalized individuals within respective group. Proportion of ventilation is given as number of individuals requiring ventilation over number of individuals admitted to ICU within respective groups.

Table 3: Hospital and ICU admissions for individuals with comorbidities who tested positive for SARS-CoV-2 between March and September 2020

Comorbidity	No. (%)*†						
	March	April	May	June	July	August	September
Hospital admission							
Diabetes‡	269 (42.0)	440 (28.9)	219 (24.2)	73 (19.4)	51 (19.4)	36 (14.9)	77 (13.6)
Immunocompromised§	56 (32.9)	94 (35.2)	63 (40.9)	11 (18.0)	10 (22.2)	18 (13.1)	
Renal conditions¶	109 (53.7)	190 (43.3)	67 (36.4)	28 (35.4)	14 (29.2)	9 (23.7)	35 (36.5)
≥ 2 of these conditions	68 (61.3)	115 (49.4)	51 (52.0)	19 (50.0)	10 (55.6)	27 (41.5)	
ICU admission							
Diabetes‡	102 (37.9)	100 (22.7)	57 (26.0)	17 (23.3)	17 (33.3)	9 (25.0)	22 (28.6)
Immunocompromised§	19 (33.9)	20 (21.3)	13 (20.6)	6 (28.6)		7 (38.9)	
Renal conditions¶	38 (34.9)	35 (18.4)	27 (40.3)	10 (35.7)	6 (26.1)		13 (37.1)
≥ 2 of these conditions	26 (38.2)	25 (21.7)	19 (37.3)	7 (24.1)		13 (48.2)	

Note: ICU = intensive care unit, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
*Some months do not show exact frequency and are aggregated owing to small cells ($n \leq 5$).
†Proportions are calculated by taking the number of patients with comorbidities who were admitted to hospital based on the total number of patients with comorbidities by month based on episode date for hospitalizations, and by taking the number of patients with comorbidities requiring ICU admission based on the total number of patients with comorbidities who were admitted to hospital.
‡Defined as an individual who self-reports they have been diagnosed with diabetes.
§Defined as a person who is less capable of battling infections because of an immune response that is not properly functioning. This can be brought about by illness and disease or medication and treatment.
¶Defined as an individual who has a condition in which the kidneys malfunction.

The LOS distribution for all 3 levels of acute care are shown in Appendices 9, 10 and 11, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1.

Mortality

Among cases designated as resolved, the mortality during our observation period was 6.2% overall (3037 deaths, 49 362

Table 4: Length of stay by level of care in individuals with comorbidities who tested positive for SARS-CoV-2 between March and September 2020

Level of care	Month; mean ± SD, d							
	March	April	May	June	July	August	September	7-mo average
Includes all individuals with outcome of “recovered” or “fatal”								
	n = 1013	*n* = 1459	*n* = 753	*n* = 202	*n* = 120	*n* = 63	*n* = 173	
Ward, *n* = 2856	10.3 ± 14.1	14.2 ± 16.0	16.1 ± 18.0	9.2 ± 8.5	10.4 ± 12.9	6.6 ± 4.5	7.7 ± 6.1	12.8 ± 15.4
ICU, no IMV, *n* = 379	9.7 ± 8.7	8.3 ± 8.2	7.1 ± 5.6	8.7 ± 9.1	8.5 ± 4.4	12.3 ± 12.4	7.1 ± 6.7	8.5 ± 7.8
ICU, IMV, *n* = 548	21.5 ± 18.7	20.4 ± 18.7	21 ± 17.5	18 ± 16.3	16 ± 11.1	10.7 ± 7.3	14.4 ± 8.0	20.5 ± 18.1
Excludes LTC residents with outcome of “recovered” or “fatal”								
	n = 970	*n* = 1042	*n* = 608	*n* = 173	*n* = 112	*n* = 61	*n* = 153	
Ward, *n* = 2251	9.4 ± 12.6	11.7 ± 14.1	14.2 ± 17.1	8.4 ± 7.7	10.3 ± 13.2	6.4 ± 4.3	7.1 ± 5.7	11 ± 13.8
ICU, no IMV, *n* = 347	9.7 ± 8.8	7.9 ± 7.6	7.2 ± 5.6	9.4 ± 9.5	8.2 ± 4.5	12.3 ± 12.4	7.5 ± 6.8	8.5 ± 7.7
ICU, IMV, *n* = 521	21.4 ± 18.7	20.3 ± 17.9	21.3 ± 17.6	18.6 ± 16.5	16 ± 11.1	10.7 ± 7.3	14.4 ± 8.0	20.5 ± 17.8

Note: ICU = intensive care unit, IMV = invasive mechanical ventilation, LTC = long-term care, SD = standard deviation.

resolved cases), 33.6% for LTC residents (1972 deaths, 5862 resolved cases), and 2.4% for non-LTC residents (1065 deaths, 43 500 resolved cases). Overall mortality is summarized by month in Appendix 12, available at www.cmajopen.ca/content/9/1/E271/suppl/DC1. Mortality decreased from a high of 13.4% (1818 deaths) in April to 1.1% (98 deaths) in September for all individuals, and from 5.1% (271 deaths) to 0.6% (55 deaths) when excluding LTC residents.

Age- and sex-specific mortality by highest level of acute care are summarized in Table 5. Mortality for individuals requiring hospital admission was 3.9% (1715 deaths, 44 475 resolved cases), and mortality for individuals not requiring hospital admission was 27.1% (1322 deaths, 4887 resolved hospitalizations). For hospitalized LTC residents, mortality was 50.4% (441 deaths, 875 resolved hospitalizations), and for nonhospitalized LTC residents, mortality was 30.7% (1531 deaths, 4987 resolved cases). For non-LTC residents, mortality was 22.0% (881 deaths, 4012 resolved hospitalizations) for hospitalized patients and 0.5% (184 deaths, 39 488 resolved cases) for nonhospitalized patients.

Overall mortality for individuals receiving care only in the ward, individuals receiving care in the ICU and individuals requiring invasive mechanical ventilation were 23.8% (911 deaths), 29.7% (124 deaths) and 45.2% (287 deaths), respectively. Excluding LTC residents, the overall mortality for the aforementioned levels of care was 17.0% (513 deaths), 26.8% (102 deaths) and 43.9% (266 deaths), respectively. Among patients with COVID-19 admitted to the ward, mortality was highest among men aged 70–79 years (23.9%, 94 deaths) and older than 80 years (48.9%, 292 deaths). Mortality for individuals requiring ICU admission was highest in individuals aged 70–79 years (45.5%, 40 deaths), and older than 80 years (64.7%, 44 deaths). Among patients with COVID-19 who required invasive mechanical ventilation, mortality was similarly highest among the older populations: 58.7% (84 deaths) among those aged 70–79 years, and 75.4% (43 deaths) among those older than 80 years.

Interpretation

We provide a descriptive analysis of total individuals testing positive for SARS-CoV-2 from Mar. 1, to Sept. 30, 2020, by age, sex and LTC residency. The population testing positive for SARS-CoV-2 changed over time: predominantly older age groups tested positive in the first 3 months, and as the summer progressed, positive tests were predominantly among younger age groups. As the demographic characteristics of those testing positive changed, so too did use of health care resources; older age groups had a larger proportion of cases requiring admission to hospital and the ICU, and requiring invasive mechanical ventilation. The burden of infection among LTC residents resulted in substantial morbidity and mortality; LTC residents represented about 12% of total cases and most deaths (65%). Individuals 70 years of age and older infected with SARS-CoV-2 had higher odds of being hospitalized.

Our results show a decline in the proportion of patients hospitalized and requiring ICU resources, and a decline in LOS between March and September. However, the decrease in use of acute care resources and mortality was observed overall and within age strata, suggesting that these decreases cannot be entirely explained by changing age distribution over time. There are several potential explanations for these observations. Changes in clinical practice patterns may have resulted in reduced hospitalizations, use of critical care resources and shorter hospital stays. As clinicians gained more experience caring for patients with COVID-19, they may have become comfortable with expectant management, favouring noninvasive oxygenation or ventilation inside and outside the ICU, in lieu of early invasive mechanical ventilation.

Table 5: Mortality by level of care, age and sex among individuals who tested positive for SARS-CoV-2 between March and September 2020

Age range, yr	No. (%)*†								
	Ward *n* = 3834			ICU, no ventilator *n* = 418			ICU and IMV *n* = 635		
	Male	Female	Other	Male	Female	Other	Male	Female	Other
0–9	–	–	–	–	–	–	–	–	–
10–19	–	–	–	–	–	–	–	–	–
20–29	9 (1.5)	35 (4.6)	–	13 (13.8)	12 (13.8)	–	14 (24.1)	–	–
30–39			–			–		–	–
40–49			–			–		7 (35.0)	–
50–59			–			–	25 (24.5)	18 (32.1)	–
60–69	45 (13.1)		–	15 (20.0)		–	63 (53.4)	33 (50.8)	–
70–79	94 (23.9)	76 (23.5)	–	29 (51.8)	11 (34.4)	–	66 (68.8)	18 (38.3)	–
≥ 80	292 (48.9)	357 (45.1)	–	22 (61.1)	22 (68.8)	–	18 (72.0)	25 (78.1)	–
Total	440 (22.8)	468 (24.7)	–	79 (29.7)	45 (29.6)	–	186 (46.4)	101 (43.5)	–

Note: ICU = intensive care unit, IMV = invasive mechanical ventilation, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
*Some age group frequency and proportions are aggregated to avoid small cells.
†Proportion of mortality is given as number of deaths over the number of cases (resolved or fatal) by level of care, within respective age and sex group.

This may have lowered prolonged hospitalization and decreased mortality from ventilator-associated bacterial pneumonia or other ICU-related complications.[11–14] Clinical practice changes including the use of prone positioning to improve oxygenation in nonintubated patients and use of dexamethasone may have contributed to improved outcomes, although data do not yet exist to support these hypotheses.[15–18] The adoption of public health measures including mask wearing and physical distancing may have resulted in lower inoculums of virus, which early evidence suggests may be associated with a reduction in the severity of illness.[19] Finally, as risk factors leading to increased severity of illness and death became widely known, those most at risk may have changed their behaviour to reduce their likelihood of becoming ill. However, evidence to support these hypotheses does not yet exist.

While results from this descriptive study suggest that the proportion of acute care resource use, outcomes (mortality) and LOS are decreasing, they do not imply that the disease has become less severe and do not capture long-term sequelae. A growing body of evidence describes long-term sequelae experienced by many who had mild acute illness, including memory loss and fatigue months after the initial illness, a condition described as "long COVID" (1 reference from preprint).[20,21]

Limitations

Our analysis has several limitations. The CCMplus is an administrative data set and is subject to underreporting and potential misclassification.[22,23] Testing policies and case definitions have changed between March and September 2020 in Ontario. For example, increased testing may identify additional nonsevere or asymptomatic cases, which would lower the proportion of hospitalization, and a switch to appointment-only testing may capture more severe cases only, increasing the proportion of hospitalization. However, these changes should only affect the proportion of hospitalization.

Furthermore, since these data have been collated from various sources, they may be more prone to underreporting of outcomes and data entry errors. Backfilling of data can result in data being added later, delaying the reporting of outcomes up to 2 months. Although we present September outcomes in our analysis, they should be interpreted with caution, as hospitalizations and outcomes are lagging indicators[24] (i.e., the data are right-censored). There is attrition or reporting bias by excluding those with unreliable follow-up data from our analysis, which in addition to our approach to missing data, may underestimate the LOS. Our study does not consider bias specific to any population subgroup or geography.

Some of these trends may be confounded by changing health care–seeking behaviours, public health interventions, implementing and lifting of restrictions, and individual differences (e.g., socioeconomic status, comorbidities and geography).[23] Owing to data availability, we were unable to analyze outcomes and resource use by all social determinants of health, an important factor in SARS-CoV-2 transmission and COVID-19 outcomes (1 reference from preprint),[25,26] but we were able to explore 3 comorbidities and their impact on hospital admissions. As such, we mostly presented data descriptively and believe it would be inappropriate to present statistical measures to identify associations without fully adjusting for confounding. Crude odds ratios should be interpreted with caution as they are not adjusted for all potential confounding variables.

Conclusion

This descriptive analysis summarizes demographic characteristics, acute care use, mortality and LOS among patients with COVID-19, stratified by age and sex over 7 months of the pandemic in Ontario, Canada. We were able to show the demographic data and outcomes over time, capturing the different stages of the pandemic. These insights are critical for policy-makers and capacity planners as the pandemic evolves. Further, our findings can be used to inform modelling and other studies estimating the impact of COVID-19 and predicting health care resource needs.

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Affiliations: Institute of Health Policy, Management and Evaluation (Mac, Barrett, Khan, Naimark, Sander), University of Toronto; Toronto Health Economics and Technology Assessment (THETA) Collaborative (Mac, Ximenes, Sander), University Health Network; University Health Network (Barrett, Khan); Sunnybrook Health Sciences Centre (Naimark); Dalla Lana School of Public Health (Rosella), University of Toronto, Toronto, Ont.; Escola de Matemática Aplicada (Ximenes), Fundação Getúlio Vargas, Rio de Janeiro, Brazil; ICES Central (Rosella, Sander); Public Health Ontario (Rosella), Toronto, Ont.

Contributors: Stephen Mac, Kali Barrett, Yasin Khan, David Naimark, Raphael Ximenes and Beate Sander contributed to the conception and design. Beate Sander and Stephen Mac contributed to the acquisition of data. Stephen Mac, Kali Barrett, Laura Rosella and Beate Sander contributed to the analysis and interpretation of data. Stephen Mac and Kali Barrett drafted the article. Yasin Khan, David Naimark, Laura Rosella, Raphael Ximenes and Beate Sander revised it critically for important intellectual content. All authors gave final approval of the version to be published and agreed to act as guarantors of the work.

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