Original Article

NUTRIC score as a predictor of outcome in COVID-19 ARDS patients: A retrospective observational study

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ABSTRACT

Background and Aims: The Nutrition Risk in Critically ill (NUTRIC) score is an appropriate nutritional assessment tool in mechanically ventilated patients. We retrospectively observed the applicability of the NUTRIC score for predicting outcomes in coronavirus disease (COVID)-19 acute respiratory distress syndrome (ARDS) patients. **Methods:** All adult COVID-19 ARDS patients admitted to the intensive care unit and requiring various forms of oxygen therapy were included in the study. The demographic characteristics and clinical information about the patients were obtained from the hospital's medical records department. The nutritional risk for each patient was assessed using the NUTRIC score at 72 hours of ICU admission. The discriminating power and ability of NUTRIC score, Sequential Organ Failure Assessment (SOFA) score, age and Acute Physiology and Chronic Health Evaluation (APACHE) II to predict the 28-day mortality and need for mechanical ventilation (MV) was calculated using receiver operating characteristic curves and area under this curve. **Results:** A total of 80 COVID-19 ARDS patients fitted into the inclusion criteria. Among non-survivors, the median Glasgow Coma Score, APACHE II score, NUTRIC score and SOFA score were 10, 16, 6 and 4, respectively. The cut-off values for NUTRIC score, SOFA, and APACHE II to predict 28-day mortality and need for MV was obtained as 3.5, 3.5 and 11.5, respectively. These cut-off values of NUTRIC score, SOFA score, and APACHE II have a sensitivity of 62%, 72.5% and 75.5%, respectively, and specificity of 95%, 72% and 83% for predicting mortality. **Conclusions:** Most COVID-19 ARDS patients requiring MV in the ICU are at nutritional risk, and a high NUTRIC score is associated with higher mortality.

Key words: COVID-19, intensive care unit, nutritional assessment, respiratory distress syndrome

INTRODUCTION

The coronavirus disease-19 (COVID-19) pandemic has been caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), as named by the International Committee on Taxonomy of Viruses. Today, the whole world is crippled with its second wave, and the number of confirmed cases has dramatically increased nearly to 34 million, with 0.44 million deaths in India.[1]

Severe COVID-19 presents with an inflammatory condition characterised by the involvement of proinflammatory cytokines.[2] The nutritional assessment and the early nutritional care management of COVID-19 patients must be integrated into the overall therapeutic strategy. The patients admitted to the intensive care unit (ICU) commonly suffer from malnutrition as these patients are underfed, and this adversely affects the ICU outcomes.[3] Nutritional therapy plays one of the most critical roles in reducing

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mortality in the ICU, especially in COVID-19 patients; so the nutritional status of these patients must be evaluated before administering general treatment. Nutritional risk is defined as the risk of adverse effects on clinical outcomes based on various dietary factors.[4] All high-nutritional risk patients must be evaluated for nutritional status during their initial ICU stay, as higher risk is associated with poorer clinical outcomes. The nutrition risk screening (NRS-2002) is a simple, easy, efficient and highly sensitive tool accepted by health practitioners worldwide.[5] In general, patients with an NRS-2002 score <3 are not at nutritional risk; so nutritional support is not required during the first week of hospitalisation. Hence, periodic NRS-2002 screening of all COVID-19 patients is needed once every three–five days. Patients with a score of >3 require immediate nutritional intervention. The Nutrition Risk in the Critically ill (NUTRIC) score, another recommended screening tool, was developed to be explicitly used for ICU patients.[6] To this date, very little is known about the nutritional risks for critically ill COVID-19 patients. Therefore, we conducted a study to assess the NUTRIC score as a predictor of outcome in COVID-19 acute respiratory distress syndrome (ARDS) patients. The primary outcome was to observe the cut-off values for NUTRIC, Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evaluation II (APACHE) II scores to predict 28-day mortality. The secondary outcome was to observe the cut-off values of these scores for the need for mechanical ventilation.

METHODS

This retrospective single-centre observational study was conducted in the COVID-19 ICUs of our Institute. The study population was COVID-19 ARDS patients admitted to the ICUs between October 1st and December 31st, 2020. Patients who were reverse transcriptase-polymerase chain reaction (RT-PCR) positive and fulfilled the criteria of ARDS were included in the study.[7] Patients were managed according to the COVID-19 clinical management guidelines released by the Director-General of Health services, Ministry of Health and Family Welfare, New Delhi, India.[8] Our nutrition management plans were determined independently by the bedside ICU team. Exclusion criteria were: age below 18 years, pregnant female, length of ICU stay less than 24 hours and patient with insufficient medical information. The patients' demographic characteristics and clinical information were obtained from the hospital's medical records department. Institutional ethical committee approval was taken for collecting data. All relevant data were filled in using standardised round book collection forms. The following data were retrieved: demographics; clinical and laboratory data; history; medical complications; main treatments; nutritional support pattern; details of oxygen therapy; ventilatory support and outcome. We defined patients alive after 28 days post ICU admission as survivors and patients who died within 28 days as non-survivors. Mechanical ventilation (MV) need was defined as the need for either non-invasive ventilation or invasive ventilation during ICU stay. We evaluated the NUTRIC score of each patient using the six variables-Age, APACHE II score, SOFA score, number of co-morbidities, days in hospital prior to admission to the ICU and values of interleukin-6 (IL-6) within 24 hours of admission to the ICU.[9,10] The NUTRIC scores were entered in a sheet [Table 1].[6] The nutritional risk for each patient was assessed at 72 hours after ICU admission using the NUTRIC score. The calculation of NUTRIC score of 1–10, is based on those six variables. A score of >5 indicates that the patient has a high nutritional risk with 20% mortality at 28 days.[6] Data including continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were expressed as a percentage. The receiver operating characteristic curve (ROC) analysis was used to find the sensitivity and specificity on comparison of outcome and NUTRIC score. In all the above statistical tools, $P = 0.05$ was considered statistically significant. We evaluated the prediction of NUTRIC scores for the 28-day outcome and need for MV by calculating the area under the ROC curve, and the best NUTRIC score cut-off for the 28-day outcome and need for MV was obtained. The collected data were analysed with International Business Machines Statistical Package for the Social Sciences (IBM, SPSS) (IBM Corp., Statistics for Windows, version 24.0, Armonk, NY). The calculation of sample size would not be appropriate for a retrospective observational study of 80 subjects., We intended to calculate the predicted mortality based on NUTRIC Score, and thus we considered the "mortality to survival ratios" for assessing the power of the study. We observed the AUC of 0.802 for NUTRIC score assessment for unfavourable outcomes, which is significant from the null hypothesis value 0.5. The observed ratio is 0.78 for survivors and non-survivors in the current

Table 1: NUTRIC Score

Variable	0-Point	1-Point	2-Point	3-Point
Age (years)	<50 years	50-74 years	≥75 years	
APACHE II	<15	15-19	20-27	≥28
SOFA Score	<6	6-9	≥10	
Number of Co-morbidities	0-1	≥2		
Days in Hospital to ICU Admission	0	≥2		
IL-6 (Pg/ml)	0-399	≥400		

Total Score is 10. Minimum is 0 has approximately 1% risk of 28-day mortality. Maximum Score 10 has approximately 80% risk of 28-day mortality. Low NUTRIC Score <5. High NUTRIC Score >5. APACHE II:Acute Physiology and Chronic Health Evaluation II; SOFA:Sequential Organ Failure Assessment; IL-6: Interleukin - 6; NUTRIC: Nutrition Risk in the Critically ill; ICU:Intensive Care Unit

study. For α-level of 0.05, the calculated power of the study appears to be nearly 99.9%.

RESULTS

A total of 96 COVID-19 ARDS patients were admitted to the ICU, out of which 80 patients met our inclusion criteria [Figure 1]. Out of 80 patients, there were 35 patients in the survivors group and 45 patients in the non-survivors group. The age in years [mean ± standard deviation(SD)] of survivors and non-survivors was 55.82 ± 13.92 and 61.69 ± 13.5. A total of 47.5% of patients were older than 60 years. The co-morbidities like hypertension, diabetes, coronary artery disease, chronic obstructive pulmonary disease (COPD)/asthma, cerebrovascular accidents, chronic kidney disease, non-Hodgkin's lymphoma and hypothyroidism were frequently seen, and the most common of these were hypertension (42.5%) and diabetes mellitus (38.7%). Among survivors, the median Glasgow coma scale (GCS) score, APACHE II score, NUTRIC score and SOFA score were 15, 8, 2 and 2, respectively. Among non-survivors, the median GCS score, APACHE II score, NUTRIC score and SOFA score were 10, 16, 6 and 4, respectively. During the ICU stay, COVID-19 ARDS patients developed several complications that included acute kidney injury in two (3.8%), shock in twelve (15%), acute liver disease in one (1.2%) and secondary infection in six (7.5%) patients.

Patients received oxygen therapy in different forms according to their clinical condition in due course of treatment in the ICU. The requirement of MV among survivors and non-survivors was 28.5% and 55.5%, respectively. A total of 15 patients (33.3%) out of 45 required vasopressors for treatment among the non-survivors group of patients. The characteristics of the study participants among survivors and non-survivors are shown in Table 2. A NUTRIC score with a value of >5 points is defined as a high score, and ≤5 points is taken as a low score.[6] Based on NUTRIC scores at ICU admission, a high nutritional

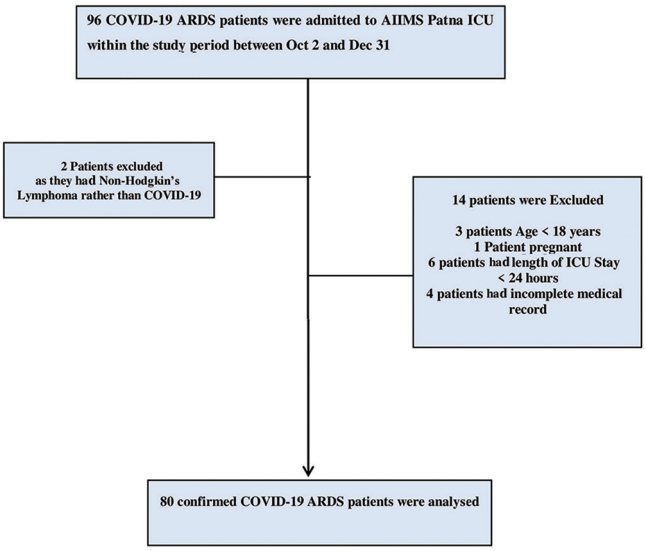

Figure 1: Flow diagram

risk (>5 points) was observed in 15% of COVID-19 ARDS patients in the current study. A low nutritional risk (≤5 points) was observed in 85%. The high nutritional risk group exhibited significantly greater incidences of shock, acute kidney injuries, secondary infection, and use of vasopressors. The 28-day mortality rate in 80 patients of COVID-19 ARDS was found to be 56.25%. Patients with high NUTRIC scores between 6 and 10 have a higher 28-day mortality risk than those with NUTRIC score between 0 and 5. The sensitivity and specificity of a high NUTRIC score (>5) to predict the mortality was 26.6% and 100%, respectively, in our subset of COVID-19 patients.

The ROC curves were plotted in the current study to find the discriminating power of the NUTRIC score in predicting 28-day mortality and the new cut-off value that would have better sensitivity as well. The discriminative powers of other scores like SOFA and APACHE II were also calculated. Sensitivity and 1-specificity were used to plot ROC curves. The area under this curve (AUC) represented the discriminative ability of the NUTRIC-score, SOFA and APACHE II

Table 2: Characteristics of the study participants

Variable	Survivor (*n*=35)	Non-Survivor (*n*=45)
Age (Mean±SD) years	55.82±13.92	61.69±13.59
Gender		
Male	26	34
Female	9	11
Co-morbidities		
Diabetes Mellitus	13	18
Hypertension	9	25
Chronic Kidney disease	2	5
Coronary artery disease	1	2
Chronic obstructive pulmonary disease	0	2
Cerebrovascular accidents	1	0
Others	2	3
Median NUTRIC Score	2	4
Median IL-6 value (pg/ml)	67	93
Median GCS	15	10
Median APACHE Score	8	12
Median SOFA Score	5	14
Complications during ICU Stay		
Acute Kidney Injury	0	2
Shock	1	11
Acute Liver dysfunction	0	1
Secondary Infection	0	6
Treatment in ICU		
IHD/SLED	1 (IHD)	1 (IHD)/3 (SLED)
Vasopressors	1 (2.8%)	15 (33.3%)
Modes of Ventilation		
Non-invasive ventilation	8 (22.8%)	12 (26.6%)
Invasive mechanical Ventilation	2 (5.7%)	23 (51.1%)

APACHE II, Acute Physiology and Chronic Health Evaluation II; IHD, Intermittent hemodialysis; SLED, Slow low efficiency dialysis; GCS, Glasgow coma scale; ICU, intensive care units; SOFA, Sequential Organ Failure Assessment, IL-6, Interleukin-6; SD, Standard deviation.

screening tool as a binary function for mortality and the need for ventilation. We considered an AUC of 0.90–1.00 as excellent, 0.80–0.90 as good, 0.70–0.80 as fair, 0.60–0.70 as poor and 0.50–0.60 as fail. The ability to predict unfavourable outcomes was APACHE II (AUC = 0.837) followed by NUTRIC score (AUC = 0.802) and SOFA (AUC = 0.795). The cut-off values for NUTRIC score, SOFA and APACHE II to predict 28-day mortality [Figure 2a] and the cut-off values for NUTRIC score, SOFA and APACHE II to predict need of MV [Figure 2b] were obtained by analysing the ROC. The derived cut-off points for NUTRIC score, SOFA and APACHE II with sensitivity and specificity are shown in Table 3. A total of 55.5% of patients with COVID-19 ARDS needed MV. The AUC of NUTRIC score, SOFA and APACHE II with their *P* value and 95% confidence interval (CI) to predict 28-day mortality and need for MV is shown in Table 4.

Patients with high NUTRIC scores between 6 and 10 had a more increased need for MV than those with a NUTRIC score between 0 and 5. The NUTRIC score was 97.29% specific for detecting the need for MV, and it had a sensitivity of 23.25%.

The majority of the patients (70%) received enteral nutrition (EN), 7% of patients received total parenteral nutrition (TPN) and 14% of patients received EN plus PN. The remaining 9% did not receive any nutritional supplement due to some contraindications.

DISCUSSION

Many studies have demonstrated the importance of the NUTRIC score in the prediction of outcomes in critically ill patients.[11-16] However, its validation in COVID-19 ARDS patients is lacking. This is the first study as per our knowledge, which assessed the NUTRIC score for a particular population, especially COVID-19 ARDS patients. Zhang *et al*.[11] found a mortality of 87% versus 49% in COVID-19 patients with high NUTRIC score. We found a mortality of 92.8% versus 38% in high NUTRIC score group whereas taking a cut-off of 3.5, Kalaiselvan *et al*.[12] reported 43% of mechanically ventilated patients as having a high nutritional risk (mNUTRIC score >5 points). Mendes *et al*.[16] reported that 49% of ICU patients were at high nutritional risk based on their

Table 3: Cut-off value of NUTRIC score, SOFA and APACHE II with their sensitivity and specificity to predict 28-day mortality and need for Mechanical Ventilation

Variables	28-day mortality			Need for Mechanical Ventilation		
	Cut off value	Sensitivity (%)	Specificity (%)	Cut-off value	Sensitivity (%)	Specificity (%)
NUTRIC Score	3.5	62	95	3.5	51.2	78.4
SOFA	3.5	72.5	72	3.5	76.7	70.3
APACHE II	11.5	75.5	83	11.5	65.1	67.6

APACHE II: Acute Physiology and Chronic Health Evaluation II; SOFA: Sequential Organ Failure Assessment; NUTRIC: Nutrition Risk in the Critically ill

Table 4: Area under Curve (AUC) of NUTRIC score, SOFA and APACHE II with their *P* Value and 95% CI to Predict 28-day mortality and need for mechanical ventilation

Variables	28-day mortality					Need for Mechanical Ventilation				
	AUC	SE[a]	Asymptotic sigb (*P*)	95% CI		AUC	SE[a]	Asymptotic sigb (*P*)	95% CI	
				Lower	Upper				Lower	Upper
NUTRIC Score	0.802	0.05	0.000	0.704	0.899	0.637	0.063	0.035	0.514	0.761
SOFA	0.795	0.05	0.000	0.696	0.893	0.804	0.049	0.000	0.708	0.900
APACHE II	0.837	0.044	0.000	0.749	0.924	0.730	0.056	0.000	0.619	0.840

The test variable(s): NUTRIC, SOFA, APACHE has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. [a]Under the non-parametric assumption, [b]Null hypothesis :True are=0.5, AUC: Area under Curve; SE: Standard Error; CI: Confidence interval; APACHE II: Acute Physiology and Chronic Health Evaluation II; SOFA: Sequential Organ Failure Assessment; NUTRIC: Nutrition Risk in the Critically ill

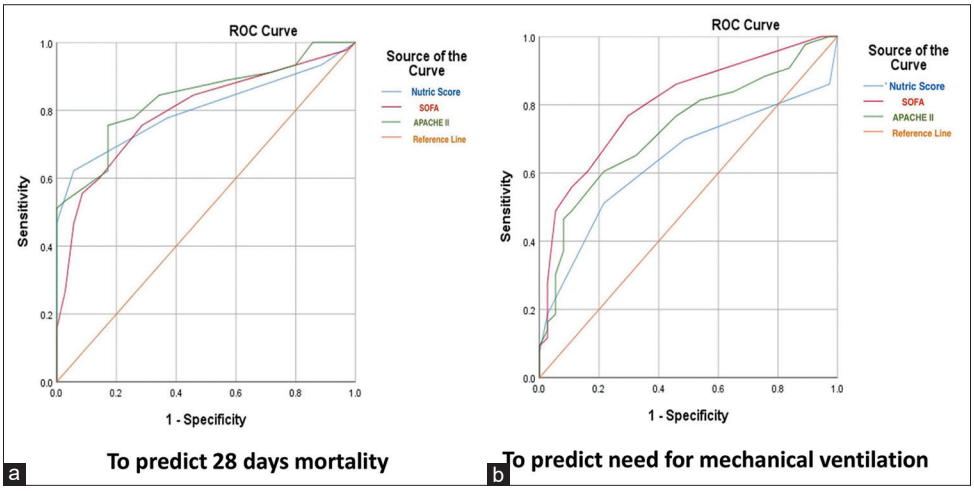

Figure 2: (a) Cut-off values for NUTRIC score, SOFA and APACHE II to predict 28-day mortality (obtained by analysing the ROC). (b) Cut-off values for NUTRIC score, SOFA and APACHE II to predict need for mechanical ventilation. (obtained by analysing the ROC)

mNUTRIC scores. During the malnutrition screening in the ICU, the severity of disease and inflammation have a potential role. The NRS 2002 and NUTRIC scoring systems include nutritional status and disease severity, and both have APACHE II scores as a common variable.

Similarly, the NUTRIC scoring system includes the SOFA score, which determines organ dysfunction levels and mortality risk in ICU patients.[17] Canadian researchers first used the NUTRIC scoring system in the ICU.[6] For assessment of nutritional status in critically ill patients, both NRS 2002 and NUTRIC Scores were recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) in the year 2016.[18] The NUTRIC score of patients at the time of ICU admission has been associated with MV, clinical complications, hospitalisation time and death.[19] The NUTRIC score has been predicted to be a risk factor associated with survival time in ICUs.[20]

In the current study, we found that patients with high NUTRIC scores between 6 and 10 had a higher 28-day mortality risk and a higher need for MV as compared to NUTRIC scores between 0 and 5. Our data suggested that the NUTRIC score may be an appropriate tool for nutritional risk assessment and prognosis prediction for COVID-19 ARDS patients. Moreover, on analysing the ROC, the cut-off values for NUTRIC score, SOFA and APACHE II to predict 28-day mortality were 3.5, 3.5 and 11.5 with specificity as 95%, 72% and 83%, respectively. Similarly, the cut-off values for NUTRIC score, SOFA and APACHE II to predict the

need for mechanical ventilation were 3.5, 3.5 and 11.5 with specificity of 78.4%, 70.3% and 67.6%, respectively. In our study, the NUTRIC score (3.5) cut-off values to predict mortality and need for MV were much less than the previously acceptable cut-off value of 5. This shows that nutrition has a more significant role in COVID-19 patients as compared to non-COVID-19 patients, and utmost importance should be given to this. On analysing the AUC, the NUTRIC score was a fair marker for predicting mortality but poorly predicted the need for MV. The study by Kalaiselvan *et al*.[12] in critically ill patients concluded a mean NUTRIC score of 4.0, which was lesser than the original validation study by Heyland *et al*.[6] with a NUTRIC score of 4.7. During this pandemic, we need to develop new approaches for performing nutritional screening of patients who have recovered from COVID-19. Still with limited treatment options, COVID-19 appropriate behaviour and vaccination remain the mainstay of controlling the disease.[21-23] Our study has few limitations. Firstly, all enroled patients were from dedicated COVID-19 ICUs of a single centre, so there may be chances of selection bias as one of the confounding factors. Secondly, only a small sample size (80) of COVID-19 ARDS patients was included. Thirdly, we did not perform dynamic nutritional risk assessments and serum prealbumin levels, which may have affected our patient outcomes and results. Fourthly, it was a retrospective observational study. Nonetheless, extensive multicentric randomised controlled studies are needed to determine nutritional interventions that can further improve the outcomes of COVID-19 ARDS patients.

CONCLUSION

A NUTRIC score of >3.5 at ICU admission has a higher 28-day ICU mortality and is associated with a higher need for MV. This study signifies the importance of NUTRIC score for prognosticating COVID-19 patients and opens the path to future research on this topic.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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