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An Assessment of COVID-19 Mortality Risk with A Novel Scoring Method in A Tertiary Care Hospital in Andhra Pradesh: A Prospective Study

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Abstract: Coronavirus (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 affected people clinically present with symptoms of fever, fatigue, loss of appetite, cough with sputum production, anosmia, nausea, vomiting, gastroenteritis, and shortness of breath. During covid pandemic, to assess the severity, we developed a novel scoring system, i.e., ACHE. The increasing score suggests an increase in severity and a possible increased mortality rate. Different parameters were included in developing a scoring system to evaluate the patient's severity. A Prospective observational study on the Covid-19 mortality risk assessment with a novel evaluation scoring in a tertiary care hospital in Andhra Pradesh. The objective is to predict the mortality risk of COVID-19 patients at admission by a novel scoring system, i.e., ACHE score (Acute covid health evaluation), and to categorize the patient using a novel acute covid health evaluation (ACHE) score—a hospital-based prospective observational study which included 800 cases of covid 19 confirmed by RT – PCR. ACHE was calculated in all these patients based on 4 major parameters: NL neutrophil-lymphocyte ratio (NLR) ratio, CRP(C-REACTVE PROTEIN), D – Dimer &Age group. Different parameters were included in developing the scoring system to evaluate the patient's severity. The novel scoring system ACHE scores>15 had the highest mortality rate. And Majority of the patients out of 800 were in the age group 51-60 (n=208, 26%) and had shown more prevalence, followed by the age group 61-70 (n=178, 22.25%). Among 800 patients, 87 died due to viral pneumonia with cytokine storm, coagulopathy, sepsis, and MODS. In the background of covid pandemic, a simplified way of assessing the severity of covid patients is the need of the hour. ACHE scoring system helped assess the patient's condition and prognosis, thus aiding in making a dynamic decision in managing the patients without any undue delay to reduce morbidity and mortality.

Keywords: Acute Covid Health evaluation, mortality, D – Dimer, CRP, NL – ratio, Age.

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1. INTRODUCTION

Coronavirus (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and rapidly spread across most of the nation's worldwide[1]. The COVID-19 incubation period may range from 2 to 14 days. The usual presentation of COVID-19 affected people has been fever, cough, fatigue, loss of appetite, sputum production, anosmia, nausea, vomiting, diarrhea, and shortness of breath. A severe disease could be associated with fatal complications such as pneumonia, hypoxemia, septic shock, disseminated intravascular coagulation, acute respiratory distress syndrome (ARDS), multi-organ failure, and ultimately leading to death.[2,3.] The standard gold test for diagnosing COVID-19 is Real-time reverse transcriptase-polymerase chain reaction (RT PCR). It's critical to recognize the patients who can be at higher risk for complications at an earlier phase. Past studies suggested a nomogram containing age, neutrophil-lymphocyte ratio (NLR), and CT severity score, assessing the short-term disease progression in hospitalized moderate COVID-19 pneumonia patients. Patients who progressed to severe covid-19 pneumonia had lower lymphocyte count, high NLR, and elevated LDH and CRP levels. In countries like INDIA with a large population and deficit of hospital resources, the need to triage is of utmost importance. The triage requires a simple scoring system to identify critically ill patients. The early recognition of clinical and laboratory indicators disease severity played a crucial role in the evaluation of hospital resources and their use in further management [4, 5]. As the COVID-19 cases are rising, so is the severity. So far, no drugs have been approved that specifically target the virus.[6, 1] No specific severity predictive factors have been identified so far to assess the severity of the disease. It is vital to identify severe COVID-19 pneumonia patients at an early stage to reduce mortality and morbidity[7]. Different parameters were included in developing this scoring system to evaluate the patient's severity. In middle-income countries like India, where resources are limited, simple scoring methods like ACHE in COVID need to be adapted to predict & triage the patients. We have developed a novel scoring system that is ACUTE COVID HEALTH EVALUATION (ACHE) score based on simple parameters like NL ratio, CRP & D –Dimer. ACHE (Acute covid health evaluation) score is the predictive scoring method to evaluate the patient's severity of illness. Morbidity and mortality have been assessed by using this scoring system. The rising scores are evidence of worsening severity and increasing mortality rate. Our study aims to predict the risk of mortality of COVID-19 patients at the time of admission by a novel scoring system, i.e., ACHE (Acute covid health evaluation), and to categorize patients by using novel acute covid health evaluation (ACHE) scores.

2. MATERIALS AND METHODS

2.1. Study design

A hospital-based prospective observational study was performed on covid – 19 positive patients. We have collected data from 800 patients in this year's study. The adverse outcome of COVID-19 patients was estimated by the number of mortalities reported during treatment.

2.2. Data collection

A specially designed proforma collected datas, including patient demographics, personal history, co-morbidities, lab parameters, respiratory support mode, medications prescribed for each patient, and clinical outcomes. Data was collected regularly from admitted patients without interfering with their treatment. The data was compiled, tabulated, interpreted, and correlated with all the age groups to establish differences in COVID-19 severity based on various laboratory parameters.

2.3. Inclusion Criteria

1. Patients with RT PCR positive.
2. Patients with Comorbid conditions.
3. Patients admitted with an emergency.

2.4. Exclusion Criteria

1. Patients who left against medical advice.
2. Patients below the age of 18 years were not included in the study.
3. Patients above 90 years were also not included in this study.
4. Pregnant patients.

2.5. *Study site*

The study was conducted in the Tulasi multi-speciality Hospital and Trauma & critical care Research Institute, Guntur.

2.6. Duration of the study period

This study was conducted for a period of 1 year (June 2020 – June 2021).

2.7. *Data management and statistical analysis*

ACHE score data were analyzed in MS Excel, and descriptive statistics were used to analyze the result of the study. The categorical values were analyzed using the chi-square test; the ANOVA test is used for continuous variables and variables with the outcome of in-hospital survival and deaths. Data obtained during the initial triage only was used to calculate the mortality score as per the aim of this study. The survival group included the discharged patients during the study course and those who were still hospitalized at the end of the study. The *t*-test was performed to compare the outcomes, and *the P value* was also calculated using two-tailed tests. It was statistically significant for the analyses done by using SPSS V.24 IBM software.

3. RESULTS

Table: 1 Demographic and clinical data of covid – 19 (N = 800)	
Sign/Symptoms	**N (%)**
Age	54 ± 15.53*, 1.074(CI), 0.0001(P – Value)
Sex	
Male	518 (64.75%)
Female	282(35.25%)
≤ 40	160(20%)
41 – 60	346(43.25%)
61 – 90	294(36.75%)
Fever	727(90.87%)
Cough	792(99.0%)
Body pains	689(86.12%)
Dyspnea	582(72.75%)
Tachycardia	738(92.25%)
Mortality	87(10.88%)

Table 2: Laboratory findings on the day of admission	
Parameters	**N (%)**
Platelet	169 ± 81.9*, 5.677(CI), 0.057 (P – Value)
D – Dimer	1958±3094.8*, 214.5(CI), 0.009(P – Value)
<500	306 (38.25%)
500 – 1000	274 (34.25%)
1001 – 2000	106 (13.25%)
2001 – 4000	51 (6.37%)
>4000	63 (7.88%)
CRP	73 ± 74.21*, 5.142(CI), 0.0164(P – Value)
< 6	102 (12.75%)
6 – 12	128 (16%)
13 – 24,	96 (12%)
25 – 48	177 (22.12%)
> 48	297 (37.13%)
NL – ratio	8.97±5.50*, 0.381(CI), 0.0001(P – Value)
<4	108 (13.5%)
4 – 6	252 (31.5%)
7 – 9	198 (24.75%)
10 – 12	98 (12.25%)
>12	144 (18%)

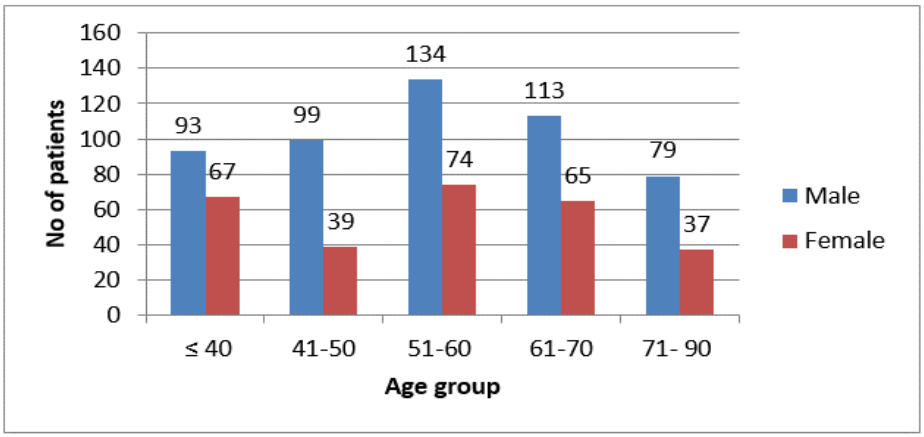


Fig 1: Shows distribution of the patients according to Age groups

In this study, we observed a total of 800 patients belonging to different age groups. Out of these, age group≤ 40 years patients are 20 % (n=160) with67 female patients and 93 male patients, followed by age group41- 50 patients are 17.25% (n=138) with 39 female and 99 male patients, then age group 51-60 patients are highest in number, i.e., 26 % (n=208) with 134 male patients and 74 female patients followed by age group 61 -70 years patients are 22.25 % (n=178) with65 male patients and 113 female patients and lowest number of patients were observed in the age of 71 - 90 years age group patients are 14.3 % (n=116).

Table 3: Sub-grouping of patients based on ACHE score at the time of admission				
S. No	ACHE – **Score**	**Male**	**Female**	**N (%)**
1.	0 – 5	243	131	374 (46.75%)
2.	6 – 10	219	109	328 (41 %)
3.	11– 15	54	36	90 (11.25%)
4.	>15	2	6	8 (1%)
Total		518	282	800

In this study, 800 patients were taken. At the time of admission, the ACHE score was assessed. The score group 0 – 5 patients were 46.75% (n=374) with 131 female patients and 243 male patients; next to that, 6 – 10 score group patients were 41%(n=328) with 109 female patients and 219 male patients, followed by 11 – 15 score group patients 11.25%(n=90) with 36 female patients and 54 male patients. Finally,>15 score group patients are 1 % (n=8) with 6 female and 2 male patients. Covid disease severity level was increased day to day till the 14th day.

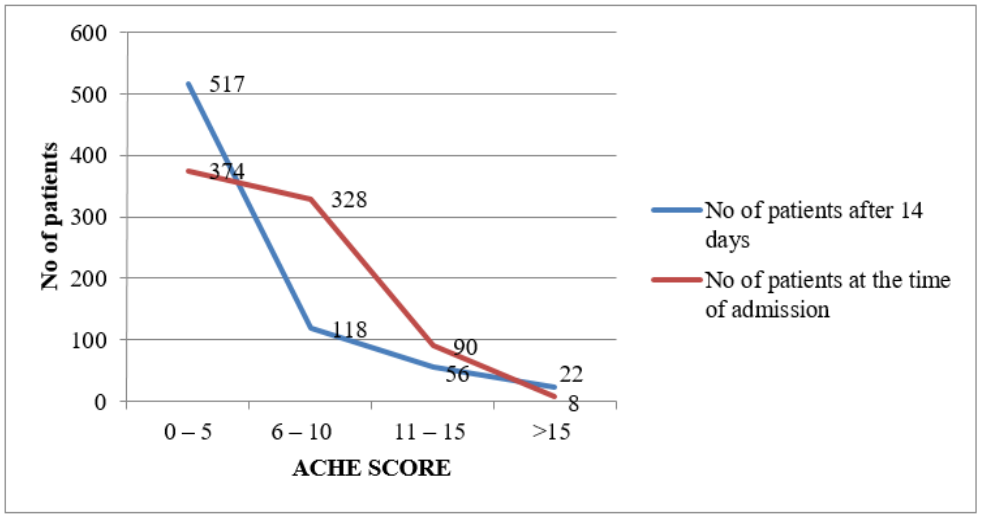


Fig 2: Comparative representation analyses

Table 4: Categorization of surviving patients after two weeks (14 days) based on ACHE score				
S. No	ACHE – **Score**	**Male**	**Female**	**N (%)**
1.	0 – 5	327	190	517 (64.62%)
2.	6 – 10	79	39	118 (14.74%)
3.	11 – 15	39	17	56 (6.99%)
4.	>15	15	7	22 (2.74%)
	Total	460	253	713

Among 800 patients who were hospitalized, 713 survived. ACHE score >15 patients are 2.74 %(n=22) and 11 – 15 score patients are 6.99 %(n=56) followed by 6 – 10 score patients are 14.74%(n=118). Patients between 0 – 5 score were 64.62% (n=517), with 327 male and 190 female patients.

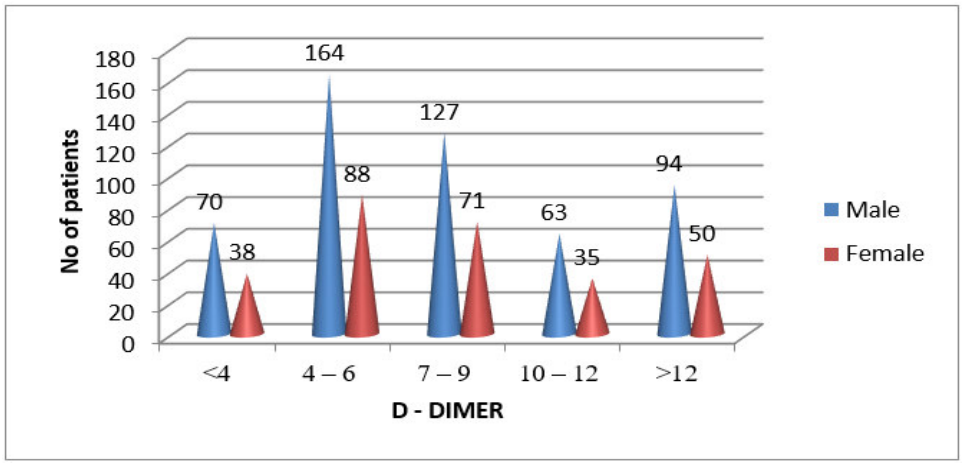


Fig 3: Distribution of patients according to higher D – Dimer levels

The distributions of D-dimer levels among patients based on different diagnostic staging. Among 800 patients, d-dimer <500 group patients are highest in number 38.25 % (n=306) with 107 female patients and 199 male patients, followed by d-dimer levels 500 – 1000 group patients are 34.25 % (n=274) with 96 female patients and 178 male patients, followed by d-dimer levels 1001 - 2000 group patients are 13.25 % (n=106) with 66 male patients and 40 female patients followed by d-dimer levels>4000 group patients are 7.88 % (n=63) with 41 male patients and 22 female patients, and lowest number of patients were observed in the d – dimer levels 2001 – 4000 group, i.e., 6.37 % (n=51).

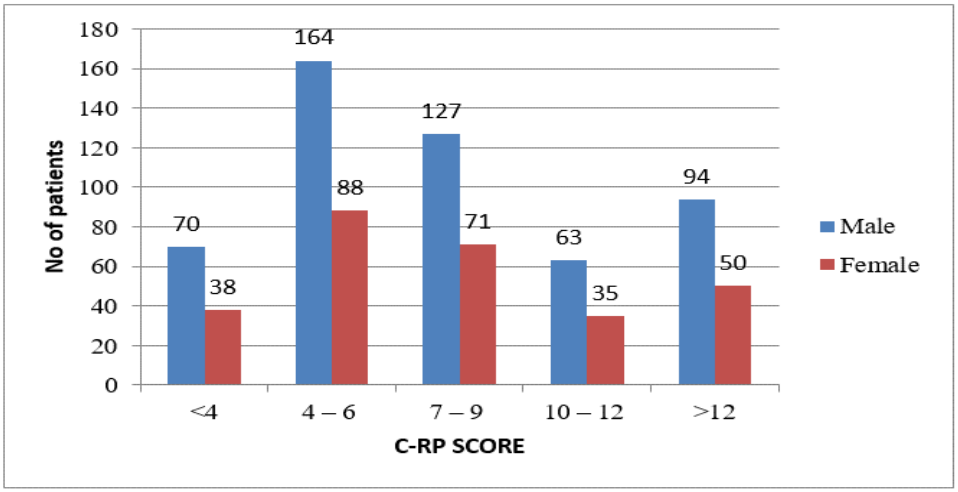


Fig 4: Distribution of patients according to higher CRP levels

The ratio of patients with high CRP levels compared to low CRP levels was high. Therefore, in this study, we categorized the patients with CRP level>48 patients are highest in number with 37.13 % (n=297),104 female patients and 193 male patients, followed by CRP level 25 – 48 patients are 22.12 % (n=177) with 63 female patients and 114 male patients followed by CRP level 6 – 12 patients are 16 % (n=128) with 83 male patients and 45 female patients followed by CRP level<6 patients are 12.75 % (n=102) with 67 male patients and 35 female patients, and lowest number of patients were observed in the CRP level 13 – 24 group patients, i.e., 12 % (n=96).

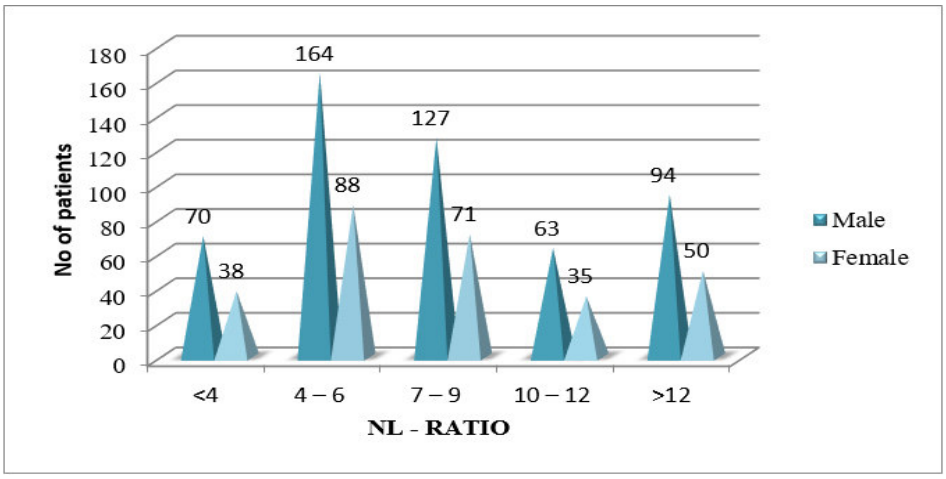


Fig 5: Distribution of patients according to higher NL ratio

In this study, we categorized among 800 patients based on NLR as NL ratio4 – 6 patients are highest in number, i.e., 31.5 % (n=252) with 88 female patients and 164 male patients, followed by NL ratio 7 – 9 patients are 24.75 % (n=198) with 71 female patients and 127 male patients followed by NL ratio>12 patients are 18 % (n=144) with 94 male patients and 50 female patients followed by NL ratio<4 patients are 13.5% (n=108) with 70 male patients and 38 female patients, and lowest number of patients were observed in the NL ratio of 10 – 12 group, i.e., 12.25 % (n=98).

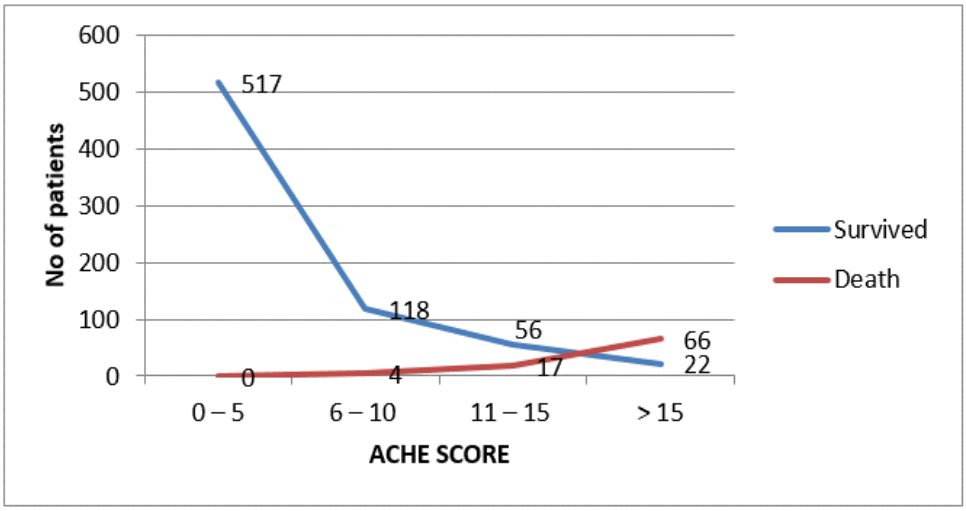
Table 5: Variables and relative score calculate the COVID–19 ACHE

S. No	Parameters	0	+1	+2	+3	+4
1.	NL ratio	<4	4 – 6	7 – 9	10 – 12	>12
2.	D - dimer	<500	500 – 1000	1000 – 2000	2000 – 4000	>4000
3.	CRP	<6	6 – 12	13 – 24	25 – 48	>48
4.	Age group	≤ 40	41-50	51-60	61-70	71- 90
	Risk categories	Mild – Moderate		Moderate	Severe	Extremely severe

ACHE score was based on 4 major parameters: NL ratio, CRP, D – Dimer & Age. A minimum score was given based on NL ratio, CRP, and D – Dimer laboratory values. The age group score was added to arrive at the field score called the acute covid health evaluation score.

Table 6: Distribution of survived and dead patients based on ACHE score

S.no	ACHE – score	Survived	Death	Percentage mortality
1.	0 – 5	517	0	**0%**
2.	6 – 10	118	4	**7.6%**
3.	11 – 15	56	17	**18.2%**
4.	> 15	22	66	**87%**
		713(89.12%)	87(10.88%)	



Among 800 hospitalized patients, 89.12 % (n=713) survived, and 10.88% (n=87) died. Patients with an ACHE score >15 have the highest percentage of mortality. Among 88 patients, 22 have survived, and 66 patients have died.

4. DISCUSSION

This prospective observational study included 800 COVID-19 patients, and the total in-hospital mortality was 10.88 %. Older age and high levels of D-dimer NLR are considered independent predictors of in-hospital death[8,9] patients were distributed according to age group and gender distribution. Of 800 cases, 282 female patients (35.25%) and male patients were 518 (64.75%). Most of the patients out of 800 were in the age group 51 – 60 (n=208, 26%). Based on the ACHE score at the time of admission, 374 patients (46.75%) had mild disease, 328 patients (41%) had moderate disease, 90 patients (11.25%) had severe disease and 8 patients (1%) are critically ill patients. Supportive therapy in the form of NIV, HFNO, and ICU Care, like infection control, was frequently needed in patients with extremely increasing ACHE scores. In contrast, only a few patients with decreasing ACHE scores required ICU care. Serum levels of CRP, a protein produced by the liver as an inflammatory response, is an important marker that elevates significantly in severe COVID-19 pneumonia patients.[10,11] SARSCoV-2 virus might act on lymphocytes triggering immune response leading to a cytokine storm.[7] Raised CRP levels are a part of the inflammatory process adversely affecting the COVID-19 patients. As shown in the above figure, comparing the demographic and clinical characteristics of patients with elevated D-DIMER and normal D-DIMERs revealed that patients with elevated D-DIMERs at the time of admission have the highest mortality rate[12]. The patients with severe illness also had extremely raised D - Dimer levels, considered one of the predictors for mortality[13,14] Severe COVID-19 pneumonia patients had higher neutrophil count and lower lymphocyte count concluding that patients with severe COVID-19 pneumonia have high NLR ratio, supported by a recent research [15,16]. Previous research showed that older age, high NLR, and CTSS were independent risk factors for clinical worsening.[17] they also investigated if a few biochemical parameters could assess COVID-19 severity scores in hospitalized patients in the initial phase. [18] WBC, NEU%, LYM%, NLR, D-DIMERS, CRP, and age indicated the severity of the disease.[8] Elicited from past research; ACHE score was implemented to assess the severity and thus triage the patients. A minimum score was given based on laboratory values for NL ratio, CRP, and D – Dimer. The Age score is also considered a part of the ACHE score to determine the functioning of different essential organs in the body. ACHE score was calculated at the time of admission to determine the severity and increase the care level. If a patient has an ACHE score of more than 10, it indicates the requirement for effective ICU monitoring. In this way, the patient can be assessed in casualty and triage, which helps to give better care to the critically ill. Higher mortality was associated with an extremely increasing ACHE score. The preceding evidence of the present study signifies the role of the ACHE score in estimating disease severity. The patients with ACHE score >15 have the highest percentage of mortality. The mortality rate also depends on the illness at presentation, day of admission (1 -14 days), comorbidities, and patient habits. Age factor also plays an important role in increasing patient compliance mortality rate or survival rate. Past research proved that there's no comprehensive system to analyze the CXR (chest x-ray) images of COVID-19 patients. Out of 800 patients, 89.12% (n=713) patients have survived after hospitalization, and 10.88% (n=87) patients have died with marked increasing levels of D – Dimer, CRP, Procalcitonin, raised IL6 (interleukin – 6) levels, and rapidly

decreasing platelet count (thrombocytopenia) leading to coagulation, cytokine storm, ARDS (acute respiratory distress syndrome) and MODS (multiple organ dysfunction syndrome).

5. CONCLUSION

The age group between 51-60 years (n = 208, 26%) has a higher prevalence rate of COVID 19patients.ACHE chart analyzes the severity level of different infection-causing parameters by the scoring system; the ACHE scoring system helped assess the patient's condition and hence helpful to prognosticate. Thereby, dynamic decisions can be taken in managing those patients without any undue delay to prevent morbidity and mortality and to increase the level of care in the ICU. This novel scoring system is a predictive marker for disease severity and has given satisfactory results by the day-to-day scoring system. This study concludes that patients with a score of 1 – 5 have survived, and patients with a score>15 have the highest mortality rate. Acute covid health evaluation could be an important tool to assess the disease severity in COVID-19 patients. Age also plays an important role in increasing the patient's mortality rate. This NL ratio, D – Dimer, age group, and CRP level are indicators of the severity of COVID-19 infection and to decide further treatment protocol.

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7. AUTHORS CONTRIBUTION STATEMENT

V. Sathish Kumar Performed work & prepared manuscript, N. Venkata Shanmukharao: Designed and generated idea; M. Saianjani Reddy: collected data and calculation, M. Amar Teja: literature review, T. Uma Shankar: Guided for research. All the authors read and approved the final version of the manuscript.

8. CONFLICT OF INTEREST

Conflict of interest declared none.

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