Cogitare Enfermagem

ORIGINAL ARTICLE

PHASE ANGLE AS A POTENTIAL MARKER OF NUTRITIONAL STATUS OF INTENSIVE CARE PATIENTS

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ABSTRACT

Objective: to verify the association of phase angle with nutritional status, length of hospitalization and death in critically ill patients. Methods: longitudinal study with 57 critically ill patients evaluated upon admission to an intensive care unit during the year 2019, in the countryside of São Paulo - BR. The phase angle was obtained by electrical bioimpedance, and nutritional assessment, by the global subjective assessment instrument and anthropometry. The data were associated with the time of hospitalization and death. For the analysis, Mann-Whitney and Pearson's chi-square tests were used. Results: in the global subjective evaluation, 59.6% of the patients presented nutritional risk, and in 91.2% the phase angle was low. Malnutrition was associated with longer hospital stay (p=0.001) in intensive care unit (p=0.023). There was a tendency to death in the group with nutritional risk (p=0.054). Conclusion: The phase angle can contribute to a better accuracy in nutritional assessment, especially when combined with other assessment methods.

DESCRIPTORS: Nutritional Status, Patients, Intensive Care Units, Electrical Impedance, Prognosis.

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INTRODUCTION

Disease-related malnutrition in hospitalized patients is a prevalent but poorly recognized condition and is considered a public health problem. Deficit in nutritional status is associated with increased risk of infectious and non-infectious complications, prolonged length of stay both in hospital and in intensive care unit (ICU), frequent readmission and increased mortality, resulting in significant clinical and economic consequences[1].

A frequent situation in critically ill patients is the rapid deterioration of the nutritional status that usually occurs after ICU admission due to severe catabolism caused by pro-inflammatory and stress-related cytokines and hormones, even when patients are well nourished[2]. A study indicates that in a 10-day period of ICU stay, patients may lose 10% to 25% of body protein content, especially those with multiple organ dysfunction syndrome[3].

A poor prognosis is usually associated with malnutrition. Therefore, this condition should be detected and avoided as early as possible by means of appropriate and intensive nutritional intervention to treat and prevent damage, which can reduce the risk of morbidity and mortality. Therefore, the correct identification of nutritional risk upon admission is fundamental in ICU patients[4].

Some instruments are indicated to screen and diagnose critically ill patients at admission, so that they can benefit from an early and appropriate nutritional intervention. Among them, the Subjective Global Assessment (SGA) and the physical examination performed at admission by a nutritionist stand out[5]. The Subjective Global Assessment (SGA) encompasses changes in weight, food intake, presence of gastrointestinal symptoms, and functional capacity.

After the stage related to nutritional screening performed at patient admission, it becomes necessary to perform a detailed assessment, aiming to identify the baseline condition and the risk of malnutrition to develop a nutritional care plan and monitor its effectiveness in preventing any loss of lean body mass. However, metabolic disturbances and organ dysfunction caused by severe diseases make nutritional assessment a challenge to the professional[6].

A detailed nutritional history of the patient often cannot be obtained due to altered state of consciousness, presence of sedation, or reliable anthropometric measurements such as body weight, height, waist, and arm circumferences may be inaccurate in the presence of significant changes in total body water. Thus, the assessment of metabolically active body cell mass by means of bedside electrical bioimpedance analysis (BIA) may present itself as a better nutritional marker in these cases, becoming a practical alternative that overcomes these limitations[6].

BIA is a non-invasive, practical, low-cost method with fast information processing, used to assess body composition. It consists of the passage through the body of a painless electric current of low amplitude and low or high frequency. It is applied by means of cables connected to electrodes or conductive surfaces, which are placed in contact with the skin, allowing measurements such as resistance (R) and reactance (Xc)[7].

In addition to estimating body components, such as muscle mass and body fat, BIA can mention the distribution of fluids in the intra and extracellular spaces as well as the quantity, size, and cell integrity[7]. Due to the amount of water and electrolytes, lean tissues and blood are highly conductive of electric current and have low resistance to the passage of current. With less water and electrolytes, fat and bones have low conductivity and high resistance[8].

The nutritional markers, provided by BIA analysis, are important for the assessment of the nutritional status, being lean mass index (MM), impedance values (X), reactance (Xc), resistance (R) and phase angle (PA), and may also provide values of total body water (TBW), intra (AI) and extracellular (AE). To assess nutritional risk or malnutrition already established and as support for strategies in nutritional therapy, the data provided by BIA are used and studied as markers with applications in various research as in patients with acquired immunodeficiency (HIV) and critically ill patients[9-10].

PA (Phase Angle)can be used as an indicator of body cell mass. It is obtained directly through the ratio of the values of Xc (Reactance) and R(resistance) by means of the equation of R and Xc as the arc tangent (Xc / R) x 180 o / ∏. Although the biological meaning of PA is not fully understood, it reflects not only body cell mass, but is also one of the best indicators of cell membrane function, related to the ratio between extracellular and intracellular water, an important tool to estimate clinical outcomes or monitor critically ill patients[11].

The possibility of using PA as a tool to evaluate clinical outcomes and monitor the evolution of critically ill patients with liver cirrhosis has been pointed out by studies[11-12]; however, it is necessary to be cautious when interpreting its values, because the association between molecular mechanisms and PA has not been fully clarified yet.

In several clinical situations, such as patients with kidney disease, cancer, critically ill and surgical patients, the PA has shown an association with nutritional assessment tools as to the classification of the patient in cases of malnutrition and nutritional risk[13]. It decreases when the nutritional risk increases, and this decrease compares to water changes and cell mass loss that occur in the malnourished person[11]. In this context, the objective was to verify the association between phase angle, nutritional status, length of stay and clinical outcome of critically ill patients in intensive care.

METHOD

This is a longitudinal, prospective study with a quantitative approach, carried out in a general teaching hospital in northwestern São Paulo, in four ICUs, three of them considered general and one neurological with care for clinical and surgical patients, totaling 60 beds, performed between the months of March to September 2019 in a teaching hospital in São José do Rio Preto, in the interior of São Paulo, Brazil.

The sample was composed of patients of both genders, aged 18 years or older, evaluated within 72 hours after admission in the four ICUs. Those who were conscious or sedated were included, and the conscious ones were responsible for answering the requested questions. For those who were unconscious, information was requested from their families and guardians. The sample was obtained by convenience according to the ICU admissions during the data collection period, totaling 57 patients.

Patients who were unable to perform the BIA test, such as those with psychomotor agitation or tremor, the presence of internal or external metallic devices (as recommended by the manufacturer for safety reasons), amputees, pacemaker patients, and pregnant women were excluded.

Initially, anthropometric nutritional assessment procedures and SGA of the patients were performed within 72 hours after their ICU admission. All assessments were performed according to protocols pre-established by the researchers and composed of instruments validated according to current clinical nutrition guidelines. After the assessment phase, the patients were followed by a nutritionist during the hospitalization period. From the electronic medical records, information on length of stay in the ICU, in another unit of the hospital after ICU discharge and clinical outcome (discharge or death) were obtained.

For screening, we applied the validated instrument called SGA, which includes information on five criteria: changes in weight in the last six months, in view of recovery or stabilization until the assessment date; current food intake compared to usual; presence of gastrointestinal symptoms, their duration and intensity; functional capacity, in other words, if there was a change in performing activities of daily living because of eating poorly or due to the disease. As for the physical examination, loss of subcutaneous fat was verified by evaluating the triceps and ribs region; muscle loss detected in the quadriceps and deltoid; sacral or ankle edema, and the presence of ascites. The nutritional status was categorized according to Detsky et al[5].

Subsequently, an objective nutritional assessment (ANO) was performed, consisting of a joint analysis of anthropometric parameters, such as estimated weight (kg), estimated height (m), body mass index (BMI) (kg/m^2) and measurements of arm and calf circumferences, performed using an inelastic tape measure. The patient's height was obtained indirectly by measuring the height of the knee, with the patient in the supine position, with the right leg forming a ninety-degree angle with the knee and ankle. The measurement was performed with a special ruler, consisting of a fixed part, which was positioned on the plantar surface of the foot (heel) and a movable part, which was pressed on the patellar head (patella). The measurements were used to calculate weight and height, as described by Chumlea et al[14-15].

Then, the BIA exam was performed to obtain the AF, according to the methods stipulated in the manufacturer's manual whose brand is Biodynamics®, model 450. In the examination to obtain R, Xc and PA, an imperceptible, painless, and low intensity electric current (800 µA) at a single frequency (50 kHz) was conducted by four surface electrodes, two proximal and two distal, fixed as follows: two fixed to the dorsal region of the hand and two to the dorsal region of the foot of the patient, on the right side of the body. The voltage drop due to impedance was detected by the proximal electrodes. For this type of analysis, the patient should be lying in a supine position.

The collected data were analyzed using the statistical software Statistical Package For Social Sciences (SPSS, IBM, version 24.0) and GraphPad Instat 3.10 (2009). Categorical variables were presented by absolute frequencies and percentages. Quantitative variables were analyzed based on calculations of measures of central tendency and dispersion, and then tested for normality by the Kolmogorov-Smirnov test. For the inferential analysis, the Mann-Whitney and Pearson's chi-square tests were used. In all analyses, a P value$\leq$ 0.05 was considered statistically significant.

The research was approved by the Research Ethics Committee of the Medicine College in São José do Rio Preto. Opinion 2,712,668.

RESULTS

57 patients participated in the study, 49 (86%) surgical and eight (14%) clinical, 36 (63.2%) male and 21 (36.8%) female, mean age 56±19.5 years (18 to 89 years). At the time of ICU admission, the most frequent diagnoses were cancer 17 (29.9%), gastrointestinal tract diseases 12 (21.0%), and neurological diseases 11 (19.3%). The demographic and clinical characteristics of the patients are shown in Table 1.

Table 1 - Demographic and clinical characteristics of patients admitted to intensive care units of a general hospital, São José do Rio Preto, SP, Brazil, 2020

Variables	**n**	**%**

Gender		
Male	36	63.2
Female	21	36.8
Age		
<60 years	29	50.9
>60 years	28	49.1
Diagnosis		
Oncologic Disease	17	29.9
Gastrointestinal Diseases	12	21.0
Neurological diseases	11	19.3
Traumatological and/or orthopedical diseases	08	14.0
Genitourinary Tract Diseases	03	05.3
Dermatologic Diseases	02	03.5
Respiratory diseases	02	03.5
Cardiac diseases	01	01.7
Diseases of the reproductive system	01	01.7
Phase Angle		
Low	52	91.2

n= number (n=57).
Source: Authors (2020).

The average length of stay in ICU was 5.5 days (1-23), and the hospital stay after ICU discharge was 10.4 days (3-34) with mortality of 5 patients (8.8%). Through the SGA, 34 (59.6%) patients were considered at nutritional risk; it was also found that 52 (91.2%) had PA below the expected cutoff values. Although the majority 31 (59.6%) were part of the nutritional risk group, no significant difference was found in the PA values in relation to the well-nourished group by SGA (p=0.601).

The mean PA observed was 5.9 ± 0.86. It was associated with length of stay in ICU, hospital stay after ICU discharge and presence of clinical complications and death, however, with significant difference only when associated with length of hospital stay (p=0.001) and length of stay in ICU (p=0.023) as shown in Table 2.

Table 2 - Association between PA, length of stay and outcome of patients in intensive care units of a general hospital, São José do Rio Preto, SP, Brazil, 2020

Variables	**Low BP n=52**		**Normal PA n=05**		
Hospitalization time	**n**	**%**	**n**	**%**	**P-value**
ICU					

Up to 10 days	36	85.7	15	100.0	
11 to 15 days	01	02.4	0	0	0.023
> 15 days	05	11.9	0	0	
HOSPITAL					
Up to 10 days	25	59.5	13	86.6	
11 to 15 days	06	14.3	01	06.7	0.001
> 15 days	11	26.2	01	06.7	
Outcome					
Death	05	11.9	0	0	0.468

n= number (n=57); PA= phase angle.
Source: Authors (2020).

As for nutritional risk observed by means of the SGA, it was not possible to observe a significant value when associated to length of stay in ICU and length of stay in another hospital admission unit. However, when the nutritional state was associated with death, it was possible to observe only a trend towards higher mortality in patients of the group that presented nutritional risk (Table 3).

Table 3 - Association between PA, length of stay and outcome of patients in intensive care units of a general hospital, São José do Rio Preto, SP, Brazil, 2020

Variables	**SGA Well nourished (n=23)**		**SGA Nutritional risk (n=34)**		**P- value**
Hospitalization time	n	%	n	%	
ICU					
Up to 10 days	21	91.3	30	88.2	
11 to 15 days	00	00.0	01	03.0	0.708
>15 days	02	08.7	03	08.8	
HOSPITAL					
Up to 10 days	18	78.3	20	58.8	
11 to 15 days	01	04.3	06	17.7	0.223
>15 days	04	17.4	08	23.5	
Outcome					
Death	23	100	34	100	0.054

n=number (n=57); SGA=Subjective Global Assessment; ICU=intensive care unit.
Source: Authors (2020).

DISCUSSION

Identification of nutritional risk at hospital admission in the ICU is important because early intervention can minimize harm to the patient, reducing length of stay and, consequently, health costs. In this study, approximately 60% of patients were classified with nutritional risk by SGA. In a study that included 40 hospitalized patients diagnosed with gastrointestinal cancer, nutritional risk was observed by SGA in 60.98% of them[16]. In another study, with the participation of 924 patients, it was possible to verify that approximately 70.7% of patients presented nutritional risk by using SGA[17]. An incongruence was observed, because the findings of this study showed a higher percentage in relation to other studies.

It is possible to observe that nutritional risk is generally present in the hospitalized population, so it is necessary to perform nutritional screening to establish a diagnosis of nutritional risk and provide early intervention to minimize complications associated with malnutrition.

As for the association between PA and nutritional risk assessed by SGA, there were no significant results, unlike a study carried out with patients with gastrointestinal diseases, in which the PA was decreased in patients with malnutrition, which were assessed by SGA[18]. Such difference may be related to the severity of the diseases presented and the high complexity of the patients.

In the association of PA, significant results were observed regarding longer length of stay in the ICU ($p=0.023$) and in other hospital units ($p=0.001$), showing a potential to be used as a prognostic marker in critically ill patients, corroborating the results of patients with low PA, who had longer hospital stay ($p= 0.001$) and in the ICU ($p= 0.006$)[19]. In another study, an inverse association was found between PA and length of hospital stay ($p= 0.006$)[20]; in another study, a significant association was found between PA with low values and longer hospital stay ($p< 0.0001$)[21].

The observed mortality was 12% in this study, a value close to that pointed out by research involving critically ill patients, which sought to assess whether the PA could be a factor for the prognosis, and observed that mortality was 17%, and 100% of deaths occurred in the group of patients with low values of PA[19]. It is important to highlight that mortality rate in ICU can vary according to the peculiarities of each sector, among them, the presence of patients undergoing elective surgeries or even less severe clinical conditions, with a tendency to present better prognoses[22].

A study showed that PA is significantly associated with mortality, showing low values of PA (women ≤4.6 and men ≤5) related to higher in-hospital mortality ($p= 0.004$) and ICU mortality ($p=0.020$)[23]. A similar result was obtained in a study evaluating male patients with liver cirrhosis, which showed lower values of PA (≤4.9) and worse clinical profiles, being an independent factor of mortality[24]. In this study, despite the death of 100% of patients who belonged to the group with low PA value, there was no significant association ($p= 0.468$).

When associating the nutritional risk detected by SGA to death, it was possible to observe only a trend towards higher mortality in patients with nutritional risk, with no significant difference ($p=0.054$). However, a study with critically ill patients showed that mortality rates were significantly higher in the moderately (45.5%) and severely malnourished (55.6%) than in the well-nourished group (10.8%; $P = 0.004$)[25]. In another study, malnutrition was associated with a 33% increase in mortality risk and showed a significant difference when comparing the group of well-nourished to the malnourished group, with higher mortality in the group of malnourished patients ($p < 0.001$)[26].

The limitations of the study were related to the heterogeneous sample regarding clinical conditions, severity, and complexity, and to the small number of patients who fit the inclusion criteria during the data collection period.

CONCLUSION

PA was not associated with nutritional status and mortality of ICU patients; however, it was associated with longer hospital stay. Nutritional status assessment by SGA showed a trend towards death in the group of patients who presented nutritional risk at ICU admission; however, it was not associated with longer length of stay.

The impact of this study was to demonstrate that PA is a potential prognostic marker for ICU patients, contributing to a better accuracy at the time of nutritional assessment, and, when combined with other methods of nutritional assessment, may indicate a worse outcome when reduced. However, further studies are required, with a larger number of patients and a more homogeneous sample in relation to clinical conditions, involving different ICUs and several hospital institutions.

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