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ORIGINAL ARTICLE

Identifying critically ill patients with cirrhosis who benefit from nutrition therapy: the mNUTRIC score study

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Abstract

Background and Aim: Malnutrition increases risk of mortality in critically ill patients with cirrhosis. Modified Nutrition Risk in Critically ill (mNUTRIC) score is a validated tool to identify at risk patients who may benefit from goal-directed nutrition therapy. We aimed to study the association between mNUTRIC score and 28-day mortality in critically ill patients with cirrhosis.
Methods: A prospective study was conducted in the liver intensive care unit of a quaternary teaching institute. Baseline and follow-up data pertaining to mNUTRIC score, clinical, hemodynamic, biochemical, nutritional parameters, mechanical ventilation, length of ICU stay, and development of sepsis were collected. Correlation between mNUTRIC score and its modulation by nutritional adequacy was determined.
Results: One hundred and fifty patients were enrolled. Out of these, 116 (77%) had a high NUTRIC score (HNS) and 34 (23%) had a low NUTRIC score (LNS). Patients with HNS had higher mortality (54% vs. 10%; $P = 0.008$), longer mechanical ventilation ($P = 0.02$), and high incidence of sepsis (32% vs. 2.6%; $P = 0.002$) compared to LNS. The probability of survival increased with increase in nutritional adequacy ($P < 0.01$) in patients with HNS.
Conclusion: mNUTRIC score is a useful tool for identifying nutrition risk in critically ill patients with cirrhosis. Goal-directed nutrition therapy in patients with HNS can significantly improve survival.
Relevance for Patients: Critically ill patients with cirrhosis who are at a higher nutritional risk as identified by the mNUTRIC score may have a better survival benefit if higher calorie and protein adequacy are achieved in the ICU.

1. Introduction

Malnutrition is a pressing condition in patients with cirrhosis with its prevalence ranging from 30 to 50% [1]. Although the therapeutic advances have improved the overall survival of these patients, this population frequently faces life-threatening complications requiring intensive care unit (ICU) admissions [2]. Nutritional therapy is the cornerstone of medical management [3] and the liver ICU is no exception. However, before commencing nutrition therapy, there is a need for a quick nutritional risk assessment using a tool that is easy to use, rapid, standardized, and independent of patient feedback [4]. A daily and systematic nutritional assessment with an effective action plan not only optimizes the nutrition therapy but also helps in monitoring the nutritional benefits among the critically ill. The discrimination of nutritional risk in critically ill patients with cirrhosis is essential to be able

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to justify the aggressiveness of the nutritional action plan given the longstanding nature of the disease and the finite resources in the ICU. Nutritional risk assessment has always been a challenge in critically ill patients with cirrhosis where most traditional tools lose their specificity [5]. Heyland *et al.* have proposed the modified Nutritional Risk in the Critically ill (mNUTRIC) score exclusively for the critically ill patients. mNUTRIC is a framework of the current metabolic status, comorbidities, starvation, inflammation, and outcome [6]. However, there is a paucity of information on association of mNUTRIC score with clinical outcome in critically ill patients with cirrhosis. Therefore, a prospective study was planned to examine the association between mNUTRIC score and 28-day mortality. The secondary objective was to study the effect of nutritional adequacy on the relationship between baseline nutritional risk and 28-day survival.

2. Materials and Methods

2.1. Patient and setting

In this prospective observational study, all critically ill patients with cirrhosis (CIC) admitted to the liver intensive care unit of the Institute of Liver and Biliary Sciences, New Delhi, from March 2017 to June 2017 were enrolled. The inclusion criteria were as follows: CIC of any etiology, requiring intensive care for more than 24 h, and age ≥18 years. Moribund patients and those with hepatocellular carcinoma or other malignancies were excluded from the study.

2.2. Study plan

Baseline and daily information including the demographic, clinical, hemodynamic, biochemical, and nutritional details were collected. All patients were managed as per the standard nutrition protocol of the institute irrespective of the nutritional risk.

2.3. Diagnosis of disease

Cirrhosis was diagnosed on the basis of standard, clinical, and biochemical criteria [7].

2.4. Assessment of disease severity

Child-Turcotte-Pugh (CTP) and Model for End-stage Liver Disease (MELD) scores were used to describe the severity of liver disease while Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evaluation (APACHE) scores were used to assess the severity of critical illness.

2.5. Nutritional risk assessment

Nutritional risk was assessed at ICU admission using mNUTRIC score [8] with variables such as age, number of days from hospital to ICU admission, number of comorbidities, APACHE II score, and SOFA score, as shown in Table 1. Patients with mNUTRIC score between 0 and 4 were classified as low mNUTRIC score (LNS) and those with a score between 5 and 9 were classified as high mNUTRIC score (HNS).

Table 1. mNUTRIC scoring system[8].

Variable	Range	Points
Age (years)	<50	0
	50 – <75	1
	≥75	2
Days from hospital to ICU admission	0 – <1	0
	>1	1
Number of co-morbidities	0 – 1	0
	>2	1
APACHE II score	<15	0
	15 – <20	1
	20 – 28	2
	>28	3
SOFA score	<6	0
	6 – <10	1
	>10	2
Modified NUTRIC score (mNUTRIC; without IL-6)	0 – 4	Low score
	5 – 9	High score

2.6. Nutritional management

Enteral nutrition was initiated within 24 h of ICU admission in mechanically ventilated (MV) patients with the help of a nasogastric tube. It was delayed in cases of upper gastrointestinal bleed, paralytic ileus, or hemodynamic instability. Nasojejunal feeding was initiated only in case of feed intolerance with a failed trial of prokinetics. Non-intubated patients were given an oral diet. Total parenteral nutrition was used for patients with a non-functional gut. Nutritional requirements were calculated as 35–40 kcal and 1.2–1.5 g protein per kg of ideal body weight [9]. Protein intake was increased up to 1.8–2 g in case of obese patients and those requiring renal replacement therapy (RRT).

2.7. Nutritional adequacy

Nutritional adequacy was defined as the percentage of calories and protein actually received over the total energy or protein prescribed in 24 h. Daily nutritional adequacy was calculated and averaged for the total duration of ICU stay [6].

2.8. Medical management

Patients were managed as per standard guidelines including endotracheal intubation for those in respiratory failure, coma, or acute respiratory distress syndrome. Fluid resuscitation in combination with vasoactive drugs was used when indicated. RRT was used in patients with acute kidney injury (AKI), severe metabolic acidosis, hyperkalemia, and fluid overload. All the patients were screened for infection and treated empirically with broad-spectrum antibiotic combinations as per the physician.

2.9. Objective

The primary objective was to study the association of nutritional risk at ICU admission with 28-day mortality. The secondary objectives were (a) to assess the effect of nutritional adequacy on the relationship between baseline nutritional risk

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and 28-day survival probability and (b) to study the effect of baseline nutritional risk on outcome parameters such as duration of mechanical ventilation (MV), new onset of infections (NOI), and length of ICU stay.

2.10. Data collection

Apart from routine baseline demographics, information was collected on the duration in hospital before ICU admission; presence of comorbidities; decompensation status comprising of ascites, jaundice, upper gastrointestinal bleed; presence of sepsis; reason of ICU admission including altered sensorium, upper gastrointestinal bleed, respiratory distress, or metabolic acidosis; and disease severity scores such as SOFA, APACHE II, CTP, and MELD. Follow-up data were collected daily until death or discharge of the patients and included hemodynamic parameters such as heart rate, mean arterial pressure, and requirement of vasopressors; biochemical parameters including complete blood count, liver function test, kidney function test, coagulation factors, and random blood sugars; blood gas parameters such as pH, PaO_2, and FiO_2; and requirement of RRT, days of MV, development of NOI, duration of ICU stay, and the nutritional adequacy.

The disease severity scores were calculated with the help of online calculators (SOFA: https://www.mdcalc.com/sequential-organ-failure-assessment-sofa-score, APACHE II: https://www.mdcalc.com/apache-ii-score, CTP: https://www.mdcalc.com/child-pugh-score-cirrhosis-mortality, and MELD: https://www.mdcalc.com/meld-score-model-end-stage-liver-disease-12-older) using the necessary parameters collected from the daily bedside hospital records by the student investigator HT, a fellow in clinical nutrition.

2.11. Definition of terms

2.11.1. Sepsis

Sepsis was defined as the presence of any one of the following: Pneumonia, spontaneous bacterial empyema, spontaneous bacterial peritonitis, positive mini-BAL or blood culture, and others (cellulitis, urinary tract infection, and cholangitis) [10].

2.11.2. New onset of infection

Absence of infection at ICU admission but subsequent development of new-onset pneumonia/positive blood or mini-BAL culture reports/line sepsis/septic shock during the entire ICU stay was considered as NOI [11].

2.11.3. AKI

The presence of any one of the following: Increase in serum creatinine by 0.3 mg/dL within 48 h or increase in serum creatinine to 1.5 times baseline value or urine volume <0.5 mL/kg/h for 6 h was classified as AKI [12].

2.11.4. Renal replacement therapy

Need for sustained low-efficiency dialysis or continuous renal replacement therapy was termed renal replacement therapy [12].

2.11.5. Mechanical ventilator days

The total number of days that the patient was on mechanical ventilation.

2.11.6. Length of ICU stay

Total duration of stay in ICU until death or discharge of the patient.

2.12. Statistical analysis

The collected data were analyzed using SPSS version 22. Data are presented as mean (± standard deviation), median (range), or number (%) as appropriate. All variables were checked for normal distribution. Non-normal data were analyzed using non-parametric tests. Baseline characteristics were compared between HNS and LNS groups using Chi-square test for categorical variables and Student's t-test or Wilcoxon rank-sum test for continuous variables. Logistic regression analysis was carried out to find the effect of mNUTRIC score on 28-day mortality adjusting for factors significantly different between the HNS and LNS group. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline patient characteristics

Out of 150 patients, majority (85%) were male with an average age of 49 ± 13 years. Table 2 summarizes the chief clinical and biochemical characteristics of the patients at the time of ICU admission, along with a comparison between patients with HNS and LNS. The most common reason for ICU admission was altered sensorium. Majority had alcohol-related liver disease and diabetes mellitus as comorbidity. A total of 86 (57.3%) patients had sepsis, 34% had shock, 49% had AKI, 64.6% were mechanically ventilated, 33.4% were non-ventilated, and 2% were on non-invasive ventilation at ICU admission.

3.2. Nutritional risk at ICU admission

Of 150 patients, 116 (77.3%) had an HNS and 34 (22.6%) had an LNS. The average mNUTRIC score of the patients was 5.4 ± 1.2, ranging from 3 to 9. The mean BMI of the patients was 24.2 ± 4.6 kg/m^2 ranging from 16.4 to 42.9 kg/m^2. The estimated requirement of calories and protein ranged from 1620 to 2840 kcal and 47 to 120 g, respectively, which was comparable between patients with HNS and LNS group (Table 3).

3.3. Nutritional adequacy

Most of the patients (81.2%) were fed enterally through NG route. During the ICU stay, 21 (14.1%) patients were kept nil per oral (NPO) at some point of time for reasons such as feed intolerance (6.6%), upper gastrointestinal bleed (6%), hemodynamic instability (1.3%), and procedures such as CT or tracheostomy (0.6%). The average calorie adequacy was 75.7 ± 28.7%; range (0–120%) and protein adequacy was 68 ± 30.3%; range (0–100%) (Table 4). The mean calorie and protein adequacy were comparable between patients with HNS and LNS.

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Table 2. Baseline clinical and biochemical characteristics of critically ill patients with cirrhosis.

Variable	Patients (n=150)	HNS (n=116)	LNS (n=34)	P-value
Demographics				
Age (years)	49±12.8 (19–87)	51±12.1	40.4±11	0.001*
Male	127 (84.6%)	97 (64.6%)	30 (20%)	0.46
Reason of ICU admission				
Altered sensorium	99 (66.4%)	77 (51.3%)	23 (15.3%)	1.00
Bleed	26 (17.5%)	19 (12.6%)	7 (4.6%)	0.609
Respiratory distress	34 (22.8%)	28 (18.6%)	6 (4%)	0.493
Metabolic or lactic acidosis	10 (6.6%)	16 (10.6%)	2 (1.3%)	0.366
Etiology				
Alcohol	84 (56%)	63 (42%)	21 (14%)	0.043*
NASH	23 (15.4%)	22 (14.6%)	1 (0.66%)	
Viral	21 (14%)	14 (9.3%)	7 (4.6%)	
Others	22 (14.6%)	17 (11.3%)	5 (3.33%)	
Disease severity scores				
CTP	11.9±1.8 (6–15)	12±1.7	11.8±1.9	0.64
MELD	28.7±8.6 (5–53)	28.8±8.4	25.6±8.9	0.06*
SOFA score	12.4±3.8 (4–22)	13.2±3.6	9.8±2.9	0.001*
APACHE II score	28±4.2 (8–40)	28.9±4.1	25.5±3.6	0.001*
Presence of co-morbidities	67 (44.6%)	57 (38%)	10 (6.6%)	0.48
Diabetes	37 (24.6%)	34 (22.6%)	4 (2.6%)	0.04*
Hypertension	20 (13.3%)	18 (12%)	2 (1.3%)	0.24
Koch's	10 (6.6%)	8 (5.3%)	2 (1.3%)	1.00
Hypothyroid	12 (8%)	11 (7.3%)	1 (0.6%)	0.29
CKD	11 (7.3%)	10 (6.6%)	1 (0.6%)	0.45
Others	23 (15.3%)	19 (12.6%)	4 (2.6%)	0.59
Prevalence of sepsis	86 (57.3%)	68 (45.3%)	18 (12%)	0.561
Foci of sepsis				
Lungs	39 (26%)	28 (18.6%)	11 (7.3%)	0.488
SBP	32 (21.3%)	28 (18.6%)	4 (2.6%)	0.158
Culture positive	4 (2.6%)	3 (2%)	1 (0.66%)	0.531
Others	34 (22.6%)	29 (19.3%)	5 (3.3%)	1.00
Hemodynamic status				
Shock	51 (34%)	47 (31.3%)	4 (2.6%)	0.002*
ABG parameters				
FiO_2	49.34±25.5 (21–100)	51.2±25.99	42.8±22.9	0.075
PaO_2	123.57±46.3 (35–200)	125.18±47	118.09±44	0.435
pH	7.3±0.09 (7.3–7.5)	7.1±0.1	7.2±0.1	0.77
Ventilatory parameters				
Mechanical ventilation	97 (64.6%)	78 (52%)	19 (12.6%)	0.620
Non-ventilated	50 (33.3%)	37 (24.7%)	13 (8.6%)	0.629
Non-invasive ventilation (NIV)	3 (2%)	2 (1.3%)	1 (0.7%)	0.330
Heart rate	106.35±19.3 (54–168)	105.25±19.2	110.12±19.2	0.197
Respiratory rate	24.93±12.6 (11-98)	25.2±13	23.8±11.5	0.586
Renal parameters				
AKI	73 (48.6%)	62 (41.3%)	11 (7.3%)	0.034*
RRT	22 (14.6%)	21 (14%)	1 (0.66%)	0.028*

(Contd..)

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Table 2. Continued.

Variable	Patients (n=150)	HNS (n=116)	LNS (n=34)	P-value
Biochemical parameters				
Hemoglobin (g/dl)	8±2.3 (4.2–17)	8.6±2.15	8.6±2.8	0.95
Leucocyte count (cumm)	13 (1–83)	13 (1–83)	12 (2–34)	0.13
International normalized ratio	2.1±1.6 (0.86–12.5)	2.59±1.7	2.33±1.1	0.42
Blood urea (mg)	84 (7-337)	94.5 (7–337)	48 (8–219)	0.01*
Serum creatinine (mg)	1.9±1.5 (0.01–8)	2.2±1.6	0.8±0.9	0.01*
Sodium (mmol/L)	135.4±8.9 (110–156)	135.1±9.3	136.1±7.4	0.57
Potassium (mmol/L)	4.3±1 (1.9.1–7.2)	4.4±1.0	4.2±0.96	0.44
Calcium (mmol/L	8.4±1.1 (3.9–13.7)	7.02±3.18	7.7±2.2	0.20
Magnesium (mmol/L	1.85±0.9 (0.9–6.8)	2.18±0.59	2.0±0.43	0.10
Total protein (g/dl)	6.2±0.9 (3.3–9.2)	6.17±0.91	5.94±1.0	0.21
Serum albumin (g/dl)	2.4±0.5 (1.2–4.1)	2.36±0.63	2.52±0.75	0.24
Total bilirubin (mg/dl)	8 (0.12–46)	8 (0.9–46)	7 (0.6-42)	0.71
Arterial ammonia (mmol/L)	211 (50–870)	209 (50–870)	227 (93–692)	0.67
Arterial lactate (mmol/L)	3 (0.1–21)	3 (1–21)	3 (1–14)	0.90
Random blood sugar (mg/dl)	154.6±47.4	158.18±50.7	142.2±30.3	0.027*

Data is expressed as mean±SD or median (min-max) or number (%), *significant at $P<0.05$; CTP: Child-Turcotte-Pugh; MELD: Model for End-Stage Liver Disease; SOFA: Sequential Organ Failure Assessment; APACHE II: Acute Physiology, Age, Chronic Health Evaluation II; FiO_2: fraction of inspired oxygen; PaO_2: partial pressure of oxygen; CLD: chronic liver disease; ACLF: acute on chronic liver failure; NASH: non-alcoholic steatohepatitis; CKD: chronic kidney disease; SBP: spontaneous bacterial peritonitis, RRT: renal replacement therapy.

3.4. Association between nutritional risk at ICU admission and 28-day mortality

Ninety-six out of 115 patients (64%) died during ICU stay. Patients in the HNS group had a significantly higher mortality (81 [70%]) compared to the LNS group (15 [30%]) (p = 0.008). Patients with an HNS had 3.14 times increased risk of mortality (OR [95% CI]: 3.14; 1.42-6.96; P = 0.005]). Factors such as etiology of the disease, random blood sugar, MELD score, and CTP score were significantly different between patients with HNS and LNS, hence, adjusted in multivariate analysis to see the effect of mNUTRIC score on mortality. However, even after adjusting for these confounding factors, patients with an HNS had 2.6 times increased risk of mortality (OR [95% CI]; 2.66 [1.15–6.167]; P = 0.022) compared to those with LNS (Table 5).

3.5. Effect of nutritional adequacy on the relationship between baseline nutritional risk and 28-day survival probability

The association between risk score and mortality was attenuated in patients who met their higher calorie and protein targets, that is, increased nutritional adequacy was associated with improved survival in patients with HNS only (P < 0.01), but not in those with LNS (Figures 1 and 2).

3.6. Effect of nutritional adequacy on other clinical outcome parameters

HNS was strongly associated with greater number of total MV days and NOI. Patients with an HNS at baseline had longer duration of MV (P = 0.02) and higher incidence of NOI in the ICU (P = 0.002) (Table 5). The chance of NOI was 7 times higher in patients with an HNS (OR [95% CI]: 7.00; 2.0–24.5). There was no significant difference in the length of ICU stay between patients with an HNS and an LNS (Table 6).

4. Discussion

Nutritional risk assessment is very important for the medical management of patients with cirrhosis, but during critical illness, the nutritional risk becomes difficult to evaluate. At our quaternary care institute, we used a well described tool – the mNUTRIC score [8,13-15] – for the nutritional risk assessment of critically ill patients with cirrhosis. We found that the majority of these patients (77%) were at high nutritional risk and had 2.6 times increased risk of 28-day mortality compared to those at a low nutritional risk. The nutritionally compromised critically ill patients with cirrhosis also had a longer duration of MV and almost 7 times higher risk of acquiring infections in the ICU. A higher nutritional adequacy was found to be strongly associated with an increased probability of survival in patients at a higher nutritional risk as assessed by the mNUTRIC score.

A number of methods have been described for nutritional risk assessment in the hospital setting [5], which becomes challenging in the ICU and goes beyond the classical definition of protein and energy malnutrition. Traditional parameters such as history of food intake, physical examination, anthropometric data, and functional assessment are difficult to obtain. In addition, rapid fluid shifts, hemodynamic instability, and numerous intubations make the entire appraisal process cumbersome [16,17]. Heyland *et al.* [6,8] have developed the mNUTRIC score – a conceptual model of various measures of acute and chronic starvation along with inflammation – for ascertaining "nutritional risk" in the critical care setting. Although devoid of the traditional nutritional variables, the mNUTRIC score has been found useful in identifying the nutritional risk for the critically ill [13-15]. The advancements in interventional and therapeutic strategies have led to a significant reduction in the ICU and in-hospital mortality in patients with cirrhosis [18], hence, nutritional interventions become essential for these patients. The catabolic response to

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Table 3. Nutritional status of critically ill patients with cirrhosis at ICU admission.

Variable	Patients (n=150)	HNS (n=116)	LNS (n=34)	P-value
mNUTRIC score	5.4±1.2 (3-9)	5.9±0.99	3.8±0.32	<0.001*
Height (cm)	165.3±6.5	165.4±6.1	166.59±6.5	0.90
Weight (kg)	72±13.6	72.3±14.4	70±10.2	0.30
BMI (kg/m^2)	24.2±4.6	24.4±4.7	23.7±4.2	0.48
BMI category				
17–23.9 kg/m^2	20.9	20.9	21.2	
24–29.9 kg/m^2	26.1	26.4	25.3	
30–39.9 kg/m^2	33.9	33.3	36.8	
>40 kg/m^2	42.9	42.9	42.9	
Energy requirement (kcal)	2296±216	2289±200	2319±262	0.48
Protein requirement (g)	91.8±15.6	92.3±14.3	90.5±19.3	0.55

Data is expressed as mean±SD or median (min-max) or number (%), *significant at $P<0.05$; BMI, body mass index.

Table 4. Nutritional adequacy of the critically ill patients with CLD during the ICU stay.

Variable	Patients (n=150)	HNS (n=116)	LNS (n=34)	P-value
Calorie adequacy (%)	75.7±28.7	75±30.1	78±23.6	0.51
Protein adequacy (%)	68±30.3	67±32	71±24	0.39

Data is expressed as mean±SD, *significant at $P<0.05$

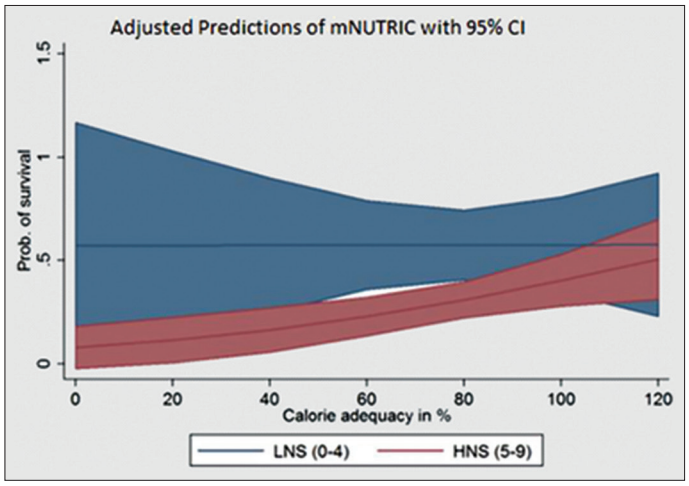

Figure 1. Predicted probability of 28-day survival versus percent of caloric adequacy.

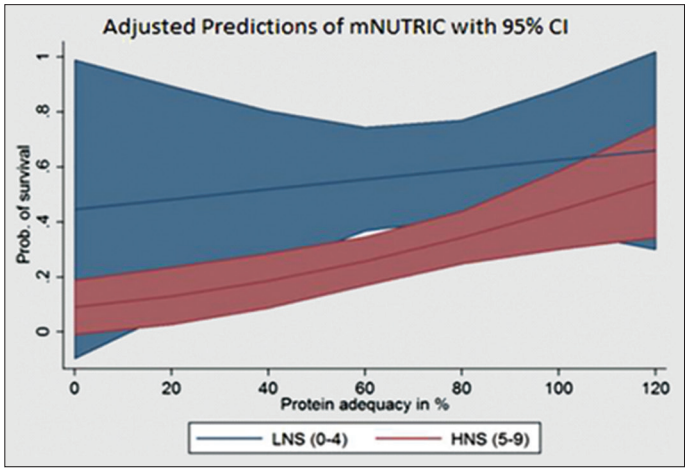

Figure 2. Predicted probability of 28-day survival versus percent of protein adequacy.

stress results in 5–25% loss of muscle mass in patients and may culminate in single and multiple organ failure [19,20]. Adequate nutritional therapy not only attenuates the metabolic response to stress but also slows down the oxidative cellular injury and favorably modulates the immune response [14].

Nutritional support is now referred to as "nutritional therapy," as it is the third most important intervention for critically ill patients after hemodynamic stability and airway securement [21,22]. Enteral nutrition plays an important role in critically ill patients with cirrhosis, who already suffer from chronic malnutrition. Limited resources such as expensive ICU beds, mechanical ventilation, and antibiotics [23] have relegated nutritional interventions to the background. Nutritional screening is, therefore, very important to judiciously redirect the hemorrhaging finances in the ICU toward high-risk patients. The mNUTRIC score enables rapid identification and documentation of malnutrition accurately, thereby ameliorating the reimbursement costs of hospital services [4].

In our study, 77% of the critically ill patients with cirrhosis in the liver ICU were at high nutritional risk, that is, having a high mNUTRIC score, whereas only 23% were at low risk (low mNUTRIC score). The patients with HNS had increased 28-day mortality (70%) compared to those with LNS (44%). After adjusting for confounding factors, patients with an HNS had 2.6 times increased risk of mortality. This finding is similar to the previous studies from a mixed ICU population having a very small percentage of patients with gastrointestinal and/or liver diseases [24,25]. A recently published Taiwanese study [26] featuring patients with cirrhosis with acute variceal bleeding reported higher mortality in patients with high nutritional risk, as assessed by the mNUTRIC score. However, the percentage of patients at this risk (38%) was much lower compared to our high-risk cohort (77%). This may be attributed to the fact that Tsai *et al.* enrolled only patients with acute variceal bleeding, who not only had a lower mean mNUTRIC score of 3.85 ± 2.22 but also lower CTP (9.65 ± 2.34) compared to 5.4 ± 1.2 and 11.9 ± 1.8, respectively, in our patient population. Our average mNUTRIC score is even higher than the original validation study [6], which reflects the severe critical illness in our patients. We also found that critically ill patients with an HNS at ICU admission not only had prolonged MV but also had a 7-fold increased incidence of NOI in the ICU. Other studies have also reported a longer duration of MV days apart from longer duration of hospital stay [6,13,14,27]. Since most of the studies are cross-sectional or retrospective in nature, none have reported a higher incidence of NOI.

The guidelines emphasize the importance of feeding early, maintaining a positive cumulative energy balance, disregarding small gastric residual volumes, early use of motility agents, and

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Table 5. Effect of nutritional status at ICU admission on overall mortality in critically ill patients with cirrhosis.

mNUTRIC score	Mortality	Odds ratio (95% CI)			
n=150	96 (64%)	Unadjusted	P-value	Adjusted	P-value
HNS (n=116)	81 (70%)	3.14 (1.42, 6.96)	0.005*	2.66 (1.15, 6.16) **	0.022**
LNS (n=34)	15 (44%)	1.00		1.00	

Data is expressed as number (%). *Significant at $P<0.05$. **Adjusted for etiology, blood sugar, CTP score and MELD score (at baseline).

Table 6. Effect of nutritional status at ICU admission on other clinical outcome parameters

Variable	Total (n=150)	HNS (n=116)	LNS (n=34)	P-value
New onset of Infection	51 (34%)	48 (32%)	4 (2.6%)	0.002*
Length of ICU stay (days)	5 (2–28)	5 (2–24)	4 (2–16)	0.13
Duration of MV (days)	4 (0–28)	5 (2–24)	3 (0–24)	0.02*

Data is expressed as Median (min-max); *significant at $P<0.05$. NOI: new onset of infection; ICU: intensive care unit; MV, mechanical ventilator.

meeting the nutritional targets. In our study population, the average calorie and protein adequacy for all the patients in the ICU were 76% and 68%, respectively. The reasons for suboptimal adequacy were the necessity for procedures such as tracheotomy, intubation, upper gastrointestinal endoscopy, CT, non-invasive ventilation, and other procedures. The incidence of feed intolerance in this study was only 6.6%, suggesting a good tolerance of nutritional therapy.

The merit of our study is, furthermore, derived from examining the effect of goal-directed nutritional therapy on CIC. To the best of our knowledge, this is the first study to examine the association between mNUTRIC score and nutritional therapy in CIC. Logistic regression analysis revealed that nutritional adequacy modified the association between the mNUTRIC score and the 28-day mortality. Higher calorie and protein adequacy were associated with better survival probability in patients who were at high nutritional risk but not in those with a low mNUTRIC score. Similar associations between the mNUTRIC score and survival probability have been shown previously [15] but in a mixed population of critically ill patients; showing a 2.2-day longer survival per 1000 kcal per day increase in energy intake. The usual target in the critically ill is 25 kcal/kg body weight. However, it should be noted that in an exclusive liver ICU with the patient population comprising decompensated patients with cirrhosis and acute on chronic liver failure, these calorie targets are much higher [1,3,9].

To date, only three studies have delved into the association between targeted nutrition therapy and NUTRIC score in the critically ill [6,8,15,28]. Nevertheless, the corollary of these investigations does not justify the misleading interpretation of withholding nutrition support in patients with an LNS [29]. A reinvestigation of the association between nutritional prescriptions and ICU mortality among LNS patients has suggested that, even though patients with LNS demonstrated prolonged ICU stay, an improvement in the nutritional adequacy did not translate to survival benefit [30]. A possibility of getting discordant results regarding nutritional adequacy and survival are higher in a heterogeneous ICU population [8]. Hence, in a clean homogenous liver-specific ICU population such as ours, the utility of mNUTRIC score [6] is well justified and the role of enhanced nutritional adequacy in improving the clinical outcome has proven meaningful. The data suggest the use of the mNUTRIC score as a valid screening tool in patients with cirrhosis.

Our study did have a few limitations. First, we did not measure interleukin-6, an important pro-inflammatory cytokine, to assess the acute-phase response to inflammation in sepsis, particularly in the critically ill. Second, a larger cohort size would have rendered the diagnostic proficiency of mNUTRIC score in critically ill patients with cirrhosis more robust.

5. Conclusion

The mNUTRIC score is a useful tool which can be administered at the time of ICU admission to identify nutritional risk in critically ill patients with cirrhosis. Nutritional risk stratification by the mNUTRIC score is not only associated with mortality but also new-onset infections and longer duration of MV. Most importantly, nutritional adequacy does impact the relationship between mNUTRIC score and survival in the critically ill patients with cirrhosis; as high nutritional adequacy is associated with a greater probability of survival among patients at high nutritional risk.

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Conflicts of Interest

The authors declare no conflicts of interest.

Ethics Approval and Consent to Participate

The study was approved by Institutional Review Board and Ethics Committee (No. IEC/2017/51/NA02). Informed consent was obtained.

Consent for Publication

Consent for publication was obtained.

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