RESEARCH LETTER

Characteristics of Hospitalized Adults With COVID-19 in an Integrated Health Care System in California

Coronavirus disease 2019 (COVID-19) has resulted in increased hospital and intensive care unit (ICU) use. In the United States, few reports have characterized patients treated outside of the ICU.[1] Northern California was an early epicenter of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) community transmission in the United States. We report hospitalization and ICU admissions from Kaiser Permanente Northern California (KPNC), a regional integrated health care system serving 4.4 million members, constituting 30% of the area's insured population.

Methods | We performed a retrospective cohort study of adults (≥18 years) with nasal/throat swabs positive for SARS-CoV-2 by polymerase chain reaction hospitalized between March 1, 2020, and March 31, 2020, at 21 KPNC hospitals. Tests were approved by infectious disease physicians based on public health and local guidelines. Patients were triaged according to clinician judgment. No patients were lost to follow-up.

We characterized patients by demographics, comorbid disease,[2] severity of illness,[2] ICU use, laboratory/chest film data, and highest level of respiratory support. Patients were treated according to national guidelines for pneumonia and acute respiratory distress syndrome. We report numbers (percentages) for binary/categorical variables and medians (interquartile ranges) for continuous variables. As of April 9, 2020, 14.8% of the cohort was still hospitalized. In-hospital mortality estimates were calculated for patients with discharge dispositions as of April 9, 2020.

The KPNC institutional review board approved the project with a waiver of informed consent.

Results | Of 16 201 tests in adults, results from 1299 patients (8.0%) were positive for SARS-CoV-2. Of these patients, 377 (29.0%) were treated as inpatients and 113 (8.7%) were treated in the ICU.

The median age was 61.0 years (interquartile range, 50.0-73.0); 56.2% were men (**Table**). The most common comorbidity was hypertension (n = 164, 43.5%). Of 166 patients who underwent testing for influenza A/B or respiratory syncytial virus (44.0% of the cohort), none tested positive. Bilateral infiltrates on chest film were seen in 63.4% (n = 239). Overall, 34 patients (9.0%) received a prednisone-equivalent dosage of 20 mg/d or more.

Most patients were treated on the general ward or intermediate care unit (n = 264, 70.0%); of whom 54.9% received

Table. Characteristics of Adult Patients Hospitalized With Coronavirus Disease 2019 in Northern California[a]

	No. (%)		
	All adults (N = 377)	Adults treated on general ward or intermediate care unit (n = 264)	Adults treated in intensive care unit (n = 113)
Age, median (IQR), y	61.0 (50.0-73.0)	60.0 (49.0-72.0)	63.0 (53.0-73.0)
Sex			
Male	212 (56.2)	138 (52.3)	74 (65.4)
Female	165 (43.8)	126 (47.7)	39 (34.5)
COPS2, median (IQR)[b]	13.0 (10.0-33.0)	13.0 (10.0-35.0)	10.0 (9.0-32.0)
Comorbidities			
Hypertension	164 (43.5)	106 (40.2)	58 (51.3)
Diabetes	118 (31.3)	73 (27.7)	45 (39.8)
Chronic kidney disease	48 (12.7)	36 (13.6)	12 (10.6)
COPD or asthma	28 (7.4)	20 (7.6)	8 (7.1)
Congestive heart failure	22 (5.8)	18 (6.8)	4 (3.5)
Liver cirrhosis	21 (5.6)	14 (5.3)	7 (6.2)
Malignancy	18 (4.8)	12 (4.5)	6 (5.3)
LAPS2, median (IQR)[c]	72.0 (52.0-95.0)	64.0 (49.0-83.0)	93.0 (73.0-115.0)
Chief symptom in emergency department			
Shortness of breath	185 (49.1)	118 (44.7)	67 (59.3)
Fever	127 (33.7)	88 (33.3)	39 (34.5)
Cough	120 (31.8)	80 (30.3)	40 (35.4)

(continued)

Table. Characteristics of Adult Patients Hospitalized With Coronavirus Disease 2019 in Northern California[a] (continued)

	No. (%)		
	All adults (N = 377)	Adults treated on general ward or intermediate care unit (n = 264)	Adults treated in intensive care unit (n = 113)
Initial laboratory tests, median (IQR)[d]			
White blood cell count, $\times 10^9$/L	6.4 (4.7-8.5)	6.2 (4.6-8.1)	7.3 (5.4-9.2)
Reference range	3.7-11.1		
Absolute neutrophil count, $\times 10^9$/L	4.8 (3.3-6.7)	4.3 (3.1-5.9)	5.6 (3.9-7.4)
Reference range	1.8-7.9		
Absolute lymphocyte count, $\times 10^9$/L	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.9 (0.7-1.2)
Reference range	0.9-3.2		
Creatinine, mg/dL	0.9 (0.7-1.1)	0.9 (0.7-1.0)	0.9 (0.8-1.2)
Reference range	≤1.11		
Lactate, mmol/L	1.2 (1.0-1.6)	1.2 (0.9-1.5)	1.4 (1.0-1.8)
Reference range	0.5-1.9		
AST, U/L	36.0 (25.0-56.0)	34.0 (24.0-55.0)	39.0 (31.0-58.0)
Reference range	10-40		
ALT, U/L	29.0 (19.0-47.0)	28.0 (18.0-48.0)	29.0 (21.0-41.0)
Reference range	0-41		
Total bilirubin, mg/dL	0.6 (0.4-0.8)	0.5 (0.4-0.7)	0.6 (0.5-0.9)
Reference range	0.2-1.2		
LDH, U/L	302 (224-398)	288 (212-365)	345 (274-489)
Reference range	≤270		
Viral respiratory panel			
Influenza A/B	0	0	0
Respiratory syncytial virus	0	0	0
Initial chest film result, opacities			
None	62 (16.4)	55 (20.8)	7 (6.2)
Unilateral	61 (16.2)	51 (19.3)	10 (8.8)
Bilateral	239 (63.4)	143 (54.2)	96 (85.0)
Highest level of respiratory support			
Nasal cannula/face mask	150 (39.8)	145 (54.9)	5 (4.4)
High-flow oxygen	12 (3.2)	8 (3.0)	4 (3.5)
Noninvasive ventilation	8 (2.1)	7 (2.7)	1 (<1)
Invasive ventilation	110 (29.2)	7 (2.7)[e]	103 (91.2)
Received steroid equivalent to prednisone ≥20 mg/d while inpatient	34 (9.0)	20 (7.6)	14 (12.4)

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; COPD, chronic obstructive pulmonary disease; COPS2, Co-morbidity Point Score version 2; IQR, interquartile range; LAPS2, Laboratory-based Acute Physiology Score version 2; LDH, lactate dehydrogenase.

SI conversion factors: To convert ALT, AST, and LDH to μkat/L, multiply by 0.0167; bilirubin to μmol/L, multiply by 17.104; creatinine to μmol/L, multiply by 88.4; and lactate to mg/dL, divide by 0.111.

[a] Hospitalizations can occur as observations or inpatient admissions. If a patient had a rehospitalization, data from the first hospitalization are reported.

[b] COPS2 is assigned based on all diagnoses incurred by a patient in the 12 months preceding the index hospitalization. Prior to the pandemic, the univariate relationship of COPS2 score with 30-day mortality was as follows: 0-39, 1.7%; 40-64, 5.2%; and ≥65, 9.0%.[2]

[c] LAPS2 is assigned based on a patient's worst vital signs, pulse oximetry, neurological status, and 16 laboratory test results in the 72 hours preceding hospitalization. Prior to the pandemic, the univariate relationship of an admission LAPS2 score with 30-day mortality was as follows: 0-59, 1.0%; 60-109, 5.0%; and ≥110, 13.7%.[2]

[d] Most patients underwent these laboratory tests (>97% for cell counts and creatinine, 88% for lactate, 80% for liver function tests, and 52% for LDH).

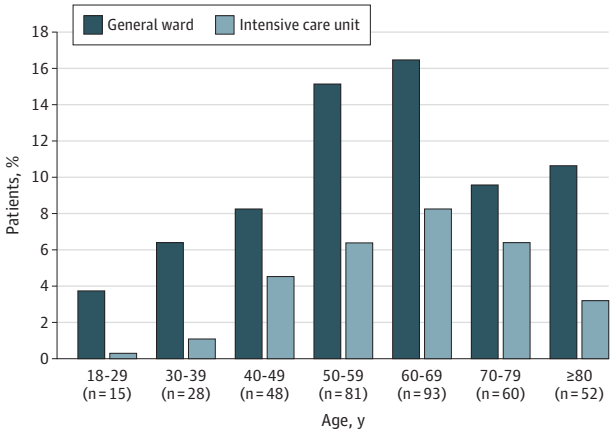
[e] Patients treated in intermediate care units capable of mechanical ventilation.

supplemental oxygen through nasal cannula/face mask. A total of 113 inpatients (30.0%) required ICU admission and 110 (29.2%) received invasive mechanical ventilation.

Patients aged 60 to 69 years represented the most common age group both hospitalized (n = 93, 24.6%) and admitted to the ICU (n = 31, 27.4%) (**Figure**). However, adults of all ages were admitted, and the proportion of younger and middle-aged adults (≤59 years) who were hospitalized (n = 172, 45.6%) was similar to the proportion of older adults (≥60 years) who were hospitalized (n = 205, 54.4%).

Of 321 patients with discharge dispositions, 50 (15.6%) died in the hospital. Of 253 patients treated on the ward with discharge dispositions, 16 (6.3%) died. Of 68 patients treated in the ICU with discharge dispositions, 34 (50.0%) died.

Figure. Distribution by Age Group of Adult Patients Admitted to General Ward and Intensive Care Unit With Coronavirus Disease 2019



Patients treated in intermediate care units are grouped under general ward.

Discussion | Estimates of patients with positive SARS-CoV-2 test results who were (1) admitted to a KPNC hospital (29.0%) and (2) treated in an ICU (8.7%) are broadly similar to those from the US Centers for Disease Control and Prevention (21%-31% and 5%-12%, respectively) and contain less missing data.[3] The KPNC estimate of ICU admissions using positive tests as denominator (8.7%) is lower than Italy (12%)[4] but higher than China (5%).[5] Given the differences in care among countries, it is important to report data from the United States. The KPNC mortality estimate is preliminary but reasonably consistent with the early Seattle, Washington, experience.[1]

Unlike previous studies, adults across age groups, not just elderly individuals, required inpatient care, with persons aged 60 to 69 years most commonly hospitalized. These findings underscore the importance of public health interventions that prevent transmission for the entire public to mitigate hospital surges.

The major limitation of this study is that these data represent an early phase of SARS-CoV-2 transmission in California. Several key factors were changing over this period, including implementation of physical distancing measures and testing speed, which could affect future results.

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Acquisition, analysis, or interpretation of data: Escobar, Liu.
Drafting of the manuscript: Myers, Escobar, Liu.
Critical revision of the manuscript for important intellectual content: Parodi, Escobar, Liu.
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