Identifying the critically ill cirrhotics who benefit the most from nutrition therapy: The mNUTRIC score study

Harshita Tripathi
Institute of Liver and Biliary Sciences
Jaya Benjamin (jayabenjaminilbs@gmail.com)
Institute of Liver and Biliary Sciences
Rakhi Maiwall
Institute of Liver and Biliary Sciences
Puneet Puri
Virginia Commonwealth University Medical Center
Puja Bhatia Kapoor
Institute of Liver and Biliary Sciences
Varsha Shasthry
Institute of Liver and Biliary Sciences
Vandana Saluja
Institute of Liver and Biliary Sciences
Prashant Agrawal
Institute of Liver and Biliary Sciences
Guresh Kumar
Institute of Liver and Biliary Sciences
Yogendra Kumar Joshi
Institute of Liver and Biliary Sciences
Shiv Kumar Sarin
Institute of Liver and Biliary Sciences

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Abstract

Background

Malnutrition increases risk of mortality in critically ill cirrhotics. Modified Nutrition Risk in Critically ill (mNUTRIC) score is a validated tool to identify patients at nutrition risk that may benefit the most from goal directed nutrition therapy. We aimed to study the association between mNUTRIC score and 28-day mortality and its modulation by nutritional adequacy in critically ill cirrhotics.

Methods

A prospective study in critically ill adult cirrhotics was designed with collection of baseline and follow-up data pertaining to mNUTRIC score, clinical, hemodynamic, biochemical, nutritional parameters, use of mechanical ventilation (MV), length of ICU stay, and development of new onset infection (NOI). Daily nutritional adequacy was calculated as percentage of prescribed energy and protein received.

Results

150 cirrhotics [(males-83%, age-51 ± 12.1 years, BMI-24 ± 4.7kg/m^2; median LOS 6 (2–24 days)] were enrolled. At ICU admission 116 (77%) had high NUTRIC Score (HNS) and 34 (23%) low NUTRIC score (LNS). Patients with HNS had significantly higher mortality [54% vs. 10%; p = 0.008; OR(95%CI) adjusted 3.0(1.39,6.9;p = 0.006)] for etiology and blood sugar ; longer MV days [5(2–24) vs. 3(1–24) ; p = 0.02]; and high incidence of NOI [32% vs. 2.6%; p = 0.002; OR(95% CI:7(2,24.5)] compared to LNS. A logistic regression analysis for interaction of nutritional adequacy and 28 day survival revealed that the probability of survival increases with increase in nutritional adequacy (p < 0.01) in patients with HNS.

Conclusion

mNUTRIC score is a useful tool in recognizing nutrition risk in critically ill cirrhotics and goal directed nutrition therapy; especially in patients with high mNUTRIC score can significantly improve survival.

Introduction

Malnutrition is a pressing condition in patients with cirrhosis with its prevalence ranging from 30% in the compensated to 50% in the decompensated patients[1]. Although the therapeutic breakthrough with standardized therapies and interventions have improved the overall survival of these patients, yet this population very often faces life-threatening complications requiring intensive care unit (ICU) admissions[2]. Nutritional therapy is the cornerstone of medical management in these patients[3] and the liver ICU is no exception. However before commencing nutrition therapy there is need for a quick nutritional assessment using a tool that is easy to use, rapid, standardized and independent of patient feedback.[4] A daily, systematic and timely assessment which when incorporated into the clinical protocol for an effective action plan not only optimizes the nutrition therapy but may also help in monitoring the nutritional benefits of clinical trials among the critically ill. The discrimination of nutritional risk in the critically ill cirrhotics, in particular, is essential to be able 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 the ICU particularly in patients with cirrhosis where most traditional tools lose their specificity.[5] Heyland et al have proposed the mNUTRIC (modified Nutritional Risk in the Critically ill) score exclusively for the critically ill patients; mNUTRIC is a framework of the current metabolic status, comorbidities, starvation, inflammation and outcome[6]. Hence for the first time, we planned to examine the association of nutritional status at ICU admission with the clinical outcome and also to study the effect of nutritional adequacy on the relationship between baseline nutritional status and 28 day survival in critically ill patients with cirrhosis.

Methods And Materials

Patient and Setting

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

Study Plan: Baseline and daily follow-up information including the demographic, clinical, hemodynamic, biochemical, and nutritional details were collected prospectively on a structured proforma, till the patient’s stay in the ICU. All patients were managed as per the standard nutrition protocol of the institute irrespective of the nutritional status. The data was entered in excel sheet and statistically analyzed.

Diagnosis of disease: Cirrhosis was diagnosed on the basis of standard, clinical, biochemical, histological and/or radiological criteria.[7]

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 Score (SOFA) and Acute Physiology and Chronic Health Evaluation (APACHE) scores were used to assess the severity of critical illness.

Nutritional Assessment:

Nutritional status was assessed at ICU admission using mNUTRIC score with the point system as developed previously,[8] with variables like age, number of days from hospital to ICU admission, number of co-morbidities, APACHE II score and SOFA score as shown in Table 1. Patients with mNUTRIC score ranging from 0 to 4 were classified as low mNUTRIC score (LNS) implying to be at low nutritional risk and those with a score between 5 to 9 as high mNUTRIC score (HNS), suggesting a higher nutritional risk.

Nutritional Management:

Enteral nutrition (EN) using a fine bore nasogastric (NG) tube was initiated within 24 hours of ICU admission in all mechanically ventilated (MV) patients unless patient was a bleeder, hemodynamically unstable, or had paralytic ileus. Naso- jejunal feeding was initiated only in case of feed intolerance with a failed trial of prokinectics. Non-intubated patients were given oral diet. Total Parenteral Nutrition was used only for patients with a non-functional gut. Nutritional requirements were calculated as per the standard guidelines of 35-40 kcal and 1.2-1.5 gm protein per kg ideal body weight[9]. Protein intake was increased up to 1.8-2 gm in case of obese patients and those requiring renal replacement therapy (RRT).

Nutritional Adequacy:

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

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 were used as appropriate. 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.

Objective:

The primary objective was to study the association of nutritional status 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 status and 28 day survival probability, (b) to study the effect of baseline nutritional status on outcome parameters like duration of mechanical ventilation (MV), new onset of infections (NOI), and length of ICU stay (LOS).

Data Collection:

Apart from routine baseline demographics, information was collected on the, duration in hospital prior to ICU admission; presence of co-morbidities; decompensation status like ascites, jaundice, upper gastrointestinal bleed; presence of sepsis; reason of ICU admission including altered sensorium, upper GI bleed, respiratory distress or metabolic acidosis; disease severity scores like SOFA, APACHE II, CTP and MELD. Follow up data collected daily until the death or discharge of the patients included the hemodynamic parameters like heart rate, mean arterial pressure, requirement of vasopressors;

biochemical parameters like complete blood count, liver function test, kidney function test, coagulation factors, random blood sugars; blood gas parameters like pH, PaO_2, FiO_2; requirement of RRT, days of MV, development of new onset infection (NOI), duration of ICU stay and the nutritional adequacy.

Definition of terms:

Sepsis: Presence of any one of the following:-pneumonia, spontaneous bacterial empyema (SBE), spontaneous bacterial peritonitis (SPB), positive minibal or blood culture and others (cellulitis, urinary tract infection, cholangitis).[10]

New onset of infection: Absence of infection at ICU admission but development of new onset pneumonia/ positive blood or minibal culture reports/ line sepsis/septic shock during the entire ICU stay.[11]

Acute kidney injury: Presence of any one -increase in serum creatinine by 0.3 mg/dl within 48 hours or increase in serum creatinine to 1.5 times from baseline or urine volume <0.5 ml/kg/h for 6 hours.[12]

Renal Replacement Therapy: If patient on sustained low-efficiency dialysis (SLED) or continuous renal replacement therapy (CRRT).[12]

Mechanical ventilator days: Total number of days on mechanical ventilation.

Length of ICU stay: Total duration of stay in ICU until death or discharge.

Statistical Analysis

The collected data was 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 ranksum 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.

Results

Baseline Patient Characteristics:

Of the total 150 patients enrolled, majority (85%) were males with an average age of 49±12.5 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 high and low mNUTRIC score. Most common reason for ICU admission was altered sensorium. Majority had alcohol related liver disease and diabetes mellitus as co-morbidity. A total of 86 (57.3%) patients had sepsis, 34% had shock, 49% had AKI, 64.6%

were mechanically ventilated and 33.4% were non-ventilated and 2% on noninvasive ventilation (NIV) at ICU admission.

Nutritional Status at ICU admission:

The mean BMI of the patients was 24.2±4.6 kg/m^2 ranging from 16.4-42.9 kg/m^2. Of 150 patients, 116 (77%) had a high mNUTRIC score (HNS) and 34 (22.6%) had a low mNUTRIC score (LNS). The average mNUTRIC score of the patients was 5.4±1.2 ranging from 3-9. The estimated requirement of calories and protein ranged from 1620-2840 kcal and 47-120g respectively, which was comparable between patients with HNS and LNS group (Table 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 like feed intolerance (6.6%), upper gastrointestinal bleed (6%), hemodynamic instability (1.3%) and procedures like 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.

Association between nutritional status at ICU admission and 28 day mortality:

Overall mortality was 96 (64%). Mortality in patients with HNS 81 (70%) was significantly higher as compared to those with LNS 15 (44%) (p=0.008). Patients with a high mNUTRIC score had 3.14 times increased risk of mortality [OR (95%CI):3.14; 1.42-6.96; p=0.005)]. Factors like etiology of the disease, and random blood sugar 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 HNS had 3.1 times increased risk of mortality [OR (95% CI); 3.1 (1.39-6.94); p=0.006] as compared to those with LNS. (Table 5)

Effect of nutritional adequacy on the relationship between baseline nutritional status and 28-day survival probability:

The association between calorie and protein adequacy and the probability of 28-day survival is summarized in Fig.1 and Fig. 2 respectively. It is evident that the association between risk score and mortality is attenuated in patients who meet their higher calorie and protein targets i.e., increased nutritional adequacy is associated with improved survival in patients with HNS only (p<0.01), but not in those with LNS.

Effect of nutritional adequacy on other clinical outcome parameters:

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

Discussion

Nutritional assessment is very important for the medical management of patients with cirrhosis, but during critical illness, its significance not only increases but also becomes difficult to gauge. At our quaternary care institute, we used a well described tool- the mNUTRIC score[8, 13–15] for the nutritional assessment of critically ill patients with cirrhosis. We found that majority of these patients (77%) were at high nutritional risk and had almost 3.5 times increased risk of 28-day mortality compared to those at a low nutritional risk. Moreover, nutritionally compromised critically ill cirrhotics also had a longer duration of mechanical ventilation and almost seven times higher risk of acquiring new onset infections in the ICU. However, a higher nutritional adequacy was found to be strongly associated with an increased probability of survival but only in patients at a higher nutritional risk as assessed by the mNUTRIC score.

A number of methods have been described for nutritional assessment in the hospital setting[5]; nevertheless, in the ICU, it becomes challenging, and goes beyond the classical definition of protein energy malnutrition. Most traditional assessment tools include parameters like history of food intake, physical examination, anthropometric data, functional assessment; which are difficult to attain, moreover the rapid fluid shifts, hemodynamic instability and numerous tubings make the whole process very cumbersome and nonspecific in the ICU [16, 17]. Heyland et al[6,8] have developed a tool, the mNUTRIC score - a conceptual model of various measures of acute and chronic starvation along with inflammation for acertaining 'nutritional risk' in the critical care setting. Though devoid of the traditional nutritional variables, yet mNUTIC 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 rates among cirrhotics, [18] hence nutritional interventions become essential among the critically ill cirrhotics. The catabolic response to stress may lead to rapid loss of muscle mass, ranging between 5–25% in patients with single and multiple organ failures respectively.[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]

Nutrition support is now referred as 'nutrition therapy,' as it is the third most important aspect in the management of a critically ill patient right after hemodynamic stability and airway securement.[21 22]. Early enteral nutrition becomes all the more important among the critically ill patients with cirrhosis, who already suffer from chronic malnutrition. However, looking at the limited resources like expensive ICU beds, costly mechanical ventilation, new onset of infections and need for expensive antibiotics [23], most of the time appropriate nutritional interventions are relegated to the background. Thus nutritional screening is very important to judiciously redirect the hemorrhaging finances in the ICU towards high risk patients. mNUTRIC score is one such screening tool that would help develop an institutional culture for such nutritional assessment inside the ICU, which would enable rapid identification, documentation or coding of malnutrition correctly, that could even change the reimbursement cost of hospital services.[4]

In our study 77% of the critically ill cirrhotics in the Liver ICU were at high nutritional risk i.e., having a high mNUTRIC score, whereas only 23% were at low risk with low mNUTRIC. The patients with HNS had increased 28-day mortality (70%) compared to those with LNS (44%). In spite of adjusting for confounding factors patients with a HNS had 3.1 times increased risk of mortality. This finding is similar to many previous studies from a mixed ICU population having a very small percentage of patients with gastrointestinal and/or liver diseases.[24, 25] Recently published Taiwanese study,[26] exclusively done in cirrhotics with acute variceal bleed, have also reported higher mortality in patients with a high nutritional risk as assessed by mNUTRIC score, however the percentage of patients at this risk (38%) were much lower as compared to ours (77%). Plausibly because Tsai et al enrolled only patients with acute variceal bleed, who not only had a lower mean mNUTRIC score of 3.85 ± 2.22, but also lower CTP of 9.65 ± 2.34, compared to 5.4 ± 1.2 and 11.9 ± 1.8 respectively, in our population. Our average mNUTRIC score is even higher than the original validation study[6]; suggestive of a very sick group of patient population treated in our ICU. We also found that critically ill patients with a high mNUTRIC score at ICU admission not only had prolonged mechanical ventilation but also had a 7 fold increased incidence of NOI in the ICU. Likewise couple of other studies has also reported a longer duration of ventilator days apart from longer duration of hospital stay [6, 13, 14,27]. Since most of the studies are crossectional or retrospective in nature, none have reported a higher incidence of NOI.

The guidelines emphasize on the importance of feeding early, maintaining a positive cumulative energy balance, disregarding small gastric residual volumes, early use of motility agents and meeting the nutritional targets. To the best of our institutional nutritional policies the average calorie and protein adequacy for all the patients in the ICU was 76% and 68% respectively. The reasons for suboptimal adequacy were NPO orders for procedures like tracheotomies, intubations, upper GI endoscopies, CT scans, non-invasive ventilation and other procedures. The incidence of feed intolerance in this study was only 6.6%, thus suggesting a good tolerance of nutritional therapy in our ICU.

The forte of our study is the pursuit to examine the potentiality of goal directed nutrition therapy on the outcome of CIC. To the best of our knowledge for the first time the association between mNUTRIC score and nutritional therapy has been studied in an exclusive population of critically ill patients with cirrhosis. A logistic regression analysis revealed that nutritional adequacy did modify the association between the mNUTRIC score and the 28 day mortality i.e., higher calorie, and protein adequacy, is associated with better survival probability in patients who were at high nutritional risk as assessed by the mNUTRIC score but not in those with a low mNUTRIC score. Similar associations between NUTRIC and survival probability have also been shown previously[15] but in a mixed population of critically ill patients; with an additional suggestion of 2.2 days of longer survival, with every 1000 kcal per day increase in energy intake. The usual targets in general critically ill is 25 kcal/kg body weight, however, It is worth mentioning that in an exclusive liver ICU with the patient population comprising of decompensated cirrhotics and acute on chronic liver failure (ACLF), these calorie targets are much higher.

To date only three studies have delved into the association between targeted nutrition therapy and NUTRIC score in the critically ill patients[6, 8, 15,28]. Nevertheless the corollary of these investigations does not justify the misleading interpretation of withholding nutrition support in patients with a low NUTRIC score (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, yet an improvement in the nutritional adequacy did not translate into 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 like ours the utility of mNUTRIC score[6] is well justified and the role of improved nutritional adequacy in improving the clinical outcome has proved very meaningful, further suggesting the use of mNUTRIC score as a valid screening tool in patients with cirrhosis. Hence, in conclusion, mNUTRIC score is a useful tool which can be administered at the time of ICU admission to identify nutritional risk in critically ill cirrhotics. Nutritional risk stratification by mNUTRIC score is not only associated with mortality but also new onset infections and longer duration of mechanical ventilation. Most importantly, nutritional adequacy does impact the relationship between mNUTRIC score and survival in the critically ill cirrhotic; as high nutritional adequacy is associated with the greater probability of survival among patients at a high nutritional risk.

Declarations

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Conflict of interest statement: The authors have nothing to declare

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Code availability: Not Applicable

Authors' contribution:

Concept and design: Jaya Benjamin, Puneet Puri

Practical performance: Harshita Tripathi, Puja Bhatia Kapoor

Statistical analysis: Guresh Kumar

Data analysis and interpretation: Guresh Kumar, Harshita Tripathi, Jaya Benjamin, Rakhi Maiwall, Puneet Puri

Literature search:, Jaya Benjamin, Harshita Tripathi, Puneet Puri, Puja Bhatia Kapoor, Varsha Shasthry

Preparation of Manuscript: Harshita Tripathi, Jaya Benjamin

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Tables

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

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%)	
NASH	23 (15.4%)	22 (14.6%)	1 (0.66%)	**0.043***
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***
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.

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/m2)	24.2±4.6	24.4±4.7	23.7±4.2	0.48
BMI category				
17-23.9 kg/m2	20.9	20.9	21.2	
24-29.9 kg/m2	26.1	26.4	25.3	
30-39.9 kg/m2	33.9	33.3	36.8	
>40 kg/m2	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

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 ***	3.0 (1.39, 6.94) **	**0.006 ****
LNS (n=34)	15 (44%)	1.00		1.00	

Data is expressed as number %. *Significant at p<0.05**Adjusted for etiology and blood sugar (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

Figures

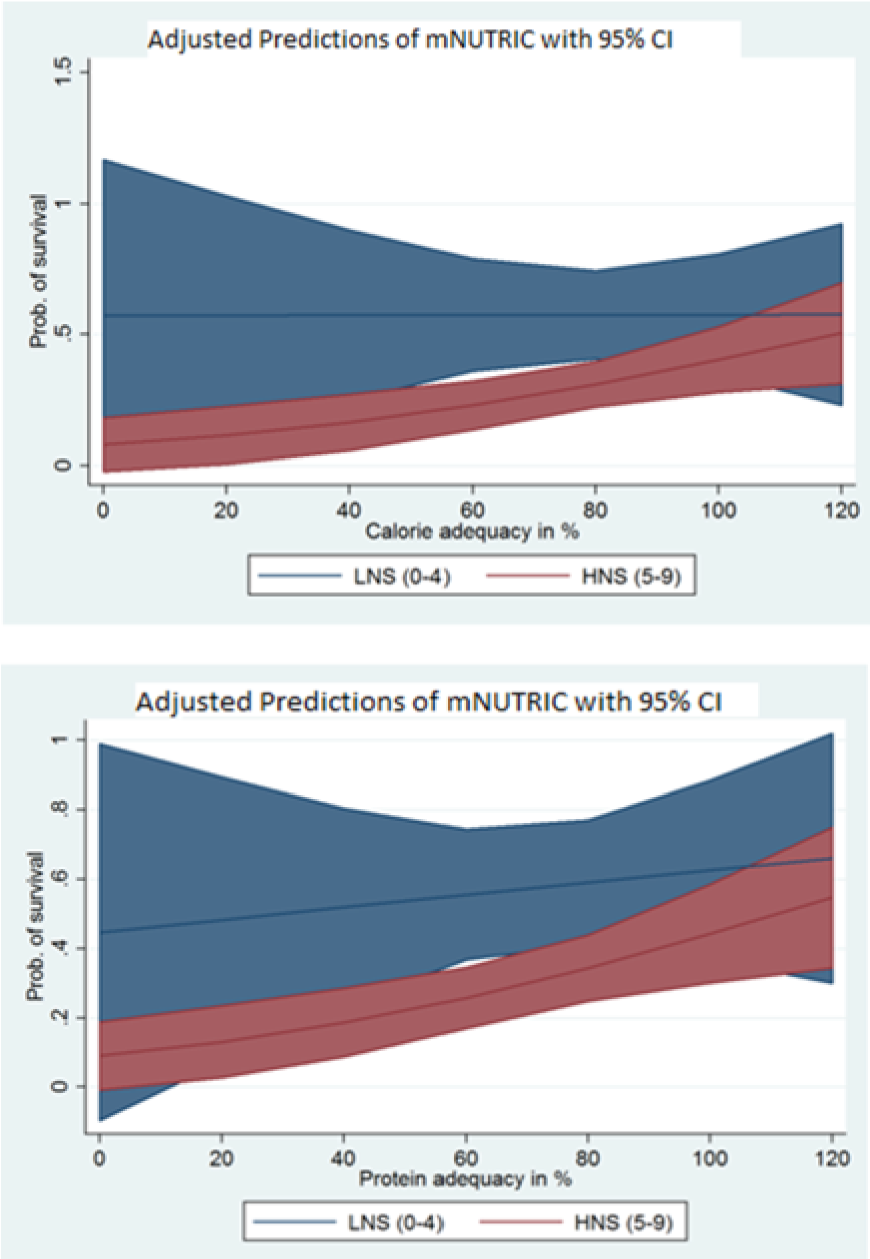

Figure 1

Predicted probability of 28-day survival versus percent of caloric and protein adequacy. X- Axis denotes the probability of survival and Y- axis depicts prescription of calorie or protein (%) received for patients with Low NUTRIC Score (LNS, n=34) and High NUTRIC Score (HNS, n=116). Lines and shading are the predicted probability and 95% confidence intervals based on logistic regression. The red band depicts the patients with HNS who have significantly improved survival with increasing nutritional (caloric and protein) adequacy and the blue band depicts the patients with LNS who are not affected by nutritional adequacy.

Supplementary Files

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- Graphicalabstract.png