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Choices and Outcomes of the Oldest Old Admitted During the First Wave of COVID-19 in New York City

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Abstract

Objectives: Morbidity and mortality are higher in older adults with COVID-19, but their decisions about aggressive care, severity of disease, and outcomes during the first surge in New York City are not well characterized. We sought to determine if the oldest patients chose intubation and comfort care at different rates compared to younger geriatric patients. We also studied outcomes among patients admitted with severe disease and those who chose aggressive versus comfort care. **Methods:** This retrospective analysis used electronic health record data from patients 65 years and older at two medical centers in New York City admitted between 3/5/2020 and 5/15/2020. The primary outcome was comfort care orders, and secondary outcomes included death, palliative care consultation, goals of care discussion, code status, and ventilator weaning. **Results:** Of the 854 patients, 214 were in the oldest old (OO, age > = 85) group, 269 middle old (MO, age 75-84), and 371 young old (YO, age 65-74). Among those with serious disease, the OO were more likely to choose comfort care (45% vs. 21% MO and 6.8% YO), less likely to be intubated (17% vs. 37% MO and 44% YO), more likely to have a palliative care consult, more likely to be DNR/DNI on admission (60% vs. 17% MO and 9.3%% YO), and more likely to die during admission (65% vs. 42% MO and 21% YO) (all p-values < 0.001). Of all 216 intubated patients, 78% of the OO died, versus 66% of the MO and 36% of the YO (p = <0.001). **Conclusions:** Adults 85 and above admitted with COVID-19 were more likely to forego intubation and die with comfort-based care. Irrespective of intubation choice, patients 85 and older had a markedly poorer prognosis than other cohorts over 65.

Keywords

coronavirus, COVID-19, geriatrics, frailty, palliative care, intubation, comfort care

Introduction

Coronavirus disease 2019 (COVID-19) has been shown to disproportionately affect adults 65 years and older, resulting in more complications and deaths.[1,2] Mortality rates from COVID-19 infection are not uniform in the geriatric population, with death occurring more frequently with advancing age.[3] Additionally, frailty has been identified as an independent predictor of outcomes of COVID-19,[4] with a nearly linear relationship between Clinical Frailty Scale (CFS) and mortality.[5]

While poor outcomes have been well characterized, whether the oldest patients with COVID-19 benefit from intensive care and intubation remains uncertain. A study of more than 10,000 patients hospitalized with COVID-19 in Germany, where the healthcare system was not overwhelmed, found that 13% of all patients received invasive ventilation; among this cohort, the overall mortality rate was 52.6% and varied widely by age: 23% in 18–59 year olds, 46% in 60–69 year olds, 63% in 70–79 year olds, and 72% in 80 and older.[6] A study in Italy comparing outcomes of hospitalization during

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peak times - when hospital beds had to be rationed - and off-peak times showed little mortality benefit from admission in patients 80 years or older.[7]

Prior studies have revealed age, frailty, and poor functional status[8] are independent predictors of worse outcomes following COVID-19 infection. Intensive care offers potential benefits of mortality but also harms of delirium, isolation, and long-term debility.[9] In COVID-19 survivors, prolonged admission leads to deficits in cognition and mobility that may linger despite extensive rehabilitation.[10] Patients admitted with COVID-19 demonstrate higher rates of readmission and multi-organ dysfunction compared to matched cohorts, a finding even more significant in patients over 70 years or those admitted to the intensive care unit (ICU).[11]

COVID-19 heavily affected our hospital system in New York City during the first US wave starting in March, 2020.[12] The choices older patients made about their care during this time have not been well characterized. There also remains a gap in studies observing outcomes by age category while controlling for a large number of variables - namely sex, functional status, residence prior to admission, social vulnerability and comorbidities. Based on our experience, we observed poor outcomes in the older adults who chose aggressive care and high rates of patients who chose comfort-focused care. The primary objective of this study was to determine if the oldest patients chose intubation and comfort care at different rates compared to younger geriatric patients. Secondary measures included in-hospital outcomes among patients with severe disease and those who chose aggressive versus comfort care.

Methods

Study Design

This is retrospective cohort study of patients admitted with COVID-19. Cases were confirmed through reverse-transcriptase–polymerase-chain-reaction assays performed on nasopharyngeal swab specimens. Data were manually abstracted from electronic health records with the use of a quality-controlled protocol and structured abstraction tool.

The primary outcome was comfort care order placement – an order set of medications given at the end of life that also designates a transition to a comfort-focused care plan - among the oldest old (OO) patients, compared to the middle old (MO) and young old (YO). Secondary outcomes included intubation, in-hospital mortality, palliative care consultation, GOC discussion, code status, code status change, and extubation or ventilator weaning. These variables were defined as detailed below in Measures.

Setting and Participants

Study participants included adults 65 years or older with confirmed COVID-19 who were admitted between March 3, 2020 (date of the first positive case) and May 15, 2020 at an 862-bed quaternary referral center and an affiliated 180-bed nonteaching community hospital in Manhattan. Three cohorts were defined: YO: ages 65 to 74 years; MO: ages 75 and 84 years; and OO: 85 years and older.

Data Collection

Data were collected directly by our group and also taken from a previous case series done at our institution;[12] variable sources can be found in appendix A. Data collected included demographics, comorbidities, home medications, functional status, oxygen requirement, code status, palliative care consultation, goals of care (GOC) discussion, comfort care status, and mortality.

Abstractors were clinicians trained to pull standard data elements into Research Electronic Data Capture (REDCap®), a secure web platform. Training for abstraction was performed across multiple sessions. Calibration was reinforced through regular meetings and auditing of five patient records per abstractor against a standard. Discrepancies in all variables were resolved by discussion and audit was repeated until 100% agreement was reached.

Measures

Comorbid conditions were abstracted from admission notes and home medications from the medication reconciliation. Underlying cognitive impairment was defined based on documentation in admission and emergency department (ED) notes. Social Vulnerability Index (SVI), a measure of the relative vulnerability of every U.S. Census tract, was obtained by inputting each patient's zip code of residence into the Center for Disease Control's interactive map and recording the value provided, ranging from 0 to 1, with 1 corresponding to highest vulnerability (https://svi.cdc.gov/map.aspx). CFS score, functional status, and residence prior to admission were abstracted based on information gathered from admission notes, progress notes, and social work/case management notes.

The highest level of supplemental oxygen within three hours of presentation to the ED was determined by review of respiratory flowsheets. Patients requiring supplemental oxygen within three hours were considered to have more serious respiratory disease. Intubation status was obtained from procedure notes. Extubation or ventilator weaning (defined as 48 + hours free from mechanical ventilation in patients with tracheostomy) was assessed from progress notes and flowsheets.

Palliative care consultation was determined by the presence of a consult order and note, and defined as either in-person or telemedicine consultation with a palliative care attending, fellow, nurse practitioner, social worker, or chaplain in response to a consult question. GOC documentation was assessed in admission, progress, palliative care consult, and event notes. Code status was determined by orders and notes, while code status change was assessed by the presence of multiple orders and concomitant documentation. Comfort care, defined as a

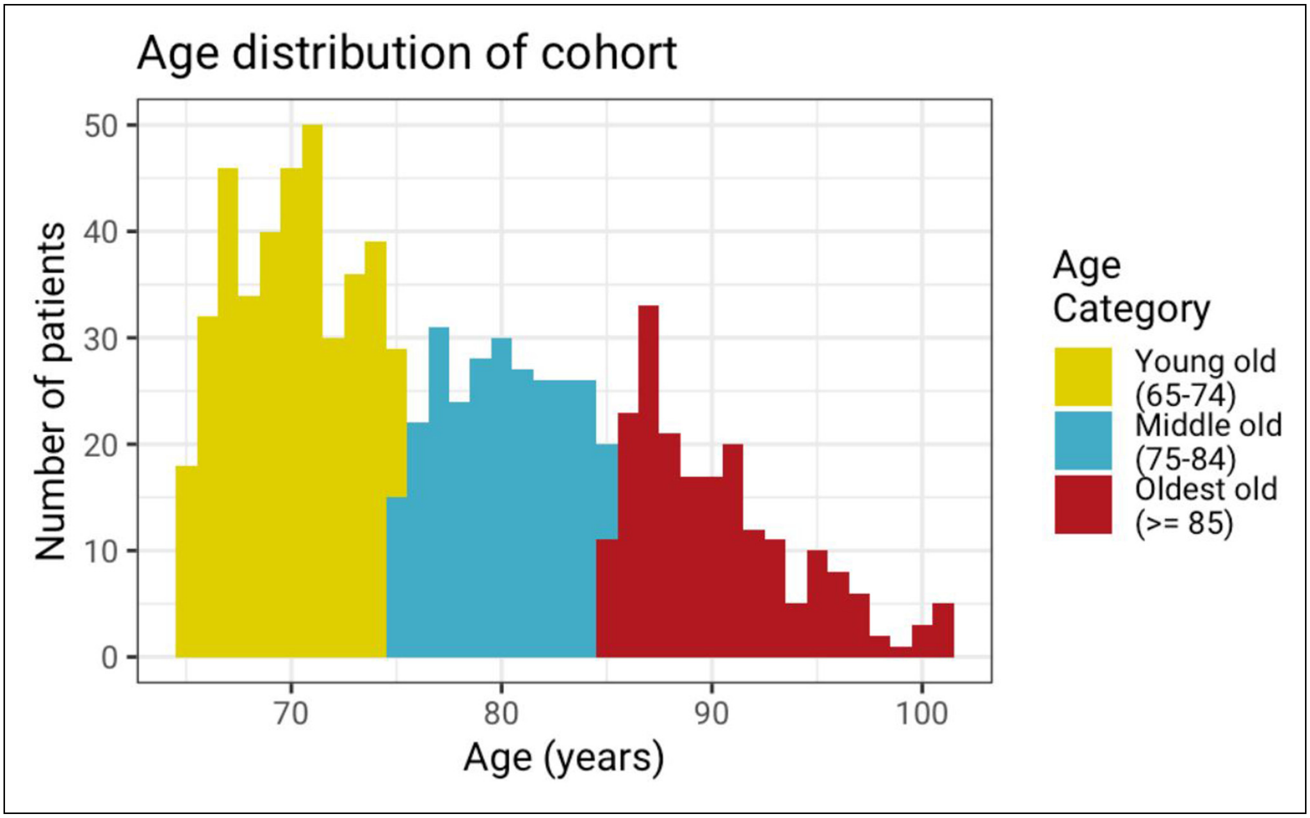

Figure 1. Age distribution of the study cohort. young old patients (ages 65-74 years) are shown in yellow, middle old patients (ages 75-84 years) are shown in blue, and oldest old patients (ages 85 years and up) are shown in red.

care plan focused on symptom control, quality of life and minimizing unnecessary interventions, was abstracted by presence of a 'comfort care' order. Death was determined by a death note and disposition in the discharge summary.

Statistical Analysis

To describe the demographics and baseline characteristics of our cohort, Pearson's Chi-squared test, Kruskal-Wallis rank sum test, and Fisher's exact test were utilized for tests of independence for normally distributed continuous, non-normally distributed continuous, and categorical variables, respectively. To examine the association between age and intubation, code status, and in-hospital mortality, we used Chi square tests of independence. Post-hoc pairwise comparisons were conducted using similar methods to determine differences between age groups. These secondary tests were adjusted for multiple comparisons using the Benjamini-Hochberg procedure. The data were analyzed in three groups: the total cohort, those requiring supplemental oxygen on admission, and those requiring intubation. We also adjusted for potential confounders using multivariable logistic regression. A type I error rate of 0.05 was used to determine statistical significance and Benjamini-Hochberg's False Discovery Rate was used to adjust for multiple comparisons. We examined the subset of intubated patients and tested for differences in outcomes of death and successful extubation across age categories using Chi square tests and controlling for the same confounders using multivariable logistic regression. All analyses were performed using R version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

Ethical Considerations

As this was a large, retrospective study, the need for informed consent was waived by the Weill Cornell Medicine Institutional Review Board.

Results

The final cohort included 854 patients aged 65 and older admitted with COVID-19. Figure 1 depicts the age distribution of the group, and Table 1 provides the basic demographics. In this sample, 42.4% of patients were female, with an increasing proportion of women with advancing age. White patients made up 42% of the studied population. There were no differences across age groups in the incidence of coronary artery disease (CAD), hypertension (HTN), cerebrovascular accident (CVA), chronic kidney disease (CKD)/end-stage renal disease (ESRD), cirrhosis, asthma, active cancer, immunosuppressed state, or underlying psychiatric disease (all p-values >0.05). Younger patients more often had type 2 diabetes (DM) ($p < 0.001$). Chronic obstructive pulmonary disease (COPD) ($p = 0.004$) and underlying cognitive impairment ($p < 0.001$) were more common in

Table 1. Demographics and Comorbidities by age Category.

Characteristic	Age Categories: Young old (YO) (65-74), N = 371[1]	Middle old (MO) (75-84), N = 269[1]	Oldest old (OO) (>= 85), N = 214[1]	Total **N = 854**	p-value: Global[2]	Pairwise Comparisons: YO versus MO[3]	MO versus OO[3]	YO versus OO[3]
Sex					0.023	0.6	0.3	0.025
Female	142 (38%)	113 (42%)	107 (50%)	362 (42%)				
Male	229 (62%)	156 (58%)	107 (50%)	492 (58%)				
Race					<0.001	0.6	0.09	<0.001
Asian	67 (18%)	59 (22%)	51 (24%)	177 (21%)				
Black	53 (14%)	26 (9.7%)	10 (4.7%)	89 (10%)				
Other or Unknown	115 (31%)	79 (29%)	46 (21%)	240 (28%)				
White	136 (37%)	105 (39%)	107 (50%)	348 (41%)				
Ethnicity					0.011	0.6	0.032	0.052
Hispanic or Latino oSpanish origin	70 (19%)	62 (23%)	26 (12%)	158 (18%)				
Not Hispanic or Latino Spanish origin	179 (48%)	128 (48%)	128 (60%)	435 (51%)				
Unknown	122 (33%)	79 (29%)	60 (28%)	261 (31%)				
BMI	27.0 (23.8, 30.6)	25.2 (22.5, 28.8)	23.2 (21.5, 26.4)		<0.001	<0.001	0.002	<0.001
Unknown	9	8	7	24				
Smoking status					0.7	0.6	>0.9	0.7
Active Smoker	12 (3.2%)	8 (3.0%)	5 (2.3%)	25 (3%)				
Former Smoker	102 (27%)	87 (32%)	65 (30%)	254 (30%)				
No	257 (69%)	174 (65%)	144 (67%)	575 (67%)				
CAD	78 (21%)	61 (23%)	63 (29%)	202 (24%)	0.053	0.8	0.3	0.076
DM	155 (42%)	100 (37%)	54 (25%)	309 (36%)	<0.001	0.6	0.041	<0.001
HTN	249 (67%)	195 (72%)	160 (75%)	604 (71%)	0.11	0.5	0.8	0.14
CVA	40 (11%)	41 (15%)	25 (12%)	106 (12%)	0.2	0.5	0.6	0.8
CKD/ESRD	25 (6.7%)	14 (5.2%)	6 (2.8%)	45 (5%)	0.12	0.7	0.6	0.14
Cirrhosis	5 (1.3%)	1 (0.4%)	1 (0.5%)	7 (0.8%)	0.4	0.6	>0.9	0.6
COPD	22 (5.9%)	22 (8.2%)	30 (14%)	74 (8.7%)	0.005	0.6	0.3	0.006
Asthma	31 (8.4%)	17 (6.3%)	14 (6.5%)	62 (7.3%)	0.6	0.6	>0.9	0.6
Active cancer	33 (8.9%)	25 (9.3%)	20 (9.3%)	78 (9.1%)	>0.9	>0.9	>0.9	0.9
Immunosuppressed state	15 (4.0%)	11 (4.1%)	5 (2.3%)	31 (3.6%)	0.5	>0.9	0.6	0.5
Underlying psychiatric disease	32 (8.6%)	21 (7.8%)	21 (9.8%)	74 (8.6%)	0.7	0.9	0.8	0.7
Underlying cognitive impairment	20 (5.4%)	54 (20%)	75 (35%)	149 (17%)	<0.001	<0.001	0.004	<0.001
Total number of home medications	5.0 (2.0, 8.0)	6.0 (3.0, 9.0)	6.0 (4.0, 9.0)	6.0 (3.0, 9.0)	<0.001	0.007	0.8	<0.001
Supplemental oxygen prior to admission	13 (3.9%)	11 (4.7%)	9 (4.7%)	33 (3.9%)	0.8	0.8	>0.9	0.7
Unknown	36	35	23	94				
Immunosuppression medications (past 30 days)	40 (11%)	25 (9.3%)	14 (6.5%)	79 (9.3%)	0.2	0.8	0.6	0.2
ACE/ARBs on admission	142 (38%)	105 (39%)	70 (33%)	317 (37%)	0.3	>0.9	0.5	0.3
Statins on admission	173 (47%)	149 (55%)	107 (50%)	429 (50%)	0.083	0.2	0.6	0.6
NSAIDs on admission	135 (36%)	93 (35%)	87 (41%)	315 (37%)	0.4	0.8	0.5	0.5
PPIs on admission	70 (19%)	66 (25%)	51 (24%)	187 (22%)	0.2	0.4	>0.9	0.3
Antipsychotics on admission	15 (4.0%)	17 (6.3%)	13 (6.1%)	45 (5.3%)	0.3	0.6	>0.9	0.5
Antidepressants/mood stabilizers on admission	36 (9.7%)	37 (14%)	39 (18%)	112 (13%)	0.013	0.5	0.5	0.018

(continued)

Table 1. Continued.

Characteristic	Age Categories: Young old (YO) (65-74), N = 371[1]	Middle old (MO) (75-84), N = 269[1]	Oldest old (OO) (>= 85), N = 214[1]	Total **N = 854**	p-value: Global[2]	Pairwise Comparisons: YO versus MO[3]	MO versus OO[3]	YO versus OO[3]
Benzodiazepines on admission	12 (3.2%)	18 (6.7%)	11 (5.1%)	41 (4.8%)	0.11	0.3	0.8	0.5
Opioids on admission	15 (4.0%)	7 (2.6%)	6 (2.8%)	28 (3.3%)	0.5	0.6	>0.9	0.6

[1]n (%); Median (IQR).
[2]Pearson's Chi-squared test; Kruskal-Wallis rank sum test; Fisher's exact test.
BMI = body mass index, CAD = coronary artery disease, DM = diabetes mellitus, HTN = hypertension,.
CVA = cerebrovascular accident, CKD = chronic kidney disease, ESRD = end stage renal disease, COPD = chronic obstructive pulmonary disease, ACE = angiotensin-converting enzyme, ARB = angiotensin receptor blocker, NSAID = non-steroidal anti-inflammatory drug, PPI = proton pump inhibitor.
[3]False discovery rate correction for multiple testing.

Table 2. Baseline Function, Frailty and Vulnerability by age Category.

Characteristic	Age Categories: ***Young old (YO) (65-74)***, N = 371[1]	***Middle old (MO) (75-84)***, N = 269[1]	***Oldest old (OO) (>= 85)***, N = 214[1]	***Total*** N = 854	***p-value***: ***Global***[2]	***Pairwise Comparisons***: ***YO versus MO***[3]	***MO versus OO***[3]	***YO versus OO***[3]
Dependence in at least 1 ADL	49 (13%)	87 (32%)	118 (55%)	254 (30%)	<0.001	<0.001	<0.001	<0.001
Clinical Frailty Score (1-9)	3.0 (3.0, 4.0)	4.0 (3.0, 6.0)	5.0 (4.0, 7.0)		<0.001	<0.001	<0.001	<0.001
Social Vulnerability Index	0.72 (0.42, 0.85)	0.63 (0.23, 0.84)	0.39 (0.16, 0.73)		<0.001	0.027	<0.001	<0.001
Residence prior to admission (categorized)					<0.001	0.027	0.003	<0.001
Assisted living facility	0 (0%)	5 (1.9%)	13 (6.1%)	18 (2.1%)				
Home	334 (90%)	229 (85%)	165 (77%)	728 (85%)				
Long-term care nursing home	14 (3.8%)	19 (7.1%)	24 (11%)	57 (6.7%)				
Other	14 (3.8%)	7 (2.6%)	0 (0%)	21 (2.5%)				
Sub-acute rehab (eg temporary skilled nursing facility visit)	9 (2.4%)	9 (3.3%)	12 (5.6%)	30 (3.5%)				
Residence prior to admission (dichotomous)					<0.001	0.078	0.030	<0.001
Home	334 (90%)	229 (85%)	165 (77%)	728 (85%)				
Not home	37 (10.0%)	40 (15%)	49 (23%)	126 (15%)				

[1]Median (IQR); n (%).
[2]Kruskal-Wallis rank sum test; Pearson's Chi-squared test.
[3]False discovery rate correction for multiple testing.
ADL = activity of daily living (bathing, dressing, hygiene, transfers, feeding, toileting).

Table 3. Intubation, Resuscitation, and in-Hospital Mortality by age Category Among Patients Requiring Supplemental Oxygen Within Three Hours of ED Arrival.

	Age Categories				***p-value***			
						Pairwise Comparisons		
Characteristic	***Young old (65-74)***, N = 236[1]	***Middle old (75-84)***, N = 151[1]	***Oldest old (> = 85)***, N = 122[1]	***Total***, N = 509	***Global***[2]	***YO versus MO***[3]	***MO versus OO***[3]	***YO versus OO***[3]
Intubated	105 (44%)	56 (37%)	21 (17%)	182 (36%)	<0.001	0.2	<0.001	<0.001
Palliative care consult	53 (22%)	46 (31%)	56 (46%)	155 (30%)	<0.001	0.083	0.016	<0.001
GOC documentation present	157 (67%)	118 (78%)	112 (92%)	387 (76%)	<0.001	0.031	0.004	<0.001
Code status on admission of DNR or DNR/DNI	22 (9.3%)	26 (17%)	73 (60%)	121 (24%)	<0.001	<0.001	0.035	<0.001
Code status change	50 (21%)	48 (32%)	30 (25%)	128 (25%)	0.063	0.031	0.2	0.5
Change in code status among full code patients only	45/214 (21%)	48/125 (38%)	29/49 (59%)	122/388 (31%)	<0.001	0.001	0.020	<0.001
Comfort care orders	16 (6.8%)	31 (21%)	55 (45%)	102 (20%)	<0.001	<0.001	<0.001	<0.001
In-hospital mortality	49 (21%)	64 (42%)	78 (64%)	191 (38%)	<0.001	<0.001	<0.001	<0.001

Extubation and in-hospital mortality by age category among patients who were intubated

					p-values			
						Pairwise Comparisons		
Characteristic	Young old (65-74), N = 122[1]	Middle old (75-84), N = 71[1]	Oldest old (> = 85), N = 23[1]	Total, N = 216	Global[2]	YO versus MO[3]	YO versus MO[3]	YO versus MO[3]
Extubated or had ventilator weaned	76 (62%)	24 (34%)	6 (26%)	106 (49%)	<0.001	<0.001	0.6	0.001
Deceased during admission	44 (36%)	47 (66%)	18 (78%)	109 (50%)	<0.001	<0.001	0.6	<0.001

[1]n (%).
[2]Pearson's Chi-squared test.
[3]False discovery rate correction for multiple testing.
YO = young old, MO = middle old, OO = oldest old, ED = Emergency Department, GOC = goals of care, DNR = do not resuscitate, DNI = do not intubate.

the oldest cohort. The OO patients were more often prescribed antidepressants or mood stabilizers ($p = 0.011$); there was otherwise no difference in home use of any other recorded medications.

Table 2 describes the baseline function and vulnerability of the cohort. Older patients had lower SVI score, reflecting less vulnerability than the younger cohort ($p < 0.001$). OO patients had higher CFS scores and poorer functional status – characterized by higher proportion of dependence in at least one ADL (bathing, dressing, hygiene, transfers, feeding, toileting) compared to younger cohorts (all p-values <0.001). The OO were less likely to live at home ($p < 0.001$) and more likely to reside in assisted living facility or sub-acute rehab.

To explore the choices and outcomes of high-risk patients – defined as those who arrived in the hospital with severe respiratory disease – we examined the 509 patients who required supplemental oxygen during their first 3 hours in the ED (Table 3). Utilizing this cohort, we reviewed the primary outcome of transition to comfort care. The OO were most likely to receive comfort care orders (45% in OO, 21% in MO, and 6.8% in YO, $p < 0.001$). Logistic regression demonstrated that even after controlling for sex, BMI, DM, COPD, race, ethnicity, cognitive impairment, residence prior to admission, SVI, frailty, and functional status on admission, comfort care order rates were higher in the OO (odds ratio 1.23, $p < 0.001$).

Secondary outcomes included rates of intubation, in-hospital mortality, palliative care consultation, GOC discussions, code status, and extubation or ventilator weaning. The oldest were less likely to be intubated (17% in OO, 37% in MO and 44% in YO, $p < 0.001$), even after logistic regression controlling for potential confounders was performed (Table 4). 64% of the OO requiring supplemental oxygen on admission died, compared to 42% of MO and 21% of YO patients. OO patients were more likely to have a palliative care consultation, DNR/DNI code status on admission, and die during admission (all p-values <0.001). Table 3 also characterizes the outcomes of the 216 patients who were intubated and mechanically ventilated. Those in the OO group were less likely to be extubated or weaned from the ventilator ($p < 0.001$)

Table 4. Adjusted Regression models[1] for Outcomes in Total, Hypoxic, and Intubated Cohorts.

Outcome	Odds Ratio	95% CI	p-value[2]
All Patients			
Deceased during admission			
Middle old (75-84)	1.11	1.03–1.19	0.005
Oldest old (>=85)	1.26	1.15–1.37	<0.001
Hypoxic Patients			
Intubation			
Middle old (75-84)	0.96	0.87–1.06	0.43
Oldest old (>=85)	0.83	0.73–0.94	0.01
Palliative care consult			
Middle old (75-84)	1.05	0.95–1.16	0.38
Oldest old (>=85)	1.16	1.03–1.30	0.04
GOC documentation present			
Middle old (75-84)	1.08	0.99–1.18	0.15
Oldest old (>=85)	1.15	1.03–1.29	0.03
Code status on admission of DNR or DNR/DNI			
Middle old (75-84)	1.00	0.93–1.08	0.97
Oldest old (>=85)	1.39	1.27–1.53	<0.001
Any change in code status			
Middle old (75-84)	1.08	0.98–1.18	0.18
Oldest old (>=85)	0.97	0.87–1.09	0.69
Change in code status among full code patients only			
Middle old (75-84)	1.10	0.99–1.22	0.14
Oldest old (>=85)	1.26	1.08–1.47	0.01
Comfort care orders			
Middle old (75-84)	1.06	0.98–1.15	0.18
Oldest old (>=85)	1.23	1.12–1.35	<0.001
Deceased during admission			
Middle old (75-84)	1.16	1.06–1.28	0.009
Oldest old (>=85)	1.34	1.19–1.51	<0.001
Intubated Patients			
Deceased during admission			
Middle old (75-84)	1.27	1.09–1.48	0.004
Oldest old (>=85)	1.44	1.15–1.81	0.004
Extubated or had ventilator weaned[3]			
Middle old (75-84)	0.79	0.68–0.93	0.005
Oldest old (>=85)	0.74	0.58–0.93	0.009

[1]Reference group is young old (65-74). Logistic regression models are adjusted for sex, BMI, DM, COPD, race, ethnicity, cognitive impairment, residence prior to admission, SVI, frailty and functional status on admission.
[2]P-value adjusted for multiple comparisons using Benjamini Hochberg method.
[3]Defined as patient with tracheostomy off the ventilator for 48 + hours.
GOC = goals of care, DNR = do not resuscitate, DNI = do not intubate.

and more likely to die, with a 78% mortality rate compared to 66% and 36% in the middle and YO groups. Each of these observations remained true after controlling for confounders (Table 4).

Among the entire cohort, the rates of palliative care consultation and GOC discussion increased with advancing age. Nearly half of the OO patients were treated with comfort-based measures. Figure 2 depicts initial code status on admission and code status after changes among patients across age categories. Sixty percent of the OO patients elected to be DNR/DNI on admission. Of the 49 remaining patients in this group who were initially "full code", 30 (61%) switched their code status to DNR or DNR/DNI during admission. Although most of these code status changes occurred prior to intubation, a small subset were made DNR after initiating invasive mechanical ventilation. Only 8 of those patients who changed their code status were not initially "full code", 3 from DNR to DNR/DNI and 5 from DNR/DNI to" full code". Notably, several of these patients underwent more than one code status change.

Lastly, because SVI decreased with advancing age – corresponding to less vulnerability – we further explored the relationship between SVI and our outcomes of interest (Table 5). Adjusted regression models for SVI coefficients among the entire cohort, hypoxic patients, and intubated patients each failed to demonstrate a significant association between SVI and any study outcomes.

Discussion

Studies examining the effects of age on COVID-19 outcomes have documented poorer outcomes in geriatric patients. Nonetheless, the age group over 65 years is not homogeneous. Our study found that: 1) GOC were more frequently discussed in the OO, and this group was most likely to choose comfort care or experience a code status change from "full code" to DNR/DNI; 2) the OO were less likely to be intubated; 3) the OO had significantly poorer outcomes than their younger over-65 counterparts even after controlling for several prespecified variables; and 4) mortality despite invasive mechanical ventilation was higher in the OO than both younger intubated patients and non-intubated patients in the same age group.

In our experience caring for patients during the pandemic, the OO (or their families) often deferred intubation or resuscitation, even during early discussions in the ED, and the findings of this study confirmed our clinical impression. We do not know why these choices were made; they may reflect advance care decisions before COVID-19 or an intuitive recognition of poor prognosis in the face of a new pandemic. The hospital met demand by dramatically expanding capacity,[13] and no one was denied intubation if they sought aggressive care. Nonetheless, palliative care access was also expanded, and its availability likely led to early and frank discussions about prognosis.[14]

Early into the first surge, the palliative care team began offering telemedicine consults, reaching out to critically-ill patients and their family members by phone or videoconference.[15] Overall high rates of palliative care consultation that increased with advancing age can likely be attributed to the expanded capacity of the consultation service. Early discussion of code status may have contributed to the higher rates of DNR/DNI in the OO group on admission. The changes in code status observed in the OO were frequently transitions from "full code" to DNR or

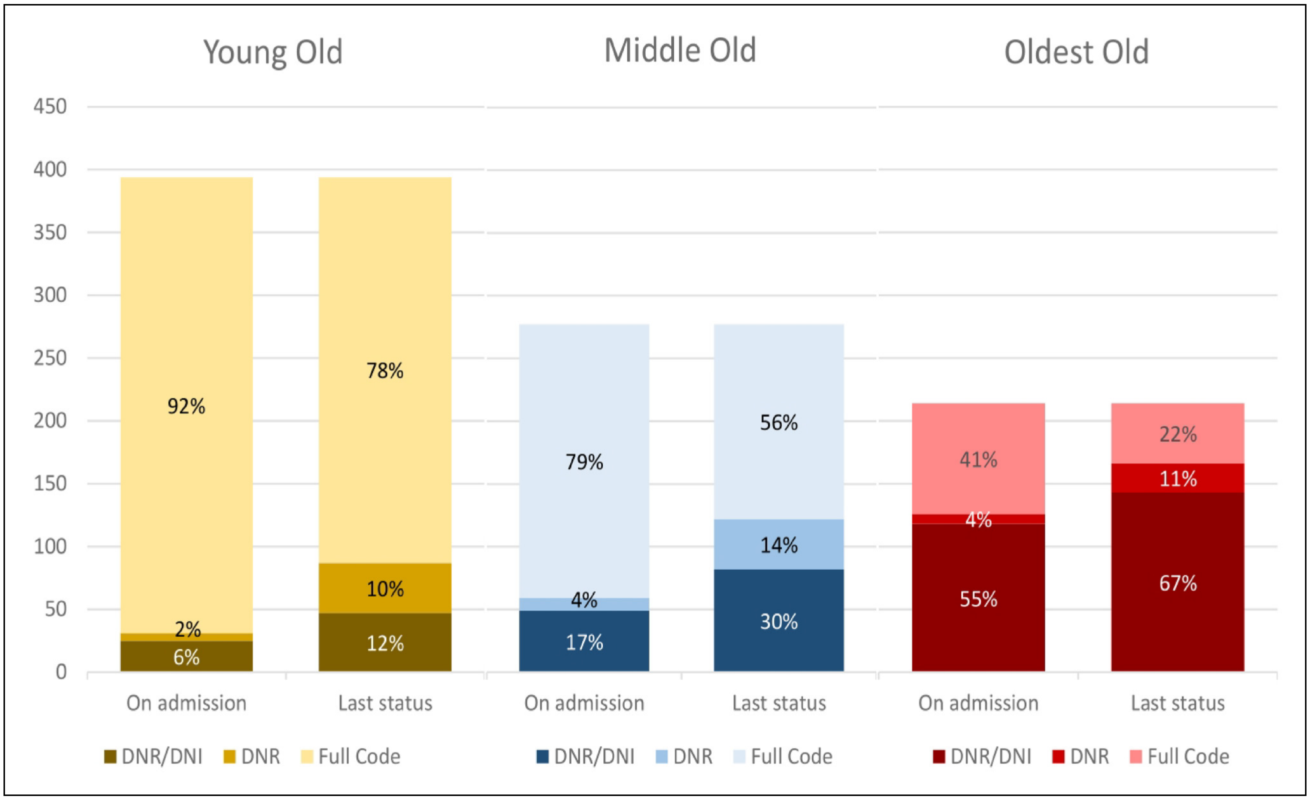

Figure 2. Depiction of patients' initial code status on admission and code status after changes among patients in the young old, middle old, and oldest old cohorts. DNR = do not resuscitate; DNI = do not intubate.

DNR/DNI, often the result of discussions prompted by clinical decompensation and anticipated need for intubation. A subset of patients had a code status change to DNR after intubation. Based on experiences in the ICU, these patients were often receiving maximum respiratory support and in multi-organ failure, making resuscitation unlikely to have a meaningful mortality benefit; families likely chose to change code status to DNR when this became clear. Many patients were treated with comfort-based measures, with the highest rates observed in the OO cohort, potentially because this was recommended in patients with severe disease and anticipated poor prognosis. A Palliative Care Unit was even created at our institution for delivering inpatient hospice services,[16] providing an additional avenue for offering comfort-focused care.

Older age has been associated with poor prognosis and increased risk for death from COVID-19.[17–21] It has also been associated with increased risk for readmission,[22] longer length of stay,[20] acute respiratory distress syndrome, cardiac decompensation, shock,[21,23] and delirium.[24] Mortality rates for older adults admitted for COVID-19 have been reported from 32–58%, with even higher rates when admitted to the ICU;[20,25] our study confirms these findings. A number of mechanisms, including inflammation,[26] mitochondrial dysfunction, and impaired autophagy[27] have been implicated as contributors to the increased pathophysiological response to severe acute respiratory syndrome from COVID-19 among older adults. These factors may influence additive risk of accelerated biological aging even if recovery occurs.[28] Our results also indicate that benefits of intubation may be limited, as the patients in the OO group who were intubated had very high mortality (78%).

Frailty, an age-related vulnerability due to decreased physiologic reserve, has been used to prognosticate outcomes of illnesses and guide treatment.[29] Multiple studies have shown an association between frailty and higher mortality in COVID-19, even after controlling for other risk factors.[5,19,30,31] Our study demonstrates that even after controlling for frailty, functional impairment, and other patient characteristics, the oldest patients were still at higher risk for mortality, suggesting that older age should be considered a significant predictor of worse outcomes in patients admitted with COVID-19. Frailty could have been overestimated and functional status underestimated in our cohort, as patients often arrived in a much worse state than their baseline due to critical illness, and documentation often relied on patient and family reporting. If frailty were overestimated only in the OO, the data would show a stronger correlation between advancing age and poor outcomes. In the recent position statement, the American Geriatrics Society discouraged use of chronological age to guide treatment in patients with COVID-19 infection, as older adults represent a heterogeneous population.[32] Rather, frailty, multimorbidity and functional trajectory were suggested to better reflect biological aging.

Surprisingly, the oldest cohort had lower SVI score, reflecting less vulnerability than the younger cohort. The

Table 5. SVI Coefficients -- Adjusted Regression Models.

Outcome	Odds Ratio	95% CI	p-value[1]
All Patients			
Deceased during admission (All Patients)	1.05	0.93–1.17	0.44
Hypoxic Patients			
Intubation	1.08	0.92–1.27	0.79
Palliative care consult	1.22	1.04–1.43	0.12
GOC documentation present	0.93	0.81–1.08	0.79
Code status on admission of DNR or DNR/DNI	0.97	0.86–1.10	0.79
Code change	0.95	0.82–1.11	0.79
Change in code status among full code patients only	0.98	0.83–1.17	0.86
Comfort care orders	0.98	0.86–1.11	0.79
Deceased during admission	1.06	0.90–1.23	0.79
Intubated Patients			
Extubated or had ventilator weaned[2]	0.96	0.73–1.25	0.74
Deceased during admission	1.06	0.81–1.38	0.69

[1]P-value adjusted for multiple comparisons using Benjamini Hochberg method.
[2]Defined as patient with tracheostomy off the ventilator for 48 + hours.
SVI = social vulnerability index, GOC = goals of care, DNR = do not resuscitate, DNI = do not intubate.

neighborhood surrounding the larger hospital is associated with low SVI score; possibly, older patients sicker on triage by EMS were brought to the nearest hospital, while the younger cohort may have chosen to travel further to receive care at an academic hospital or where their outpatient providers work. This difference in access may have led to confounding, explaining why after adjusted regression analysis, SVI did not impact outcomes.

Despite public health efforts, COVID-19 infections continue to surge globally, even in countries with high vaccination rates.[33,34] Our findings of high mortality in the OO patients regardless of intubation choice could help inform decisions for critically ill older adults, equipping them with information needed to make choices in line with their values. Surges of COVID-19 have also pushed hospital systems beyond capacity and necessitated guidance for rationing resources.[35] Because a relationship between age, frailty and mortality has been consistently established, carefully considering these variables along with other risk factors may help identify patients most likely to benefit from intensive care and intubation if resources become scarce again. Our findings also indicate the importance of palliative care services, which helped facilitate decision-making and provide support and symptom management to unprecedented numbers of patients at our institution during the pandemic. Our outcomes could be used to predict the patients most likely to benefit from palliative care consultation and encourage planning to expand capacity for consultation services during surges.

Our study has several limitations. The study design was retrospective using electronic health record data and limited chart review. Our cohort was limited to two hospitals. The primary data collection occurred during a surge at the beginning of the COVID-19 pandemic during a time of rapid escalation of critical care facilities, and prior to the widespread use of current standard therapies (dexamethasone, remdesivir) and vaccines. Strengths of our study are the large size, advanced age of the cohort, and robustness of the sociodemographic and outcome variables collected. This provided us the opportunity to analyze the considerable outcome variability based on the effects of age within the geriatric population.

Conclusion

Compared to their YO counterparts, adults aged 85 years and above admitted with COVID-19 were more likely to choose comfort-focused care, less likely to be intubated, more likely to have a palliative care consultation, more likely to be DNR/DNI, and more likely die during admission, even after controlling for demographics, functional status, frailty, and SVI. Irrespective of intubation choice, patients 85 and older had a markedly poorer prognosis than younger geriatric patients.

Conflict of Interest:

None of the authors have any financial or personal conflicts to disclose.

Author Contributions:

EC & RKal & ES participated in study concept and design, acquisition of data, interpretation of data, and preparation of the manuscript. RKo participated in acquisition of data. AY and GW participated in acquisition of data, interpretation of data, and preparation of the manuscript. KH participated in acquisition of data, analysis, and interpretation of data. PG participated in study concept and design, interpretation of data and preparation of the manuscript. RKan participated in study concept and design, interpretation of data and preparation of the manuscript. VPho participated in study concept and design, interpretation of data and preparation of the manuscript.

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Declaration of Conflicting Interests

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Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Informed Consent

Not applicable, because this article does not contain any studies with human or animal subjects.

Trial Registration

Not applicable, because this article does not contain any clinical trials.

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Appendix A

Variables collected by original case series

Demographics	
Race	White, black, Asian, other, unknown
Ethnicity	Hispanic, not Hispanic, other or unknown
Sex	Male, female
Age	Documented and calculated based on DOB
Co-morbidities	
CAD (Coronary Artery Disease)	y/n
Heart Failure	y/n
CVA (Stroke)	y/n
Diabetes Mellitus (DMI, DMII)	y/n
HTN (Hypertension)	y/n
Non-invasive home O2 at baseline	y/n
Invasive mechanical ventilation at baseline	y/n
Pulmonary Disease	y/n
Renal Disease	y/n
Cirrhosis	y/n
Hepatitis B or C	y/n
HIV	y/n
Active Cancer (excluding non-melanoma skin cancer)	y/n
History of Transplant	y/n
Inflammatory Bowel Disease	y/n
Rheumatologic Disease	y/n
Other immunosuppressed state	y/n
Symptoms	
Date of first symptoms	MM/DD/YY
Date of first healthcare contact	MM/DD/YY
Smoking status	Active, former, never
Vaping status	Active, former, never
Recent travel	y/n
Confirmed COVID positive contacts	y/n
Recent travel (within 14 days of symptoms)	y/n
Symptoms	Fever, Cough, Dyspnea, Sore throat, Rhinorrhea or nasal congestion, Conjunctival congestion, Headache, Myalgias, Nausea or vomiting, Diarrhea, Sputum production, Presyncope or Syncope, Chest Pain, Abdominal Pain, Altered Mental Status, Anosmia, Ageusia, Other
Home Medications	
Use of ACEi or ARB	y/n
Use of NSAIDs (non-steroidal anti-inflammatory drugs)	y/n
Use of proton pump inhibitors	y/n
Use of Steroids	y/n
Use of oseltamivir (Tamiflu)	y/n
Use of Antivirals (excluding oseltamivir and HIV treatment)	y/n
Use of Statins	y/n
Use of hydroxychloroquine/ Plaquenil (for treatment of RA, SLE, etc)	y/n
Use of Immunosuppressive Medication (within last 30 days)	y/n
ED course	
Supplemental oxygen within the first 3 hours of arrival	y/n
Highest level of supplemental oxygen required (within first 3 hours)	Nasal Cannula, Venti mask, High flow nasal cannula, Non-rebreather, NIV (BIPAP, CPAP), Mechanical Ventilation
Mechanical Ventilation	
Non-invasive mechanical ventilation	y/n
Intubation	y/n
Date of intubation	MM/DD/YY
New trach during hospitalization	y/n
Date of trach	MM/DD/YY
Extubated	y/n
Extubation date	MM/DD/YY
Was patient intubated a second time?	y/n
ICU Stay	
Admitted to ICU	y/n
Date of admission to ICU	MM/DD/YY
Discharged from ICU	y/n
Discharge date	MM/DD/YY
Second admission to ICU	y/n
Date of second admission to ICU	MM/DD/YY
Discharge	
Did the patient die in the hospital?	y/n
Date of death	MM/DD/YY
Was the patient discharged from the hospital?	y/n
Date of discharge from the hospital	MM/DD/YY
Testing	
COVID Test Result	Positive/negative
COVID specimen source	Nasopharyngeal, sputum, bronchoalveolar lavage, other
COVID Test Date	MM/DD/YY

Functional status	
Dependence in at least 1 ADL on admission	y/n
Use of cane/walker	y/n
Use of wheelchair	y/n
Clinical frailty scale	score 1-9
Residence prior to admission	home, assisted living, subacute rehab, skilled nursing facility, inpatient hospice, other
Comorbidities	
Underlying cognitive impairment	y/n
Baseline orientation	score 0-3
Psychiatric disease	y/n
Major depressive disorder	y/n
Schizophrenia	y/n
Bipolar	y/n
Substance use disorder	y/n
Substance used	alcohol, benzo, opiate/opioid, cocaine, amphetamines, marijuana, hallucinogens
Antipsychotics on admission med rec	y/n
Antidepressants/mood stabilizers on discharge med rec	y/n
Benzos on discharge med rec	y/n
Opioids on discharge med rec	y/n
Mental status on admission	
Alertness	alert, lethargic, obtunded, stuporous, comatose
Orientation	score 0-3
Sedative use during admission	
Sedative used	(fentanyl, hydromorphone, midazolam, precedex, propofol)
Sedative start date	MM/DD/YY
Sedative end date	MM/DD/YY
Duration of use	Days
Date of extubation or vent weaning (if trach'd)	MM/DD/YY
	y/n
Use of sedative drips after extubation/vent weaning	
Use of PO opioids after extubation/vent weaning	(oxycodone, hydromorphone, methadone, morphine, fentanyl patch, Oxycontin, MS contin)
Use of PO benzos after extubation/vent weaning	(chlordiazepoxide, lorezepam, clonazepam, diazepam)
Use of clonidine	y/n
Use of antipsychotics during admission	y/n
Anti-psychotic used	quetiapine, olanzapine, haldol, risperidone
Anti-psychotics on discharge med rec	y/n
Antidepressants/mood stabilizers on discharge med rec	y/n
Benzos on discharge med rec	y/n
Opioids on discharge med rec	y/n
Palliative care/code status	
Palliative care consult	y/n
Date of consult	
Code status on admission	full code, DNR/DNI, DNR
Code status change	y/n
Date of change	
GOC (goals of care) documentation	y/n
Palliative care involved in GOC	y/n
Ethics consult	y/n
Comfort care orders	y/n
Deceased during admission	y/n
Autopsy	y/n
Discharge destination	home, assisted living, subacute rehab, skilled nursing facility, acute rehab, inpatient hospice, deceased, other
Discharge mental status	
Alertness	alert, lethargic, obtunded, stuporous, comatose
Orientation	score 0-3
New dependence in ADLs on discharge	y/n
Use of cane/walker	y/n
Use of wheelchair	y/n
Clinical frailty scale	score 1-9