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# Nutritional risk assessment and cultural validation of the modified NUTRIC score in critically ill patients—A multicenter prospective cohort study

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ABSTRACT

*Purpose:* Characterize the nutritional risk of critically ill patients with the modified NUTrition Risk in the Critically ill (NUTRIC) score.
*Materials:* National, multicenter, prospective, observational study conducted in 15 polyvalent Portuguese intensive care unit (ICU), during 6 months. Adult patients were eligible. Those transferred from another ICU or readmitted, brain dead at admission, and with length of ICU stay (LOS) of 72 hours or less were excluded. NUTRIC score was calculated at admission; scores ≥5 represent a high nutritional risk. Main outcome was mortality from all causes at 28 days after admission to the ICU; LOS and days without mechanical ventilation (days free of MV) were secondary outcomes.
*Results:* From 2061 admissions, 1143 patients were considered, mostly males (n = 744, 64.7%) with median ($P_{25}$-$P_{75}$) age of 64 (51-75). Patients at high nutritional risk were 555 (48.6%). High NUTRIC score was associated with longer LOS ($P < .001$), less days free of MV ($P = .002$) and higher 28-day mortality ($P < .001$). The area under the curve of NUTRIC score ≥5 for predicting 28-day mortality was 0.658 (95% CI, 0.620-0.696). NUTRIC score ≥5 had a positive predictive value 32.7% and a negative predictive value 88.8% for 28-day mortality.
*Conclusions:* Almost half of the patients in Portuguese ICUs are at high nutritional risk. NUTRIC score was strongly associated with main clinical outcomes.



## 1. Introduction

Malnutrition is common in hospitalized patients and highly prevalent in the population of critically ill patients all around the world [1,2]. It is associated with increased morbidity, mortality and occurrence of nosocomial infections, prolonged hospitalization, worse functional status at discharge from the Intensive Care Units (ICU) and increased hospital costs [3,4].

In Portugal, data regarding the impact of malnutrition at hospital admission has demonstrated that the frequency of patients at nutritional risk is very high, comprising 29% to 47%, depending on the methodology used [5]. Data on Portuguese critically ill patients is still, to date, not available.

Most of the scores and tools to assess nutritional risk were validated in the hospital setting [6-12], and include a variety of criteria to identify nutritional risk, such as food/nutritional intake, physical examination, severity of illness, anthropometric data and functional assessment. Many of these criteria are difficult to obtain in critically ill patients since almost all of these patients require mechanical ventilation and sedation. Changes in weight can be influenced by fluid status, given the large volumes necessary to maintain hemodynamic stability, and consequently muscle and fat wasting evaluation become more difficult. Many traditional tools do not provide information regarding inflammatory status which is crucial in an ICU population, since it's one of the factors responsible for hypermetabolic status and hence, muscle wasting [13].

Based on the assumption that the nutritional risk is not the same for all critically ill patients, Heyland et al developed and validated the NUTrition Risk in the Critically ill (NUTRIC score), the first nutritional risk assessment tool developed specifically for the ICU population that could identify patients that require more aggressive nutritional support, based on their nutritional risk [14,15]. The conceptual model links patient predictor markers of acute and chronic starvation, acute and chronic inflammation and outcome. The severity of illness is derived from the use of the variables with traditional scores of severity of illness,

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the Acute Physiology and Chronic Health Evaluation II (APACHE II) score [16] and baseline Sequential Organ Failure Assessment (SOFA) [17].

The variables in the NUTRIC score are easy to obtain in the critical care setting, except Interleukin-6 (IL-6) level, which is not commonly measured. As it has already been demonstrated, the performance of the NUTRIC score varies only slightly when excluding IL-6 levels from the score or when this is replaced by another available inflammatory biomarker. The modified NUTRIC score (without IL-6) has been recently validated [18].

## 2. Objective

To characterize the nutritional risk of hospitalized patients in Portuguese ICU using the modified NUTRIC score.

## 3. Materials

A prospective, observational, multicentric cohort study was conducted in a convenient sample of tertiary polyvalent ICUs across Portugal. Nationwide, around 4100 patients per year were expected to be admitted in the ICUs. Polyvalent ICUs from public academic hospitals were considered eligible to participate. From the 30 identified ICUs, 23 expressed the will to participate and 15 ICUs provided the complete dataset for effective enrolment. All enrolled ICUs had allocated nutritional staff. Patients consecutively admitted to the participant ICUs were enrolled during a period of 6 months, in 2014, with only admission to the ICU being considered. Patients aged over 18 years were considered eligible for recruitment. Patients were excluded if diagnosed as being brain dead at admission or if they had been transferred from another ICU or readmitted into the ICU. Only patients with a length of ICU stay (LOS) of more than 72 hours were considered for analysis.

The transcultural adaptation of the tool was previously done as an independent part of the project. The process of cross-cultural adaptation followed the multistep approach, according to the international guidelines [19]. The original English version of the NUTRIC score was independently translated to Portuguese by two bilingual translators with specific skills in English and Portuguese and proved experience in the health sciences. A panel of experts (physicians, nurses and dietitians working in ICU) evaluated the two translations of NUTRIC score, by analyzing the phrasing of each item, and consensually obtaining the proposed version. An official translator, registered in the Portuguese Translators Society, proceeded to back-translate the proposed version to English, the language of the original version. The back-translated version was reviewed by the developers of the original tool to assess the adequateness of the content (content validity). A pilot study was conducted with 46 critically ill patients admitted in one of the ICU's from the study, to assess the understanding and applicability of the translated version of the modified NUTRIC Score. The cultural validation from English to Portuguese language has succeeded in achieving idiomatic, semantic, and conceptual equivalence between the original toll and the Portuguese version. The official endorsement of the proposed Portuguese version of the NUTRIC score was obtained.

The NUTRIC score, without IL-6 levels includes five variables: age, APACHE II, SOFA, number of co-morbidities and days from hospital to ICU admission. The score was calculated with data from the first 24 h after ICU admission. The NUTRC score ranges from zero to nine; a score ≥5 indicates a high nutritional risk [14]. Main outcome was mortality from all causes at 28 days after admission to the ICU; LOS and days without invasive mechanical ventilation (days free of MV) were secondary outcomes. Outcomes were collected until day 28, starting at admission to the ICU. Data were recorded from the patient chart (electronic and/or paper) following the standardized data collection procedures stated in the manual of procedures developed specifically for the study. Local researchers received training to collect data. The study was approved by the Ethics Committees for Health for every participant Hospitals and was licensed in the Portuguese Data Protection Authority (no. 6635/2013). As mandated by the same Authority, informed consent was obtained from all patients included.

Prevalence rates are presented with 95% confidence intervals (95% CI). Proportions are compared with binomial test, $\chi^2$ test or Fisher exact test (as adequate). The normality of the distribution of the NUTRIC score was excluded. The association of the NUTRIC score with the three main outcomes (LOS, days off MV and 28-day mortality) was analyzed with Mann-Whitney *U* test and Spearman correlation, adjusted to confounding factors when needed. Logistic regression analysis was used to further characterize the association between the NUTRIC score and the three main outcomes, using odds ratio (OR) with 95% CI of the estimates; linear regression was performed but discarded due to rejection of the normality of the residuals. The model discrimination for predicting 28-day mortality was assessed by the area under the receiving operating characteristic curve (AUC) (interpretation: excellent ≥0.90, adequate 0.70-0.89, poor <0.70) and the generalized max-rescaled R-squared statistic.

The following software packages were used for analysis: OpenEpi (Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health. www.OpenEpi.com, Version 2015/05/04, accessed 2015/07/25), SISA (Uitenbroek, Daan G. SISA. 1997. http://www.quantitativeskills.com/sisa.htm. (2015/07/25)), SPSS 22.0 (SPSS for Windows, Rel. 22.0.1. 2013. SPSS Inc, Chicago, IL; EUA), Stata (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX; StataCorp LP, USA) and VassarStats (Lowry R. VassarStats. http://vassarstats.net/. Vassar College, Poughkeepsie, NY, USA, accessed 2015/07/25).

## 4. Results

During the 6-month recruitment period, 2061 patients were eligible for enrolment in the 15 participating ICUs and 1143 were included in the analysis. Exclusion occurred in case the patient presented one of the previously established criteria: 26 were diagnosed brain dead at admission and 50 had been transferred from another ICU, informed consent was not obtained from 149 patients and LOS in the ICU was less than 72 hours in 670 patients; 23 patients were excluded from analysis due to incomplete data collection for obtaining the NUTRIC score.

Patients that were excluded had similar age distribution than the recruited sample, but a significantly lower proportion were males (58.2% vs 64.8%; $P = .002$) and had a significantly lower baseline APACHE II (median 17 vs 20; $P = .009$) and SOFA (median 5 vs 7; $P < .001$).

In the recruited sample, the median ($P_{25}$-$P_{75}$) age at admission was 64 (51-75) years. Males predominated (n = 740, 64.8%; $P < .001$). The median ($P_{25}$-$P_{75}$) baseline APACHE II and SOFA were 20 (14-26) and 7 (5-10), respectively. Primary admission diagnoses were respiratory (n = 262, 23.0%), sepsis (n = 230, 20.2%) and trauma (n = 167, 14.6%); 2 or more co-morbidities were present in 393 (34.4%) patients. Patients' baseline characteristics are summarized in Table 1.

The median ($P_{25}$-$P_{75}$) of the days free of MV was 2 (1-4) days and LOS was 9 (5-15) days. At day 28, 243 of 1122 patients with known status were deceased (21.7%; 95% CI, 19.35-24.16).

The median ($P_{25}$-$P_{75}$) of the NUTRIC score was 4 (3-6). There were 555 patients (48.6%; 95% CI, 45.67-51.45) at high nutritional risk (NUTRIC score ≥5). Patients at high nutritional risk had higher median ($P_{25}$-$P_{75}$) LOS 10 (5-16.5) days vs 8 (5-14) days ($P < .001$), less median ($P_{25}$-$P_{75}$) days free of MV 2 (1-4) days vs 3 (1-4) days ($P < .001$), and higher 28-day mortality 32.7% vs 11.2% ($P < .001$).

On logistic regression analysis, NUTRIC score ≥5 was associated with longer LOS (≥9 days) (OR 1.72; 95% CI, 1.36-2.17; $P < .001$; n = 1126), less days free of MV (≤2 days) (OR 1.46; 95% CI, 1.16-1.85; $P = .002$; n = 1124) and higher 28-day mortality (OR 3.84; 95% CI, 2.80-5.26; $P < .001$; n = 1122). A NUTRIC score ≥5 predicted 28-day mortality with AUC 0.658 (95% CI, 0.620-0.696) (Supplementary Fig. S1), with a positive predictive value of 32.7% (95% CI, 28.91-36.77) and a negative