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Nutrición Hospitalaria

Trabajo Original

Paciente crítico

Nutritional assessment of patients with aneurysmal subarachnoid hemorrhage using the modified "Nutrition Risk in the Critically ill" score, and its association with outcomes

Evaluación nutricional de pacientes con hemorragia subaracnoidea aneurismática mediante la "Puntuación de Riesgo Nutricional en el Enfermo Crítico" modificada y su asociación con los resultados clínicos

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Abstract

Introduction: subarachnoid hemorrhage (SAH) is a rare and life-threatening cerebrovascular disease. Mitigating the factors that compromise patient recovery during neurocritical care due to SAH is of clinical benefit.

Objectives: to evaluate the nutritional risk of patients with aneurysmal subarachnoid hemorrhage using "The Modified Nutrition Risk in the Critically Ill" (mNUTRIC) score, and examine its association with outcomes such as mortality, time of mechanical ventilation, and functional status among survivors.

Methods: we designed a cross-sectional study. Patients with SAH admitted to the neurointensive critical care unit (neuroICU) in a tertiary care public hospital were eligible. The inclusion criteria were a minimum stay in the intensive care unit (ICU) of 24 hrs for subarachnoid hemorrhage from a nontraumatic, spontaneously ruptured cerebral aneurysm, and hospital admission within 24 hrs after the onset of symptoms.

Results: high nutritional risk as stratified by the mNUTRIC score was associated with discharge type (OR = 0.346; 95 % CI = 0.182-0.650; p = 0.001), acute hypertensive hydrocephalus (OR = 4.371; 95 % CI = 2.283-8.549; p < 0.001), and functional outcome (OR = 0.106; 95 % CI = 0.025-0.0388; p < 0.001). The mNUTRIC score was significantly different among median age (p < 0.001), length of stay in the neuroICU (p = 0.005), SOFA score (p < 0.001), and APACHE II score (p < 0.001) categories.

Conclusions: this study demonstrated an association between nutritional risk assessment and outcomes such as length of stay in the neuroICU, type of discharge, functional status, and mortality prediction accuracy.

Keywords:

Subarachnoid hemorrhage. Aneurysm. Nutritional sciences. Intensive care units. Critical care outcomes. Mortality.

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Resumen

Introducción: la hemorragia subaracnoidea es una forma rara de enfermedad cerebrovascular que pone en peligro la vida del paciente. Reducir los factores que comprometen la recuperación de los pacientes durante los cuidados neurocríticos tiene benefício clínico.

Objetivo: evaluar el riesgo nutricional de los pacientes con hemorragia subaracnoidea por aneurisma utilizando la puntuación "The Modified Nutrition Risk in the Critically Ill" (mNUTRIC) y su asociación con resultados como la mortalidad, el tiempo de ventilación mecánica y el estado funcional entre los supervivientes.

Método: diseñamos un estudio transversal. Fueron elegibles los pacientes con hemorragia subaracnoidea ingresados en la unidad de cuidados críticos neurointensivos (neuroUCI) de un hospital público de atención terciaria. Los criterios de inclusión fueron una permanencia mínima de 24 horas en la UCI, hemorragia subaracnoidea por rotura espontánea no traumática de aneurisma cerebral, e ingreso hospitalario en las 24 horas siguientes al inicio de los síntomas.

Resultados: el alto riesgo nutricional estratificado por la puntuación mNUTRIC se asoció con el tipo de alta (OR = 0,346; IC 95 % = 0,182-0,650; p = 0,001), la hidrocefalia hipertensiva aguda (OR = 4,371; IC 95 % = 2,283-8,549; p < 0,001) y el resultado funcional (OR = 0,106; IC 95 % = 0,025-0,0388; p < 0,001). La puntuación mNUTRIC presentó diferencias estadísticamente significativas entre las medianas de edad (p < 0,001), duración de la permanencia en la neuroUCI (p = 0,005), puntuación SOFA (p < 0,001) y puntuación APACHE II (p < 0,001).

Conclusión: este estudio demuestra una asociación de la evaluación del riesgo nutricional con resultados como la necesidad de ventilación mecánica, la duración de la permanencia en la neuroUCI, el tipo de alta, el estado funcional y la precisión en la predicción de la mortalidad.

Palabras clave:

Hemorragia subaracnoidea. Aneurisma. Ciencias de la nutrición. Unidades de cuidados intensivos. Resultados de cuidados críticos. Mortalidad.

INTRODUCTION

Subarachnoid hemorrhage (SAH) is a rare and life-threatening form of cerebrovascular disease, with rupture of one aneurysm accounting for 85 % of all subarachnoid hemorrhages (1). The mortality rate of SAH is up to 35 %, and at least 33 % of those who survive present with permanent disabilities (2).

Mitigating the factors that compromise patient recovery during neurocritical care due to SAH is of paramount importance. Poor nutrition is one of the main factors that leads to an increase in pro-inflammatory cytokines and a hypercatabolic state due to the release of stress hormones (3). The gold standard for nutritional evaluation is indirect calorimetry (IC), which is not usually available in the public health system. Previous studies have shown that aneurysmal subarachnoid hemorrhage creates a catabolic state similar to traumatic brain injury (4), and patients undergoing interventions experience a considerable elevation in resting energy expenditure (3).

The American Society for Enteral and Parenteral Nutrition (ASPEN) and the Society of Critical Care Medicine (SCCM) recommend that patients be evaluated within 48 h of admission to an intensive care unit to analyze nutritional risk (5). The Nutrition Risk in Critically ill (NUTRIC) score is an effective nutritional risk assessment tool developed specifically for critically ill patients (6). The Modified Nutrition Risk in the Critically Ill (mNUTRIC) score is a simpler version that incorporates age, APACHE II, SOFA, number of comorbidities, and days from hospital to intensive care unit admission as variables. The patients were then divided into two categories: 0-4, the low score category, and 5-9, the high score category (7,8).

This study aimed to evaluate the nutritional risk of patients with aneurysmal subarachnoid hemorrhage using the mNUTRIC score in a public hospital critical care unit and its association with outcomes such as mortality, time of mechanical ventilation, and functional status among survivors.

METHODS

STUDY DESIGN AND PATIENTS

This cross-sectional study was conducted between July 2020 and December, 2021. Patients with SAH admitted to the neurointensive critical care unit (neuroICU) in a tertiary-care public hospital were eligible. The total number of ICU beds was 20.

Inclusion criteria were a minimum stay in the intensive care unit (ICU) of 24 h, subarachnoid hemorrhage from a nontraumatic, spontaneously ruptured cerebral aneurysm, and hospital admission within 24 h after the onset of symptoms. The exclusion criteria were the absence of properly registered information in the medical records, history of trauma, hematologic diseases, and severe hepatic or renal dysfunction.

The present study was approved by our institutional research ethics committee (CAAE: 33398920.1.0000.8153) and was developed in compliance with the principles of the World Medical Association and the Declaration of Helsinki.

DATA COLLECTION

The variables analyzed were age, sex, comorbidities, length of mechanical ventilation, length of stay in the ICU, occurrence of brain death, vasospasm, delayed cerebral ischemia, acute hypertensive hydrocephalus requiring external ventricular drainage, therapeutic modalities (endovascular embolization or surgical clipping), Hunt-Hess score, Fisher scale, SOFA score, APACHE II score, mNUTRIC score, modified Rankin scale (mRS) at 3 months after hospital discharge, and body mass index.

Nutritional status at ICU admission was classified according to the mNUTRIC score in the nutritional low-risk (mNUTRIC score < 5) and high-risk group (mNUTRIC score ≥ 5).

Functional outcomes defined by the mRS were classified into good functional outcomes (mRS score of 0-2) and poor functional outcomes (mRS score of 3-6).

STATISTICAL ANALYSIS

IBM SPSS version 22.0 statistical software was used for the analysis. The Kolmogorov-Smirnov test was used to verify sample normality. The results are expressed as percentage (for category variables) and median and interquantile range 1-3 (25^{th}-75^{th} percentile for continuous variables). Categorical variables were analyzed using Pearson's chi-square test and Fisher's exact test. Logistic regression analysis was used to analyze the association between mNUTRIC groups and other categorical variables. Results are presented as odds ratios (OR) and confidence intervals (CI). The Mann-Whitney U-test was used to compare continuous variables between the two groups. Survival analysis was performed using Kaplan-Meier survival and expressed as the log-rank Mantel-Cox chi-square. Receiver operating characteristic (ROC) curve analysis was performed to analyze the accuracy of mNUTRIC for death. In all analyses a significance level of 0.05 was considered.

RESULTS

One hundred and eighty-four patients were screened for this study, and seven patients were excluded (met an exclusion criterion or more). Clinical data were collected.

Table I describes the general characteristics of the samples. The sample was comprised mostly of women (67.2 %). Median patient age was 56 years (interquartile range IQ1-IQ3: 47-64). The most commonly reported symptoms were syncope and headache, whether isolated or not. Grade-II and grade-III Hunt-Hess Scale clinical status conditions were most frequently observed. Sixty-two patients presented with Fisher Scale grade-4 conditions, and 23 presented with Fisher Scale grade-3 conditions. Rates of vasospasm, delayed cerebral ischemia, and rebleeding were 48.6 %, 48.6 %, and 5.1 %, respectively. Acute hypertensive hydrocephalus requiring external ventricular drainage occurred in 36.7 % of the patients.

Mechanical ventilation was required in 68.9 % of the patients. Median total time of mechanical ventilation was 10 days (interquartile range IQ1-IQ3: 6-15) and median hospitalization time in the neuroICU was also 10 days (interquartile range IQ1-IQ3: 6-17). Systemic arterial hypertension and smoking were the most common comorbidities.

Other relevant medians were as follows: body mass index, 26 (interquartile range IQ1-IQ3: 23-29); SOFA score, 5 (interquartile range IQ1-IQ3: 1-9); and APACHE II score, 19 (interquartile range IQ1-IQ3: 12-26).

Table II presents the comparison between the percentages of sex and outcomes as divided according to the mNUTRIC score nutritional group risk. There were no differences between groups

Table I. General characteristics of patients in the neuroICU

Variables	Median (IQR, 1-3)	n (%)
Age (years)	56 (47-64)	177 (100 %)
Sex		
Female	-	119 (67.2 %)
Male		58 (32.8 %)
First symptom		
Syncope		46 (26 %)
Isolated headache	-	41 (23.2 %)
Headache and syncope		29 (16.3 %)
Seizures		10 (5.6 %)
Hunt Hess Scale		
I		8 (4.5 %)
II		50 (28.2 %)
III	-	49 (27.7 %)
IV		18 (10.2 %)
V		48 (27.1 %)
Fisher Scale		
1		6 (3.4 %)
2	-	15 (8.5 %)
3		42 (23.7 %)
4		110 (62.1 %)
Mechanical ventilation requirement		
Yes	-	122 (68.9 %)
No		55 (31.1 %)
Vasospasm	-	86 (48.6 %)
Delayed cerebral ischemia	-	86 (48.6 %)
Rebleeding	-	9 (5.1 %)
Acute hypertensive hydrocephalus	-	65 (36.7 %)
Discharge to neurosurgery ward	-	105 (59.3 %)
Death	-	72 (40.7 %)
Time of mechanical ventilation (days)	10 (6-15)	122 (68.9 %)
Length of stay in the neuroICU (days)	10 (6-17)	177 (100 %)
Body mass index (kg/m^2)	26 (23-29)	177 (100 %)
SOFA	5 (1-9)	177 (100 %)
APACHE II	19 (12-26)	177 (100 %)
Systemic arterial hypertension	-	115 (65 %)
Diabetes *mellitus*	-	14 (7.9 %)
Smoking	-	52 (29.4 %)
Alcoholism	-	23 (13 %)
mNUTRIC score		
High risk	-	63 (35.6 %)
Low risk		114 (64.4 %)
Therapeutics		
Endovascular coiling	-	55 (31.1 %)
Neurosurgical clipping		75 (42.4 %)

Table II. Comparisons between mNUTRIC score groups considering sex and outcomes

Variables		mNUTRIC score classification		p*
		High nutritional risk	Low nutritional risk	
Sex	Female Male	40 (33.6 %) 23 (39.7 %)	79 (66.4 %) 35 (60.3 %)	0.4
Need of mechanical ventilation	Yes No	63 (51.6 %) 0 (0 %)	59 (48.4 %) 55 (100 %)	< 0.001
Type of discharge	Ward Death	27 (25.7 %) 36 (50 %)	78 (74.3 %) 36 (50 %)	0.001
Rebleeding	Yes No	3 (33.3 %) 60 (35.7 %)	6 (66.7 %) 108 (64.3 %)	0.88
Brain death	Yes No	15 (44.1 %) 48 (33.6 %)	19 (55.9 %) 95 (66.4 %)	0.24
Vasospasm	Yes No	28 (32.6 %) 35 (38.5 %)	58 (67.4 %) 56 (61.5 %)	0.41
Delayed cerebral injury	Yes No	22 (39.3 %) 35 (33.3 %)	34 (60.7 %) 70 (66.7 %)	0.74
Acute hypertensive hydrocephalus	Yes No	37 (56.9 %) 26 (23.3 %)	28 (43.1 %) 86 (76.8 %)	< 0.001
Functional outcome (mRS)	Good functional outcome Poor functional outcome	4 (8 %) 9 (45 %)	46 (92 %) 11 (55 %)	< 0.001

**Significant differences were calculated using the chi-square test. Differences between groups were considered significant at p < 0.05.*

in term of distribution of sexes. Among the patients who required mechanical ventilation, 51.6 % had a high nutritional risk, and 48.4 % had a low nutritional risk ($p < 0.001$). It is noteworthy that all patients classified as having a high nutritional risk required mechanical ventilation. Among patients who were discharged to the ward, the majority (74.3 %) were classified as having low nutritional risk. Only 25.7 % of patients discharged to the ward were classified as having high nutritional risk ($p = 0.001$). Among patients who developed acute hypertensive hydrocephalus, 56.9 % had a high nutritional risk and 43.1 % had a low nutritional risk ($p < 0.001$). The majority of patients classified as having low nutritional risk presented with good functional outcomes in the third month after discharge ($p < 0.001$).

Table III shows the results of the univariate logistic regression analysis. High nutritional risk stratified by mNUTRIC score was associated with discharge type (OR = 0.346; 95 % CI = 0.182-0.650; $p = 0.001$), acute hypertensive hydrocephalus (OR = 4.371; 95 % CI = 2.283-8.549; $p < 0.001$), and functional outcome (OR = 0.106; 95 % CI = 0.025-0.0388; $p < 0.001$).

Table IV displays the comparison between the parameter medians of the high and low mNUTRIC score groups. Patients classified under high nutritional risk presented with higher medians in all analyzed variables. Nevertheless, a statistically significant difference was found only between the medians of age ($p < 0.001$), length of stay in the neuroICU ($p = 0.005$), SOFA score ($p < 0.001$), and APACHE II score ($p < 0.001$).

Figure 1 shows a Kaplan-Meier survival curve stratified according to nutritional risk status. Although the survival of patients at high nutritional risk was found to be lower, a statistically significant association was not observed (log-rank Mantel-Cox: 1.205, $p = 0.272$).

Figure 2 is a ROC curve of the capability of mNUTRIC score to predict the occurrence of death in the neuroICU. The area under the curve was 0.694 ($p < 0.001$). mNUTRIC scores were significantly associated with ICU mortality with the cutoff score > 4 (sensitivity = 0.73, specificity = 0.52).

DISCUSSION

The main objective of this retrospective single-center study was to evaluate the mNUTRIC score in a neurocritical care population and its association with death, time of mechanical ventilation, and functional status among survivors. To the best of our knowledge, this is the first Brazilian study to evaluate the mNUTRIC score in patients with SAH, and one of the few in the country to report epidemiological data about this population.

Table III. Association between mNUTRIC score, sex, and outcomes

Variable	OR (95 % CI)	Z-value	p*
Sex (male)	1.298 (0.674-2.48)	0.787	0.431
Need of mechanical ventilation	< 0.0001 (< 0.0001- < 0.0001)	0.014	0.989
Type of discharge	0.346 (0.182-0.650)	-3.268	0.001
Rebleeding	0.9 (0.185-3.541)	-0.45	0.884
Brain death	1.562 (0.722-3.340)	1.150	0.250
Vasospasm	0.772 (0.414-1.431)	-0.819	0.413
Delayed cerebral ischemia	1.263 (0.651-2.426)	0.697	0.486
Acute hypertensive hydrocephalus	4.371 (2.283-8.549)	4.391	< 0.0001
Functional outcome (mRS)	0.106 (0.025-0.0388)	-3.257	0.001

**Results presented as odds ratios (OR) and confidence intervals (CI). Associations were calculated using logistic regression and were considered significant at p < 0.05.*

Table IV. Comparison of median values for the groups with high and low mNUTRIC scores

Variables	mNUTRIC score classification		p*
	High nutritional risk Median (IQR1-IQR3)	Low nutritional risk Median (IQR1-IQR3)	
Age (years)	62 (55-70)	52 (45-60)	< 0.001
Time of mechanical ventilation (days)	10 (6-15)	8 (6-14)	0.300
Length of stay in the neurolCU (days)	12 (8-23)	9 (6-15)	0.005
Body mass index (kg/m^2)	27 (24-29)	25 (22-29)	0.057
SOFA	9 (6-11)	2 (1-6)	< 0.001
APACHE II	27 (24-30)	14 (10-18)	< 0.001

**Significant differences were calculated using the Mann-Whitney U-test. Differences between groups were considered significant at p < 0.05.*

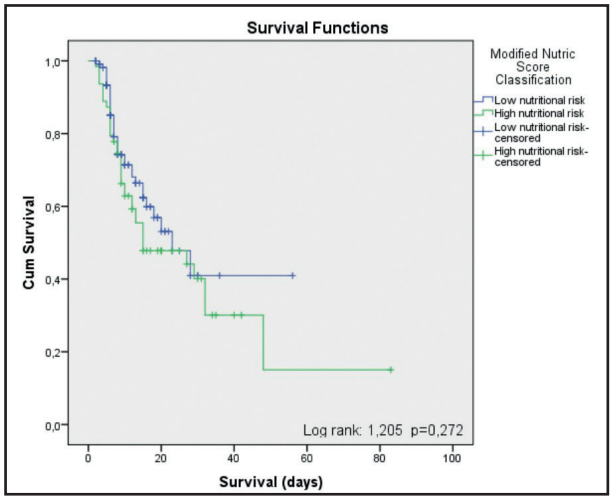

Figure 1.

Kaplan-Meier survival curves of patients according to nutritional risk status.

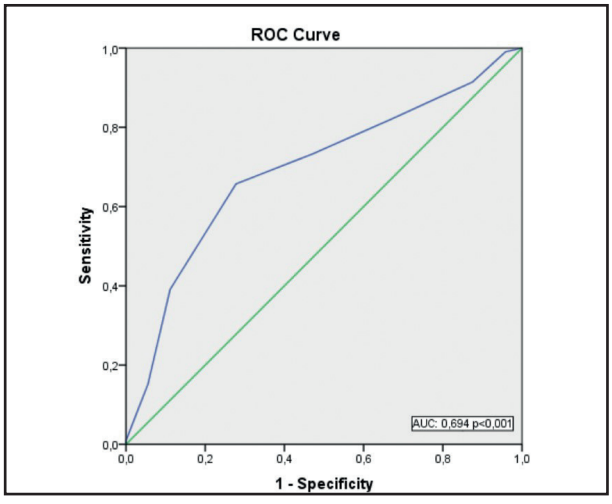

Figure 2.

Receiver operating characteristic curve of mNUTRIC score according to mortality risk.

Our study showed that aneurysmal subarachnoid hemorrhage was more common among women, with a median age of 56 years. It is widely recognized that women are most commonly affected by SAH among the two sexes, and that the peak of involvement occurs around the fifth decade of life (9). A Swiss report showed that the median age of incidence of SAH in patients was 56 years, and that patients in that age group were more severely affected, according to stratification and prognosis scales; they also have a higher chance of rupture in case of anterior circulation aneurysm (10).

It has been reported that patients with acute neurological injury have increased energy parameters due to hormonal and pro-inflammatory cytokines, but factors such as delay in finding appropriate intensive care units or recognizing the illness can also interfere with correct treatment (3). Patients at high nutritional risk also are at an elevated risk of adverse effects (mortality, infections, complications, and prolonged ICU hospitalization), which may indicate a causal realtionship (11-13).

In our sample, 35.6 % of patients were classified as having a high-risk nutritional score. Nutritional risk status was significantly associated with discharge type, acute hydrocephalus, and functional outcomes.

There are intrinsic characteristics that also need to be considered, such as the strong dependence of nerve cells on energy and nutrients to maintain homeostasis (14). Acute injury exacerbates this dependence, and the importance of defining patients at nutritional risk lies in the identification of a modifiable factor that can optimize the recovery of this population. For example, it was already shown that brain injury disrupts the effects of insulin on brain glucose metabolism (15). Once insulin fosters glycogen storage in astrocytes, stimulates protein and genetic material synthesis in the brain, and drives glucose metabolism to neuronal repair pathways, it is important to be aware of the nutritional strategy that may optimize its action (15). All these factors may affect functional outcomes.

The association between nutritional status and development of acute hypertensive hydrocephalus is noteworthy. This complication occurs due to inflammation, apoptosis, oxidative stress, and fibrotic processes caused by the blood in the arachnoid granulations (16,17). Catabolic states and a negative nitrogen balance occur because of inflammation. This disease process makes it essential to identify patients and provide them with adequate nutritional sources, in order to reduce its severity (18).

Although there was no difference in patients requiring mechanical ventilation and time under mechanical ventilation between the low and high nutritional risk groups, all patients classified as having high nutritional risk needed mechanical ventilation, and the median time under mechanical ventilation was greater in this group. In other samples from critically injured patients (surgical and general non-neurological studies), the mNUTRIC score was significantly associated with an increased duration of mechanical ventilation (19-22). On the other hand, the longer length of stay in the ICU among patients with high nutritional risk agrees with previously reported findings (21,23).

The mNUTRIC score can not only be considered a nutritional tool but also a prognostic marker owing to its wide impact on mortality. In our study, it was associated with the type of discharge (death or discharge to the hospital ward). From these results, we can infer that patients who fit the high risk nutritional score profile should receive early nutritional intervention to decrease mortality (21,22,24).

In the current study, although a high mNUTRIC score was associated with a shorter survival curve, this association was not statistically significant. Previous studies and the original description by Rahman et al. demonstrated that a high mNUTRIC score was strongly associated with shorter survival curves (7,20,21,25).

As seen in previous studies, the mNUTRIC score can be used to predict nutritional risk related to mortality, even in a critically ill population, such as patients with aneurysmal subarachnoid hemorrhage. Although our area under the curve value was slightly smaller than that reported in previous studies, there are no other reports applying this score specifically in this population. Perhaps, to achieve greater accuracy in this specific population, it is necessary to incorporate neurological prognostic score scales into the variables analyzed by the mNUTRIC score. In other profiles of critically ill patients, mNUTRIC scores are helpful in assessing nutritional risk as well as general outcomes (7,26,27).

The present study had some limitations. First, it had a cross-sectional design and, consequently, may include inference when looking for causal relationships. Second, it was conducted at a single center, in which data were retrieved from electronic medical records. Conducting further research, such as multicenter, randomized controlled trials, is needed to better determine which nutritional interventions can indeed improve patient outcomes according to stratification by mNUTRIC.

CONCLUSIONS

Subarachnoid hemorrhage (SAH) is a devastating disease. Patients with this condition are a susceptible population, and screening their nutritional status helps design strategies that may improve their outcomes. This is the first Brazilian study to apply the mNUTRIC score in patients with SAH, and one of the few reports applying this score in patients with neurological compromise. It demonstrates an association between nutritional risk assessment and outcomes such as length of stay in the neuro-ICU, type of discharge, functional status, and mortality prediction accuracy.

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