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El impacto del significado pronóstico de la puntuación CONUT en pacientes críticos en la unidad de cuidados intensivos: un estudio descriptivo

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ABSTRACT

Background: the CONUT score is a validated tool used to assess the nutritional status based on serum albumin, total cholesterol, and lymphocyte count. This study aimed to determine the effect of the CONUT score used for malnutrition assessment on the prognosis of critically ill patients in the ICU.

Methods: in this descriptive and retrospective study, demographic data, duration of hospital stay and observation, diseases leading to ICU admission, comorbidities, vital signs, APACHE II score, SOFA score, Charlson comorbidity index, blood serum parameters, treatment supports, duration of invasive mechanical ventilation, feeding methods, and complication status were obtained from patient files. Patients were categorised according to their CONUT scores into normal (0-1), light (2-4), moderate (5-8) and severe (9-12) groups. In statistical analyses, significance was defined as $P<0.05$. Descriptive statistics, Kaplan-Meier survival curves, and Cox regression models were employed to evaluate the prognostic significance of the CONUT score.

Results: the study included 152 patients. For each additional unit in the CONUT score, a 12 % increase in mortality was observed (p = 0.013). The CONUT score was shown to be significantly associated with APACHE II score, SOFA score and Charlson Comorbidity Index, which have prognostic importance in critically ill patients (p = 0.007, p = 0.048, p = 0.024, respectively). According to the CONUT score, patients were divided into four groups, and a statistically significant decrease in survival was observed proportionally from the normal to the severe group in the Kaplan-Meier survival curves ($p < 0.001$).

Conclusions: the CONUT score, which is a reliable and practical tool for assessing the nutritional status of critically ill patients in ICU, is significantly associated with ICU mortality.

Keywords: CONUT score. Malnutrition. Intensive care unit. Critical illness. Mortality.

RESUMEN

Antecedentes: la puntuación CONUT es una herramienta validada que se utiliza para evaluar el estado nutricional a partir de la albúmina sérica, el colesterol total y el recuento de linfocitos. Este estudio tuvo como objetivo determinar el efecto de la puntuación CONUT utilizada para la evaluación de la desnutrición en el pronóstico de los pacientes críticos en la UCI.

Métodos: en este estudio descriptivo y retrospectivo se obtuvieron de los expedientes de los pacientes datos demográficos, duración de la estancia hospitalaria y de la observación, enfermedades que motivaron el ingreso en la UCI, comorbilidades, constantes vitales, puntuación APACHE II, puntuación SOFA, índice de comorbilidad de

Charlson, parámetros del suero sanguíneo, soportes del tratamiento, duración de la ventilación mecánica invasiva, métodos de alimentación y estado de las complicaciones. Los pacientes se clasificaron según su puntuación CONUT en los grupos normal (0-1), leve (2-4), moderado (5-8) y grave (9-12). En los análisis estadísticos, la significación se definió como $p < 0,05$. Se emplearon estadísticas descriptivas, curvas de supervivencia de Kaplan-Meier y modelos de regresión de Cox para evaluar la importancia pronóstica de la puntuación CONUT.

Resultados: el estudio incluyó 152 pacientes. Por cada unidad adicional en la puntuación CONUT, se observó un aumento del 12 % en la mortalidad ($p = 0,013$). Se demostró que la puntuación CONUT estaba significativamente asociada con la puntuación APACHE II, la puntuación SOFA y el índice de comorbilidad de Charlson, que tienen importancia pronóstica en los pacientes críticos ($p = 0,007$, $p = 0,048$, $p = 0,024$, respectivamente). Según la puntuación CONUT, los pacientes se dividieron en cuatro grupos y se observó una disminución estadísticamente significativa de la supervivencia proporcional del grupo normal al grave en las curvas de supervivencia de Kaplan-Meier ($p < 0,001$).

Conclusiones: la puntuación CONUT, que es una herramienta fiable y práctica para evaluar el estado nutricional de los pacientes críticos en la UCI, se asocia significativamente a la mortalidad en la UCI.

Palabras clave: Puntuación CONUT. Desnutrición. Unidad de cuidados intensivos. Enfermedad crítica. Mortalidad.

INTRODUCTION

According to the World Health Organisation, the definition of malnutrition means excessive or inadequate intake of nutrients, the imbalance of essential nutrients or the impaired utilisation of nutrients (1). In particular, involuntary weight loss, losing 5 to 10 per cent or more of weight within 3 to 6 months, is one of the main signs of malnutrition, and a BMI below 18.5 is defined as underweight (2). The prevalence of malnutrition in ICUs is 38 %-78 % worldwide (3). Malnutrition leads to increased costs for inpatients and an increased burden on the healthcare system. Providing nutritional support for patients with malnutrition or patients at risk reduces the risk of hospital-associated infections and readmission while improving discharge rates and survival rates. Therefore, preventing malnutrition also alleviates the increased cost burden (4).

One study showed that 25 % of these critically ill patients experienced malnutrition in the first 4 days after discontinuation of enteral nutrition (5).

Nutrition plays an important role in maintaining muscle mass, immune response, gastrointestinal mucosal integrity and catabolic balance in critically ill patients. Mortality in critically ill patients is associated with prognostic factors such as infection, duration of mechanical ventilation and length of hospital stay. There are two main causes of malnutrition in critically ill patients. These are inadequate nutrient intake and stress catabolism. Catabolic hormones and proinflammatory mediators such as IL-1, IL-6 and TNF-α contribute to this process. It is important to identify patients at risk by performing nutritional screening on these patients. It is recommended to perform the scan 24-28 hours after hospitalisation. Although there are many assessment scores, there is not yet a standardised method that can provide a definitive diagnosis (6). Excessive and/or inadequate administration of medical nutrition therapies in critically ill patients creates various problems. The term nutri-trauma is used to describe complications of medical nutrition therapies such as refeeding syndrome (7). Protection from overfeeding or malnutrition prevents nutri-trauma. The feeding route is also important. For example, for patients who can eat, this route should be preferred if the patient can meet 70 % of his/her needs between days 3-7 without the risk of vomiting or aspiration (8).

There are standardisation efforts in the assessment of malnutrition. For example, the Global Leadership Initiative on Malnutrition (GLIM) criteria have established a two-step model. The first is the use of any screening scoring tool. The second step is based on at least one phenotypic criterion and one etiological criterion (9). A systematic review and meta-analysis emphasised that the use and validity of GLIM criteria among critically ill patients in the intensive care unit (ICU) is still limited. Therefore, there is currently no definitive tool (10).

As is understood from this, malnutrition risk management in ICUs requires a 'delicate balance'. The CONtrolling NUTritional status score (CONUT) score attracts attention because it is a simple and feasible method for the assessment of nutritional status. The CONUT score is assessed by blood parameters including albumin, total cholesterol and total lymphocytes. In inpatients, increased CONUT score was associated with increased risk of in-hospital death and complications (11). In a study conducted in our country, it was found that the CONUT score was highly associated with mortality in ICU patients and was a practical and reliable tool for assessing the nutritional status of ICU patients (12). Assessment of nutrition in critically ill patients in ICU is important in terms of determining medical nutrition treatment strategies and preventing possible negative outcomes. The lack of verbal communication with critically ill patients in the ICU has reduced the usability of traditional methods in nutritional assessment due to reasons such as high catabolism, changing body composition and weight that may distort measurements, and has led to the need for standardised assessment tools (13). CONUT score has been very curious in chronic diseases, especially in cancer patients, many studies and meta-analyses have been conducted until now (14-16). However, as far as we have investigated critically ill patients in the ICU, there is no definite data available yet in terms of CONUT score.

This study aimed to determine the effect of CONUT score on prognosis in critically ill patients in ICU, so we think that our study sheds light on future studies to be planned.

MATERIAL AND METHODS

Study cohort and data collection

This retrospective descriptive study was performed in the Buca Seyfi Demirsoy Training and Research Hospital. Patients aged 18 years and older admitted to the ICU between January 2023 and January 2024 were included in the study. Clinical and laboratory data of the patients were retrospectively obtained using the hospital database. The primary endpoint was defined as either mortality or a ninety-day observation period. The observation period refers to the time from ICU admission to the occurrence of an endpoint, such as discharge or death. Age, gender, BMI (kg/m^2), length of hospital stay and observation, diseases that caused admission to ICU, comorbidities, vital signs (body temperature, heart rate, respiratory rate, mean arterial pressure), Acute Physiology and Chronic Health Evaluation II (APACHE II) score, Sequential Organ Failure Assessment (SOFA) score, Charlson comorbidity index, blood serum parameters (WBC x *10^3/µL*, lymphocytes x *10^3/µL*, hemoglobin *g/dl*, platelet x *10^3/µL*, INR, CRP *mg/L*, albumin *g/dl*, AST *iu/l*, ALT *iu/l*, total bilirubin *mg/dl*, direct bilirubin *mg/dl*, creatinine *mg/dl*, BUN *mg/dL*, sodium *mEq/L*, potassium *mEq/L*, chloride *mEq/L*, magnesium *mg/dl*, calcium *mg/dl*, total cholesterol *mg/dl*, procalcitonin *µg/L*), treatments (hemodialysis, invasive mechanical ventilation, insulin infusion, inotropic support, systemic glucocorticosteroid), invasive mechanical ventilation duration, feeding methods (peroral, enteral/nasogastric tube, total parenteral nutrition), complications [(acute kidney injury (AKI), septic shock, myocardial damage, ventilatory associated pneumonia (VAP)] were obtained from the patient files. Sepsis was defined as a SOFA score ≥ 2 in patients who fulfilled the infection criteria and Septic shock is defined as the need for vasopressors to maintain a mean arterial pressure ≥ 65 mmHg and a serum lactate level ≥ 2 mmol/L (17).

For predicting negative outcomes, length of hospital stays, deterioration in vital signs, APACHE II and SOFA scores, length of invasive mechanical ventilation, AKI, VAP, myocardial damage, septic shock and death. Data related to mechanical ventilation, as well as clinical information such as acute kidney injury and ventilator-associated pneumonia, were obtained by reviewing patient records. Inclusion criteria were defined as being 18 years of age or older and having been monitored in the ICU for any reason. Exclusion criteria were defined as not falling within the specified age range and having incomplete data. A total of 184 patients meeting the inclusion criteria were identified. Eighteen patients were excluded due to being under 18 years of age, and 14 patients were excluded due to incomplete data. The study was conducted with 152 patients. Serum albumin (g/dl), total lymphocyte count/ml and total cholesterol (mg/dl) levels were obtained to calculate the CONtrolling NUTritional status score. Patients were categorised according to their CONUT scores into normal (0-1), light (2-4), moderate (5-8) and severe (9-12) groups (Fig. 1). Death information of the patients was accessed through the hospital information management system and the central population administration system of Turkey (MERNİS) (18). Subsequently, these groups were analysed as low (light and normal) and high (moderate and severe) groups.

Statistical analysis

All analyses were performed using the Statistical Package for Social Sciences (version 24.0, IBM, New York, USA). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used for normality tests. Percentages for categorical variables, mean ± standard deviation (SD) for normal numeric variables and median (interquartile range/IQR) for non-normally distributed numeric variables were presented. Student’s t-test was used to compare parametric continuous variables, while the Mann-Whitney U-test was used for non-parametric continuous variables, with results presented as mean ± SD and median (min-max). For categorical variables, Pearson's Chi-square test and Fisher's exact test were used, with results given as *n* (%). Variables related to mortality were evaluated using Kaplan-Meier (log-rank) and Cox regression analysis. Utilizing receiver operating characteristic (ROC) curves, CONUT score, APACHE II score and SOFA score were evaluated for their performance with/without pneumosepsis. Statistical significance was defined as $p < 0.05$.

Ethical approval

Ethics committee approval was obtained by the non-interventional ethics committee of Buca Seyfi Demirsoy Training and Research Hospital (Decision no: 2024/344). This study was performed in line with the principles of the Declaration of Helsinki. Informed verbal consent was obtained from the patients. Patient information confidentiality was protected.

RESULTS

A total of 152 patients were included in the study. Sixty-two percent of 152 patients were men. The mean age of the patients was 69.8 ± 15.2 years. The most common reason for admission to the ICU was pneumosepsis, occurring in 91 patients (60 %), followed by neurological conditions in 23 patients (15 %) and respiratory issues in 17 patients (11 %). The most commonly observed comorbidity was congestive heart failure, followed by hypertension, cerebrovascular accident, chronic obstructive pulmonary disease (COPD), diabetes *mellitus* and coronary artery disease. Additionally, 20 patients had a diagnosis of malignancy. During the follow-up period, complications developed in 65 patients (43 %) with acute kidney injury (AKI), 52 patients (34 %) with septic shock, 9 patients (6 %) with myocardial injury, and 6 patients (4 %) with ventilator-associated pneumonia

(VAP). Mechanical ventilation (MV) was required in 35 patients (23 %), and haemodialysis (HD) was needed in 8 patients (5 %). The mean CONUT score, APACHE II score, SOFA score and Charlson comorbidity index of patients are respectively 4.9 ± 3.3, 27.1 ± 6.3, 5.6 ± 2.1 and 5.7 ± 3.3. During the 66.1 ± 36.1-month observation period, 31 % of the patients died. All clinical and laboratory parameters related to the patients are presented in table I.

Patients were categorised according to their CONUT scores into normal (31 patients, 20 %), mild (44 patients, 29 %), moderate (55 patients, 36 %), and severe (22 patients, 15 %) groups. Subsequently, these groups were analysed as Low (75 patients, 49 %) and High (77 patients, 51 %) groups. The Low group was younger compared to the High group (p = 0.008), while there was no significant difference in gender ratios (p = 0.259). Cerebrovascular accidents were more prevalent in the High group (p = 0.020). No significant differences were found among the other comorbidities. Length of hospital stay and invasive mechanical ventilation duration were more prevalent in the High group (p = 0.006, $p < 0.001$). CONUT, APACHE II, SOFA, and Charlson comorbidity indices were found to be significantly higher in the High group. All complications were more frequent in the High group, and except for acute kidney injury (AKI), the other complications were statistically significantly more prevalent. A comparison of clinical characteristics between patients with Low and High CONUT scores is presented in table II.

Age, sex, Charlson comorbidity index, APACHE II, and CONUT scores were evaluated first using univariate and then multivariate Cox regression analyses. After adjusting for age, sex, Charlson comorbidity index, and APACHE II, an independent increase of 12 % in mortality was observed for each additional unit of the CONUT score (p = 0.013) (Table III). According to the CONUT score, patients were divided into four groups, and a statistically significant decrease in survival was observed in a proportional manner from the normal to the severe group in the Kaplan-Meier survival curves ($p < 0.001$) (Fig. 2).

In the analyses, an APACHE score of 30.5 and above at admission in the non-pneumosepsis group was found to be a significant parameter that could predict mortality with a sensitivity of 100 % and specificity of 79 % (AUC = 873, $p = 0.028$, Youden J index = 0.794). Therefore, since the Youden J index is lower than 0.80, we can say that it is a poor predictor. The ROC analysis model was not statistically significant for CONUT and SOFA scores ($p > 0.05$ for both). In the group with pneumosepsis, since the ROC curve areas were limited and the models were not significant, diagnostic value points for CONUT, APACHE and SOFA scores that could distinguish the prediction of mortality were not determined (Table IV, Fig. 3).

DISCUSSION

In this study, the significant association of the high CONUT score with length of hospital stay, invasive mechanical ventilation duration, serious complications and mortality was shown. In addition, it has been shown that CONUT score has a significant relationship with APACHE II score, SOFA score and CCI, which have prognostic importance in critically ill patients.

In a prospective cohort study comparing five nutritional scores to assess malnutrition, the CONUT score identified more people at risk of malnutrition than the others. The authors considered that the study shows that CONUT overestimates malnutrition in critically ill patients. And they attribute this to the limiting effect of albumin. Similar to our study, age, APACHE II and SOFA scores were found to be higher in the group with high CONUT scores compared to the group with low CONUT scores ($p = 0.018$, $p = 0.004$, $p < 0.001$). BMI did not show a significant difference between the groups as in our study ($p = 0.884$). Consistent with our study, they found a significant relationship between CONUT score and mortality ($p = 0.048$) (19). In a retrospective study of 809 patients, high CONUT values were associated with intubation, age, APACHE-II scores, number of comorbidities and death ($p = 0.012$, $p < 0.001$, $p < 0.001$, $p < 0.001$, $p = 0.030$ and $p < 0.001$, respectively). The consistency of our results is seen with the literature (12). A study conducted in Cuba showed a relationship between nutritional status and length of hospital stay in ICU. In the obtained ROC curve, CONUT was shown to have a high sensitivity in predicting the relationship between nutritional risk and mortality (20).

In a prospective observational study, CONUT score was significantly associated with readmissions ($p = 0.041$), complications ($p = 0.036$) and mortality ($p = 0.007$). In our study, consistent with these data, it was shown that VAP, myocardial damage and septic shock complications were significantly associated with CONUT score (21). APACHE II and SOFA have prognostic importance in critically ill patients in intensive care unit. Therefore, the relationship with CONUT score was investigated in our study (22).

In a study conducted in our country, enteral nutrition was given to 67.8 % of patients in the ICU. In our study, this rate was 70 %. These results emphasise that physicians consider enteral nutrition as the first choice in the absence of any contraindication. In the analysis of 109 patients in the mentioned study, the median age was 72 [57-83] years and the median BMI was 25.32 [21.22-29.38]. Patients with similar age and BMI to our study had a median SOFA score of 6 [4-9] and a median APACHE II score of 23 [18-29]. In our patients, the APACHE II score was 27.1 ± 6.3 and the SOFA score was 5.6 ± 2.1 (23).

In our results, ROC analyses for APACHE and CONUT scores were not significant in predicting mortality especially in the group with pneumosepsis. The APACHE II score predicted mortality in the group without pneumosepsis with 100 % sensitivity and 79 % specificity at a cut-off value of 30.5, while the CONUT score was not significant. Notably, studies suggest that CONUT may overestimate malnutrition due to the influence of acute-phase reactants like albumin, especially in patients with sepsis or inflammatory conditions (24). This could explain the limited prognostic value we observed in the pneumosepsis subgroup. Still, the consistent association of CONUT with complications such as septic shock, myocardial injury, and ventilator-associated pneumonia supports its clinical relevance beyond mortality prediction. A systematic review and meta-analysis showed that the CONUT score is a valuable prognostic factor for survival, disability and development of infection after stroke in stroke patients. It shows the importance of assessing malnutrition in predicting quality of life after recovery from critical illness. In our study, complication rates were higher in the high CONUT score group (25).

In a multicentre study conducted in South Korea, the CONUT score was significantly different in 30-day survivors and 30-day non-survivors ($p < 0.001$). For CONUT, 30-day survival rates associated with no, mild, moderate and severe malnutrition risk categories were 89.7 %, 89.2 %, 84.0 % and 70.8 %, respectively (log-rank $p < 0.001$). Consistent with our study, the HR for a 1-point increase in the CONUT score was 1.10 (95 % CI, 1.08-1.12), $p < 0.001$ in multivariate analyses (26). In our results, an independent increase of 12 % in mortality was observed for each additional unit of the CONUT score (HR 1.12 (95 % CI, 1.02-1.24, $p = 0.013$). This results show that, even after adjustment for age, sex, Charlson comorbidity index, and APACHE II score. This finding underscores the potential utility of CONUT as a simple, inexpensive, and objective prognostic tool. Unlike more complex indices such as APACHE II or SOFA, which require multiple physiological and clinical variables, the CONUT score relies solely on routinely available laboratory parameters enabling rapid bedside implementation. Furthermore, the CONUT score provides valuable insight into the nutritional and immunological status of critically ill patients, dimensions that are often underrepresented in conventional severity indices. Despite its limitations in discriminative power based on ROC analysis, the CONUT score’s independent prognostic significance suggests that it may serve as a complementary marker alongside established scoring systems in the intensive care setting. This is consistent with a Japanese study that found a hazard ratio of 1.13 for 30-day mortality per 1 percentage point increase in CONUT (27).

In a study by Santivanez et al., in 200 critically ill patients, the CONUT score showed a significant correlation with ICU length of hospital stay and duration of mechanical ventilation ($p < 0.001$ and $p = 0.011$). In this study, 74 % of the patients had moderate or severe CONUT scores, whereas this value was 51 % in our study. In the above study, the predominance of polytrauma patients with severe catabolism may have been the cause of more severe malnutrition. Considering the different patient diversity, the APACHE II score showed superiority over the CONUT score in predicting mortality, similar to our study. No significant result was found in the ROC analysis of the CONUT score for predicting mortality in the above study ($p = 0.849$) (20). This mirrors our findings and suggests that while the CONUT score captures clinical vulnerability, its standalone discriminative accuracy may be insufficient.

In a study conducted in ICU patients with acute myocardial ischaemia, higher inotrope requirement ($p = 0.002$) and longer hospital duration ($p = 0.005$) were found in patients with higher CONUT values (28). In a study with 91 patients receiving mechanical ventilation support, CONUT score was found to be an independent risk factor in predicting 28-day mortality (29). In our study, the duration of invasive mechanical ventilation was found to be longer in the group with high CONUT score. In our study, there was no significant difference between the low and high CONUT groups in terms of inotropic support, while there was a significant difference in terms of length of hospital stay. This may be because, as in our study, a predictive value of 5 points is usually used to differentiate the groups with low and high CONUT scores, whereas a predictive value of 3 points was used in the study above, and the primary diseases were different in the two studies, even though they were ICU patients (30). On the other hand, there was no difference between the low and high CONUT score groups in terms of our patients being complicated with AKI.

Our study had several limitations. The retrospective nature of the study, it was performed in a single centre, lack of comparison with other nutritional risk scores and multiple comorbidities of patients cannot be standardised are the main limitations. Nevertheless, we think that our article will contribute to the role of determining the value of applicable and practical nutritional scales in the critically ill patient group. Our results should be supported by prospectively planned studies with a larger sample size.

CONCLUSIONS

In conclusion, our study reveals that the CONUT score, a reliable and practical tool to assess the nutritional status of critically ill patients in the ICU, is significantly associated with ICU mortality.

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Table I. Baseline clinical characteristics of the cohort

	Total (*n*: 152)
Age *mean ± sd*	69.8 ± 15.2
Gender, n (%)	
Men	94 (62)
Women	58 (38)
Body mass index, *mean ± sd*	24.9 ± 4.7
Length of hospital stay (days), *mean ± sd*	12.5 ± 10.7
Observation duration (months), *mean ± sd*	66.1 ± 36.1
Primary disease, n (%)	
Pneumosepsis	91 (60)
Neurological	23 (15)
Respiratory failure	17 (11)
Trauma	6 (4)
Postoperative	2 (1)
Other	13 (9)
Comorbidities, n (%)	
Congestive heart failure	59 (39)
Hypertension	58 (38)
Cerebrovascular accident	39 (26)
COPD	39 (26)
Diabetes *mellitus*	29 (19)
Malignancy	20 (13)
Coronary artery disease	19 (13)
ESRD	8 (5)

Asthma	5 (3)
Liver cirrhosis	1 (1)
Vital signs, mean ± sd	
Body temperature, °C	36.4 ± 0.9
Heart rate, bpm	95.9 ± 19.8
Respiratory rate, rpm	22.1 ± 4.2
MAP, mmHg	83.6 ± 17.4
Indexes, mean ± sd	
CONUT score	4.9 ± 3.3
APACHE II score	27.1 ± 6.3
SOFA score	5.6 ± 2.1
Charlson comorbidity index	5.7 ± 3.3
CONUT score stage, n (%)	
Normal	31 (20)
Light	44 (29)
Moderate	55 (36)
Severe	22 (15)
Blood parameters, mean ± sd	
WBC, x *10^3/μL*	14.4 ± 8.9
Lymphocytes, x *10^3/μL*	1.4 ± 1.6
Hemoglobin, *g/dl*	11.2 ± 2.4
Platelet, x *10^3/μL*	260 ± 120
INR	1.30 ± 0.53
CRP, *mg/L*	85.5 ± 84.1
Albumin, *g/dl*	3.21 ± 0.59
AST, *iu/l*	47 ± 100
ALT, *iu/l*	33 ± 49
Total bilirubin, *mg/dl*	0.67 ± 0.69
Direct bilirubin, *mg/dl*	0.37 ± 0.48

Creatinine, *mg/dl*	1.62 ± 1.88
BUN, *mg/dL*	79 ± 69
Sodium, *mEq/L*	138.3 ± 6.5
Potassium, *mEq/L*	4.4 ± 0.9
Chloride, *mEq/L*	100.7 ± 6.9
Magnesium, *mg/dl*	2.08 ± 0.27
Calcium, *mg/dl*	8.6 ± 0.7
Total cholesterol, *mg/dl*	157 ± 47
Procalcitonin, *µg/L*	3.7 ± 13.5
Treatments, n (%)	
Glucocorticosteroid Inotropic support Invasive mechanical ventilation Insulin infusion Hemodialysis	77 (51) 41 (27) 35 (23) 35 (23) 8 (5)
Invasive mechanical ventilation duration (days), *mean ± sd*	6 ± 12
Feeding methods, n (%)	
Enteral	
- Peroral	62 (40)
- Nasogastric tube	45 (30)
Total parenteral nutrition	45 (30)
Complications, n (%)	
AKI	65 (43)
Septic shock	52 (34)
Myocardial damage	9 (6)
VAP	6 (4)

Death, *n (%)*	47 (31)

AKI: acute kidney injury; ALT: alanine transferase; AST: aspartate transferase; BUN: blood urea nitrogen; CRP: C-reactive protein; COPD: chronic obstructive pulmonary disease; ESRD: end-stage renal disease; MAP: mean arterial pressure; MV: mechanical ventilation; INR: international normalised ratio; VAP: ventilator-associated pneumonia; WBC: white blood cell.

Table II. Comparison of clinical characteristics between patients with low and high CONUT scores

	Low CONUT Scores (*n*: 75)	**High CONUT Scores (*n*: 77)**	***p*-value**
Age, *mean ± sd*	67.4 ± 13.8	72.2 ± 16.3	*0.008*
Gender, n (%)			0.259
Women	32 (43)	26 (34)	
Men	43 (57)	51 (66)	
Body mass index, *mean ± sd*	25.4 ± 3.5	24.6 ± 5.6	0.092
Length of hospital stay (days), *mean ± sd*	11.6 ± 12.8	13.4 ± 8.1	*0.006*
Observation duration (months) *mean ± sd*	76.8 ± 30.4	55.6 ± 38.3	*0.001*
Primary disease, n (%)			N/A
Pneumosepsis	45 (60)	46 (60)	
Respiratory	6 (8)	11 (14)	
Neurological	15 (20)	8 (11)	
Trauma	2 (3)	4 (5)	
Postoperative	1 (1)	1 (1)	
Other	6 (8)	7 (9)	
Comorbidities, n (%)			
Hypertension	33 (44)	25 (33)	0.143
Diabetes *mellitus*	17 (23)	12 (16)	0.267
Congestive heart	31 (41)	28 (36)	0.530
failure	11 (15)	8 (10)	0.423

Coronary artery	13 (17)	26 (34)	*0.020*
disease	23 (31)	16 (21)	0.163
Cerebrovasculer	2 (3)	3 (4)	0.671
accident	3 (4)	5 (7)	0.719
COPD	1 (1)	0 (0)	0.493
Asthma	6 (8)	14 (18)	0.063
ESRD			
Liver cirrhosis			
Malignancy			
Vital signs mean ± sd			
Body temperature, *°C*	36.3 ± 1.2	36.5 ± 0.2	0.430
Pulse, *bpm*	96 ± 16	95 ± 23	0.531
Respiratory rate, *rpm*	22 ± 5	22 ± 4	0.536
MAP, *mmHg*	86 ± 16	21 ± 18	0.088
Indexes mean ± sd			
CONUT	2.2 ± 1.4	7.6 ± 2.1	*< 0.001*
APACHE II	25.9 ± 6.4	28.3 ± 6.1	*0.007*
SOFA	5.2 ± 2.1	5.9 ± 2.0	*0.048*
Charlson comorbidity	5.1 ± 3.1	6.3 ± 3.5	*0.024*
index			
Laboratory tests mean ± sd			
WBC, x *10^3/μL*	14.8 ± 8.4	13.9 ± 9.4	0.266
Lymphocytes, x	1.9 ± 0.2	0.8 ± 0.9	*< 0.001*
10^3/μL	12.1 ± 2.2	10.3 ± 2.3	*< 0.001*
Hemoglobin, *g/dl*	257 ± 114	263 ± 127	0.884
Platelet, x *10^3/μL*	1.20 ± 0.26	1.40 ± 0.68	*0.005*
INR	80 ± 81	90 ± 86	0.531
CRP, *mg/dL*	3.65 ± 0.41	2.79 ± 0.39	*< 0.001*
Albumin, *g/dl*	38 ± 94	56 ± 105	*0.017*
AST, *iu/l*	28 ± 47	38 ± 51	0.409
ALT, *iu/l*	0.60 ± 0.68	0.75 ± 0.71	0.203

Total bilirubin, *mg/dl*	0.27 ± 0.35	0.45 ± 0.56	*0.034*
Direct bilirubin, *mg/dl*	1.49 ± 1.39	1.75 ± 2.27	0.808
Creatinine, *mg/dl*	66 ± 55	91 ± 79	*0.015*
BUN, *mg/dL*	138 ± 6	138 ± 7	0.557
Sodium, *mEq/L*	4.5 ± 0.9	4.3 ± 0.9	0.206
Potassium, *mEq/L*	100 ± 6	101 ± 7	0.420
Chloride, *mEq/L*	2.12 ± 0.21	2.03 ± 0.32	*0.019*
Magnesium, *mg/dl*	8.7 ± 0.7	8.4 ± 0.8	*0.016*
Calcium, *mg/dl*	184 ± 44	131 ± 34	*< 0.001*
Total cholesterol, *mg/dl*	1.99 ± 6.95	5.31 ± 17.63	0.058
Procalcitonin, *µg/L*			
Treatments, n (%)			
Hemodialysis	6 (8)	2 (3)	0.164
Invasive MV	18 (24)	17 (22)	0.778
Insulin infusion	21 (28)	14 (18)	0.151
Inotropic support	15 (20)	26 (34)	0.056
Glucocorticosteroid	39 (52)	38 (49)	0.744
Invasive mechanical ventilation duration (days), *mean ± sd*	3.9 ± 11.4	8.0 ± 12.0	*< 0.001*
Feeding methods, n (%)			*0.019*
Peroral	39 (52)	23 (30)	
Enteral/nasogastric tube	19 (25)	26 (34)	
Total parenteral nutrition	17 (23)	28 (36)	
Complications, n (%)			
AKI	27 (36)	38 (49)	0.096
VAP	0 (0)	6 (8)	*0.028*

Myocardial damage	1 (1)	8 (10)	*0.034*
Septic shock	14 (19)	38 (50)	*< 0.001*
Death, *n (%)*	12 (16)	35 (46)	*< 0.001*

AKI: acute kidney injury; ALT: alanine transferase; AST: aspartate transferase; BUN: blood urea nitrogen; CRP: C-reactive protein; COPD: chronic obstructive pulmonary disease; ESRD: end-stage renal disease; MAP: mean arterial pressure; MV: mechanical ventilation; N/A: not applicable; INR: international normalized ratio; VAP: ventilator-associated pneumonia; WBC: white blood cell.

Table III. Analysis with Cox-regression model of all-cause mortality

	Univariate			**Multivariate**		
	HR	**95 % CI**	***p*-value**	**HR**	**95 % CI**	***p*-value**
Age	1.019	0.998-1.041	0.078	0.996	0.974-1.019	0.747
Gender (men)	1.590	0.851-2.973	0.146	1.804	0.938-3.468	0.077
Charlson comorbidity index	1.223	1.123-1.333	< *0.001*	1.178	1.076-1.290	< *0.001*
CONUT score	1.182	1.086-1.286	< *0.001*	1.128	1.026-1.241	*0.013*
APACHE II	1.106	1.055-1.160	< *0.001*	1.093	1.034-1.156	*0.002*

CI: confidence interval; HR: hazard ratio.

Table IV. ROC analysis for overall survival in patients with and without sepsis by APACHE II, SOFA and CONUT scores

	APACHE II			**SOFA**			**CONUT**		
	AUC	**95 % CI**	***p***	**AUC**	**95 % CI**	***p***	**AUC**	**95 % CI**	***p***
Overall survival in patients with pneumosepsis	0.545	0.367-0.724	0.685	0.550	0.354-0.745	0.657	0.536	0.283-0.788	0.751
Overall survival in patients without pneumosepsis	0.873	0.780-0.966	*0.028*	0.811	0.598-1.000	0.067	0.751	0.476-1.000	0.140

AUC: area under curve; CI: confidence interval.

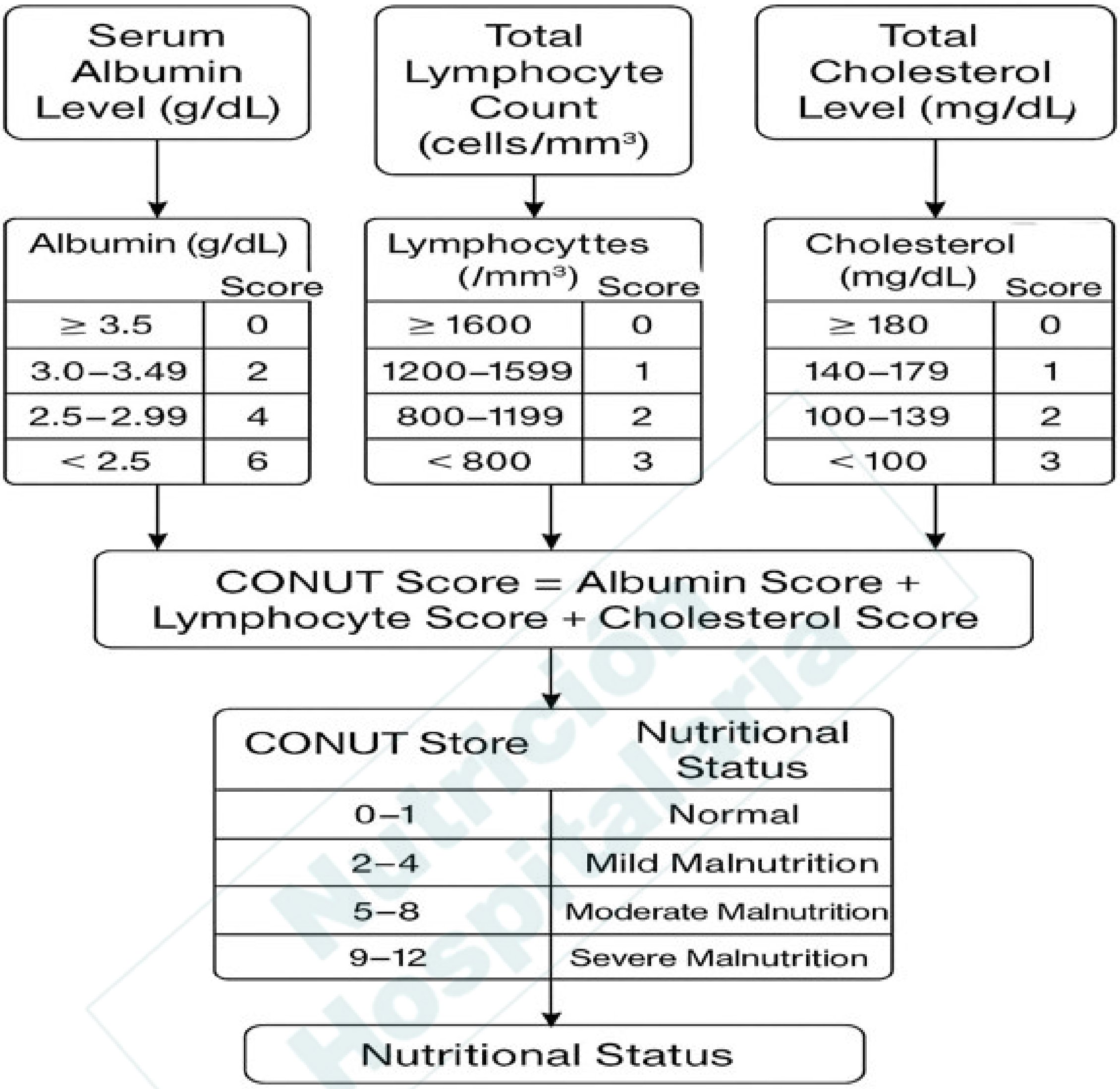

Figure 1. CONUT score.

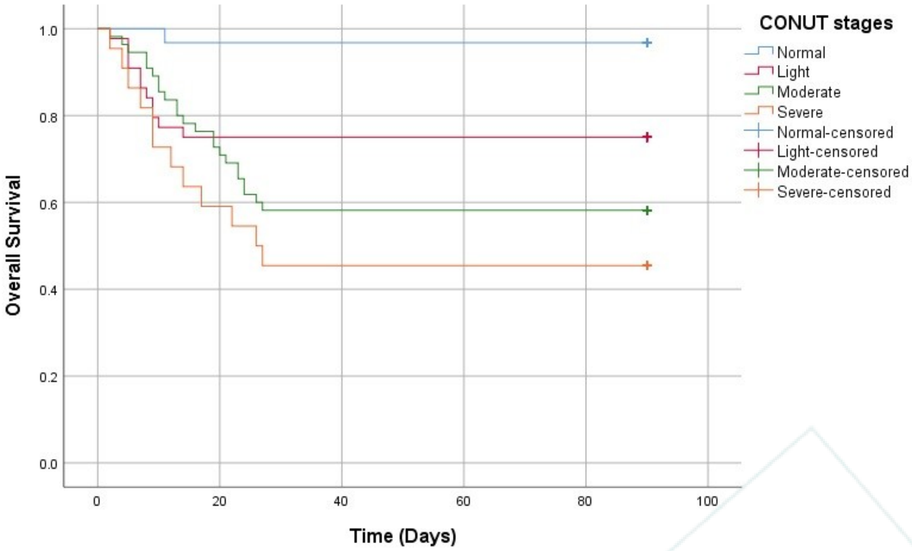

Figure 2. Survival curves by CONUT stages (p < 0.001).

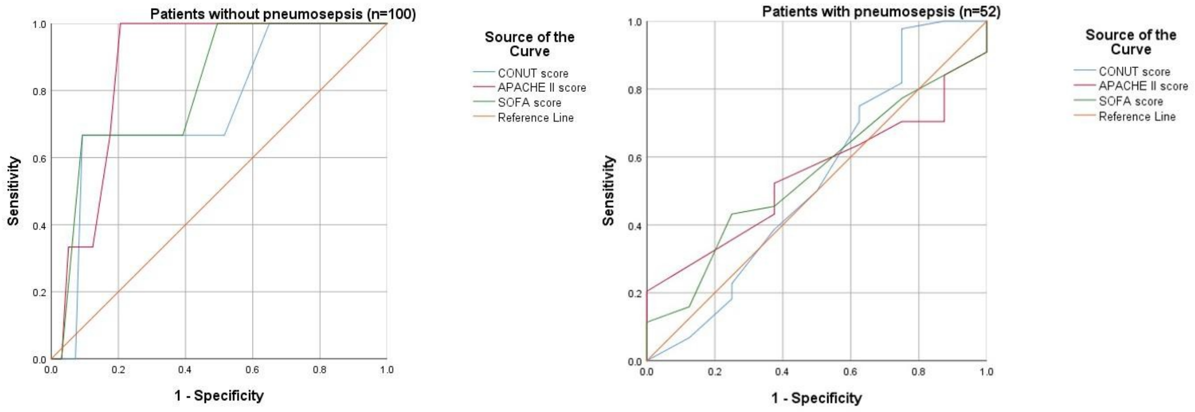

Figure 3. ROC curves for patients without and with pneumosepsis by CONUT (blue line), APACHE II (red line) and SOFA (green line) scores.