Determinants of COVID-19 Hospital Outcomes in the University of Pennsylvania Health System

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Introduction

Background:

- SARS-CoV-2 and its associated clinical disease, COVID-19, have caused over 2.5 million deaths worldwide since December 2019, including over 500,000 in the United States alone.
- Disproportionate impact of COVID-19 across racial, economic, and clinical risk factors is well-documented.
- Patterns during and after hospitalization are not as well understood.
- Conflicting results regarding race among the few existing hospital studies [1, 2].

Study Objectives:

- Describe the determinants of clinical outcomes among patients hospitalized for COVID-19 in the University of Pennsylvania Health System (UPHS).
- Assess time trends in rates of discharge and mortality as competing risks within eight weeks of hospital admission.
- Investigate death and re-admission after discharge.

Methods

- Study Cohort: 2,785 admissions across 2,500 individuals hospitalized with PCR-confirmed COVID-19 prior to September 17, 2020 at five UPHS hospitals.
- Data collected using Electronic Health Records (EHR).
- Comorbid conditions classified using ICD-10 codes within past year.
- Cumulative incidence curves calculated for outcomes of interest.
- Two multivariate cause-specific Cox proportional hazards models fit for death and discharge.
  - Model 1 predictors: demographic information, baseline clinical factors, month of admission, hospital of admission, indicator for ICU-level care on day of admission as measure of severity of disease at admission.
  - Model 2 predictors: demographic information, baseline clinical factors, month of admission, hospital of admission, indicators for comorbidities identified as potential risk factors for severe COVID.
  - Markers of severity at presentation and comorbidities considered separately to address potential mediation.
- Multivariable Poisson regression model with robust variance estimation fit for incidence of death after discharge.

Results: Racial Disparities in Underlying Conditions

- Rates of underlying conditions, markers of severe disease at admission, and residence in lower-income zip codes higher in Blacks compared to Whites and Other race.

Condition	White (N = 984)	Black (N = 1273)	Other (N = 243)	p-Value
Age in years, median (IQR)	68 (48, 79)	59 (41, 71)	60 (44, 72)	< 0.001
Female, n (%)	502 (51.0)	704 (55.3)	116 (47.7)	0.031
Median zip code income < $50K	167 (17.0)	929 (73.0)	167 (68.7)	< 0.001
ICU at Admission	143 (14.5)	221 (17.4)	58 (23.9)	0.002
Obesity	362 (37.4)	631 (50.8)	72 (30.5)	< 0.001
Any ICD-10 Comorbidity	502 (51.0)	910 (71.5)	117 (48.1)	< 0.001
Diabetes	139 (14.1)	381 (29.9)	23 (9.5)	< 0.001
Respiratory Disease	98 (10.0)	269 (21.1)	21 (8.6)	< 0.001
Cardiovascular Disease	415 (42.2)	777 (61.0)	100 (41.2)	< 0001

Figure: **Patient characteristics by race; n (%) unless otherwise noted**

Results: Cumulative Incidence

- 384 (15.4%) of patients died within eight weeks of initial hospital admission.
- 2073 (82.9%) were discharged without death.
- From March to November 2020, hospital admission and mortality rates decreased while discharge rates increased.

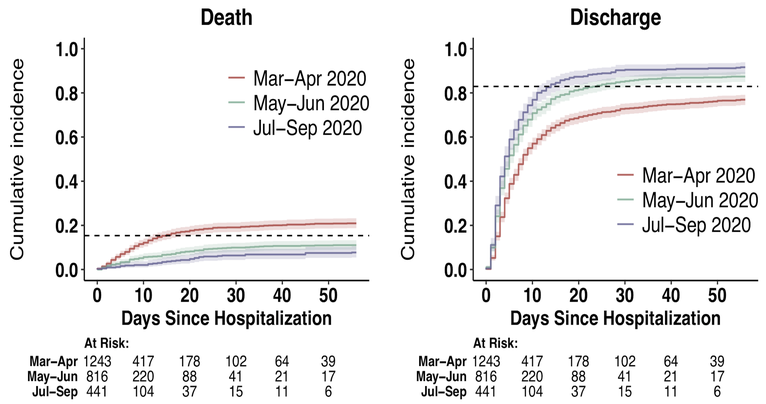

Figure: **Cumulative incidence curves for death and discharge**

Results: Factors Associated with Mortality

Characteristic	Level	HR (95% CI)	p-Value
Age	< 40	reference	
	40-59	1.77 (0.85 - 3.67)	*0.124*
	60-74	2.85 (1.42 - 5.69)	*0.003***
	75 +	6.67 (3.35 - 13.26)	*<0.001****
Race	White	reference	
	Black	0.83 (0.62 - 1.12)	*0.224*
	Other	0.93 (0.65 - 1.34)	*0.702*
Hospital	Site 1	reference	
	Site 2	2.37 (1.52 - 3.67)	*<0.001****
	Site 3	0.82 (0.52 - 1.30)	*0.402*
	Site 4	1.98 (1.30 - 3.02)	*0.002***
	Site 5	1.10 (0.79 - 1.53)	*0.556*
Month of Admission	Mar-Apr 2020	reference	
	May-Jun 2020	0.70 (0.54 - 0.89)	*0.005***
	Jul-Sep 2020	0.61 (0.42 - 0.89)	*0.011**
Blood Pressure	Normal	reference	
	High	0.81 (0.61 - 1.09)	*0.167*
	Low	3.25 (2.52 - 4.20)	*<0.001****
ICU at Admission	No	reference	
	Yes	1.34 (1.06 - 1.70)	*0.014**

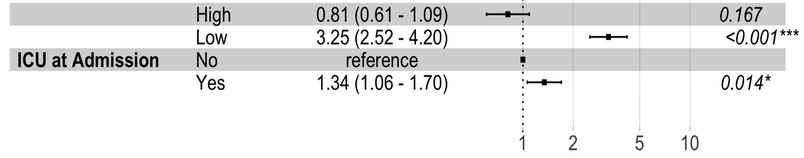

Figure: **Selected hazard ratios with 95% CIs for mortality using Model 1**

- Severe disease at admission, increasing age, underweight, time period, and admitting site associated with an increased hazard for mortality.
- Similar risk factors persist after discharge. 11.6% of discharged patients age 75+ still died within 56 days of first admission.
- In Model 2, no comorbidities associated with increased hazard for mortality, but cancer and heart failure associated with decreased hazard for discharge.

Discussion

- Racial disparities in underlying conditions and severe disease risk factors present among individuals hospitalized with COVID-19.
- No racial differences in discharge or mortality outcomes after controlling for other demographics, clinical factors, and site of admission.
- Further research needed to understand drivers of the outcomes differences by hospital.
- EHR data have limitations and potential bias. Prospective studies needed to confirm identified associations.

References

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