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Research Article

Predictors of Clinical Outcomes in Elderly COVID-19 Patients Admitted to a Tertiary Care Hospital in Tamil Nadu: An Analytical Retrospective Study

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ABSTRACT

Background: Understanding the factors leading to mortality in the elderly population would help in warning the patients with risk factors to be cautious and in informing the policymakers of any required changes in policies.

Methods: This retrospective, analytical study included 133 elderly patients with laboratory-confirmed SARS-CoV-2 infection requiring oxygen support or ICU admission during the period of May-Dec 2020. Data including age, gender, comorbidities, oxygen support requirement and level of its escalation, HRCT severity score, laboratory findings, and duration of stay were collected and analysed to find the predictors that influence the outcome of death.

Results: Univariate Cox analysis showed that hypertensive patients had a hazard ratio of 0.52 (CI: 0.32-0.85, p = 0.009) and those with acute kidney injury had a hazard ratio of 2.50 (CI: 1.46-4.29, p = 0.001). Patients with severe CT severity scores had 3.23 times higher risk of death than patients with moderate CT severity scores. Positive procalcitonin showed a higher hazard ratio of 1.72 (CI: 1.02-2.88) while the hazard ratios for elevated CRP levels, D-dimer, LDH, troponin I, and IL-6 were lower yet significant with the values being: 1.004 (CI: 1.000-1.007), 1.0002 (CI: 1.0000-1.0003), 1.002 (CI: 1.001-1.004), 1.0001 (CI: 1.0000-1.0001), and 1.0007 (CI: 1.000-1.001) respectively.

Cox multivariate regression analysis reported hypertension (HR: 0.22, CI: 0.08-0.58), presence of AKI (HR: 3.97, CI: 1.12-14.08), and higher serum troponin values (HR: 1.00, CI: 1.0000-1.0003) to be significantly associated with an increased risk of death.

Conclusion: Our study showed that the presence of acute kidney injury at the time of admission to COVID-ICU was associated with a poor outcome. Hypertensive patients had better outcomes.

Keywords: Elderly, COVID-ICU, Acute Kidney Injury, Hypertension

Introduction

SARS-COV-2, the coronavirus responsible for COVID-19, is the reason behind the largest pandemic to hit mankind since the Spanish flu. There was a frenzy in the healthcare industry due to the rapid spread of COVID-19, which affected a considerable number of the elderly, immunocompromised individuals, and persons with underlying metabolic, cardiovascular, or respiratory problems, and put them at a higher risk of unfavourable outcomes.

Due to the immunoglobulin-mediated cytokine response to viral replication, excessive damage occurs to the alveoli with the inflammatory phase dominating, resulting in a severe form of acute respiratory distress (ARDS) and the requirement for increased oxygen support and intensive care measures.[1] COVID-19 is a multisystem disease because it affects haematology, gastrointestinal tract, and kidneys as well as skin, nervous system, and psyche.[2]

People over the age of 80 years have a five-fold increased risk of death and severe illness following the infection. There is evidence that COVID-19 could have a serious impact on adults over the age of 70 years in part because 66% of them have at least one underlying disease.[3] More than half of the 56,292 COVID-19 deaths in India by Aug 22, 2020, were in the 50-70 years age range, with the highest number of COVID-19 deaths being in the age category of 61-70 years for both genders.[4]

Inflammatory biomarkers are a more objective method of assessing disease severity. In COVID-19 patients, there is a substantial correlation between heightened inflammatory markers, increased respiratory support, and survival.[5]

Age-related changes in physiology and vigour can affect the symptoms and course of the disease. We aimed to examine the clinical data of elderly COVID-19-infected patients admitted to the intensive care unit of a tertiary hospital in South India and determine what factors affected their survival when they were critically unwell. Our primary goal was to describe the clinical features, laboratory trends, and outcomes of COVID-19 patients admitted to the ICU during the first wave. We also attempted to assess whether the higher level of oxygen support necessary at the time of ICU admission had any effect on the patient's outcome.

Methodology

This retrospective, analytical study was performed at Chettinad Hospital and Research Institute, Kanchipuram, which is a tertiary COVID care centre. All elderly (age ≥ 65 years) patients with laboratory-confirmed SARS-CoV-2 infection requiring oxygen support, admitted to the ICU during the period of May- Dec 2020 were enrolled in the study. Institutional ethics board approval was sought prior to the commencement of the study (Proposal No. 297/IHEC/March 2021). We followed the ethical standards according to the Helsinki Declaration of 1975. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. In view of the retrospective nature of the study, informed consent from the patients was waived off.

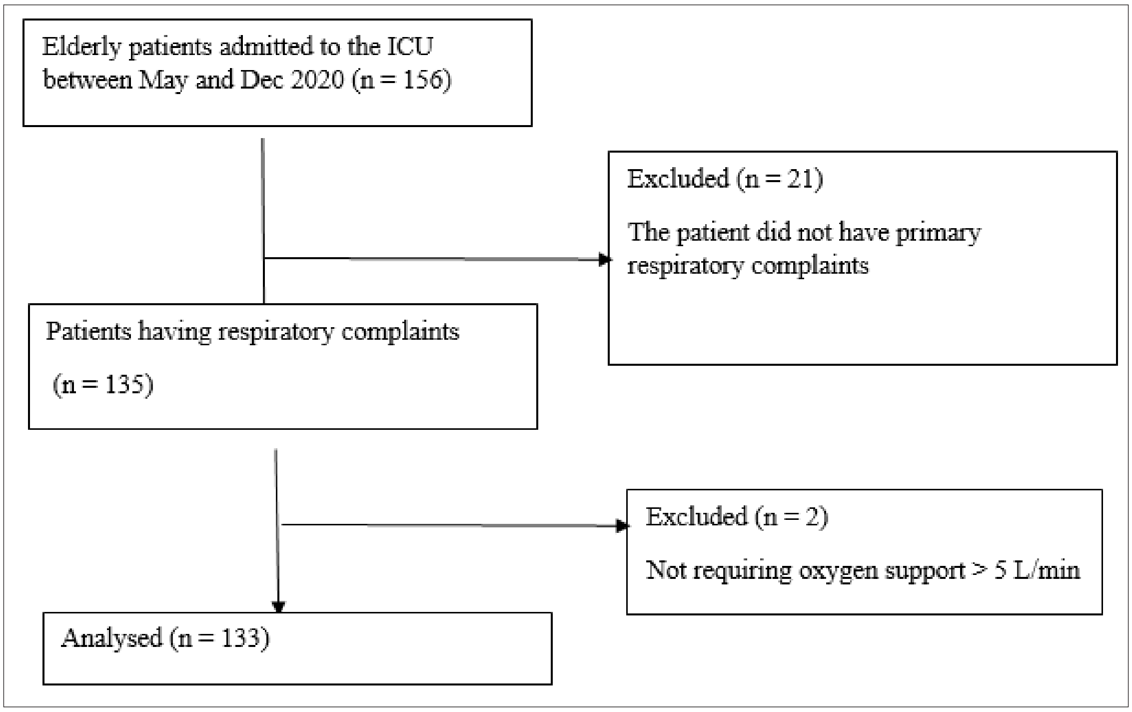

Figure 1.Flowchart of Patient Selection

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As shown in Figure 1, the final sample size was 133. Demographic and clinical data including age, gender, comorbidities (diabetes, hypertension, AKI, CKD, CAD, and others), duration of existing comorbidities, laboratory data, oxygen support requirement at admission, level of oxygen escalation, and duration of hospital stay were collected from the patient file stored in the medical records department of the hospital. Laboratory data consisted of total leucocyte count, lymphocytes, neutrophils, neutrophil:lymphocyte ratio, serum creatinine, and infection biomarkers: c-reactive protein, procalcitonin, D-dimer, serum ferritin, troponin I, lactate dehydrogenase, and interleukin-6.

A High-resolution computerised tomography (HRCT) report of lungs at the time of admission to the ICU was obtained from the electronic medical records of the patient. CT severity grading (score out of 25) was given by the radiologist.

Study endpoints were in-hospital mortality which was obtained from hospital records or 28-day survival as noted on follow-up for 28 days from admission to ICU.

Definition

According to WHO guidelines, a laboratory-confirmed SARS-CoV-2 diagnosis is defined as a positive real-time reverse transcriptase-polymerase chain reaction examination of nasal and pharyngeal swabs.

ICU admission of COVID-19 patients was done in cases of respiratory failure requiring higher levels of oxygen support (> 5 L/min) to maintain oxygen saturation ≥ 92% or severe systemic disease process that is incapacitating. We included COVID patients who required respiratory support. Patients who came to ICU were either transferred from the inpatient COVID ward or were directly admitted there from the emergency department.

Acute kidney injury was diagnosed according to Kidney Disease: Improving Global Outcomes Definition criteria as an increase in serum creatinine level by 0.3 mg/dL within 48 h or 1.5-1.9 times increase in serum creatinine from baseline within 7 days.

Table 1.CT Severity Score

Infection Percentage	Score
5	1
5-25	2
25-50	3
50-75	4
> 75	5

CT severity score in patients with CORADS 5 was determined based on the percentage of ground glass opacities in each lobe, upper, middle and lower lobes of right lung and upper and lower lobes of left lung (Tables 1 and 2), as described by Chang et al.[6]

CT severity was computed by the sum of the involvement of all 5 lobes.

Table 2.Overall CT Severity Grading

Score	CT Severity
< 8	Mild
9-15	Moderate
> 15	Severe

Statistical Analysis

Demographic data were analysed with descriptive statistics such as mean with SD for continuous variables and for categorical variables, frequencies and percentages were provided. These categorical variables were associated with the outcome between two groups using the chi-square test or Fisher's exact test. All continuous variables were compared across the groups using an independent t-test.

Time-to-event-death analysis was done based on the characteristics that were studied. The time of analysis was measured in days from ICU admission to death (event) or until 28 days after admission. Censoring was done when the patient was lost to follow-up. Survival analysis was visually presented by Kaplan-Meier curves, while the log-rank test was used to confirm the significance of survival probability trends between patients with and without hypertension/ acute kidney injury/ procalcitonin positivity, between patients with different CT severity grading, and between patients started on non-rebreathing masks and non-invasive ventilation at ICU admission of COVID-19 patients.

Cox proportional hazards univariate analysis was done for demographic and clinical parameters – age, gender, diabetes mellitus, hypertension, chronic kidney disease, acute kidney injury, comorbidities, level of oxygen support at admission, maximum escalation of support required, procalcitonin, total leucocyte count, neutrophil count, lymphocyte:neutrophil ratio, lactate dehydrogenase (LDH), D-dimer, IL-6, troponin I, and c-reactive protein (CRP). The parameters which were statistically significant were used in the multivariate Cox regression model to describe risk factors associated with lower 28-day survival. The hazard ratios were given with confidence intervals and p values. Two-sided $p < 0.05$ indicated significance.

All analysis was done using STATA software (version 16).

Results

We collected data of 156 elderly patients (≥ 65 years of age), admitted to COVID-ICU at our hospital, between May and

Dec 2020. Patients who did not have positive SARS-CoV-2 RT-PCR test reports or those who did not require oxygen support or required only minimal support were excluded from the analysis. The clinical data of 133 patients admitted to the ICU at Chettinad Hospital and Research Institute, a tertiary hospital in Tamil Nadu, India were analysed. Figure 2 shows the distribution of elderly patients admitted to the ICU each month in the study period.

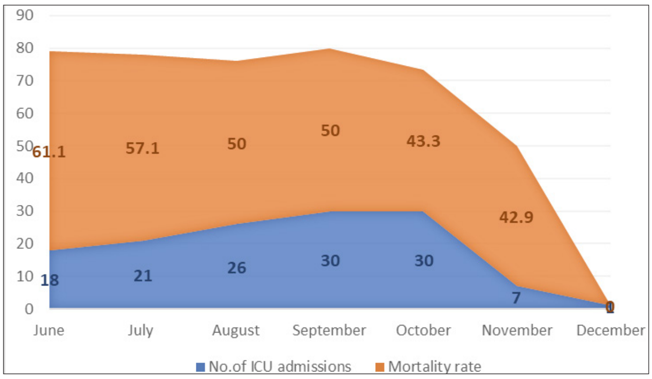

Figure 2.Distribution of Number of SARS-CoV-2 RT-PCR Positive Patients admitted to the ICU

We analysed the data of 133 patients, of which a majority (93, 69.9%) were men and 40 were women (30.1%). The overall mortality was 67 patients (50.37% of admissions; 76.1% men and 23.9% women). The mortality rate was 54.8% in males and 40% in females (Figure 3). We observed that men showed higher mortality than women, though there was no significant difference in the mortality rate among both genders.

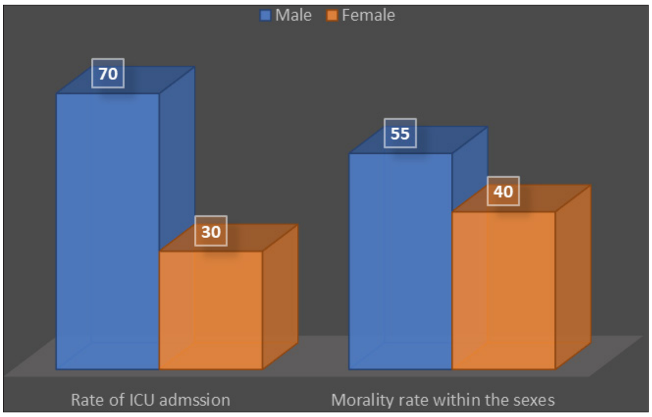

Figure 3.Percentage of Elderly (≥ 65 years) SARS-CoV-2 RT-PCR Positive Males and Females admitted to the ICU and Mortality Rate as per the Genders

Table 3.Frequency Distribution of Variables

Variables	No. of Patients (%)
Demographic data	
Age (years, mean ± SD)	72 ± 7
Male	93 (70.0)
Female	40 (30.0)
Comorbidities	
None	15 (11.2)
Diabetes	90 (67.6)
Hypertension	77 (57.8)
CAD	33 (24.8)
CKD	17 (12.7)
AKI	23 (17.3)
Others	35 (26.3)
Initial level of oxygen support	
Room air	1 (0.8)
NRBM	71 (53.4)
Venturi mask	31 (23.3)
HFNC	2 (1.5)
NIV	19 (14.3)
Intubation	9 (6.7)
Maximum level of oxygen support	
NRBM	33 (24.8)
Venturi mask	10 (7.5)
HFNC	1 (0.75)
NIV	26 (19.5)
Intubation	63 (47.3)
CT severity	
Mild*	11 (8.2)
Moderate**	38 (28.0)
Severe***	76 (57.1)
NA	8 (6.0)
Inflammatory markers	
Procalcitonin positive	34 (25.5)
Procalcitonin negative	99 (74.4)
Total count	132 (99.0)
Lymphocytes	132 (99.0)
Neutrophil:lymphocyte ratio	127 (95.4)
C-reactive protein	132 (99.0)
D-dimer	132 (99.0)
Lactate dehydrogenase	123 (92.4)
Troponin I	116 (87.2)
Serum ferritin	126 (94.7)
Interleukin-6	101 (76.0)

*CT score ≤ 8, **CT score 9-15, ***CT score > 15, CAD: Coronary Artery Disease, CKD: Chronic Kidney Disease, AKI: Acute Kidney Injury, NRBM: Non-rebreathing Mask, HFNC: High-frequency Nasal Cannula, NIV: Non-invasive Ventilation.

Characteristics of Patients, Laboratory Investigations, Imaging and Oxygen Support

The frequency distribution of characteristics of the patients

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especially with existing co-morbid states, severity of lung involvement as assessed by CT severity score and laboratory investigations at the time of admission to COVID-ICU, as well as the level of oxygen support required initially and the maximum support required, have been shown in Table 3.

Majority of the elderly patients admitted to COVID-ICU had some existing co-morbid disease. Acute kidney injury was present in 23 patients (17%) on admission to COVID-ICU as assessed by the serial rise in serum creatinine levels compared to baseline at admission or previous recorded creatinine levels in the past six months.

A little over 50% of the elderly patients admitted to COVID-ICU during the first wave of the pandemic at our hospital required initial oxygen support of 10 to 15 litres of oxygen through NRBM, while 14% of the elderly patients required non-invasive ventilation on admission to COVID-ICU. Nearly 47.3% of the participants worsened and needed intubation and mechanical ventilation.

As shown in Table 3, we were able to obtain the CT severity scores of all but only 8 patients. Most of the patients (57%) had a higher percentage of lung infection coming under the severe CT severity category (score > 15) on initial admission to COVID-ICU. Inflammatory markers like procalcitonin, c-reactive protein, D-dimer, lactate dehydrogenase, and serum ferritin were performed for nearly all patients on admission to COVID-ICU. Interleukin-6 was done in 101 patients.

Univariate and Multivariate Cox Analysis

Univariate Cox analysis (Table 4) showed that hypertensive patients had a hazard ratio of 0.52 (CI: 0.32-0.85) and p value of 0.009. It showed that hypertensive patients were 48% less likely to die when compared to non-hypertensive patients. Patients with acute kidney injury (AKI) had a hazard ratio of 2.50 (CI: 1.46-4.29) and p value of 0.001.

Patients with severe CT severity scores were 3.23 times (HR: 3.23, CI: 1.00-10.39) more likely to die as compared to patients with moderate CT severity scores. However, multivariate analysis (Table 5) showed no significant difference in 28-day mortality between the two CT grades.

Table 4.Univariate Cox Regression Analysis of Patient Demographics, Co-morbid States, Initial Level of Oxygen Support, CT Severity Score, and Laboratory Investigations

Variables	No. of Patients (N = 133)	No. of Deaths (n = 67)	HR (95% CI)	p Value
Age	133	67	1.01 (0.98-1.04)	0.403
Men	93	51	1.45 (0.83-2.55)	0.188
Presence of comorbidities	133	67	1.14 (0.52-2.49)	0.742
Comorbid states				
Diabetes	90	50	1.57 (0.90-2.73)	0.105
Hypertension	77	31	0.52 (0.32-0.85)	0.009
CAD	33	18	1.18 (0.68-2.02)	0.547
CKD	17	7	0.72 (0.32-1.57)	0.412
AKI	23	19	2.50 (1.46-4.29)	0.001
Initial level of oxygen support				
NRBM	71	33	1.05 (0.14-7.68)	0.961
Venturi mask	31	9	0.57 (0.07-4.51)	0.595
NIV	19	16	3.12 (0.41-23.63)	0.269
Intubation	9	9	4.22 (0.52-33.90)	0.176
CT severity				
Moderate - 1*	38	10	0.95 (0.26-3.48)	0.950
Severe - 2**	76	49	3.23 (1.00-10.39)	0.048
Inflammatory markers				
Procalcitonin positive	34	21	1.72 (1.02-2.88)	0.040

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Total count	132	66	1.00 (0.99-1.00)	0.150
Neutrophils	127	61	1.02 (0.992-1.051)	0.145
Lymphocytes	132	66	0.98 (0.95-1.02)	0.563
Neutrophil:lymphocytes	127	61	1.003 (0.98-1.02)	0.700
C-reactive protein	132	66	1.004 (1.000-1.007)	0.030
D-dimer	132	66	1.0002 (1.0000-1.0003)	0.006
Lactate dehydrogenase	123	63	1.002 (1.001-1.004)	< 0.001
Troponin I	116	58	1.0001 (1.0000-1.0001)	< 0.001
Serum ferritin	126	62	1.0003 (0.99-1.00)	0.340
Interleukin-6	101	47	1.0007 (1.000-1.001)	0.028

* CT score 9-15, ** CT score > 15, CAD: Coronary Artery Disease, CKD: Chronic Kidney Disease, AKI: Acute Kidney Injury, NRBM: Non-rebreathing Mask, NIV: Non-invasive Ventilation.

Table 5.Multivariate Cox Regression Analysis

Variables	No. of Patients (N = 133)	No. of Deaths (n = 67)	HR (95% CI)	p Value
Hypertension	77	31	0.22 (0.08 – 0.58)	0.002
AKI	23	19	3.97 (1.12 – 14.08)	0.032
CT severity - severe 2*	76	49	3.13 (0.883 – 11.77)	0.091
Procalcitonin positive	34	21	1.02 (0.35 – 2.91)	0.969
C-reactive protein	132	66	1.00 (0.99 – 1.00)	0.815
D-dimer	132	66	1.00 (0.99 – 1.00)	0.145
Lactate dehydrogenase	123	63	0.99 (0.99 – 1.00)	0.217
Troponin I	116	58	1.00 (1.0000– 1.0003)	0.049
Interleukin-6	101	47	1.00 (0.99 – 1.00)	0.717

* CT score > 15, AKI: Acute Kidney Injury.

Likewise, positive procalcitonin and elevated levels of CRP, D-dimer, LDH, troponin I, and IL-6 found in serum on the admission of elderly COVID patients to ICU were found to be significantly associated with an increased hazard ratio of survival on univariate analysis. On performing Cox multivariate regression analysis (Table 5) including hypertension, AKI, severe CT severity score 11-15, procalcitonin, CRP, D-dimer, LDH, troponin I and IL-6, elevated troponin I levels in the model, absence of hypertension, AKI, and elevated troponin values were found to be significantly associated with an increased risk of death.

Elderly patients with hypertension showed improved survival (HR: 0.52 with a 95% CI: 0.32-0.85, p value < 0.009). At the end of 20 days of ICU stay, there was 64.2% mortality among those without hypertension compared to 42.8% mortality among those with hypertension. Patients diagnosed with AKI upon admission to COVID-ICU were two and half times more at risk of death in the 28-day follow-up (HR: 2.50 with 95% CI: 1.46-4.29, p value < 0.001). Kaplan Meier survival curves for hypertension, AKI, oxygen support with non-rebreathing mask and non-invasive ventilation, CT severity grading, and positive serum procalcitonin on admission are given in Figures 4-8 respectively.

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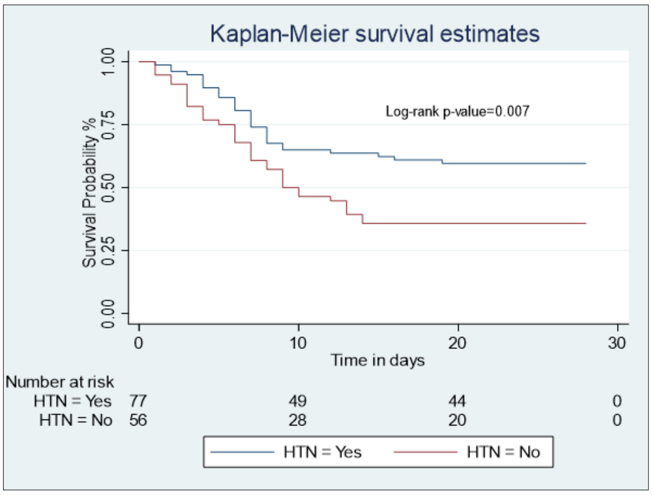

Figure 4.Kaplan-Meier Survival Analysis of the Elderly Patients with and without Hypertension on Admission to ICU

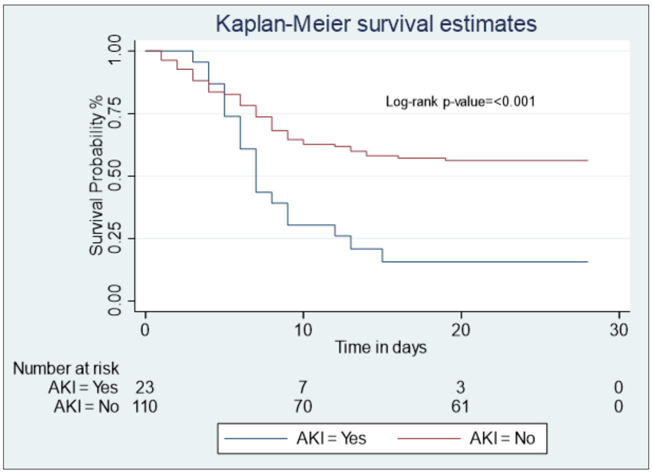

Figure 5.Kaplan-Meier Survival Analysis of the Elderly Patients with and without AKI on Admission to ICU

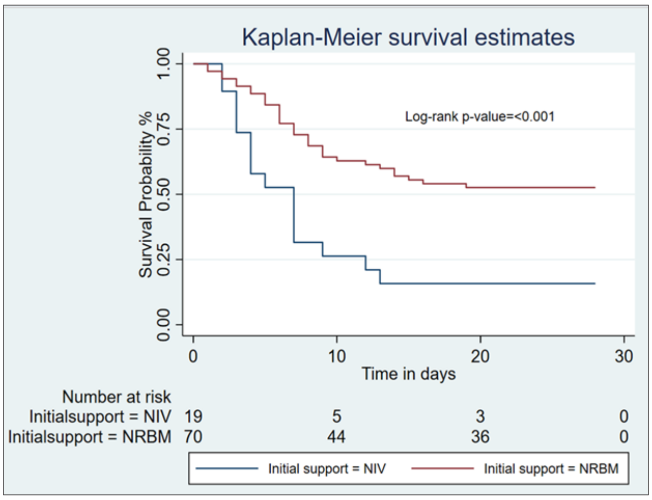

Figure 6.Kaplan-Meier Survival Analysis of the Elderly Patients requiring Oxygen Support through NRBM and NIV on Initial Admission to ICU

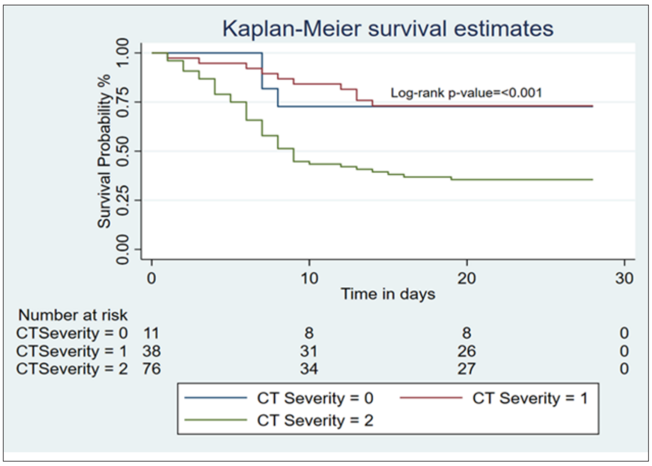

Figure 7.Kaplan-Meier Survival Analysis of CT Severity Grading of Elderly Patients on Initial Admission to ICU (CT Severity = 0: Mild, 1: Moderate, 2: Severe)

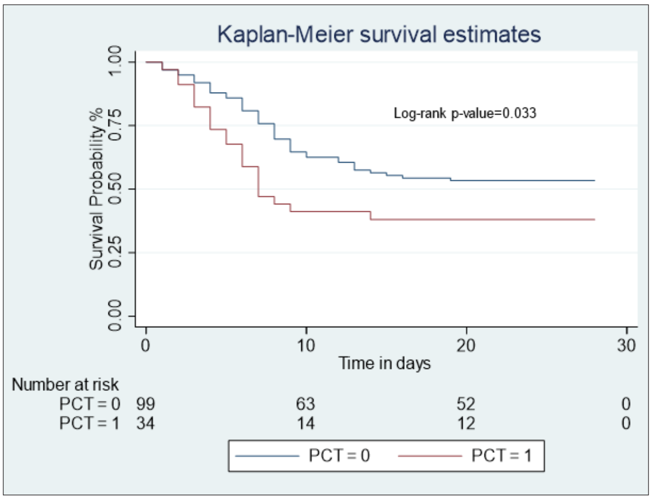

Figure 8.Kaplan-Meier Survival Analysis of Positive Serum Procalcitonin in Elderly Patients on Initial Admission to COVID-ICU (PCT = 0: procalcitonin negative, PCT = 1: procalcitonin positive)

Discussion

Tackling the first wave of COVID-19 was a monumental challenge for the medical fraternity and policymakers all over the world, especially with the logarithmic increase in morbidity and mortality, in particular for low-middle-income countries like India and the dependent sects of the population like the elderly. In this retrospective, analytical, cohort study, we looked at the clinical data of elderly COVID-19-infected patients admitted to the intensive care unit of a tertiary hospital in South India and analysed the patient characteristics, level of lung involvement, and laboratory factors which led to ICU admission and how these affected 28-day survival.

A bulk of the elderly patients admitted to COVID-ICU had some pre-existing co-morbid state, of which diabetes was more common (67.6%) followed by hypertension (57.8%). Our results were in concordance with the existing prevalence of multimorbidity in the state[7] as well as the presence of co-morbidities and the increased hospital admission of COVID-positive patients with diabetes and hypertension in Tamil Nadu.[8]

Similar to Wang et al.[9] and Li et al.[10] we found that those elderly, critically ill COVID-19-infected people with pre-existing hypertension had improved survival at the end of the 28th day. This may be due to the continuation of anti-hypertensive therapy including angiotensin-converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARB) in most of these patients. The exact mechanism of the protective effect of ACEi and ARB is yet unclear, though animal studies have shown that ARB prevents the downregulatory effect of the SARS-CoV virus on the angiotensin-converting enzyme-2 in the lung precipitating lung injury.[11]

In our study, we found that though acute kidney injury (AKI) was detected in only 17% of the patients on admission to COVID-ICU, its presence was associated with twice as much reduced chance of 28-day survival and is congruent with a similar study in the state by Sindhu et al.[12] Multiple pathophysiological processes have been postulated relating the existence of a renal injury in critically ill COVID-19 patients.[13] Kidney injury occurs due to a decreased cardiac output from right heart failure, hypoxia and elevated intrathoracic pressures as well as direct renal infection at times. We also observed that the fluid restriction imposed on the elderly especially those with severe cardiac conditions and chronic kidney disease may have precipitated a pre-renal damage leading to an acute on chronic insult.

We observed in our study that the elevated levels of cardiac troponin I in critically ill elderly at admission to the intensive care unit were significantly associated with increased mortality at the end of a 28-day follow-up and may be an independent predictive factor for survival. The physiological decline of cardiac function makes the elderly more prone to myocardial damage. The myocardial demand is increased by the presence of pre-existing conditions which increase peripheral vascular resistance and decrease oxygen supply to the heart from hypoxia putting the heart at risk of ischaemic injury. Myocarditis from direct injury by the virus also adds to the high-risk profile of the critically ill elderly. Moreover, the patients are immobile for the most part contributing to the risk of a thromboembolic phenomenon. Our results were similar to that of Shah et al.[14]

Limitations

Our study has several limitations. Firstly, though we could analyse that hypertensive patients on treatment for the same showed improved prognosis, we did not collect the type of anti-hypertensives used and the duration for which they had been taken. Secondly, cardiac troponin I was not performed in 17 patients and the interpretation of the same as an independent predictive factor for mortality of the critically ill elderly must be made with caution.

Further larger studies are necessary to confirm if hypertension had any decreased risk of death in critically ill elderly COVID patients, and if so, to study if drugs had any impact on its protective role. CT severity score failed to show any significant role in the risk of death in the final model probably because of the interaction of independent factors which have to be studied in a larger study.

Conclusion

In our study, we found that the presence of acute kidney injury in critically ill elderly patients at the time of admission to COVID-ICU was associated with a poor outcome. The presence of hypertension in critically ill elderly patients had a protective role against poor outcomes. However, large-scale studies are needed to corroborate the finding and to delve into the nature of the protectiveness of anti-hypertensive agents which our study did not look into.

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Conflict of Interest: None

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