Clinical Nutrition 38 (2019) 2846–2850

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Complementarity of NUTRIC score and Subjective Global Assessment for predicting 28-day mortality in critically ill patients

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ARTICLE INFO

Article history:
Received 17 May 2018
Accepted 12 December 2018

Keywords:
Nutritional risk
Nutritional assessment
Prognosis
Critical illness
Critical care outcomes

ABSTRACT

Aims: To compare the prognostic power of nutritional screening (NUTRIC score) and Subjective Global Assessment (SGA), executed alone or their complementarity, for predicting 28-day mortality risk in ICU patients. We also aimed to identify the cut-off point obtained in the NUTRIC that presented the best validity parameters for predicting mortality in this population.
Methods: A sample of 159 patients was evaluated in the first 24 hours of ICU admission. Modified NUTRIC score was performed (without interleucina-6). ROC curve and Youden criterion were used to identify the best cut-off point. Poisson regression and the number needed to screen (NNS) were used to test the complementarity between the tools and their ability to predict 28-day mortality.
Results: A sample of 159 patients was evaluated (51% male, 56.6 ± 20 years) and the APACHE II, SOFA and NUTRIC score medians were 22 (IQR:15;26), 6 (IQR:2;9) and 3 (IQR: 2;5), respectively. Almost 60% of the patients were malnourished (SGA B or C) and 32.7% died during 28-day follow-up. The area under ROC curve for NUTRIC score was 0.79. Using a new cutoff (NUTRIC score ≥ 4), patients with nutritional risk have a 28-day mortality risk almost 6 times higher than subjects without nutritional risk. Patients classified as SGA C showed a 28-day mortality risk 2.19 times higher compared to nourished ones. Evaluating the complementarity of the tools, patients classified as nutritional risk (NUTRIC score ≥ 4) and SGA C showed a 28-day mortality risk 7 times higher and a lower NNS when compared to those patients with a NUTRIC < 4 and any SGA category.
Conclusions: A new cutoff value was identified for this population. Simultaneous SGA assessment in patients with nutritional risk may enhance the predictive power of 28-day mortality, providing better identification of higher risk patients who may benefit from a more aggressive nutritional therapy.

1. Introduction

Serious or critical illness refers to the range of clinical or surgical conditions which pose risk to life and, most often, require hospitalization in an Intensive Care Unit (ICU) [1]. After an aggression, many metabolic and hormonal changes occur to maintain the homeostasis of the organism. Such scenario often causes, beyond other effects, insulin resistance and protein catabolism, exposing the patient to a significant nutritional risk [1–4].

There are still some controversies about the nutritional therapy in critical ill patients, although recently published guideline recommends nutritional therapy for all patients with an ICU stay longer than 48 h [5]. Recent studies showed that not all the critical patients would benefit from an aggressive nutritional therapy in the early phase of critical illness and the only exception would be patients with a higher nutritional risk [6]. For this reason, the correct and early identification of nutritional risk in ICU patients is paramount.

Nutritional risk can be defined as a higher risk of development of adverse outcomes associated with nutritional status [7]. Nutrition Risk Screening – 2002 (NRS -2002) and the Nutrition Risk in Critically Ill (NUTRIC) score combine the assessment of nutritional status and disease severity to identify nutritional risk, and they are

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https://doi.org/10.1016/j.clnu.2018.12.017
0261-5614/

the nutritional screening tools indicated by Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN) to nutritional screening in ICU patients [8].

NUTRIC is the first tool developed to assess nutritional risk in ICU patients [7]. It encompasses variables such as age, number of comorbidities, cores from severity assessment tools as Acute Physiologic and Chronic Health Evaluation (APACHE II) and Sequential Organ Failure Assessment (SOFA), and number of days at hospital prior to admission in the ICU. NUTRIC is considered an easy tool to use since it contains variables routinely used in most ICUs, exception for interleukin-6 (IL-6), which is not frequently requested due to its high cost [9]. Thus, another version of NUTRIC was created later, removing from the final score the IL-6 measurements [9]. Patients with a score ≥6 (for the original version) or ≥ 5 (without IL-6 measurement) are considered at a higher risk [8].

However, nutritional screening, whether using NRS 2002 or NUTRIC, detects only the presence of malnutrition risk. Raslan et al. suggested that if a patient were at nutritional risk, it would be beneficial to use a complementary tool to assess his/her nutritional status [10]. The Subjective Global Assessment (SGA) is a nutritional assessment tool based on some items from patient history, as the recent change of weight and dietary intake, the presence of gastrointestinal symptoms with nutritional impact, functional capacity and severity of stress, and a subjective physical assessment of muscle and fat reserves [11,12]. The use of SGA is recommended to identify patients who could benefit from nutritional interventions, and even after almost three decades, it is still considered a gold-standard method for conducting such assessment in the hospital environment. SGA is also becoming a practical tool to identify malnourished ICU patients with a higher risk for negative outcomes [13,14] and have a better predictive validity in ICU patients when compared to other nutritional assessment tools [15]. Therefore, SGA could complement nutritional assessment of critical patients identified as at malnutrition risk.

Thus, the present study aimed to compare the prognostic power of NUTRIC and SGA, executed alone or concurrently, in critically ill patients, to predict the death risk within 28 days after ICU admission. Moreover, the study intended to identify the cut-off point obtained in the NUTRIC that presented the best validity parameters for predicting mortality in this population.

2. Methods

Longitudinal study developed with patients 18 years-of-age or older admitted to an ICU. Data collection was carried out from April 1 to November 30, 2017. All patients admitted to the ICU during this period were eligible, excluding those with a hospital stay in this sector for less than 24 h, those with major burn injuries, amputees, and patients with anasarca.

The study was approved by the Research Ethics Committee of the Medical School of the Federal University of Pelotas, as well as by the Research Department of the University Hospital (Approval number CAAE: 64157316.8.0000.5317). Participants or family members signed the Informed Consent Form. A single interviewer evaluated patients in the first 24 h of ICU admission using the NUTRIC and SGA score, in addition to the outcome after 28 days (patient discharge, still in hospital or death).

The NUTRIC score version modified by Rahman [9] was used (without interleukin-6), as shown in Table 1. Therefore, the final NUTRIC score ranged from 0 to 9 points. The two cut-off points available in the literature were used to identify risk: NUTRIC ≥5, according to Rahman [9] and NUTRIC ≥ 6, according to Heyland [7]. The study verified the performance of these two cut-off points, and the need of using any other cut-off point that would be more specific to this studied population.

SGA assessed nutritional status using a combination of clinical data (weight loss, change of food intake, gastrointestinal symptoms, and functional changes) in addition to a physical examination of muscle and fat reserves. According to these data, the patient was classified as well-nourished (A), suspected or moderately malnourished (B) or severely malnourished (C) [12].

The data were double-entered and validated in the EpiData program version 3.1, and the analyses were carried out in the STATA 14.2 (Stata Corp., College Station, Texas, USA). Variables were described from relative and absolute frequencies and mean and standard deviation or median and interquartile range, depending on their distribution.

NUTRIC's performance to predict mortality in this population was assessed using the *Receiver Operator Characteristic curve* (ROC curve). The Youden criterion [16] (sensitivity + specificity − 1) identified the best cut-off point (value of 1 indicates that the test is perfect) for mortality prediction 28-day after ICU admission. Poisson regression with adjustment for robust variance was used to calculate the relative risk with a respective 95% confidence interval in order to assess the mortality risk among patients classified into the categories of each of the tools, their different cut-off points, as well as the combination between them, to analyze the complementarity between the tools.

The number needed to screen (NNS) represents the required number of patients needed to screen to identify one patient with a higher risk, who should receive an intervention to prevent death [10]. It will be calculated as the inverse of the difference in risk between the two categories, using a strategy like that used to calculate the number needed to treat (NNT). Statistical significance level of 5% ($p < 0.05$) was considered for all analyses.

Table 1
Original variables used for the NUTRIC score [9].

Variable	Value	Score
Age	<50 years	0
	50–< 75 years	1
	≥75 years	2
APACHE II	<15	0
	15–19	1
	20–27	2
	≥28	3
SOFA	<6	0
	6–9	1
	≥10	2
Number of comorbidities	0–1	0
	≥2	1
Days of hospitalization before admission to ICU	0–< 1	0
	≥1	1

Table 2
Clinical and laboratory characteristics of the sample (n = 159).

Variable	Mean ± SD or median (IQR)
Axillary Temperature (°C)	36.7 ± 1.0
Average Arterial Pressure (mmHg)	86 ± 14
Heart Rate (bpm)	91.6 ± 23.4
Breath Rate (rpm)	18 (15; 23)
Si FiO2 ≥ 0.5 (pO2) (mmHg)	126.2 ± 53.8
Arterial pH	7.4 ± 0.1
Plasma Sodium (meq/l)	140 (137; 144)
Plasma Potassium (meq/l)	4.3 (3.7; 4.8)
Serum Creatinine (meq/l)	1 (0.7; 2.1)
Hematocrit (%)	34.1 ± 6.7
Leukocytes (mm^3)	13.410 (9.450; 19.920)
Respiration (PaO_2/FiO_2, mmHg)	436.6 ± 190.6
Platelets (10^3 mm^3)	224 (160; 307)
Glasgow Coma Scale	9 (3; 15)

SD: standard deviation; IQR: interquartile range.

Table 3
Characteristics of the sample according to prognostic, nutritional risk, nutritional assessment, and outcome at 28 days (n = 159).

Variables	Median (IQR) or n (%)
APACHE II score	22 (5; 26)
SOFA score	6 (2; 9)
NUTRIC score	3 (2; 5)
Subjective Global Assessment	
A	67 (42.1)
B	74 (46.5)
C	18 (11.3)
Outcome at28 days after ICU admission	
Discharged from the ICU	81 (50.9)
Death	52 (32.7)
Stay in the ICU	22 (13.8)
Stay in the ICU of another hospital	3 (1.9)
Escape from the ICU	1 (0.7)

IQR: interquartile range; APACHE II: Acute Physiologic and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; NUTRIC: Nutrition Risk in the Critically Ill.

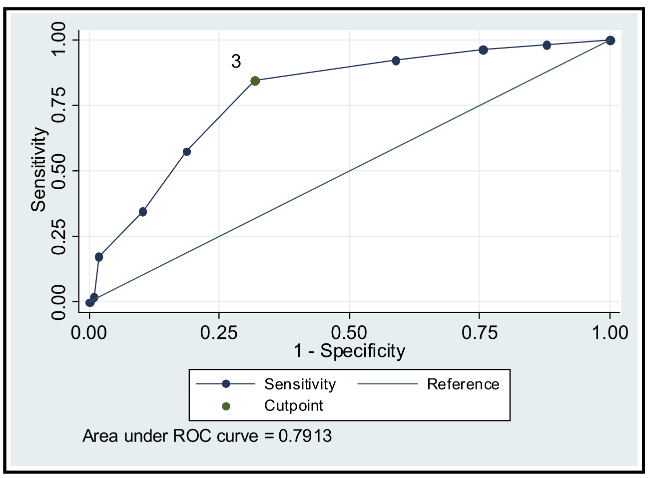

Fig. 1. *Receiver Operation Characteristic* curve of the Nutrition Risk in the Critically Ill (NUTRIC) score in relation to the mortality risk within 28 days.

3. Results

During the study period, 205 patients were admitted to the ICU. Due to the exclusion criteria, incomplete data in medical records, or absence of family to sign the written consent form, 46 patients could not be included, resulting in a final sample of 159 patients.

Males had a slight predominance in the sample (51%) and the patients had a mean age of 56.6 ± 20 years. Most of these individuals presented comorbidities (62.9%), were admitted to the hospital directly to the ICU (66%), and only 11.3% were patients from elective surgeries.

Table 2 describes both the clinical and laboratory characteristics of the sample. It can be noted that the mean results of each parameter were within normal limits.

The APACHE II, SOFA and NUTRIC median scores were 22 (IQR = 15; 26), 6 (IQR = 2; 9), and 3 (IQR = 2; 5), respectively, and are described in Table 3. The SGA results showed that most of the sample was severely malnourished or suspected of being malnourished (SGA B or C = 57.8%) and 50.9% were discharged from the ICU within 28 days, while 32.7% died.

The mortality prediction by using NUTRIC showed an area under the ROC curve of 0.79 (Fig. 1). Table 4 describes Youden's analysis considering sensitivity and specificity. The previously published cut-off points had a poor performance in this sample, with sensitivity and specificity of 34.6% and 89.7%, respectively using NUTRIC ≥6 (cut-off = 5) or sensitivity of 57.7% and specificity of 81.3% using NUTRIC ≥ 5 (cut-off = 4). A new cut-off point 3 (patients at risk if NUTRIC ≥ 4) was identified for the studied population, showing the best parameters of both sensitivity and specificity for the prediction of mortality 28 days after ICU admission. This point had a sensitivity of 84.6% (% of patients identified as at nutritional risk among those who died) and a specificity of 68.2% (% of patients identified as not at nutritional risk among the survivors).

Table 5 shows the relative mortality risk for each tool and different cut-off points used. It was observed that patients classified as B in the SGA did not present a statistically significant risk of death within 28 days (RR = 1.33; 95% CI: 0.79–2.24; p = 0.28), whereas patients classified as C showed a 2.19 times higher risk of death after 28 days in the ICU in relation to those classified in not malnourished (SGA A) (95% CI: 1.22–3.93; p = 0.009).

When observing the risk of death in relation to the NUTRIC classification, we were able to see different results depending on the cut-off point. When using the cut-off points previously published, there is a 2.37 and 2.97 times higher mortality risk in patients classified as at risk with NUTRIC ≥6 and NUTRIC ≥5, respectively. Using the new cut-off point suggested for this sample (NUTRIC ≥ 4), the patients classified at nutritional risk had on average a mortality risk almost 6 times higher after 28 days than individuals classified with no nutritional risk (95% CI: 2.87–11.37; $p < 0.001$).

Evaluating the complementarity of the tools, patients classified as at nutritional risk from the NUTRIC ≥4 and classified as severely malnourished (SGA C), showed a death risk after 28 days ICU admission over 7 times higher (95% CI: 3.45–15.14; $p < 0.001$) when compared to those patients with no nutritional risk by NUTRIC, no matter the nutritional status from SGA (SGA A, B or C). The NNS calculation suggests that patients with SGA "C" and NUTRIC ≥4 had lower values for NNS than the patients classified as "SGA" C″ or "NUTRIC ≥4" (Table 5) singly. This result suggests that one death could be avoided for each 1.62 patients identified as higher risk by NUTRIC score and severely malnourished who received an adequate nutritional intervention.

4. Discussion

Although the knowledge of nutritional therapy in ICU has increased in the last decade, some basic steps as the best tool for nutritional screening or nutritional assessment for these patients are not well defined [5,6,8,17]. The early identification of a higher nutritional risk or severely malnourished patients is crucial, because those patients are the only ones who will benefit from an early and full nutritional therapy [5,8].

Table 4
Sensitivity and specificity according to the *Nutrition Risk in Critically Ill* (NUTRIC) score suggested cut-offs for 28-day mortality risk.

Cut-off points	Sensitivity (%)	Specificity (%)	Correctly classified (%)	Youden
3	**84.6**	**68.2**	**73.6**	**53**
4	57.7	81.3	73.6	39
5	34.6	89.7	71.7	24

Values for the chosen cut-off point.

Table 5
Relative 28 days-mortality risk according to nutritional risk, nutritional assessment or both (n = 159).

Classification	RR[a]	CI	p	NNS
SGA[b]				
SGA B	1.33	0.79–2.24	0.282	11.90
SGA C	2.19	1.22–3.93	0.009	3.31
NUTRIC				
NUTRIC ≥ 6[c]	2.37	1.58–3.56	<0.001	2.79
NUTRIC ≥ 5[d]	2.97	1.92–4.60	<0.001	2.51
NUTRIC ≥ 4[e]	5.71	2.87–11.37	<0.001	2.15
NUTRIC & SGA[f]				
NUTRIC ≥4 and SGA A or B	5.38	2.67–10.82	<0.001	2.31
NUTRIC ≥4, and SGA C	7.23	3.45–15.14	<0.001	1.62

RR: relative risk; CI: confidence interval; NNS: number needed to treat to avoid a negative outcome (death). [a]Obtained by Poisson's simple regression; [b]Reference category: Patients classified as "A" in SGA (Subjective Global Assessment); [c]Reference category: Patients with score NUTRIC < 6; [d]Reference category: Patients with score NUTRIC < 5; [e]Reference category: Patients with score NUTRIC < 4; [f]Reference category: Patients with score NUTRIC < 4 and ranked as "A, B, or C" by SGA.

The most used tools for nutritional screening or nutritional assessment (NUTRIC and SGA) were used in this study. NUTRIC showed a good performance for the prediction of 28-day mortality, presenting an area under the curve of 0.79 (95% CI: 0.7–0.9), but the recommended cut-offs had better specificity than sensitivity. In our population, patients who had a NUTRIC score ≥4 were better identified as being at high mortality risk. This cut-off is slightly lower than presented in the first validation study [7], and slightly lower than the suggested a cut-off point of ≥5 points for high-risk, when IL-6 is not used [9]. The median NUTRIC score in this study was 3, lower than the scores found in the first NUTRIC validation study, where the authors found a mean score of 4.7 [7]. Such difference may have been due to the lower age of the patients in the current study (56.6 vs. 63.9 years, respectively). The APACHE II value obtained in our study was slightly higher than that found by Heyland et al. [7] (median: 22 and IQR: 15; 26 vs. median: 21 and IQR: 16; 27). In contrast, the value found for SOFA was lower compared to the same study (median: 6 and IQR: 2; 9 vs. median: 7 and IQR: 5; 9). These differences may suggest that the performance of this tool may be different if the characteristics of the studied population are different from the original validation study, resulting in a different cut-off point. Despite the differences between the population studied, we found an overall mortality rate of 32.7%, similar to that found at the validation study of the NUTRIC score (29%) [9].

Other studies compared NUTRIC and SGA to identify risk for a longer hospital and ICU stay in critically ill patients [18]. NUTRIC showed better results, as patients considered to be at nutritional risk by this score had a longer stay when compared to those identified as malnourished by the SGA. The authors concluded that traditional tools for nutrition assessment, such as the SGA, might not be ideal for patients in an ICU because they do not associate nutrition status with the severity of the current disease, which could lead to an inaccurate nutrition risk assessment. These results are similar to ours, where the patients identified by the NUTRIC specific-population score (≥4) showed a higher risk for mortality than the patients identified as severely malnourished (RR: 5.71 and 2.19, respectively).

However, the complementation of the instrument that assesses nutritional risk with an instrument that assesses nutritional status has been shown to be beneficial in the identification of hospitalized patients at higher risk [10]. When both tools were used together, one complementing the other, a higher efficiency can be showed in comparison with their use separately. Raslan et al. compared the results of two tools (NRS-2002 and SGA) to test their efficiency, identifying which would be the most appropriate to detect patients with probable unfavorable clinical findings, such as severe complications, longer hospital stay and mortality. They found higher values of NNS when the instruments were used in a combined form, also suggesting in their study, the complementary of these instruments [10]. Our results suggest that SGA and NUTRIC may be complementary in the mortality prediction among critically ill patients, showing a greater probability of a 28-day mortality.

The use of SGA and NUTRIC may help to improve the efficiency and economic distribution of resources for nutrition therapy among these patients, as those identified at higher risk, for example, could benefit from receiving a more aggressive nutritional therapy, improving clinical outcomes. Early recognition of patients with a higher risk and severely malnourished is also important because they are the most likely to benefit from an early and more aggressive nutritional intervention, either for enteral or parenteral nutrition [5,8].

Our results showed that NUTRIC score and SGA can be used as complementary tools, and those patients identified as at nutritional risk and considered severely malnourished had the highest risk of mortality in 28-days when compared to those without risk and well-nourished. Both tools suggest that a nutritional intervention could potentially reduce morbidity and mortality from nutrition-associated complications [7,11,13]. The approach used in this study (NNS) may suggest that one death could be prevented for each 1.62 patients identified as a higher NUTRIC score and as severely malnourished who received an adequate nutritional therapy. Future interventions studies could show if nutritional interventions may really change the prognostic of these patients based on the use of these two tools together.

5. Conclusion

Based on our results, we suggest that NUTRIC should be used within the first 24 h of ICU admission to detect patients at greater risk of mortality, and a score ≥4 seemed to be more adequate to our population. The subsequent nutritional assessment using SGA in patients identified as at risk is associated with a better identification of patients with an increased risk of mortality and those candidates for a more aggressive nutritional therapy. Thus, its use is recommended, enabling the identification of those who would benefit from greater benefit from nutrition therapy to prevent mortality.

Conflicts of interest

PKS, RBM, SPO and MCG have no personal or financial conflicts to declare.

Statement of authorship

All the authors are responsible for the reported research and have made substantial contributions to the conception and design of the study, acquisition and analysis of data.

Acknowledgements

PKS, RBM, and SPO designed and conducted the study. PKS collected the data and helped in drafting the manuscript. MCG proposed the idea, supervised the analyses and drafted the manuscript. RBM and SPO participated reviewing the analyses, interpreting results and reviewing the manuscript. All authors read and approved the definitive version of this manuscript.

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