# **Supplementary Material\***

Anesi GL, Jablonski J, Harhay MO, et al. Characteristics, Outcomes, and Trends of Patients With COVID-19–Related Critical Illness at a Learning Health System in the United States. Ann Intern Med. 19 January 2021 [Epub ahead of print]. doi:10.7326/M20-5327

Supplement. Supplement Tables and Figures

\* This supplementary material was provided by the authors to give readers further details on their article. The material was reviewed but not copyedited.

### SUPPLEMENTAL TABLES

eTable 1. Characteristics of COVID-19 patients with critical illness by period

eTable 2. Acute physiology of patients with COVID-19 critical illness at ICU admission by period

eTable 3. Mechanical ventilation over time

eTable 4. All-cause 28-day in-hospital mortality over time

eTable 5. All-cause 28-day in-hospital mortality among patients requiring mechanical ventilation over time

eTable 6. All-cause 28-day in-hospital mortality over time adjusted for COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity

eTable 7. All-cause death at any time over time

eTable 8. All-cause 28-day in-hospital mortality over time among patients less than or equal to 50 years of age

#### SUPPLEMENTAL FIGURES

eFigure 1. Penn Medicine Critical Care Alliance COVID-19 Task Force Timeline

eFigure 2. Charlson Comorbidity Index diagnosis proportions

eFigure 3. Mechanical ventilation over time

eFigure 4. All-cause 28-day in-hospital mortality among patients requiring mechanical ventilation over time

eFigure 5. COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity

eFigure 6. All-cause 28-day in-hospital mortality over time adjusted for COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity

eFigure 7. All-cause death at any time over time

eFigure 8. All-cause 28-day in-hospital mortality over cumulative COVID-19 patient volume

eFigure 9. All-cause 28-day in-hospital mortality over time among patients less than or equal to 50 years of age

eFigure 10. Age and in-hospital mortality

### TABLES

### eTable 1. Characteristics of COVID-19 patients with critical illness by period

	Period					
Characteristics	3/13-3/27	3/28-4/11	4/12-4/26	4/27-5/11		
Patients, n	63	165	140	96		
Age, median years (IQR)	63 (53-75)	66 (59-74)	65 (54-73)	64 (48-78)		
Female sex, n (%)	24 (38.1)	70 (42.4)	60 (42.9)	42 (43.8)		
Race, n (%)						
Black	24 (38.1)	90 (54.6)	79 (56.4)	52 (54.2)		
White	20 (31.8)	45 (27.3)	29 (20.7)	20 (20.8)		
Other <sup>a</sup>	19 (30.2)	30 (18.2)	32 (22.9)	24 (25.0)		
Hispanic ethnicity, n (%)	5 (7.9)	15 (9.1)	13 (9.3)	10 (10.4)		
Hospital admission source, n (%)						
Emergency department	57 (90.5)	152 (92.1)	123 (87.9)	86 (89.6)		
Other institution	5 (7.9)	9 (5.5)	16 (11.4)	8 (8.3)		
Outpatient clinic	1 (1.6)	3 (1.8)	1 (0.7)	2 (2.1)		
Insurance, n (%)						
Private	28 (44.4)	57 (34.6)	49 (35.0)	25 (26.0)		
Medicare	30 (47.6)	85 (51.5)	67 (47.9)	41 (42.7)		
Medicaid or no insurance <sup>b</sup>	3 (4.8)	11 (6.7)	15 (10.7)	18 (18.8)		
Missing	2 (3.2)	12 (7.3)	9 (6.4)	12 (12.5)		
Body mass index at admission, n (%)						
< 18.5	2 (3.2)	3 (1.8)	2 (1.4)	3 (3.1)		
18.5-34.9	45 (71.4)	121 (73.3)	101 (72.1)	64 (66.7)		
≥ 35	15 (23.8)	35 (21.2)	34 (24.3)	25 (26.0)		
Missing	1 (1.6)	6 (3.6)	3 (2.1)	4 (4.2)		
Pregnancy, n (%)	1 (1.6)	3 (1.8)	1 (0.7)	2 (2.1)		
Charlson Comorbidity Index, n (%) unless otherwise noted						
Median (IQR)	3 (0-5)	3 (1-5)	3 (1-6)	3 (2-6)		
Points = 0	18 (28.6)	26 (15.8)	27 (19.3)	10 (10.4)		
Points = 1	4 (6.4)	24 (14.6)	10 (7.1)	13 (13.5)		
Points ≥ 2	41 (65.1)	115 (69.7)	103 (73.6)	73 (76.0)		
Duration from acute care presentation to ICU admission, median hours (IQR)	2.6 (0.6-47.7)	2.6 (0.6-41.0)	2.2 (0-48.7)	1.6 (0.5-19.0)		

Notes: <sup>a</sup> Other race includes Hispanic/Latino Black, Hispanic/Latino White, Asian, East Indian, Pacific Island, other, and unknown. <sup>b</sup> The no insurance population includes patients confirmed to have no insurance and require safety net support, as distinct from missing insurance status. ICU, intensive care unit; IQR, interquartile range.

### eTable 2. Acute physiology of patients with COVID-19 critical illness at ICU admission by period

Acute physiology assessments					
Acute physiology assessments	3/13-3/27	3/28-4/11	4/12-4/26	4/27-5/11	
Patients, n	63	165	140	96	
Composite acuity measures		1		1	
p <sub>A</sub> O2 : FiO <sub>2</sub> ratio, median (IQR) <sup>a</sup>	103 (66-212)	110 (66-204)	100 (65-160)	94 (59-175)	
$p_AO2$ : FiO <sub>2</sub> ratio $\leq$ 300, n (%) <sup>a</sup>	40 (63.5)	107 (64.9)	76 (54.3)	56 (47.9)	
SOFA score, median (IQR) <sup>b</sup>	5 (3-6)	5 (3-7)	4 (2.5-6.5)	4.5 (1-7)	
Respiratory SOFA sub-score, median (IQR)	2 (0-4)	3 (0-4)	2 (0.4)	0 (0-3)	
Vital signs					
Maximum Glasgow Coma Score < 15, n (%)	15 (32.6)	51 (32.9)	38 (31.7)	35 (38.5)	
Temperature ≥ 38.0 °C, n (%)	43 (68.3)	99 (60.0)	76 (54.3)	45 (46.9)	
Maximum heart rate, median beats per minute (IQR)	105 (93-124)	115 (99-127)	111 (97-129)	113 (98-129)	
Minimum systolic blood pressure, median mmHg (IQR)	87 (81-101)	87 (77-98)	92 (82-106)	96 (83-110)	
Minimum mean arterial pressure, median mmHg (IQR)	64 (59-74)	64 (55-71)	67 (60-76)	69 (59-79)	
Maximum respiratory rate, median breaths per minute (IQR)	36 (30-40)	35 (30-42)	35 (29-42)	35 (28-42)	
Minimum oxygen saturation, median SpO <sub>2</sub> , % (IQR)	85 (77-90)	86 (77-90)	87 (81-091)	87 (78-92)	
FiO <sub>2</sub> at ICU admission, median % (IQR)	91 (56-100)	91 (60-100)	60 (50-100)	60 (42-100)	
Arterial blood gas measurements					
Minimum pH, median (IQR)	7.30 (7.21-7.39)	7.28 (7.22-7.37)	7.33 (7.24-7.40)	7.36 (7.27-7.42)	
Minimum p <sub>A</sub> O <sub>2</sub> , median mmHg (IQR)	65 (51-93)	60 (41-85)	59 (41-80)	54 (42-72)	
Maximum P <sub>A</sub> CO <sub>2</sub> , median mmHg (IQR)	56 (43-62)	50 (40-61)	45 (38-54)	46 (38-53)	
Maximum lactate, median mmol/L (IQR)	1.8 (1.3-2.8)	1.9 (1.3-3.3)	2.1 (1.4-3.1)	2.0 (1.3-3.2)	
Blood counts	,/				
White blood cell count, maximum, n (%)					
< 4 × 10 <sup>9</sup> /L	7 (11.1)	1 (0.6)	6 (4.3)	3 (3.1)	
4-12×10 <sup>9</sup> /L	36 (57.1)	118 (71.5)	75 (53.6)	65 (67.7)	
	19 (30.2)				
$> 12 \times 10^{9}/L$		45 (27.3)	54 (38.6)	28 (29.2)	
Minimum absolute lymphocyte count, median cells/L (IQR) Minimum hemoglobin, median mmol/L (IQR)	635 (380-830) 7.1 (6.3-7.9)	700 (400-1000)	600 (400-900) 7.3 (5.8-8.1)	585 (275-1000)	
	. 1	7.0 (6.0-7.9)		7.0 (5.4-8.2)	
Minimum platelet count, median × 10 <sup>9</sup> /L (IQR)	175 (129-223)	196 (147-260)	203 (149-276)	204 (144-271)	
Chemistries	125 (122, 120)	125 (122, 120)	125 (122 140)	126 (122, 120)	
Minimum sodium, median mmol/L (IQR) Maximum potassium, median mmol/L (IQR)	135 (133-139) 4.4 (4.0-4.8)	135 (132-139) 4.5 (4.1-5.0)	135 (132-140) 4.6 (4.2-5.3)	136 (132-139) 4.4 (4.1-4.9)	
Maximum potassium, median minor/ L (IQR) Maximum blood urea nitrogen (BUN), median mmol/L (IQR)	7.1 (5.0-12.1)	8.9 (6.4-16.4)	10.7 (6.1-17.1)	8.9 (5.7-15.4)	
	98.2 (70.7-153.0)	117.6 (79.6-213.1)	111.4 (83.1-210.4)	104.3 (70.7-194.5)	
Maximum creatinine, median μmol/L (IQR) [mg/dL (IQR)]	[1.11 (0.80-1.73)]	[1.33 (0.90-2.41)]	[1.26 (0.94-2.38)]	[1.18 (0.80-2.20)]	
Minimum bicarbonate, median mmol/L (IQR)	22 (19-24)	21 (18-24)	21 (19-24)	23 (20-25)	
	6.0 (5.2-7.2)	6.1 (5.1-7.2)	6.0 (5.2-7.6)	5.7 (4.6-7.2)	
Minimum glucose, median mmol/L (IQR) [mg/dL (IQR)]	[108 (93-129)]	[109 (92-129)]	[108 (93-136)]	[102 (83-130)]	
Maximum anion gap, median mmol/L (IQR)	15 (10-18)	13 (11-17)	13 (11-17)	13 (11-16)	
Liver function tests		·			
Minimum albumin, median g/L (IQR)	30 (28-34)	30 (27-32)	31 (27-34)	30 (26-33)	
Maximum aspartate aminotransferase (AST), median units/L (IQR)	44 (31-84)	48 (31-73)	43 (29-70)	38 (27-60)	
Maximum alanine aminotransferase (ALT), median units/L (IQR)	27 (19-61)	31 (18-49)	29 (18-55)	26 (17-46)	
Maximum total bilirubin, median µmol/L (IQR) [mg/dL (IQR)]	10.3 (6.8-13.7)	12.0 (6.8-17.1)	10.3 (6.8-13.7	10.3 (6.8-15.4)	
	[0.6 (0.4-0.8)]	[0.7 (0.4-1.0)]	[0.6 (0.4-0.8)]	[0.6 (0.4-0.9)]	
Coagulation parameters					
Maximum international normalized ratio (INR), median (IQR)	1.2 (1.2-1.5)	1.2 (1.2-1.5)	1.3 (1.1-1.4)	1.3 (1.2-1.4)	
Maximum partial thromboplastin time (PTT), median seconds (IQR)	32.4 (30.4-37.3)	32.9 (29.8-37.9)	34.4 (30.2-42.2)	33.8 (29.7-51.6)	
Maximum D-dimer, median nmol/L (IQR)	6.24 (3.23-11.44)	7.94 (5.15-25.68)	9.42 (3.72-26.12)	9.31 (4.82-25.08)	
Maximum fibrinogen, median g/L (IQR)	6.1 (4.7-6.5)	5.4 (4.2-6.9)	6.8 (5.3-7.7)	4.4 (3.5-5.9)	
Inflammation and injury markers					
Maximum procalcitonin, median ng/mL (IQR)	0.24 (0.15-1.64)	0.40 (0.20-0.90)	0.48 (0.18-2.13)	0.35 (0.17-1.26)	
Maximum C-reactive protein, median mg/L (IQR)	51.9 (25.4-98.7)	104.4 (51.4-142.6)	108.1 (82.1-134.6)	97.1 (27.2-125.8)	
Maximum ferritin, median μg/L (IQR)	1403 (482-2742)	945 (448-1978)	654 (293-1775)	668 (367-1409)	
	0.03 (0.02-0.29)	0.05 (0.02-0.19)	0.08 (0.02-0.19)	0.90 (0.03-0.45)	
Maximum troponin-T, median µg/L (IQR)		7.3 (5.5-9.5)	6.2 (5.1-9.3)	6.6 (4.8-9.1)	
Maximum lactate dehydrogenase (LDH), median µkat/L (IQR)	8.9 (7.4-12.0)		A 4 4 - 1 - 1		
Maximum lactate dehydrogenase (LDH), median µkat/L (IQR) Maximum interleukin 6 (IL-6), median pg/mL (IQR)	15 (7-33)	40 (10-159)	11 (7-15)	21 (11-265)	
Maximum lactate dehydrogenase (LDH), median µkat/L (IQR) Maximum interleukin 6 (IL-6), median pg/mL (IQR) Notes: Descriptive statistics calculated among non-missing data prior to imputa	15 (7-33) tion. Minimum and ma	aximum refer to the mos	t extreme measuremen	ts in the 24 hours	
Maximum lactate dehydrogenase (LDH), median µkat/L (IQR) Maximum interleukin 6 (IL-6), median pg/mL (IQR) Notes: Descriptive statistics calculated among non-missing data prior to imputa prior to and after ICU admission. <sup>a</sup> $p_A O_2$ : FiO <sub>2</sub> ratio calculated based on the	15 (7-33) tion. Minimum and ma P <sub>A</sub> O <sub>2</sub> and FiO <sub>2</sub> meas	aximum refer to the mos surements closest to ICU	admission among the	ts in the 24 hours full study cohort. <sup>b</sup>	
Maximum lactate dehydrogenase (LDH), median µkat/L (IQR) Maximum interleukin 6 (IL-6), median pg/mL (IQR) Notes: Descriptive statistics colculated among non-missing data prior to imputa	15 (7-33) tion. Minimum and ma P <sub>A</sub> O <sub>2</sub> and FiO <sub>2</sub> meas ffter ICU admission, a c	aximum refer to the mos surements closest to ICU conversion of supplement	admission among the ntal oxygen in liters per	ts in the 24 hours full study cohort. <sup>b</sup> minute to FiO <sub>2</sub> ,	

Model	Period	OR (95% CI, p-value)	Mechanical ventilation % (95% CI)	
	3/13-3/27	Reference	85.7 (77.1-94.4)	
Linediusted	3/28-4/11	0.49 (0.22-1.07, 0.074)	74.5 (67.9-81.2)	
Unadjusted	4/12-4/26	0.29 (0.13-0.64, 0.002)*	63.6 (55.6-71.5)	
	4/27-5/11	0.20 (0.09-0.44, <0.001)*	54.2 (44.2-64.1)	
	3/13-3/27	Reference	95.6 (89.7-101.6)	
Adjusted for	3/28-4/11	0.52 (0.11-2.45, 0.41)	91.9 (87.0-96.7)	
P <sub>A</sub> O2:FiO2	4/12-4/26	0.22 (0.05-1.01, 0.052)*	82.8 (7490.7)	
	4/27-5/11	0.14 (0.03-0.66, 0.013)*	75.5 (64.0-87.1)	

eTable 3. Mechanical ventilation over time

Notes: \* p < 0.05. CI, confidence interval; OR, odds ratio.

Model	Period	OR (95% CI, p-value)	Mortality % (95% CI)
	3/13-3/27	Reference	46.0 (33.7-58.3)
	3/28-4/11	0.64 (0.35-1.15, 0.132)	35.2 (27.9-42.4)
Unadjusted	4/12-4/26	0.41 (0.22-0.76, 0.005)*	25.7 (18.5-33.0)
	4/27-5/11	0.25 (0.12-0.52, <0.001)*	17.7 (10.1-24.3)
	3/13-3/27	Reference	43.5 (31.3-53.8)
Core	3/28-4/11	0.57 (0.28-1.15, 0.119)	32.2 (26.0-38.6)
Adjusted <sup>a</sup>	4/12-4/26	0.47 (0.23-0.97, 0.042)*	28.9 (21.9-35.8)
	4/27-5/11	0.24 (0.10-0.57, 0.001)*	19.2 (11.6-26.7)
	3/13-3/27	Reference	45.3 (28.9-61.7)
Expanded	3/28-4/11	0.66 (0.24-1.80, 0.42)	37.9 (29.9-45.8)
Adjusted <sup>b</sup>	4/12-4/26	0.60 (0.21-1.77, 0.36)	36.3 (26.6-45.9)
	4/27-5/11	0.29 (0.09-0.99, 0.047)*	24.7 (13.3-36.1)

eTable 4. All-cause 28-day in-hospital mortality over time

Notes: \* p < 0.05. <sup>a</sup> Adjusted for age, Charlson Comorbidity Index, SOFA score, and hospital. <sup>b</sup> Additionally adjusted for body mass index, Glasgow Coma Score, oxygen saturation, respiratory rate, platelet count, and  $P_AO_2$ :Fi $O_2$  ratio. Cl, confidence interval; OR, odds ratio; SOFA, Sequential Organ Failure Assessment.

Model	Period	OR (95% CI, p-value)	Mortality % (95% CI)
	3/13-3/27	Reference	52.9 (38.5-65.2)
	3/28-4/11	0.61 (0.32-1.17, 0.139)	39.8 (31.2-48.5)
Unadjusted	4/12-4/26	0.43 (0.21-0.86, 0.016)*	31.5 (21.8-41.1)
	4/27-5/11	0.31 (0.14-0.71, 0.005)*	25.0 (13.2-36.8)
	3/13-3/27	Reference	43.5 (31.3-53.8)
Core	3/28-4/11	0.53 (0.25-1.12, 0.096)	32.2 (26.0-38.6)
Adjusted <sup>a</sup>	4/12-4/26	0.47 (0.21-1.03, 0.060)	28.9 (21.9-35.8)
	4/27-5/11	0.29 (0.11-0.76, 0.012)*	19.2 (11.6-26.7)
	3/13-3/27	Reference	46.5 (29.6-63.4)
Expanded	3/28-4/11	0.64 (0.23-1.76, 0.38)	38.2 (29.8-46.6)
Adjusted <sup>b</sup>	4/12-4/26	0.59 (0.19-1.79, 0.35)	36.8 (25.9-47.8)
	4/27-5/11	0.21 (0.05-0.78, 0.021)*	20.5 (8.2-32.8)

eTable 5. All-cause 28-day in-hospital mortality among patients requiring mechanical ventilation over time

Notes: \* p < 0.05. <sup>a</sup> Adjusted for age, Charlson Comorbidity Index, SOFA score, and hospital. <sup>b</sup> Additionally adjusted for body mass index, Glasgow Coma Score, oxygen saturation, respiratory rate, platelet count, and P<sub>A</sub>O<sub>2</sub>:FiO<sub>2</sub> ratio. Cl, confidence interval; OR, odds ratio; SOFA, Sequential Organ Failure Assessment.

# eTable 6. All-cause 28-day in-hospital mortality over time adjusted for COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity

Model	Period	OR (95% CI, p-value)	Mortality % (95% CI)
Core Adjusted <sup>a</sup>	3/13-3/27	Reference	50.2 (38.1-62.4)
	3/28-4/11	0.38 (0.19-0.78, 0.008)*	31.5 (25.0-38.0)
	4/12-4/26	0.29 (0.13-0.66, 0.003)*	27.0 (20.0-34.3)
	4/27-5/11	0.17 (0.07-0.40, <0.001)*	18.6 (11.1-26.2)

Notes: \* p < 0.05. <sup>a</sup> Adjusted for age, Charlson Comorbidity Index, SOFA score, and COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity. CI, confidence interval; OR, odds ratio; SOFA, Sequential Organ Failure Assessment.

Model	Period	OR (95% CI, p-value)	Mortality % (95% CI)
	3/13-3/27	Reference	47.6 (35.3-60.0)
Unadjusted	3/28-4/11	0.77 (0.43-1.38, 0.38)	41.2 (33.7-48.7)
	4/12-4/26	0.63 (0.35-1.15, 0.133)	35.4 (28.5-44.4)
	4/27-5/11	0.41 (0.21-0.80, 0.009)*	27.1 (18.2-36.0)
	3/13-3/27	Reference	44.2 (33.2-55.3)
Core	3/28-4/11	0.73 (0.36-1.49, 0.39)	38.6 (32.2-45.0)
Adjusted <sup>a</sup>	4/12-4/26	0.75 (0.36-1.56, 0.44)	39.1 (32.0-46.1)
	4/27-5/11	0.42 (0.18-0.94, 0.036*)	29.0 (20.6-37.5)
	3/13-3/27	Reference	51.1 (34.6-67.6)
Expanded	3/28-4/11	0.61 (0.21-1.73, 0.35)	42.3 (34.5-50.1)
Adjusted <sup>b</sup>	4/12-4/26	0.66 (0.22-2.02, 0.47)	43.9 (34.3-53.4)
	4/27-5/11	0.40 (0.12-1.34, 0.137)	35.1 (22.6-47.5)

eTable 7. All-cause death at any time over time

Notes: \* p < 0.05. <sup>a</sup> Adjusted for age, Charlson Comorbidity Index, SOFA score, and hospital. <sup>b</sup> Additionally adjusted for body mass index, Glasgow Coma Score, oxygen saturation, respiratory rate, platelet count, and  $P_AO_2$ :Fi $O_2$  ratio. CI, confidence interval; OR, odds ratio; SOFA, Sequential Organ Failure Assessment.

eTable 8. All-cause 28-day in-hospital mortality over time among patients less than or equal to 50 years of age

Model	Period	OR (95% CI, p-value)	Mortality % (95% CI)
	3/13-3/27	Reference	21.7 (2.2-41.3)
Core Adjusted <sup>a</sup>	3/28-4/11	1.93 (0.24-15.70, 0.54)	29.7 (15.5-43.9)
	4/12-4/26	0.07 (0.003-1.35, 0.078)	4.4. (-1.7-10.6)
	4/27-5/11	0.06 (0.002-2.18, 0.127)	4.4. (-2.6-11.4)

Notes: \* p < 0.05. <sup>a</sup> Adjusted for age, Charlson Comorbidity Index, SOFA score, and COVID-19 patient occupancy of pre-COVID-19 ICU and ward bed capacity. CI, confidence interval; OR, odds ratio; SOFA, Sequential Organ Failure Assessment.

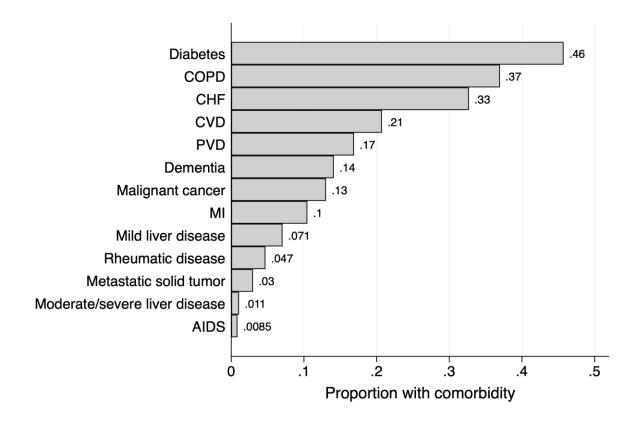
# **FIGURES**

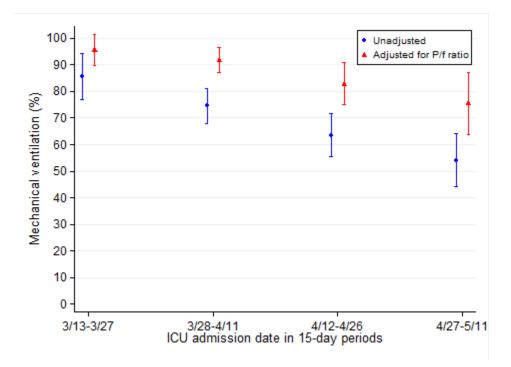
### eFigure 1. Penn Medicine Critical Care Alliance COVID-19 Task Force Timeline

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6 Team Resources	Week 7	Week 8	Week 9 Guideline	Week 10 Huddles and
Guideline	Team Resources	Team Resources	Team Resources	Team Resources	Team Resources	Team Resources	Guideline		Practice Bundle
Pharmacological	Convened first	Formalized the Critical Care Alliance COVID-	Telemedicine support	COVID-19 online	Respiratory Therapists	Proning teams	Pain, Agitation, and	Tracheostomy clinical practice guideline	Extubation Bundle
Treatment Suideline for SARs-	meeting to develop COVID-19 ICU	19 Task Force	expanded to cover novel COVID ICUs:	interdisciplinary curriculum available to	added to telemedicine team to support COVID	established at all entities	Delirium clinical practice guideline	(version 2):	(version 2):
OV2 Managed by	clinical practice	10000000	added	all staff	ICUs		<ul> <li>Avoiding over</li> </ul>	Aligned timing with	Reduced
ealth System ntibiotic	guidelines	Guideline	24/7 ICU Intensivist and Advanced Practice	Guideline	Guideline	Guideline	sedation	non-COVID	anesthesia
tewardship Team		Intubation Procedure	Provider			COVID Venous	<ul> <li>Strategies to address drug</li> </ul>	population	presence at extubation
		& intubation team safety clinical practice	Guideline	Tracheostomy clinical practice guideline	Respiratory Escalation & ICU Management clinical	Thrombo-embolism	shortages		
		guideline	Guideline	(Version 1)	practice guideline	Prophylaxis clinical practice guideline	Respiratory Escalation	Models and Tools	
			Respiratory Escalation & ICU Management	T-1-101.0	(version 2):		& ICU Management	COVID Admission	
Mar			clinical practice	Timing and Staff Safety	Expanded use of	Proning for Non- Intubated COVID	clinical practice guideline; (version 3)	order set added to EHR	
1-7	Mar 8-14		guideline	00000	high-flow nasal cannula and heimet	Patients clinical	Further liberalized	Lint	
	8-14	Mar	(version 1):	Palliative Withdraw of Mechanical Ventilation	non-invasive	practice guideline	use of high-flow nasal cannula and		
		15-21	Advocated early	clinical practice	ventilation	Airway Humidification	helmet CPAP		
			intubation	guideline	QT Monitoring with	to Reduce ETT Biofilm clinical practice	ventilation		
			Models and Tools	Nutrition Support Pathway	COVID Therapies clinical practice guideline	guideline	Models and Tools		Apr 26-
			Health System ventilator and ECMO		Huddles and	Ventilator Liberation,	Dialysis equipment	Apr 26-	May 2
			supply tracking tool	Models and Tools	Practice Bundles	Extubation, and Cuff Leak Test clinical	tracking tool	May 2	
			established	ICU staffing and	Emergency Safety	practice guideline	established		
			Mar	location surge models developed	Huddle #1 <ul> <li>Endotracheal tube</li> </ul>	Huddles and			
			22-28		<ul> <li>Endotracrieal tube obstructions with dry</li> </ul>	Practice Bundles			
				Point of Entry Letter for Visitors	ventilator circuits	Bundles			
				VIBIOIS	Emergency Safety	Extubation Bundle	Ann		
					Huddle #2	(version 1): • Cuff leak Test	Apr 19-25		
				Mar 29-	Reintubation risks	Corticosteroids			
				Apr 4	Apr 5-11	<ul> <li>Anesthesia present</li> </ul>			
					5-11	Apr			

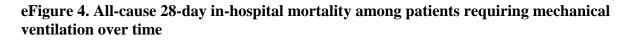
#### eFigure 2. Charlson Comorbidity Index diagnosis proportions

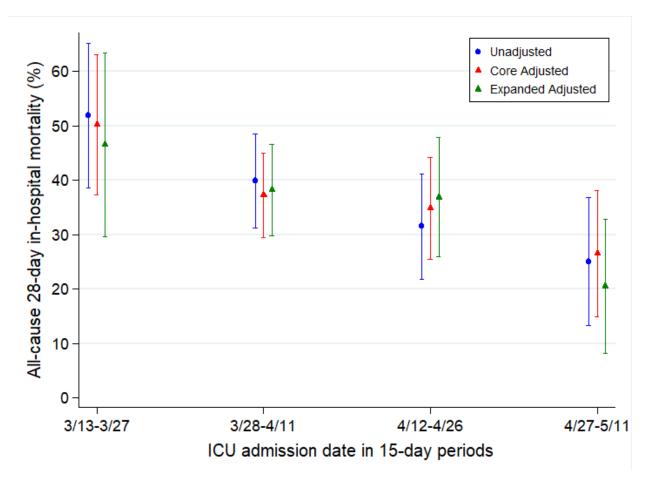
Notes: AIDS, acquired immunodeficiency syndrome; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; MI, myocardial infarction; PVD, peripheral vascular disease.

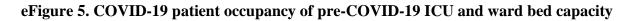


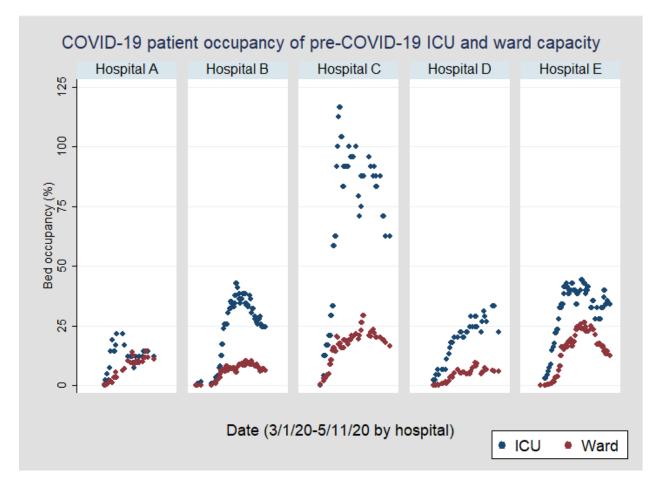


eFigure 3. Mechanical ventilation over time

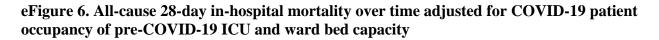


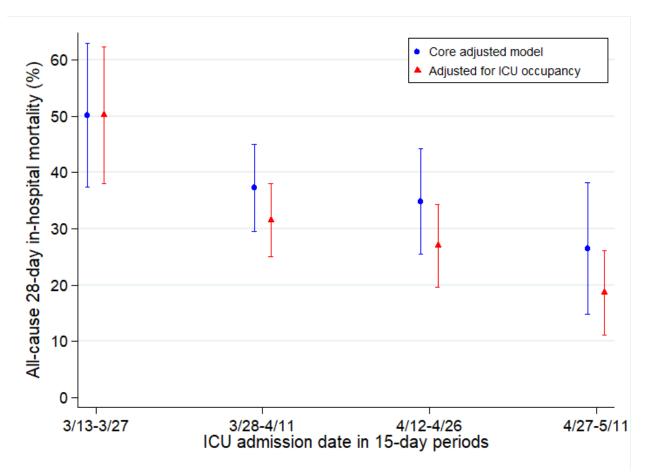




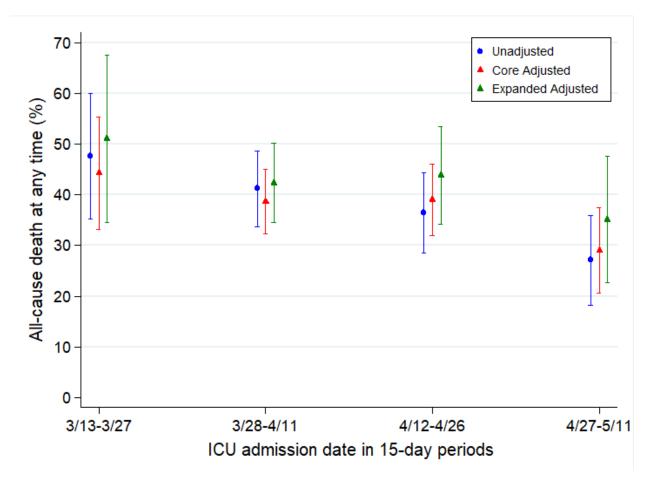


*Notes:* Bed occupancy is calculated as a percentage of the pre-COVID bed capacity occupied by COVID-19 patients stratified by ICU vs ward and by hospital over time by calendar day.



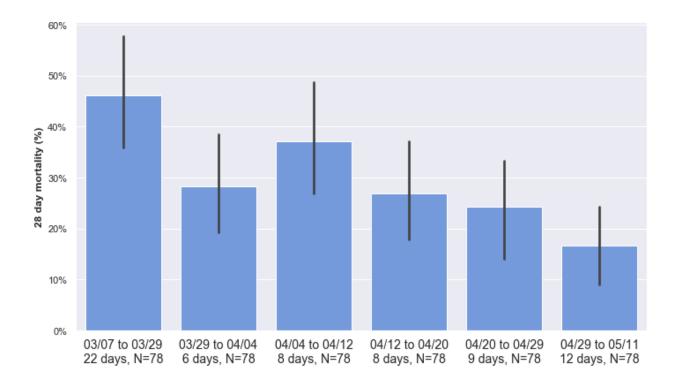


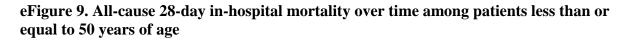


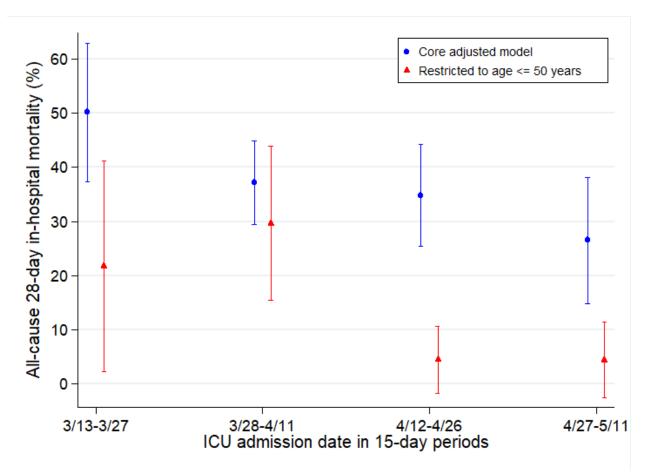


# eFigure 8. All-cause 28-day in-hospital mortality over cumulative COVID-19 patient volume

All-cause 28-day in-hospital mortality decreased over cumulative COVID-19 patient volume in equal increments of 78 consecutive ICU admissions across the study period.







### eFigure 10. Age and in-hospital mortality

Notes: Red subtotals report deaths by age category.

