Letters

Readmission and Death After Initial Hospital Discharge Among Patients With COVID-19 in a Large Multihospital System

Although more patients are surviving severe coronavirus disease 2019 (COVID-19), there are limited data on outcomes after initial hospitalization. We therefore measured the rate of readmission, reasons for readmission, and rate of death after hospital discharge among patients with COVID-19 in the nationwide Veterans Affairs (VA) health care system.

Methods | We identified index hospitalizations for COVID-19 among veterans at 132 VA hospitals (admitted March 1-June 1, 2020; discharged March 1-July 1, 2020) in the VA's Corporate Data Warehouse.[1] Definitions included *definite* hospitalizations for COVID-19, in which the patient was diagnosed during hospitalization, and *probable* hospitalizations, in which the patient was diagnosed during the 14 days preceding or 7 days following hospitalization.[2,3]

We also identified comparison cohorts of hospitalizations for non-COVID pneumonia and heart failure during the same time frame, using the Agency for Healthcare Research and Quality's Clinical Classification Software Refined diagnosis groupings.[4] We extracted demographics, intensive care unit (ICU) use, length of hospitalization, receipt of invasive mechanical ventilation, and receipt of vasopressors.[5] We applied weights from coarsened exact matching to balance

Table. Characteristics Between Patients With COVID-19 With vs Without 60-Day Readmission, Death, or Readmission or Death[a]

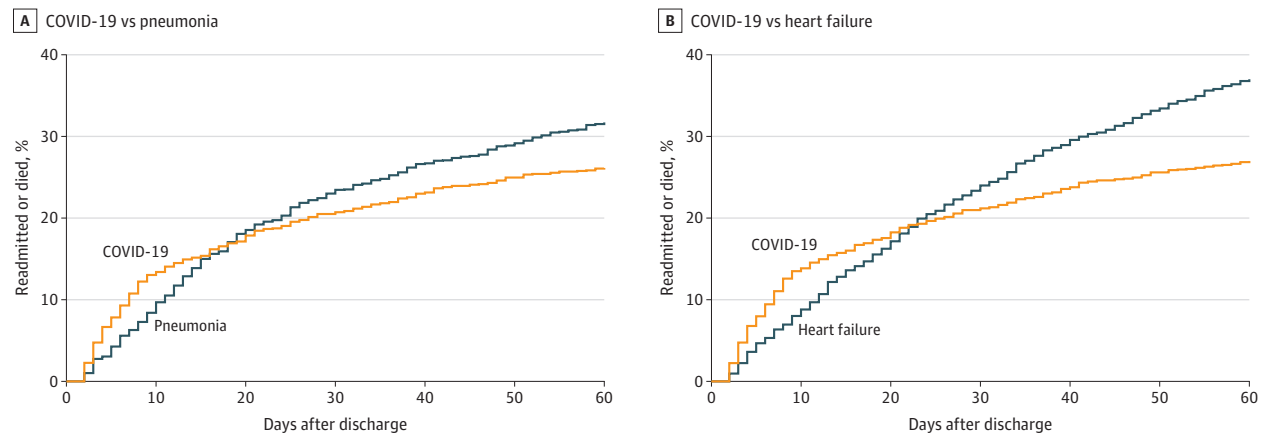| Characteristics	60-Day readmission			60-Day death			60-Day readmission or death		
	Not readmitted (n = 1421)	Readmitted (n = 354)	P value	Survived (n = 1613)	Died (n = 162)	P value	Survived and not readmitted (n = 1296)	Died or readmitted (n = 479)	P value
Age, y									
Median (IQR)	70 (62-76)	71 (64-76)	.12	70 (62-75)	80 (72-89)	<.001	69 (61-75)	72 (66-81)	<.001
No. (%)									
<45	46 (3.2)	<10[b]		52 (3.2)	<10[b]		46 (3.6)	<10[b]	
45-64	217 (15.3)	44 (12.4)	.21	257 (15.9)	<10[b]	<.001	215 (16.6)	46 (9.6)	<.001
65-79	898 (63.2)	237 (67.0)		1058 (65.6)	77 (47.5)		840 (64.8)	295 (61.6)	
≥80	260 (18.3)	67 (18.9)		246 (15.3)	81 (50.0)		195 (15.1)	132 (27.6)	
Sex, No. (%)									
Women	71 (5.0)	16 (14.5)	.71	83 (5.2)	10[b]	.13	67 (5.2)	2 (4.2)	.39
Men	1350 (95.0)	338 (95.5)		1530 (94.9)	158 (97.5)		1229 (94.8)	459 (95.8)	
Race, No. (%)[c]									
Black	705 (49.6)	186 (52.5)		825 (51.2)	66 (40.7)		662 (51.1)	229 (47.8)	
White	626 (44.1)	152 (42.9)	.35	693 (43.0)	85 (52.5)	.04	551 (42.5)	227 (47.4)	.13
Missing/other	90 (6.3)	16 (4.5)		95 (5.9)	11 (6.8)		83 (6.4)	23 (4.8)	
Length of hospitalization									
Median (IQR), d	8 (4-15)	7 (4-16)	.12	8 (4-15)	9 (4-15)	.64	8 (4-15)	8 (4-16)	.76
No. (%), d									
<7	557 (39.2)	169 (47.7)		669 (41.5)	57 (35.2)		522 (40.3)	204 (42.6)	
7-13	456 (32.1)	75 (21.2)	<.001	472 (29.3)	59 (36.4)	.14	405 (31.3)	126 (26.3)	.13
≥14	408 (28.7)	110 (31.1)		472 (29.3)	46 (28.4)		369 (28.5)	149 (31.1)	
Treatment during index hospitalization, No. (%)									
ICU use	312 (22.0)	84 (23.7)	.47	361 (22.4)	35 (21.6)	.82	280 (21.6)	116 (24.2)	.24
Mechanical ventilation	73 (5.1)	18 (5.1)	.97	77 (4.8)	14 (8.6)	.03	61 (4.7)	30 (6.3)	.19
Vasopressor use	95 (6.7)	23 (6.5)	.90	101 (6.3)	17 (10.5)	.04	80 (6.2)	38 (7.9)	.19

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; IQR, interquartile range.

[a] This table presents data for 1775 patients with COVID-19 who survived hospitalization (1226 definite, 493 probable diagnosed during the 14 days preceding admission, and 56 probable diagnosed during 7 days after discharge). *P* values from Wilcoxon rank sum tests of equal distribution for age and length of stay, defined as continuous variables; all other *P* values from Pearson χ^2 tests of association.

[b] Not specifically reported due to fewer than 10 patients.

[c] Race was defined based on self-report with options determined by the initial application for health benefits. The missing/other category includes responses of Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, declined to answer, or unknown. We assessed race in this study to determine if the proportion of patients with COVID-19 who were readmitted or died within 60 days of discharge differs by race.

Figure. Kaplan-Meier Curves and Hazard Ratios for 60-Day Readmission or Death Among Patients With COVID-19 and Matched Patients to Comparison Hospitalizations

In weighted analyses, patients who survived their hospitalizations were balanced on age, sex, week of discharge, intensive care unit admission, and length of hospitalization using coarsened exact matching. Hazard ratios for readmission or death were estimated using piecewise Cox proportional hazards regression.

A, Included 1366 patients with coronavirus disease 2019 (COVID-19) and 1799 with pneumonia. The hazard ratios for 0 to 10 days were 1.43 (95% CI,

1.09-1.87); for 11 to 20 days, 0.51 (95% CI, 0.36-0.74); for 21 to 40 days, 0.63 (95% CI, 0.45-0.88); and for 41 to 60 days, 0.57 (95% CI, 0.38-0.85).

B, Included 1430 patients with COVID-19 and 3505 with heart failure. The hazard ratios for 0 to 10 days were 1.62 (95% CI, 1.31-2.01); for 11 to 20 days, 0.55 (95% CI, 0.41-0.74); for 21 to 40 days, 0.43 (95% CI, 0.33-0.56); and for 41 to 60 days, 0.39 (95% CI, 0.28-0.55).

survivors of COVID-19 and control hospitalizations on age, sex, week of discharge, length of hospitalization, and ICU use.[6]

We measured readmission and death to 60 days after discharge among survivors of COVID-19 hospitalizations, determined the most common readmission diagnoses, and measured use of ICU, mechanical ventilation, and vasopressors during readmission.[1] We compared characteristics of COVID-19 survivors who experienced vs did not experience 60-day readmission or death using Pearson χ^2 and Wilcoxon rank sum tests. We compared rates of outcomes between matched survivors of COVID-19 and control hospitalizations using Rao-Scott–corrected χ^2 tests. Statistical tests were 2-tailed, with $P < .05$ considered significant. We generated Kaplan-Meier curves for readmission or death to 60 days after the initial hospital discharge. We also estimated hazard ratios and 95% CIs for 0 to 10, 10 to 20, 20 to 40, and 40 to 60 days after discharge using piecewise Cox proportional hazards regression. Analyses were performed using SAS version 9.4 (SAS Institute Inc) and Stata MP version 15.1 (Stata-Corp). The study was deemed exempt by the Ann Arbor VA institutional review board.

Results | There were 2179 index hospitalizations for COVID-19, of which 678 patients (31.1%) were treated in an ICU, 279 (12.8%) were mechanically ventilated, 307 (14.1%) received vasopressors, and 1775 (81.5%) survived to discharge.

Within 60 days of discharge, 354 patients (19.9%) who survived COVID-19 hospitalization were readmitted, 162 (9.1%) died, and 479 (27.0%) were readmitted or died. Survivors with 60-day readmission or death were older, but otherwise similar to survivors without readmission or death (Table). Of those readmitted, the most common readmission diagnoses were

COVID-19 (30.2%), sepsis (8.5%), pneumonia (3.1%), and heart failure (3.1%). During readmission, 22.6% were treated in intensive care, 7.1% were mechanically ventilated, and 7.9% received vasopressors. Index admissions totaled 27 496 hospital days, whereas readmissions after COVID-19 resulted in 3728 additional hospitalization days.

Of the index hospitalizations, 2156 patients had pneumonia and 4269 had heart failure, of whom 97.8% and 98.3% survived to discharge, respectively. After excluding patients who died during hospitalization or could not be matched, 1799 with pneumonia and 3505 with heart failure who survived were included in the weighted comparisons with patients with COVID-19. COVID-19 survivors had lower rates of 60-day readmission or death than matched survivors of pneumonia (26.1% vs 31.7%; $P = .006$) and heart failure (27.0% vs 37.0%; $P < .001$). However, COVID-19 survivors had higher rates of readmission or death within the first 10 days after discharge than matched survivors of pneumonia (13.4% vs 9.7%; $P = .01$) and heart failure (13.9% vs 8.8%; $P < .001$) (Figure).

Discussion | In this national cohort of VA patients, 27% of survivors of COVID-19 hospitalization were readmitted or died by 60 days after discharge, and this rate was lower than matched survivors of pneumonia or heart failure. However, rates of readmission or death were higher than pneumonia or heart failure during the first 10 days after discharge following COVID-19 hospitalization, suggesting a period of heightened risk of clinical deterioration. Study limitations include the inability to measure readmissions to non-VA hospitals and an older, male-predominant study population, which may be at higher risk of severe manifestations of COVID-19. Public health surveillance or clinical trials focused exclusively on

inpatient mortality may substantially underestimate burdens of COVID-19.

John P. Donnelly, PhD
Xiao Qing Wang, MPH
Theodore J. Iwashyna, MD, PhD
Hallie C. Prescott, MD, MSc

Author Affiliations: Department of Learning Health Sciences, University of Michigan, Ann Arbor (Donnelly); Division of Pulmonary and Critical Care Medicine, University of Michigan, Ann Arbor (Wang); VA Center for Clinical Management Research, HSR&D Center of Innovation, Ann Arbor, Michigan (Iwashyna, Prescott).

Corresponding Author: John P. Donnelly, PhD, Department of Learning Health Sciences, University of Michigan, 2800 Plymouth Rd, NCRC Bldg 14, #G100, G014-130, Ann Arbor, MI 48109 (jpdonn@med.umich.edu).

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