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Evaluation of Modified Nutrition Risk in Critically-ill Scoring System as an Assessment and Predictive Tool in Critically-ill Surgical Patients

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Abstract

Background: Several nutritional screening tools have been developed for nutritional risk assessment but no specific tool was identified for critically ill patients. Although the mNUTRIC score was developed for nutritional risk assessment in critically ill patients, data on nutritional risk assessment in critically ill surgical patients using mNUTRIC score are limited.

Aim of the study: This study aims to evaluate the prognostic capacity of the m-NUTRIC score and evaluation of its ability to recognize patients with high nutritional risk who are expected to benefit from aggressive energy and protein provision.

Patients and Methods: Our prospective non-randomized study that included 100 patients admitted postoperatively to our ICU. Data were collected on m-NUTRIC score within 48-72 hours after ICU admission and then patients were classified according to m-NUTRIC score into high risk group with mNUTRIC score >4 (n=12, 12%) and low risk group with m-NUTRIC score ≤4 (n=88, 88%). Both groups were followed up for at least 30 days period to identify their outcomes in the form of 30-day mortality, mechanical ventilation duration, duration of using vasopressor and ICU length of stay to study the association between high m-NUTRIC score and poor outcomes to evaluate its predictive capacity and prognostic performance.

Results: mNUTRIC cut-off score of > 4 was reported in most of the previous studies, however from our analysis the cut-off value of > 3 showed higher significant specificity and sensitivity. mNUTRIC score over 3 was associated with higher 30-day mortality rate (AUC=0.835, Sensitivity=79%, Specificity=72%, P=0.001), longer MV (AUC=0.679, Sensitivity=61%, Specificity=65%, P=0.018) and vasopressor duration (AUC=0.717, Sensitivity=71%, Specificity=67%, P=0.001)..

Conclusion: m-NUTRIC score can be used as an initial screening tool for nutritional assessment in patients admitted to surgical ICU and can be used as an assessment tool to identify critically ill surgical patients most likely to benefit from additional energy and protein provision.

Keywords: Mechanical Ventilation; Scoring Systems; Nutrition Assessment; Prediction.

INTRODUCTION

Adequate Nutrition is an important element in the treatment of critically ill surgical patients. Malnutrition affects up to 39-50% of ICU patients; this prevalence depends on the tool used for nutritional assessment and the type of the studied population [(1)]**.** Malnutrition in ICU patients worsen their outcomes in the form of a higher incidence of sepsis, longer period of hospital stay and increased ICU mortality rate. Critically ill surgical patients are subjected to stress, this stress causes some metabolic changes including stress hyperglycaemia and muscle mass loss, so they need to be provided with adequate nutrition to abolish these metabolic changes and to avoid oxidative cellular damage [(2)]**.**

Nutritional assessment in surgical ICU patients is a complicated task; as most of the previous nutritional assessment tools use several parameters to assess patients' nutritional status such as anthropometric parameters, physical signs, history of dietary supplement and loss of weight, and clinical diagnosis, some of these data such as history of dietary supplement and loss of weight are difficult to assess, as many of the ICU patients are mechanically ventilated and sedated [(3)]. In addition, body weight in critically ill patients may be affected by the edema due to their underlying disease and massive volume resuscitation administered to maintain stable hemodynamics, so evaluation of muscle mass loss and fat-wasting becomes more difficult [(4)].

Most of the previous nutritional assessment tools were not appropriate for ICU patients because nutritional state of ICU patients is influenced by both inflammatory and hyper metabolic state, and most of the previous nutritional assessment tools didn't consider these important factors which aggressively affect nutritional state of ICU patients, and this is strongly considered in mNUTRIC score. Hence, the mNUTRIC score is the most preferred nutritional screening tool in critically ill patients [(5-8)].

Parameters of the NUTRIC score include age of the patient, the APACHE II scoring system, SOFA scoring system, comorbidities, days between hospitalization and ICU transfer, and the level of interleukin-6, which was designed by **Heyland *et al.*** in order to link starvation, inflammatory state in ICU patients and clinical outcomes [(9)]. The mNUTRIC score is similar to NUTRIC score with the only difference is the exclusion of the use of Interleukin-6. According to mNUTRIC score patients get scores from 0 to 9, a score of 5 or more denotes a high risk of malnutrition. The mNUTRIC score can be used as an independent predictor of ICU mortality in medical, surgical ICU patients and in postoperative patients [(7)].

Data on nutritional assessment in surgical ICU patients using mNUTRIC score is limited**. So,** we carried out this work to assess the ability of mNUTRIC score to identify mal-nourished patients who are expected to benefit from additional nutritional provision as there is no institutionalized tool for assessing nutritional state in surgical ICU patients and it is paramount to introduce such effective screening tool as it will facilitate identifying malnourished patients early and hence early management of malnutrition and then improvement of outcomes of surgical ICU patients

PATIENTS AND METHODS

This prospective observational non-randomized study involved 100 patients admitted postoperatively to our surgical intensive care unit at Al-Azhar university hospital, Damietta, Egypt from February 2024 till August 2024. Our study was guided by the declaration principals of Helsinki. Ethical approval was obtained from our institution. Written informed consent was obtained from the first degree relative of the studied populations. Patients were non-randomly allocated into 2 groups based on their m-NUTRIC score level within 48-72 hours after admission into the ICU. The 2 groups were group 1 (12 patients) which included high m-NUTRIC score >4. 2, and group 2 (88 patients) which included patients with m-NUTRIC score of ≤ 4. We included our studied patients according to the following criteria:

The Inclusion criteria were: 1) Age > 21 years old. 2) Postoperative ICU patients. 3) Stay in the ICU for at least 24 hours.

The Exclusion criteria were: 1) Patients diagnosed with brain death. 2) COVID-19 patients. 3) Transfer to another hospital or ICU. 4) Readmission to the ICU or stay in the ICU for less than 24-hours. 5) Incomplete data on m-NUTRIC score. 6) End stage renal disease.

Sample size calculation: We used Epi Info STATCALC to calculate the sample size by considering the following assumptions: - 95% two-sided confidence level, with a power of 80%. Error of 5% odds ratio calculated = 1.115. The final maximum sample size taken from the Epi- Info output was 100 patients. Patients were followed up for at least 30-day period to evaluate the study hypothesis including the ICU related outcomes (30-day mortality, duration of mechanical ventilation, duration of using vasopressor and ICU average length of stay).

Data collection: We collected our data after 48 hours of admission to ICU to avoid bias resulting from data collection during the acute phase of illness. All of the included patients were subjected to the following; medical history, general examination including vital data assessment; pulse, respiratory rate, GCS, MAP and temperature. Baseline data including number and nature of comorbidities, cause of admission to ICU and type of operation. Data collected also included the incidence of Shock, use of vasopressors or inotropic and its duration, incidence of infection, incidence of acute kidney injury, mechanical ventilation duration, ICU average length of stay, ICU 30-day mortality, and route of administration of nutrition. Laboratory investigations were done for every

patients including CBC, ABG, kidney function tests, liver function tests, C-reactive protein and serum levels of electrolytes. We calculated the APACHE-II, SOFA and mNUTRIC scores within 48-72 hours after ICU admission by electronic medical calculator (MD CALC calculator).

Nutrition was provided as follows

Enteral nutrition: For patients who are candidate for enteral nutrition, standard polymeric formula was used which contained (1 kcal/ml). Patients were started on intentional hypocaloric nutrition of 12-15 kcal/kg/day during the early acute phase of their critical illness (first 24-48 hours) then gradually increased by 3-5 kcal/kg/day to reach full normo-caloric nutrition of 25-30 kcal/kg/day on the 5th to 7th day

Parenteral nutrition: Parenteral nutrition was used when there were impaired gastrointestinal function or contraindications to enteral nutrition. We used a mixture of separate components which contained dextrose, lipid emulsions, amino acids, vitamins, electrolytes, minerals, and trace elements. All postoperative patients admitted to our ICU were started on oral feeding or enteral nutrition immediately after admission unless there were contraindication. If enteral nutrition was contraindicated, we started patients on parenteral nutrition within 24-48 hours after admission to ICU. After nutritional assessment and allocation of patients according to their nutritional risk, patients with low risk of malnutrition were continued on the nutritional regimen already started. We referred patients with high risk of malnutrition to nutritional specialist who completed nutritional assessment and prompted maximizing nutritional support with full caloric and protein provision and evaluation of deficient elements (as minerals, electrolytes and vitamins) with correction according to recommended guidelines.

Parameters of the modified NUTRIC score included: They were age, comorbidities, days between hospitalization and ICU transfer, APACHE-II score and SOFA score. Because we don't routinely measure serum IL-6 is not in our hospital, we used the modified NUTRIC score instead of the NUTRIC score for analysis.

End points: We evaluated the association between mNUTRIC score and patient outcomes in ICU including ICU 30-day mortality, duration of ventilator use, duration of vasopressor use and ICU average length of stay. Then we used this relationship to assess the ability of the mNUTRIC score to identify patients at high risk of malnutrition and to predict the outcomes of surgical ICU patients. The relationship between high mNUTRIC score, acute renal failure and infection was also assessed. Also, the association of mNUTRIC score with other scoring systems (APACHE 2 and SOFA scores) was evaluated.

Outcomes: The primary outcome was the 30-day mortality and duration of mechanical ventilation to evaluate their association with high m-NUTRIC score. The secondary outcome was the duration of using vasopressor and average length of ICU stay to evaluate their association with high levels of m-NUTRIC score. The tertiary outcome was to use the mNUTRIC scoring system to recognize high nutritional risk group to provide them with adequate nutrition according to the recommended nutritional regimens, and to evaluate its ability to recognize patients who are expected to benefit from additional energy and protein provision.

Statistical analysis: We revised, coded, and tabulated the collected data using the Statistical Package for Social Science (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp.). The normality of the data was tested by the Kolmogorov-Smirnov test. Qualitative data were presented as numbers and percentages and were compared by the Chi square test, while quantitative normally distributed data were presented as mean and standard deviations and were compared by the independent t test. Not normally distributed data were described as median and (IQR) and were compared by the Mann Whitney U test. As a result, the p-value will be considered significant at the level of <0.05

RESULTS

A total number of 100 patients were included in our study including patients at low risk of malnutrition (n=88) and patients at high risk of malnutrition (n=12) using a cut-off score of > 4 to define high risk patients. The mean Age of the patients was 45.5 ± 20.5 years. The mean BMI was 27.6 ± 3.9 Kg/m^2. According to their gender, 60% were males and 40% were females (Table 1). The most common comorbidities in our study were hypertension (25%), DM (19%), and the cardio vascular disease (18%) (Table 2). The ICU data of the included patients were reported in (table 3). Table (4) shows a comparison between the two groups in terms of the demographic data with no statistically significant differences was found between the two groups (P > 0.05 for ALL).

As regard to ICU related data, we found significant differences between high mNUTRIC score and low mNUTRIC score patients. High mNUTRIC score was found to be associated with statistically significant longer average length of stay in ICU, MV duration, use of vasopressor and higher 30-day mortality rate. High mNUTRIC score was also found to be associated with statistically significant higher APACHE2 and SOFA scores, it was associated with increased occurrence of infection and acute kidney injury as shown in (Table 5).

mNUTRIC cut-off score of > 4 was reported in most of the previous studies, however from our analysis the cut-off value of > 3 showed higher significant specificity and sensitivity. mNUTRIC score over 3 was associated with higher 30-day mortality rate (AUC=0.835, Sensitivity=79%, Specificity=72%, P=0.001), longer MV (AUC=0.679, Sensitivity=61%, Specificity=65%, P=0.018) and vasopressor duration (AUC=0.717, Sensitivity=71%, Specificity=67%,

P=0.001). Table (6) shows statistical analysis of sensitivity and specificity of the mNUTRIC scoring system to predict outcomes in critically ill surgical patients. To evaluate the association of high m-NUTRIC score with ICU 30-day mortality, we used a ROC curve to calculate the AUC which was 0.835 for 30-day mortality (P=0.001). The ROC curve was also used to evaluate the relationship between mNUTRIC score and other ICU outcomes which was AUC=0.717 for using vasopressor, 0.584 for ICU ALOS and 0.679 for MV duration as shown in (Table 6)

Table (1): Demographic data of studied group

		Mean	SD
Age (years)		45.5	20.2
BMI (kg/m^2)		27.6	3.9
		N	%
Sex	Female	40	40
	Male	60	60
Number of comorbidities	No	41	41
	1	25	25
	2	16	16
	3	14	14
	4	4	4

Table (2): Co-morbidity of studied group

	N	%
DM	19	19
HTN	25	25
Malignancy	14	14
B. Asthma	7	7
CNS disease	8	8
CVD	18	18
CLD	11	11
Rheumatological disease	4	4
Endocrinological disease	6	6
CKD	1	1
Pulmonological diseases	1	1

Table (3): ICU related data

		Median	IQR
Days Before ICU admission (day)		1.5	0.5
APACHE2		8	4.3
SOFA		2	1.5
mNUTRIC (Mean± SD)		2.1	1.7
Duration of using vasopressor (day)		4	2.8
Duration of MV (day)		4	2.10
ICU ALOS (day)		4	2.10
		N	%
30-day mortality		24	24
Intubation	No	56	56
	DCL	18	18
	Respiratory Failure	17	17
	Shocked	9	9
Route of nutrition	Enteral	62	62
	Parenteral	31	31
	Enteral with parenteral	7	7
Infection		41	41
AKI		29	29

Table (4): Comparison of study group as regard level of mNUTRIC score (Cut-off 4)

		Low (88)		High (12)		P value
		Mean	SD	Mean	SD	
Age		44.2	19.9	55.7	20.1	0.06
BMI		27.4	3.7	28.9	4.9	0.17
		N	%	N	%	
Sex	Female	33	37.5	7	58.3	0.16
	Male	55	62.5	5	41.7	
Number of comorbidities	No	36	40.9	5	41.7	0.17
	1	24	27.3	1	8.3	
	2	15	17	1	8.3	
	3	10	11.4	4	33.3	
	4	3	3.4	1	8.3	

Table (5): Comparison of ICU related data as regard level of mNUTRIC score (Cut-off 4)

		Low (88)		High (12)		P value
		Median	**IQR**	**Median**	**IQR**	
Days Before ICU admission (Day)		2	0.6	1	0.3	**0.4**
APACHE2		7	4.10	24	19.28	**0.001***
SOFA		2	1.4	9	6.13	**0.001***
Duration of vasopressor (Days)		3	2.5	9	4.10	**0.01***
Duration of MV (Days)		3	1.9	9	3.12	**0.001***
ICU ALOS (Days)		4	2.8	10	4.3	**0.04***
30-day mortality (n,%)		15	17	9	75	**0.001***
Intubation		**N**	**%**	**N**	**%**	
No		54	61.4%	2	16.7%	**0.002***
Yes (Causes)	DCL	14	15.9%	4	33.3%	
	Respiratory Failure	15	17%	2	16.7%	
	Shocked	5	5.7%	4	33.3%	
Route of nutrition	Enteral	60	68.2%	2	16.7%	**0.001***
	Parenteral	22	25%	9	75%	
	Enteral with parenteral	6	6.8%	1	8.3%	
Infection		32	36.4%	9	75%	**0.01***
AKI		19	21.6%	10	83.3%	**0.01***

Table (6): Analysis of sensitivity and specificity of mNUTRIC score

Outcome	Cut-Point	AUC	SN	SP	P value
Mortality	3	0.835	79	72	0.001*
Vasopressor	3	0.717	68	74	0.001*
ICU LOS (>6 days)	3	0.584	43	62	0.15
MV duration (>6 days)	3	0.679	61	65	0.018*
Vasso Duration (>3 days)	3	0.755	71	67	0.001*
AKI	3	0.814	76	75	0.001*
Infections	3	0.648	54	70	0.01*

DISCUSSION

Nutritional assessment in ICU patients is a difficult task. We aimed in this work to validate the m-NUTRIC score as a nutritional screening tool and to evaluate its ability to predict the patient outcomes in the surgical ICU patients based on their risk of malnutrition and also to assess the beneficial effect of aggressive nutritional intervention in patients with high risk of malnutrition. We used the mNUTRIC score to recognize patients with high risk of malnutrition. We evaluated the performance of the mNUTRIC score through assessment of the association of mNUTRIC score with ICU 30-day mortality, duration of ventilator use, using vasopressor and its duration and average length of stay in the ICU. Most of the previous nutritional assessment tools were not appropriate to be used in ICU patients because malnutrition in ICU patients is aggravated by their inflammatory and hyper catabolic state, and the previously used tools didn't consider these important factors [5].

Many of the previously used tools for nutritional assessment use anthropometric data of the patients and history of food intake and loss of weight to identify high nutritional risk patients. Anthropometric data may not be reliable in critically ill patients because they may have some sort of edema related to their disease and also it's difficult to obtain a reliable history of food intake and loss of weight in ICU patients because these patients are sometimes mechanically ventilated and under sedation. Hence, the mNUTRIC score is the most appropriate tool for nutritional assessment in critically ill patients [2,8].

Many studies have established that the mNUTRIC score is a good predictor of outcomes in ICU patients [2,8,9].

In our study we demonstrated that the m-NUTRIC score was a good predictor of ICU outcomes in our postoperative ICU patients. We found that malnutrition was associated with prolonged MV, prolonged vasopressor use, increased ICU average length of stay and increased ICU 30-day mortality rate. These results are in line with the study of **Mahmoodpoor *et al.*** [10] as well as previous studies [9,11,12]. **Mahmoodpoor *et al.*** [10] validated the performance of the mNUTRIC score to predict prognosis in general ICU patients. They found that the (AUC) of the mNUTRIC score as regard to predicting mortality and duration of ventilator use were 0.973 and 0.710 respectively. They used cut-off score of >4 to identify patients at risk of malnutrition. Our results are consistent with these results. In our study, the (AUC) of mNUTRIC score for predicting ICU 30-day mortality, duration of vasopressor use and duration of ventilator use were 0.835, 0.755 and 0.679 respectively, indicating a good predictive performance of mNUTRIC score regarding ICU mortality. We observed that the cut-off score of >3 had the best significant sensitivity and specificity for prediction of mortality and poor outcomes. The same authors also found that lower amounts of calories and proteins were provided to patients with m-NUTRIC score >4 indicating underfeeding, however this couldn't be assessed in our study due to insufficient data on this regard due to short stay of most postoperative patients in the ICU

In our study we reported a lower mortality rate than in the previous reports which was 24%. The ICU mortality rate in the previous reports was in the range of 10%-50% depending on the severity of the underlying disease and the type of the studied group of patients [2,13]. Our lower mortality rate may be explained by the inclusion of only surgical patients, as in many institutions surgical ICU patients present with an acute event impairing single organ system making them critically ill with high potential for reversibility. The results by **Majari *et al.*** [14] are in line with our results, they reported that mNUTRIC score had a good performance for predicting 28-day mortality in ICU patients in Iran with an area under the curve = 0.806. They demonstrated that m-NUTRIC ≥ 5 and NRS-2002 ≥ 3 were associated with an increased ICU average length of stay, prolonged MV of >2 days, and higher 28-day mortality. Their results showed that the m-NUTRIC and NRS-2002 had AUC of 0.806 and 0.695, respectively indicating that the mNUTRIC score had a better performance. They also reported that MUST score ≥ 2 was not significantly associated with a increased ICU average length of stay, prolonged ventilator use and increased 28-day mortality with the lowest AUC= 0.551 indicating also that he mNUTRIC score is better than the MUST score for predicting ICU outcomes

We didn't involve the NRS-2002 and the MUST score in our study because it was reported in many previous studies that these tools are inappropriate in the intensive care setting [8].

The results of the study of **Kalaiselvan *et al.*** are in line with our results. They reported that patients with malnutrition who had mNUTRIC score ≥ 5 had longer ICU average length of stay and higher mortality rate. They reported that mNUTRIC score (≥5) was a good predictor of mortality with an (AUC) of 0.582. They found that the sensitivity and specificity of mNUTRIC score for mortality prediction were 41.5% and 73.8%. respectively. They suggested that high risk of mal-nutrition should prompt early nutritional intervention to improve patients outcome [2].

The results of **Wang *et al.*** [15] are in line with our results. They used the m-NUTRIC score for nutritional screening in ICU patients. They reported that the mNUTRIC score was a good predictor of ICU mortality and that patients with high mNUTRIC score had higher mortality rate, higher severity of illness scores, prolonged ICU LOS, increased incidence of infection and acute kidney injury and prolonged mechanical ventilation. They found that every point increase in the mNUTRIC score was associated with an increase in the 28-day mortality by 8.5% with an area under curve of 0.763 for predicting 28-day mortality. The best cut-off value of m-NUTRIC score for predicting ICU mortality was at >4.

The results of **de Vries *et al.*** [11] are in line with our results, they demonstrated a good performance of the modified NUTRIC-score regarding prediction of ICU mortality (AUC 0.768). These findings are consistent with the studies by **Heyland *et al.*** [9] (AUC 0.783) **Rahman *et al.*** [8] (AUC 0.648) and **Mukhopadhyay *et al.*** [12] (AUC 0.71), in Caucasian and Asian patients. The cohort study of **de Vries *et al.*** [11] as well as the study of **Rahman *et al.*** [8] reported a poor performance of the mNUTRIC-score as regard to prediction of ventilation duration. Our results are in line with the results of **Heyland *et al.*** [9] showed a significant association between high mNUTRIC score and prolonged duration of ventilator use (AUC=0.679).

Some of the previous studies have emphasized adequate nutritional supply to be linked with a reduction in ICU mortality in patients with high mNUTRIC-score (>4) [8,9]. Because feeding parameters were not available in our study as well as in the cohort of **de Vries *et al.*** [11], the relationship between adequate nutritional supply, mNUTRIC-scores and ICU mortality could not be approved, this can be explained by the short stay of most postoperative patients in ICU.

Different cut-off values of mNUTRIC score for defining patients at risk of malnutrition have been emphasized in the previous studies, cut-off value of ≥ 5 was reported by **de Vries *et al.* [11], and Wang *et al.* [15],** reported a cut-off value of ≥ 6.

The lower cut-off score reported in our results may be because we included only surgical patients with acute events progressing extremely rapidly and causing life threatening conditions (such as major intraoperative complications, and the post-traumatic nature in large proportion of our study subjects) this can lead to high mortality even in low mNUTRIC score patients and can explain the lowered cut-off point for predicting ICU mortality and poor outcomes in surgical ICU patients. This lower cut-off score can also be explained by the use of the modified NUTRIC score instead of the original NUTRIC score. Also, we excluded patients with diagnosis of brain death, patients with readmission to the ICU and patients with ICU stay of less than 24 hours. The modified NUTRIC score was developed based on parameters linked to severity of disease and is specific for assessing ICU patients. It requires an integrated medical record system to calculate. Our results emphasized that the modified NUTRIC score is an excellent tool for assessing ICU patient's nutritional state. All its parameters can be obtained from patient sheets and records facilitating the application of this tool

Conclusion: The modified NUTRIC score is a good predictor of ICU outcomes, it is a practical tool, easy-to-apply depending on parameters which are easy to access in the intensive care setting. So m-NUTRIC score can be used to evaluate the nutritional risk in postoperative ICU patients and can be used to identify patients who are expected to benefit from additional energy and protein provision.

Conflict of interest: none

Financial disclosure: none

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