

**1 Patients Hospitalized with Laboratory-Confirmed COVID-19 in Canadian Acute-Care
2 Hospitals, March 1 to June 22 2020**

3 Robyn Mitchell¹, Kelly Baekyung Choi¹, Linda Pelude¹, Wallis Rudnick¹, Nisha Thampi^{2,*} and Geoffrey
4 Taylor^{3,*} for the CNISP COVID-19 Working Group^a

5 Affiliations

- 6 1. Public Health Agency of Canada, Ottawa, ON
- 7 2. Children’s Hospital of Eastern Ontario, Ottawa, ON
- 8 3. University of Alberta Hospital, Edmonton, AB

9 *These authors contributed equally to this report

10 ^aOther members of the CNISP COVID-19 Working Group:

11 James Brooks, Public Health Agency of Canada, Ottawa, ON; Kathryn Bush, Alberta Health Services,
12 Calgary, BC; Jeannette Comeau, IWK Health Centre, Halifax, NS; John Conly, University of Calgary,
13 Calgary, AB; Chelsey Ellis, The Moncton Hospital, Moncton, NB; John Embil, Health Sciences Centre,
14 Winnipeg, MB; Gerald A. Evans, Kingston Health Sciences Centre, Kingston, ON; Charles Frenette, McGill
15 University Health Centre, Montreal, QC; Gregory German, Queen Elizabeth Hospital, Charlottetown, PEI;
16 Lynn Johnston, QEII Health Sciences Centre, Halifax, NS; Jennie Johnstone, Sinai Health, Toronto, ON;
17 Kevin C. Katz, North York General Hospital, Toronto, ON; Bonita E. Lee, Stollery Children’s Hospital,
18 Edmonton, AB; Marie-Astrid Lefebvre, Montreal Children’s Hospital, Montreal, QC; Yves Longtin, SMBD-
19 Jewish General Hospital, Montreal, QC; Allison McGeer, Sinai Health, Toronto, ON; Dominik Mertz,
20 McMaster University and Hamilton Health Sciences, Hamilton, ON; Jessica Minion, Saskatchewan Health
21 Authority, Regina, SK; Caroline Quach, CHU Sainte-Justine, Montreal, QC; Stephanie Smith, University of
22 Alberta Hospital, Edmonton, AB; Jocelyn Srigley, BC Women’s and Children’s Hospital, Vancouver, BC;
23 Paula Stagg, Western Memorial Hospital, Corner Brook, NL; Vivienne Steele, Public Health Agency of
24 Canada, Ottawa, ON; Kathryn N. Suh, The Ottawa Hospital, Ottawa, ON and Alice Wong, Royal University
25 Hospital, Saskatoon, SK.

26 **Abstract**

27 Understanding the epidemiology of patients hospitalized with laboratory-confirmed COVID-19 in
28 Canadian acute-care hospitals is essential to inform infection prevention and control strategies and
29 public health measures. As of June 22, 2020, the Canadian Nosocomial Infection Surveillance Program
30 received preliminary data for 1,030 patients hospitalized with COVID-19 in 31 sentinel hospitals in 8
31 provinces. The majority of Canadian patients hospitalized with COVID-19 were older (median age 70
32 years) and had underlying medical conditions (83.3%). Few pediatric COVID-19 hospitalizations were
33 reported (n=20, 1.9%). Acquisition of COVID-19 in hospitals was infrequent (3.0% of all cases). Overall,
34 31.2% of patients acquired their infection in long-term care or retirement homes. Healthcare workers
35 represented 4.4% of all COVID-19 hospitalized patients. Thirty-day attributable mortality was 15.7%.
36 Hospitalization rates peaked in mid-April and were highest in Ontario and Quebec. Active surveillance of
37 patients hospitalized with COVID-19 identifies populations at risk for severe outcomes and helps to
38 guide Canada's public health response.

39 **Introduction**

40 SARS-CoV-2, the novel coronavirus that causes coronavirus disease 2019 (COVID-19), has spread across
41 the globe and placed a significant burden on healthcare systems. In Canada, the first laboratory-
42 confirmed case of COVID-19 was hospitalized on January 23, 2020^{1,2}; as of July 22, 2020, 104,772 cases
43 of COVID-19 have been reported³. Detailed data on hospitalized patients and those admitted to
44 intensive care units with COVID-19 are essential to inform infection prevention and control strategies,
45 prioritize healthcare resources and inform public health measures. Patients hospitalized with COVID-19
46 have been described in the United States⁴⁻¹⁰, China^{11,12} and Italy¹³; however, a detailed understanding of
47 the patient population hospitalized with COVID-19 in Canada has not yet been reported.

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49 **Methods**

50 The Canadian Nosocomial Infection Surveillance Program (CNISP) conducts surveillance for healthcare-
51 associated viral respiratory infections. Beginning March 15, 2020, surveillance was expanded to include
52 all patients hospitalized with laboratory-confirmed COVID-19. The CNISP is a collaboration between the
53 Public Health Agency of Canada (PHAC) and sentinel hospitals across Canada that participate as
54 members of the Canadian Hospital Epidemiology Committee, a subcommittee of the Association of
55 Medical Microbiology and Infectious Disease Canada.¹⁴

56 Patients of any age who were admitted to a participating CNISP hospital within 14 days of a positive
57 SARS-CoV-2 test were eligible for inclusion. Healthcare acquisition was defined as symptom onset ≥ 7
58 calendar days after admission to the reporting hospital or if the patient was readmitted with a positive
59 test < 7 days after discharge from hospital and using best clinical judgement (e.g. symptom onset < 7
60 days but known epi link to a positive case). Experienced and trained hospital staff reviewed the medical
61 records of eligible patients using a standardized case report form to collect data on patient
62 demographics and characteristics, underlying medical conditions, clinical presentation, treatment,
63 interventions and outcomes. Retrospective case identification of patients admitted back from March 1,
64 2020, was conducted. In addition, weekly aggregate data on the number of incident COVID-19 cases in
65 hospital were collected from 44 CNISP and 91 non-CNISP hospitals beginning the week of March 15,
66 2020. Data were submitted through the Canadian Network for Public Health Intelligence, a secure online
67 platform. Analyses were conducted using R, version 3.5.1 and SAS EG, version 7.1. Fisher-Freeman-
68 Halton Exact tests and Chi-square tests were used to compare proportions.

69 This report presents preliminary data on patients hospitalized with laboratory-confirmed COVID-19 in a
70 subset of Canadian acute care hospitals.

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72 Results

73 As of June 22, 2020, detailed data on patients hospitalized with laboratory-confirmed COVID-19 were
74 available from 31 CNISP acute-care hospitals in 8 provinces (Table 1). Among 1,030 patients hospitalized
75 with COVID-19, the median age was 70 years (interquartile range (IQR) = 54–83) and 52.0% (527/1,013)
76 were male. The proportion of males in the 50–64 year age group was significantly higher compared to
77 the proportion in other age groups ($p=0.0008$) (Table 2).

78 Twenty (1.9%) pediatric patients (<18 years) were hospitalized with COVID-19; 6 (30.0%) were less than
79 1 year of age and 6 (30.0%) were 1–4 years of age. Fifty-three percent (8/15) had an underlying medical
80 condition and two (10.0%) were admitted to an intensive care unit (ICU). No deaths were reported
81 among pediatric patients.

82 Healthcare workers (HCWs) comprised 4.4% (37/846) of adult (> 18 years) hospitalized cases; 77.8%
83 (21/27) reported having provided direct care to COVID-19-positive patients. One hospitalized HCW
84 reported travel outside of Canada in the 14 days prior to symptom onset. The median age of HCWs
85 hospitalized with COVID-19 was 53 years (IQR = 46-56); 67.6% (25/37) were female and 68.6% (24/35)
86 had at least one underlying medical condition. Ten (27.8%) were admitted to the ICU due to COVID-19
87 and one death was reported. HCWs were significantly younger than non-healthcare workers (53 vs. 71
88 years, $p<0.001$); were more likely to be female (67.6% vs. 48.6%, $p=0.02$) and less likely to have an
89 underlying medical condition (68.6% vs. 80.1%, $p=0.003$).

90 Among all hospitalized cases, 59.0% (599/1,015) acquired their infection in the community while 3.0% of
91 cases were due to hospital acquisition (30/1,015) (Table 2). Overall, 31.2% of patients (313/1,002)
92 acquired their infection in long-term care or retirement homes. The proportion of deaths among
93 patients admitted from long-term care or retirement homes was 37.4% (117/313), significantly higher
94 than all other hospitalized patients (12.2%, 84/686, $p<0.001$).

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3 95 The majority of patients (83.3%, 722/867) had at least one underlying medical condition and the
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5 96 presence of medical conditions significantly increased with age ($p<0.001$) (Table 2). Chronic heart
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7 97 disease (42.2%), diabetes (25.3%) and chronic lung disease (20.2%) were the most frequently
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10 98 documented conditions among all patients. Among 76 females aged 15–44 years in hospital with COVID-
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12 99 19, 26 (34.2%) were pregnant. Among all patients, pneumonia was the most common clinical
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14 100 presentation (63.8%, 542/849), with the most commonly reported symptoms being cough (64.2%,
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16 101 552/860), fever (62.8%, 540/860), and shortness of breath (57.9%, 498/860). Diarrhea was reported in
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18 102 22.1% of patients (190/860), while 13.6% (117/860) had nausea or vomiting. Significant differences in
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20 103 symptoms were identified between age groups (Table 2). Secondary bacterial infection was identified in
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22 104 18.3% (150/820) of hospitalized patients, and the most common pathogens were *Escherichia coli*
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24 105 (28.7%, 43/150) and coagulase-negative Staphylococci (16.0%, 24/150). Common treatments included
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26 106 ceftriaxone (36.9%, 314/851) and hydroxychloroquine combined with azithromycin (29.7%, 253/851)
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28 107 (Table 3).
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33 108 During hospitalization, 21.0% (214/1,018) of patients with COVID-19 were admitted to the ICU; 14.7%
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35 109 (150/1,021) required mechanical ventilation and two patients (0.2%) required extracorporeal membrane
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37 110 oxygenation. The proportion of patients requiring mechanical ventilation and/or ICU admission was
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39 111 significantly higher among those 50–64 years compared to all other age groups (Table 3). ICU admission
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41 112 was three times higher among patients with an underlying medical condition compared to those
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43 113 without (75.7% vs. 24.3%, $p<0.001$).
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47 114 All cause 30-day mortality was 19.8% (203/1,026) and 30-day attributable mortality was 15.7%
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49 115 (161/1,026). The median age of all patients who died was 83 years (IQR = 75-90) and 57.7% (116/201)
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51 116 were male (Figure 1). Mortality among those admitted to the ICU was 23.0% (49/213) and, of those
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53 117 patients who were mechanically ventilated, 25.3% (38/150) died. The median age of ICU patients who
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55 118 died was 69 years (IQR = 69-79.5) and 75.0% (36/48) were male. Thirty-day all-cause mortality was 19

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3 119 times higher among patients with a reported underlying medical condition than those without (95.1%
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5 120 vs. 4.9%, $p < 0.001$).
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8 121 The incidence of patients with laboratory-confirmed COVID-19 among 135 Canadian acute care hospitals
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10 122 increased from 3.4 cases per 1,000 admissions during the week of March 15, 2020, peaked at 12.4 per
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12 123 1,000 admissions the week of April 19 and decreased to 1.6 per 1,000 admissions the week of June 21,
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14 124 2020 (Figure 2). Hospitalization rates were highest in the Central region of Canada (Ontario and
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16 125 Quebec), which coincides with the areas of highest prevalence of COVID-19 in Canada.³
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20 126 **Interpretation**

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23 127 These data contribute to our understanding of the epidemiology of COVID-19 among adults and children
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25 128 hospitalized in Canadian acute-care hospitals. These findings suggest that a large proportion of
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27 129 Canadians hospitalized with COVID-19 are older and have underlying medical conditions. Few pediatric
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29 130 COVID-19 hospitalizations were reported. These results are consistent with data from the United
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31 131 States^{4,6,7,10,15-17} and Europe¹⁸ and with reports of milder COVID-19 illness among pediatric patients.<sup>16,19-
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37 133 A large proportion of pregnant women were identified among women 15-45 years hospitalized with
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39 134 COVID-19. However, this finding may reflect screening and testing policies for pregnant women upon
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41 135 admission, as 69.2% (18/26) were admitted for labour or pregnancy-related complications rather than
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43 136 COVID-19 related illness. Our surveillance data identified that 4.4% of patients hospitalized with COVID-
44
45 137 19 were HCWs, similar to reports from the United States^{6,7,22} and China¹¹ (3.4% to 5% and 3.5%
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47 138 respectively). While many hospitalized HCWs had provided care to COVID-19 patients, it is beyond the
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49 139 scope of our surveillance to ascertain whether acquisition was occupational or in the community.
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52 140 However, recent evidence from Seattle found that there was no significant difference in the prevalence
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54 141 of COVID-19 infection between frontline HCWs and non-frontline staff.²² In addition, a seroprevalence
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3 142 study conducted among hospital staff in Belgium²³ found that neither being directly involved in clinical
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5 143 care nor working in a COVID-19 unit increased the odds of being seropositive, suggesting that
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7 144 transmission in hospitals is likely limited when appropriate infection prevention and control measures
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10 145 are in place. Further plans for enhanced surveillance are underway to better understand the impact of
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12 146 COVID-19 on HCWs.

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15 147 Of concern is the large proportion of hospitalized patients (31.2%) who acquired their infection in long-
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17 148 term care or retirement homes. The severe impact of COVID-19 on this vulnerable population has also
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19 149 been reported by the European Union²⁴ and United States.^{5,8,25} Furthermore, mortality among
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21 150 hospitalized patients was highest in patients 85 years and older. These findings highlight the severity of
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23 151 this pandemic among older adults and among those in facilities in Canada.²⁶ Timely identification of
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25 152 COVID-19 in the community is important for rapid implementation of control measures to protect these
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27 153 populations.

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31 154 COVID-19 hospitalization rates indicate that, with a few exceptions, public health measures were able to
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33 155 mitigate a surge in patients during the first pandemic wave. Ongoing monitoring of hospital and ICU
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35 156 admissions is a key indicator that will provide timely information on COVID-19 disease activity and
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37 157 severity in Canada to inform public health decision making and optimize mitigation strategies, including
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39 158 the extent to which non-urgent care should be scaled down in preparation for future waves.

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43 159 Our data have several limitations. This report describes preliminary findings of the epidemiology of the
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45 160 first wave of COVID-19 in a subset of Canadian acute-care hospitals. These findings may change as
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47 161 additional data become available. CNISP hospitals are predominantly large teaching hospitals, therefore
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49 162 results may not be generalizable to all Canadian acute-care facilities. It is important to note that the data
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51 163 represent those cases that were severe enough to require hospitalization and are not fully descriptive of
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53 164 all persons identified with COVID-19.

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3 165 **Conclusion**
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6 166 This report describes the current epidemiology of patients hospitalized with COVID-19, using preliminary
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8 167 data from a subset of Canadian acute-care hospitals. Our findings have identified populations at risk for
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10 168 severe outcome (such as long-term care home residents) for whom coordinated and targeted control
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12 169 measures are required. Continued surveillance of hospitalization rates, clinical characteristics and
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14 170 outcomes of patients hospitalized with COVID-19 is critical to enhancing our knowledge of the
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16 171 epidemiology of COVID-19 in Canada and guiding our response to future waves of infection.
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3 173 **Acknowledgements**
4

5 174 The authors thank Joelle Cayen and Cecilia McClellan for their support with data entry and gratefully
6 175 acknowledge the dedication and contributions of the infection control practitioners, epidemiologists
7 176 and staff for their data collection and submission at each participating hospital, as well as the following
8 177 members of the Canadian Nosocomial Infection Surveillance Program:

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10
11 178 Bonita E. Lee, Stollery Children's Hospital, Edmonton, AB; Caroline Quach, CHU Sainte-Justine, Montreal,
12 179 QC; Chelsey Ellis, The Moncton Hospital, Moncton, NB; Dominik Mertz, McMaster University and
13 180 Hamilton Health Sciences, Hamilton, ON; Geoffrey Taylor, University of Alberta Hospital, Edmonton, AB;
14 181 Gerald A. Evans, Kingston Health Sciences Centre, Kingston, ON; Gregory German, Queen Elizabeth
15 182 Hospital, Charlottetown, PEI; Ian Davis, QEII Health Sciences Centre, Halifax, NS; Jeannette Comeau, IWK
16 183 Health Centre, Halifax, NS; Jennie Johnstone, Sinai Health, Toronto, ON; Jerome Leis, Sunnybrook Health
17 184 Sciences Centre, Toronto, ON; Jessica Minion, Saskatchewan Health Authority, Regina, SK; Joanne
18 185 Embree, Health Sciences Centre, Winnipeg, MB; Jocelyn Srigley, BC Children's Hospital, BC Women's
19 186 Hospital, Vancouver, BC; Johan Delpont, London Health Sciences Centre, London, ON; John Embil,
20 187 Health Sciences Centre, Winnipeg, MB; Joseph Vayalumkal, Alberta Children's Hospital, Calgary, AB;
21 188 Kathryn Bush, Alberta Health Services, Calgary, AB; Kevin C. Katz, North York General Hospital, Toronto,
22 189 ON; Lynn Johnston, QEII Health Sciences Centre, Halifax, NS; Marie-Astrid Lefebvre, Montreal Children's
23 190 Hospital, Montreal, QC; Michelle Science, Hospital for Sick Children, Toronto, ON; Natalie Bridger,
24 191 Eastern Health-HSC, St. John's, NL; Nisha Thampi, Children's Hospital of Eastern Ontario, Ottawa, ON;
25 192 Pamela Kibsey, Royal Jubilee Hospital, Victoria, BC; Paula Stagg, Western Memorial Hospital, Corner
26 193 Brook, NL; Stephanie Smith, University of Alberta Hospital, Edmonton, AB; Susy Hota, University Health
27 194 Network, Toronto, ON and Yves Longtin, SMBD-Jewish General Hospital, Montreal, QC.

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Table 1. Summary of participating hospitals who provided detailed patient information (N=31), March 1 – June 22, 2020

Province	Number of hospitals	Number and proportion of cases	
	n	n	%
British Columbia	3	20	1.9
Alberta	6	231	22.4
Saskatchewan	2	5	0.5
Manitoba	2	9	0.9
Ontario	13	273	26.5
Quebec	2	446	43.3
Atlantic provinces*	3	46	4.5

*Atlantic provinces includes: Nova Scotia and Newfoundland and Labrador

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Table 2. Demographics and clinical characteristics of patients hospitalized with laboratory-confirmed COVID-19 (N=1,030), March 1 – June 22, 2020

	Age group (years), no./total no. (%)					
	All ages	<18	18–49	50–64	65+	<i>p</i>
No. patients	1,030	20 (1.9)	171 (16.6)	239 (23.3)	598 (58.2)	N/A
Age - median (IQR)*	70 (54-83)	1 (0–11)	39 (33–45)	57 (54–61)	81 (73–88)	
Sex (Male)	527/1,013 (52.0)	7/20 (35.0)	80 (47.1)	147 (62.8)	293 (49.9)	0.0008
Sex (Female)	486/1,013 (48.0)	13/20 (64.0)	90 (52.9)	87 (37.2)	294 (50.1)	0.0011
Healthcare worker	37/846 (4.4)	N/A	13/122 (10.7)	23/184 (12.5)	1/540 (0.2)	<0.0001
Long term care or retirement home resident	313/1,002 (31.2)	N/A	1/169 (0.6)	19/238 (8.0)	291/591 (49.3)	<0.0001
Underlying medical conditions	n=867	n=15	n=123	n=184	n=539	
Any condition	722 (83.3)	8 (53.3)	79 (64.2)	78 (63.4)	503 (93.3)	<0.0001
Heart disease	366 (42.2)	2 (13.3)	13 (10.6)	55 (29.9)	295 (54.7)	<0.0001
Diabetes	219 (25.3)	0	15 (12.2)	38 (20.7)	166 (30.8)	<0.0001
Lung	175 (20.2)	2 (13.3)	14 (11.4)	30 (16.3)	128 (23.8)	0.0053
Kidney	71 (8.1)	1 (6.7)	3 (2.4)	10 (5.4)	57 (10.6)	0.0059
Immunosuppression	38 (4.4)	0	4 (3.3)	12 (6.5)	22 (4.1)	0.4563
Cancer	49 (5.7)	1 (6.7)	4 (3.3)	10 (5.4)	34 (6.3)	0.5632
Neurological disorder	44 (5.1)	0	2 (1.6)	7 (3.8)	35 (6.5)	0.1013
Liver disease	19 (2.2)	0	2 (1.6)	6 (3.3)	11 (2.0)	0.7065
Pregnant**	26/76 (34.2)	N/A	N/A	N/A	N/A	N/A
Symptoms		n=15	n=129	n=186	n=528	
Cough	552/860 (64.2)	6 (40.0)	87 (67.4)	142 (76.3)	315 (59.7)	<0.0001
Fever	540/860 (62.8)	7 (46.7)	83 (64.3)	136 (73.1)	312 (59.1)	0.0031
Shortness of breath	498/860 (57.9)	3 (20.0)	79 (61.2)	131 (70.4)	284 (53.8)	<0.0001
Weakness	186/860 (21.6)	2 (13.3)	19 (14.7)	47 (25.3)	118 (22.4)	0.1200
Diarrhea	190/860 (22.1)	2 (13.3)	33 (25.6)	62 (33.3)	93 (17.6)	0.0001
Pain	169/860 (19.6)	0	40 (31.0)	60 (32.3)	67 (12.7)	<0.0001

Vomiting or nausea	117/860 (13.6)	2 (13.3)	21 (16.3)	33 (17.7)	61 (11.6)	0.1217
Sore throat	86/860 (10.0)	2 (13.3)	25 (19.4)	25 (13.4)	33 (6.3)	<0.0001
Headache	82/860 (9.5)	1 (6.7)	20 (15.5)	35 (18.8)	25 (4.7)	<0.0001
Runny nose	52/860 (6.0)	2 (13.3)	14 (10.9)	12 (6.5)	23 (4.4)	0.0193
Loss of smell or taste	27/860 (3.1)	1 (6.7)	10 (7.8)	10 (5.4)	6 (1.1)	0.0001
Acquisition	n=1,015	n=20	n=167	n=238	n=588	<0.0001
Community	599 (59.0)	17 (85.0)	149 (89.2)	196 (82.4)	236 (40.1)	N/A
Reporting healthcare facility	30 (3.0)	0	3 (1.8)	3 (1.3)	24 (4.1)	N/A
Other healthcare facility	326(32.1)	1 (5.0)	1 (0.6)	24 (10.1)	229 (50.9)	N/A
Unknown	60 (5.9)	2 (10.0)	14 (8.4)	15 (6.3)	29 (4.9)	N/A
		n=15	n=115	n=179	n=509	
Secondary bacterial infection	150/820 (18.3)	0	12 (10.4)	30 (16.8)	108 (21.2)	0.0078

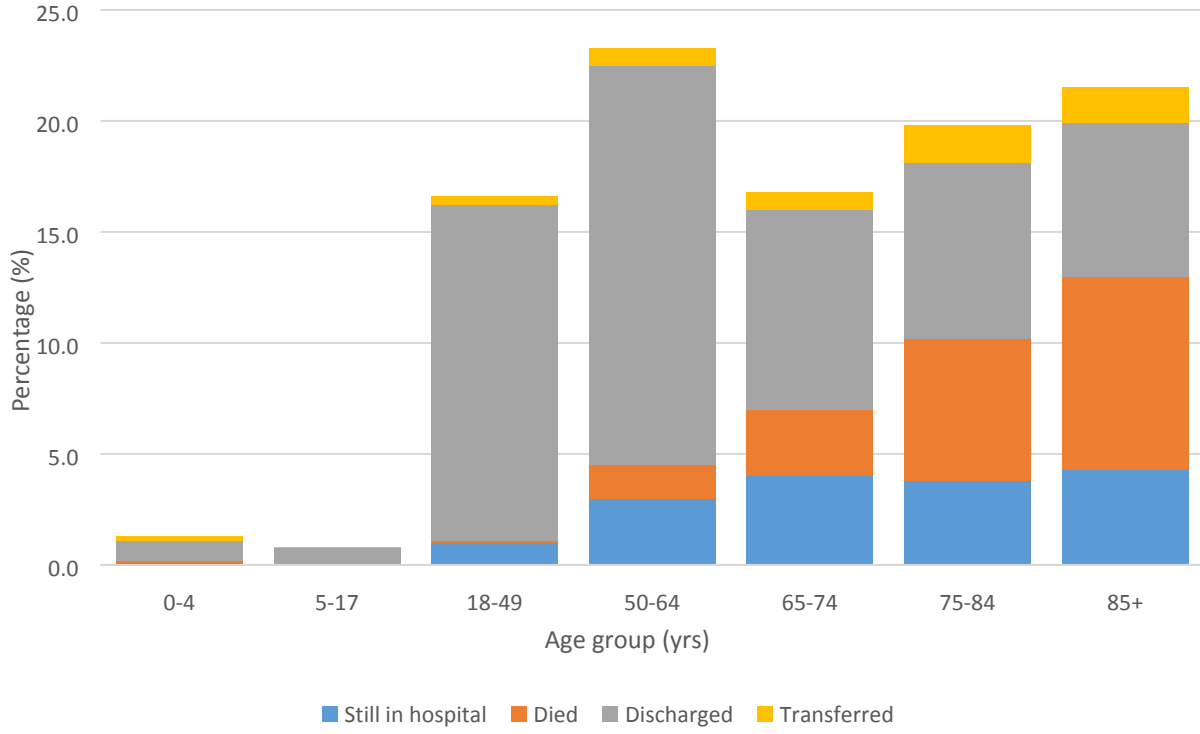
*IQR, interquartile range; **Among females age 15-44 years; N/A, not applicable

Table 3. Treatment, interventions and outcomes of patients hospitalized with laboratory-confirmed COVID-19 (N=1,030), March 1 – June 22, 2020

	All ages	Age group (years), no./total no. (%)				p
		<18	18–49	50–64	65+	
Antimicrobials						
Ceftriaxone	314/851 (36.9)	0	37/124 (29.8)	78/183 (42.6)	197/527 (37.4)	0.0010
Azithromycin	199/851 (23.4)	0	29/124 (23.4)	32/183 (23.5)	126/527 (23.9)	0.1511
Piperacillin/Tazobactam	99/851 (11.6)	0	5/124 (4.0)	17/183 (9.3)	76/527 (14.4)	0.0020
Treatment						
Hydroxychloroquine + azithromycin	253/851 (29.7)	1/15 (6.7)	31/124 (25.0)	68/183 (37.2)	152/527 (28.8)	0.0163
Steroids	79/851 (9.3)	0	5/124 (4.0)	13/183 (7.1)	60/527 (11.4)	0.0262
Oseltamivir	60/754 (8.0)	0	9/104 (8.7)	16/158 (10.1)	35/476 (7.4)	0.5394
ICU admission and interventions						
ICU admission due to COVID-19	214/1,014 (21.1)	2/20 (10.0)	33/169 (19.5)	75/235 (31.9)	104/588 (17.7)	<0.0001
Invasive mechanical ventilation	150/1,021 (14.7)	0	18/171 (10.5)	62/237 (26.2)	70/591 (11.8)	<0.0001
Extracorporeal membrane oxygenation	2/1,014 (0.2)	NR*	NR	NR	NR	NR
Dialysis as a result of COVID-19	26/836 (3.1)	0	2/116 (1.7)	10/179 (5.6)	14/525 (2.7)	0.2273
30 day outcome						
Still in hospital	n=1,026 166 (16.2)	n=20 1 (5.0)	n=170 10 (5.9)	n=239 31 (13.0)	n=595 124 (20.8)	<0.0001 N/A
Discharged	602 (58.7)	17 (85.0)	155 (91.2)	185 (77.4)	244 (41.0)	N/A
Transferred	55 (5.4)	2 (10.0)	4 (2.4)	8 (3.4)	41 (6.9)	N/A
Died	203 (19.8)	0	1 (0.6)	15 (6.3)	186 (31.3)	N/A
Death attributable to COVID-19	161/197 (81.7)	0	1/1 (100)	13/14 (92.9)	141/181 (80.7)	0.5701

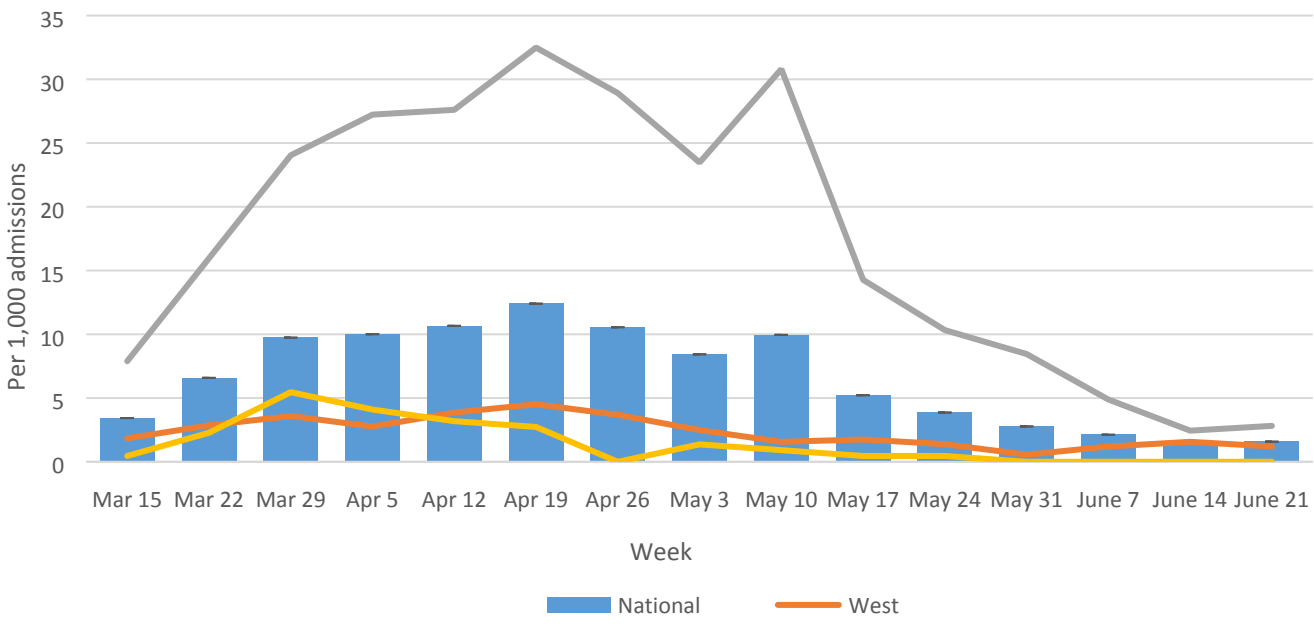
*NR = data not reported due to small numbers

Figure 1. 30-day outcome among patients hospitalized with laboratory-confirmed COVID-19, by age group (N=1,025), March 1 – June 22, 2020



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Figure 2. National and regional incidence of patients hospitalized with laboratory-confirmed COVID-19 per 1,000 admissions, by week, March 15 – June 27, 2020



West includes British Columbia, Alberta, Saskatchewan and Manitoba (107 reporting hospitals)

Central includes Ontario and Quebec (11 reporting hospitals)

East includes Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland and Labrador (17 reporting hospitals)