SAPS 3 in the modified NUTrition RIsk in the Critically ill score has comparable predictive accuracy to APACHE II as a severity marker

INTRODUCTION

The NUTrition RIsk in the Critically ill (NUTRIC) scoring system is the only nutritional screening tool developed specifically for critically ill patients.\(^1\) It was proposed by Heyland et al. for assessing the risk of adverse events (i.e., mortality, days on mechanical ventilation - MV), which are potentially modifiable by adequate nutritional intervention.\(^1\) The tool is based on a...
conceptual model that addresses current lines of thought on malnutrition in adult patients and includes disease severity, chronic starvation, and inflammation, stressing their influence on the nutritional and prognostic status of a patient on intensive care unit (ICU) admission.\(^{(1)}\)

The instrument has been modified and validated without interleukin-6, which was included in the first version but then removed due to measurement difficulties in most centers. When the interleukin 6 measurement was removed, Rahman et al. did not observe any clinically or statistically significant changes in their data, recommending the removal of the score marker without prejudice to the score.\(^{(2)}\)

The NUTRIC scoring system is recommended by national and international guidelines\(^{(3,4)}\) and identifies that approximately half of patients admitted to the ICU have high nutritional risk.\(^{(5)}\)

The NUTRIC system uses the Acute Physiology and Chronic Health Evaluation (APACHE) II score as a marker of severity and prognosis. However, there is a new generation of prognostic scores that are widely available and can be applied earlier and more easily, such as the Simplified Acute Physiology Score (SAPS) 3.\(^{(6-8)}\)

The SAPS 3 system was developed in a global cohort and consists of 20 variables divided into demographic data, physiologic parameters, and reasons for ICU admission. Total SAPS 3 score may range from 16 to 217 points.\(^{(8)}\)

With the increasing adherence to the SAPS 3 rather than APACHE II as a severity score in ICUs, the use of NUTRIC score modified version (mNUTRIC) as a nutritional screening tool in clinical settings is finding difficulties.\(^{(8,9)}\)

METHODS

This retrospective cohort study included patients admitted to an ICU of a private general hospital in Brazil who stayed more than 24 hours from April 2017 to January 2018. They underwent nutritional risk assessment on ICU admission using the mNUTRIC score in the first 24 - 48 hours.

The study was conducted in accordance with the Declaration of Helsinki and was approved by the local research ethics committee (protocol #18-0271). The authors signed an agreement to preserve patient and staff anonymity related to the use of these data. Given the characteristics of the study, patient consent was waived.

Data collection

The following epidemiological and clinical variables were collected: age, sex, body mass index (BMI), Sequential Organ Failure Assessment (SOFA), APACHE II, SAPS 3, use of MV, place of origin (before ICU admission), reason for ICU admission, lengths of ICU and hospital stay, and ICU and in-hospital mortality.

Nutritional risk assessment was performed using the mNUTRIC score, whose final score consists of the sum of scores assigned to the following components: age, APACHE II, SOFA, number of comorbidities, and length of hospital stay before ICU admission. Classification was based on the system proposed for the modified version: a low score was zero to four points (low risk), and a high score was ≥ 5 - 9 points (high risk).\(^{(2)}\)

Substitution of APACHE II by SAPS 3 in mNUTRIC

Simplified Acute Physiology Score 3 scoring ranges were defined using APACHE II cutoff points from linear regression modeling and comparison in the Receiver Operating Characteristic (ROC) curve for in-hospital mortality. The score assigned to the ranges of the SAPS 3 component was maintained according to the original instrument (zero to three points). Patients were classified as high nutritional risk when the score was ≥ 5 - 9 points. To validate this model, all-cause in-hospital mortality was used as the outcome.

Statistical analysis

The sample size was calculated based on the study of Silva Junior et al.,\(^{(8)}\) which evaluated whether SAPS 3 is
applicable to Brazilian ICUs and found a 75.8% sensitivity in the discrimination between survivors and nonsurvivors. Considering a 0.7 sensitivity with a 0.1 precision and a 0.55 prevalence of mortality (obtained from institutional data), the minimum number of patients was 148.

Quantitative variables were summarized as medians and interquartile ranges. Qualitative variables were expressed as absolute and relative frequencies. The Shapiro-Wilk test was used to assess the normality of variables. Poisson regression was used to assess the relationship between severity scores and in-hospital mortality, adjusted for number of comorbidities, age, sex, place of admission, use of MV, and BMI. Correlations between instruments were analyzed using the Pearson correlation coefficient.

Agreement between the instruments on nutritional risk classification was assessed using Fleiss’ kappa (k). This index ranges from zero to one and considers < 0.2 low agreement, 0.2 to 0.4 fair agreement, 0.4 to 0.6 moderate agreement, 0.6 to 0.8 substantial agreement, and > 0.8 almost perfect agreement.

The ability to predict in-hospital mortality in a model composed of the SAPS 3 score was analyzed using the area under the ROC curve (AUC) and 95% confidence intervals (95%CI). The level of significance was set at 5%. The predictive validity of the proposed model versus the mNUTRIC score was assessed using Poisson regression with robust variance for in-hospital mortality, adjusting for age and sex. For data analysis, the Statistical Package for the Social Sciences (SPSS) software, version 21.0, was used.

**RESULTS**

From April 2017 to January 2018, 1,516 patients were considered eligible. The sample was randomly divided into two-thirds for model development (n = 1,025) and one-third for model performance evaluation (n = 490). Patients’ characteristics are described in table 1.

A correlation was observed between APACHE II and SAPS 3 scores toward increased value and in-hospital mortality after adjustment (relative risk – RR of 1.11 [1.07 - 1.14]; p < 0.001 - AUC with 95%CI 0.779 (0.751 - 0.806); RR of 1.01 (1.00 - 1.01); p < 0.001; AUC with 95%CI 0.819 (0.795 - 0.843), respectively).

Table 2 shows the mNUTRIC with SAPS 3. For development, data on the performance of the new instrument versus the mNUTRIC score in the study sample (n = 1,025) were as follows: correlation between scores of r = 0.839 (p < 0.001); agreement on nutritional risk classification between the instruments of k = 0.543 (p < 0.001); and the ability to predict in-hospital mortality from AUC resulted in an area of 0.869 (95%CI 0.844 - 0.894) (Figure 1).
Table 1 - Patients’ characteristics

| Characteristics                              | Model development (n = 1,025) | Model performance evaluation (n = 490) |
|----------------------------------------------|------------------------------|--------------------------------------|
| Age (years)                                  | 72 (57 - 83)                 | 72 (57 - 83)                         |
| Sex (n/%)                                    |                              |                                      |
| Female                                       | 488 (47.6)                   | 241 (49.2)                           |
| Male                                         | 537 (52.4)                   | 249 (50.8)                           |
| APACHE II score                              | 15 (11 - 20)                 | 14 (11 - 18)                         |
| SOFA score                                   | 2 (1 - 5)                    | 2 (1 - 5)                            |
| SAPS 3 score                                 | 47 (37 - 59)                 | 45 (35 - 56.2)                       |
| BMI (kg/m²)                                  | 25.2 (22 - 28.4)             | 25.1 (22.1 - 28.5)                   |
| Place of origin (n/%)                        |                              |                                      |
| Emergency department                         | 440 (42.9)                   | 187 (38.2)                           |
| Ward                                         | 135 (13.2)                   | 65 (13.3)                            |
| Hemodynamic unit                             | 41 (4)                       | 19 (3.9)                             |
| Surgical unit                                | 331 (32.3)                   | 180 (36.7)                           |
| Semi-intensive care unit                     | 39 (3.8)                     | 24 (4.9)                             |
| Other                                        | 14 (1.4)                     | 6 (1.2)                              |
| Transferred from another health care facility| 24 (2.3)                     | 9 (1.8)                              |
| Reason for ICU admission (n/%)                |                              |                                      |
| Clinical condition                           | 713 (69.6)                   | 320 (65.3)                           |
| Surgery                                      | 296 (28.9)                   | 156 (31.8)                           |
| Trauma                                       | 14 (1.4)                     | 11 (2.2)                             |
| Burn                                         | 1 (0.1)                      | 2 (0.4)                              |
| Unspecified diagnosis                        | 0 (0)                        | 1 (0.2)                              |
| ICU outcome (n/%)                             |                              |                                      |
| Discharge                                    | 907 (88.5)                   | 438 (89.4)                           |
| Death                                        | 118 (11.5)                   | 52 (10.6)                            |
| Hospital outcome (n/%)                       |                              |                                      |
| Discharge                                    | 778 (75.9)                   | 380 (77.6)                           |
| Death                                        | 239 (23.3)                   | 108 (22.0)                           |
| Length of hospital stay (days)               | 15 (7 - 32)                  | 16 (7 - 30.2)                        |
| Length of ICU stay (days)                    | 4 (2 - 8)                    | 4 (3 - 7)                            |
| Use of MV (n/%)                               |                              |                                      |
| Yes                                          | 327 (31.9)                   | 150 (30.6)                           |
| No                                           | 698 (68.1)                   | 340 (69.4)                           |

APACHE II - Acute Physiology and Chronic Health Evaluation II; SOFA - Sequential Organ Failure Assessment; SAPS 3 - Simplified Acute Physiology 3; BMI - body mass index; ICU - intensive care unit; MV - mechanical ventilation.
Data on the discriminative ability to predict 28-day mortality of the mNUTRIC score are described in table 2.

The performance of the proposed model was evaluated using one-third of the sample (n = 490). The agreement between the instruments (mNUTRIC composed of SAPS 3 versus mNUTRIC score) was 0.563 (p < 0.001); the correlation was 0.804 (p < 0.001); and the discriminative ability of the proposed model to predict in-hospital mortality was AUC of 0.825 (95%CI 0.787-0.863) (Figure 1).

Patients classified as high nutritional risk in the proposed model showed an incidence ratio (IR) for in-hospital mortality of 1.263 (95%CI 1.178 - 1.353; p < 0.001) in the analysis after adjusting for age and sex. Similarly, the predictive validity of the mNUTRIC score showed a higher IR for in-hospital mortality in patients with high nutritional risk (IR 1.321; 95%CI 1.231 - 1.417; p < 0.001).

DISCUSSION

In this study, we hypothesized that APACHE II substitution by SAPS 3 in the mNUTRIC score would result in a comparable accuracy for all-cause in-hospital mortality prediction. Our data show good performance with regard to the ability to predict in-hospital mortality after adjusting for age and sex, as well as discriminative ability for in-hospital mortality. These results strongly relate to the results of both the original NUTRIC study (AUC: 0.783)\(^{(1)}\) and its modified version (AUC: 0.768) for mortality.\(^{(2)}\) The NUTRIC scoring system is the first specific tool for ICU nutritional screening and can be easily applied to critically ill patients as long as other variables, such as the APACHE II and SOFA scores, are available when patients are admitted to an ICU.\(^{(10)}\) It was created for nutritional screening, but it has proven to be an effective predictor of mortality in patients at nutritional risk.\(^{(11,12)}\)
Objetivo: Avaliar o Simplified Acute Physiology Score 3 (SAPS 3) como substituto do Acute Physiology and Chronic Health Evaluation II (APACHE II) como marcador de gravidade no escore NUTrition Risk in the Critically ill (mNUTRIC; sem interleucina 6), com base em uma análise de sua capacidade discriminativa para predição de mortalidade hospitalar.

Métodos: Este estudo de coorte retrospectiva avaliou 1.516 pacientes adultos internados em uma unidade de terapia intensiva de um hospital geral privado entre abril de 2017 e janeiro de 2018. A avaliação de desempenho incluiu a análise Kappa de Fleiss e correlação de Pearson. A capacidade discriminativa para estimar a mortalidade hospitalar foi avaliada com a curva Característica de Operação do Receptor.

Resultados: A amostra foi dividida aleatoriamente em dois terços para o desenvolvimento do modelo (n = 1.025; idade 72 [57 - 83]; 52,4% masculino) e um terço para avaliação do desempenho (n = 490; idade 72 [57 - 83]; 50,8 % masculino). A concordância com o mNUTRIC foi Kappa de 0,563 (p < 0,001), e a correlação entre os instrumentos foi correlação de Pearson de 0,804 (p < 0,001). A ferramenta mostrou bom desempenho para prever a mortalidade hospitalar (área sob a curva de 0,825 [0,787 - 0,863] p < 0,001).

Conclusão: A substituição do APACHE II pelo SAPS 3 como marcador de gravidade no mNUTRIC mostrou bom desempenho para prever a mortalidade hospitalar. Esses dados fornecem a primeira evidência da validade da substituição de APACHE II pelo SAPS 3 no mNUTRIC como marcador de gravidade. Multicêntricos estudos adicionais de adequação nutricional são necessários.

Descritores: Avaliação nutricional; Cuidados críticos; APACHE; Escore fisiológico agudo simplificado; Mortalidade; Índice de gravidade de doença
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