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Nutritional status, hyperglycemia, early nutrition, and mortality of patients hospitalized in an intensive care unit

Estado nutricional, hiperglicemia, nutrição precoce e mortalidade de pacientes internados em uma unidade de terapia intensiva

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ABSTRACT

Objective: Because patients hospitalized in intensive care units are at risk for poor nutrition, and nutritional therapy is not always started at an appropriate time, the present study aimed to correlate nutritional status, early nutrition, and hyperglycemia with patient mortality in an intensive care unit.

Methods: This archival cohort study used the secondary database of 453 patients who stayed at least 48 hours in an intensive care unit and were assessed for 8 days of hospitalization. Patient nutritional status was defined according to the body mass index. Early nutrition was defined as an feeding energy within the first 48 hours of hospitalization, regardless of the administration route. Blood glucose levels were monitored using a glucometer.

Results: A majority of patients were male (54.2%), and approximately half of patients were overweight (48.4%). At the end of the first 48 hours, 69.4% of patients had received nutrition, and only 13.5% of patients still exhibited hyperglycemia. The patients who received early nutritional therapy exhibited lower a mortality risk (p = 0.002), regardless of the presence of other factors associated with mortality.

Conclusions: The significant correlation between early nutritional therapy and survival emphasizes the importance of nutrition in severely ill patients. The low frequency of hyperglycemia found in this study might indicate that the prescription of nutritional therapy and the application of an insulin protocol are appropriate at institutional intensive care units.

Keywords: Hyperglycemia; Nutritional status; Critical care/methods; Nutritional therapy

INTRODUCTION

Severe or critical diseases are descriptions that are applied to clinical or surgical life-threatening conditions. These conditions typically require admission to an intensive care unit (ICU).[1] Nutritional depletion is common among patients admitted to ICUs because their metabolic responses to stress promote an intense catabolism of proteins to repair damaged tissues and supply energy.[2, 3] Other important alterations during severe conditions include hypermetabolism and hyperglycemia associated with insulin resistance and increased lipolysis.[1-3] Nutritional depletion impairs immune response, affects wound healing, alters bodily composition and organ function, and is associated with consequences that lead to a higher probability of infections and pressure ulcers and that increase the risks for clinical morbidity and mortality.[4]

Although the frequency and consequences of in-hospital malnutrition are

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known, nutritional therapy (NT) is not always started at an appropriate time.[5] Based on the available evidence, enteral nutrition (EN) should be started within the first 24 to 48 hours of admission to an ICU, provided that the patients are hemodynamically stable. Under these circumstances, EN is known as early nutrition.[6,7] EN is associated with improvements in negative nitrogen balance, bowel function, immunity, cellular antioxidant ability, and hypercatabolic response.[4]

Stress hyperglycemia is also a common condition among critical patients regardless of a previous history of diabetes.[8] The isolated occurrence and duration of hyperglycemia as well as abrupt variations in serum glucose levels are associated with unfavorable events such as an increased clinical morbidity and longer hospital stays.[9] Van den Berghe et al.[10] showed that controlling a patient's glycemia between 80-100 mgh/dL was beneficial and decreased both clinical morbidity and mortality rates. However, other authors have found that high rates of hypoglycemia are associated with strict glycemia control, which contributes to a poorer prognosis and increased mortality rates.[11,12] Because patients in an ICU are at nutritional risk, the present study assessed the possible correlations between patient survival and nutritional status, early nutrition, and hyperglycemia.

METHODS

The present study examined an archival cohort whose data were collected at a hospital ICU. These data included information concerning 453 patients of both sexes admitted to the ICU of a private hospital between June and November 2008. The study inclusion criterion was an ICU stay of at least 48 hours. Patients younger than 20 years old as well as those with missing data concerning body mass and height, which are needed to calculate the body mass index (BMI), were excluded. Therefore, 386 patients were included in the statistical analyses. The Research Ethics Committee of the Cardiologic Institute of the Fundação Universitária de Cardiologia (protocol number 4514-10) approved this study in agreement with the Declaration of Helsinki and informed consent was waived.

Retrospective data were collected after patients had stayed 48 hours in the ICU. Patients were assessed daily during the first eight days of their stay. Data concerning the time that elapsed before the onset of NT as well as the underlying disease, age, sex, and mortality of patients were collected from patients' clinical records. For the purpose of the present study, early NT was considered in patients who received enteral or oral nutrition less than 48 hours after admission regardless of whether its onset was appropriately planned.

A bed scale (Stryker Epic II Critical Care Bed, Michigan, USA) was used to assess patient body mass. A three-meter tape measure was used to measure patient height in segments. Whenever possible, an anthropometric scale coupled with a stadiometer was used (Filizola, Brazil); barefooted patients stood in an upright position while wearing a gown and fixed their eyes on a horizontal plane parallel to the floor. Patients' nutritional status was classified based on their BMI using the cut-off points recommended by the World Health Organization (WHO)[13] for adults; the cut-off points recommended by Lipschitz were used for patients older than 60 years.[14]

A glucometer (Accu-Check Performa, Roche, São Paulo, Brazil) was used to assess glycemia at least four times per day; hyperglycemia was considered to be present when at least half of the daily measurements were greater than 160 mg/dL.

The data were analyzed using Statistical Package for the Social Sciences (SPSS), Version 17.0 for Windows. Absolute and relative frequencies were used to describe the sample. Categorical variables were correlated using x^2, whereas continuous variables were examined using Pearson's correlation coefficient (when the data were distributed normally) or Spearman's correlation coefficient (when the data were non-normal). To assess the effect of possible confounds, a multivariate analysis was performed with the variables age, nutritional status, and underlying disease. The level of significance was set at $\alpha = 0.05$.

RESULTS

Table 1 shows the sample characteristics. A majority of patients were male and older than 60 years old, and approximately half of the sample was overweight. The most prevalent pre-existing diseases were diabetes (25.4%), neoplasms (20.7%), and ischemic heart disease (25.6%). In addition, 39.6% of the patients had a surgical procedure during their eight days of hospitalization.

Table 2 displays the descriptive data that correspond to NT during the first 48 hours as well as the percentage of patients with hyperglycemia. Approximately half of the patients received oral nutrition by the end of the first 48 hours. Hyperglycemia was infrequent after 48 hours of hospitalization, which might have been the result of an adequate patient insulinization protocol. Of the 52 patients who exhibited hyperglycemia within the first 48 hours, 30 received nutrition; however, the presence of

Table 1 - Sample descriptive data (N=386)

Variables	Result
Age (years)	65.83 ± 17.01
Elderly (≥ 60 years old)	259 (70.4%)
Gender (male)	209 (54.2%)
Body mass (kg)	73.30 ± 16.38
Height (m)	1.66 ± 0.99
BMI (kg/m²)	26.49 ± 5.09
Nutritional status	
Low weight	53 (13.7%)
Normal	146 (37.8%)
Overweight	158 (40.9%)
Obesity	29 (7.5%)

Values are expressed as mean ± SD or the number of patients (frequencies) based on the characteristics analyzed.

Table 2 - Nutritional therapy and hyperglycemia during the first 48 hours of hospitalization

Patient condition	24 hours N (%)	48 hours N (%)
Patients without nutrition	206 (53.4)	111 (28.8)
Total parenteral nutrition	2 (0.5)	7 (1.8)
Nutritional therapy	37 (9.6)	79 (20.5)
Oral nutrition	141 (36.5)	189 (48.9)
Hyperglycemia	66 (17.1)	52 (13.5)

hyperglycemia within the first 48 hours was not correlated with the establishment of early nutrition (p = 0.245).

During the 8-day ICU hospitalization, the overall patient mortality was 22.8%. Table 3 shows the mortality correlation data with regard to the other variables. Patients who did not receive early nutrition were twice as likely to die than those who began NT within the first 48 hours after admission, regardless of the other factors (p < 0.001; RR = 1.99). In addition, an age greater than 60 years and the presence of comorbidities such as congestive heart failure, dementia, hematologic disease, or neuromuscular disease increased the mortality risk of patients.

DISCUSSION

The first 48 hours of intensive care are crucial to patient prognosis. Strict control of glycemia and the application of an early nutrition protocol should be performed in patients who are critically ill, as several important, specialized guidelines emphasize.[15,16] Early NT is of paramount importance to improve the prognosis of patients who are critically ill; furthermore, early NT is associated with lower rates of infectious complications and shorter ICU stays.[17,18] However, these recommendations cannot always be applied due to several situations that occur in the ICU.

Several aspects of a single condition, including injury response, the physical limitations inherent to each individual, and his/her nutritional status before injury, hinder the nutritional status management of patients who are critically ill.[12] Therefore, we cannot assess these patients using anthropometric nutritional indicators alone because their body mass might be significantly altered due to a depletion or an overload of the plasma volume that results from major water-balance disorders over a short period of time. Thus, daily physical and laboratory exams are needed as complement assessments.[17]

Table 3 - Correlations between patient death and the analyzed variables

Variables		N	Mortality N (%)	p value	RR (95% CIs)	Adjusted RR*
Excess weight	Yes	199	47 (23.6)	0.692	1.077 (0.745-1.558)	-
	No	187	41 (21.9)	-	-	-
Without nutrition	Yes	111	37 (33.3)	0.002	1.797 (1.252-2.580)	1.99 (1.410-2.826)
	No	275	51 (18.5)	-	-	-
Hyperglycemia	Yes	52	16 (30.8)	0.141	1.427 (0.904-2.252)	-
	No	334	72 (22.6)	-	-	-
Age	≥60	259	74 (28.6)	< 0.001	2.592 (1.525-4.405)	2.31 (1.409-3.819)
	< 60	127	14 (11.0)	-	-	-
Gender	Male	209	45 (21.5)	0.519	0.886 (0.614-1.279)	-
	Fem.	177	43 (24.3)			-
Heart failure	Yes	56	23 (41.1)	< 0.001	2.085 (1.423-3.055)	2.06 (1.421-2.999)
	No	330	65 (19.7)	-	-	-
Dementia	Yes	28	13 (46.2)	< 0.001	2.216 (1.419-3.461)	
	No	358	75 (20.9)	-	-	-
Hematologic disease	Yes	10	6 (60.0)	< 0.001	2.751 (1.602-4.726)	3.38 (1.898-6.030)
	No	376	82 (21.8)	-	-	-
Neuromuscular disease	Yes	19	9 (47.4)	0.003	2.201 (1.318-3.674)	2.32 (1.470-3.674)
	No	367	79 (21.5)	-	-	-

RR - relative risk; CI - confidence interval. *Multiple Poisson regression adjusted for variables without nutrition, age, congestive heart failure, dementia, hematologic disease, and neuromuscular disease.

The relationship between body mass and mortality in patients who are critically ill has not previously been examined. Nutritional status directly affects the clinical progression of these patients, and better nutrition improves the prognosis of several clinical and surgical processes.[19,20] Patients who were malnourished before hospitalization suffered higher rates of complications, including death, and prolonged recovery than those with adequate nutrition.[4] NT must be started between 24 and 48 hours after admission in hemodynamically stable patients; this treatment is an important factor in the reduction of physiological stress and the maintenance of immunity.[17] Kurihayashi et al.[21] assessed 25 patients who were admitted to an ICU and subjected to total parenteral nutrition. These authors found that when nutritional support began early, mortality rates decreased by approximately 13%.

Patients who are overweight might exhibit several complications that directly affect their care management and their prognosis at an ICU.[20] Moock et al.[22] compared obese and normal-weight patients admitted to an ICU with regard to clinical morbidity and mortality rates and found that obesity did not increase the rate of mortality but did increase the length of stay in the ICU.[20] Despite the high prevalence of overweight patients in the present sample, a significant correlation between weight and mortality was not found.

Cartolano et al.[23] assessed adult patients at an ICU at different time points to examine the appropriateness of NT to indicate quality of care. In compliance with current recommendations, NT began (on average) 26 hours after admission.[17] Teixeira et al.[3] found similar data among 33 patients in an ICU who received nutrition (on average) 25.3 hours after admission. The present study found a later onset of nutritional support, which might negatively affect clinical morbidity and mortality rates.

Hyperglycemia is the body's natural response to metabolic stress due to hormonal alterations.[8] In addition, the care provided to patients who are critically ill increases the hyperglycemic response when corticosteroids, adrenergic agents, and glucose-rich nutritional support are used.[15] Although hyperglycemia is a normal bodily response, reducing glycemia improves the clinical progression of patients and decreases the risk of complications, especially infectious diseases. In a prospective randomized study conducted at a surgical ICU, Van den Broek et al.[19] assessed strict glycemic control using a protocol that included continuous insulin infusion to maintain glucose levels below 110 mg/dL. These authors found that reduced clinical morbidity and mortality rates were associated with decreases in bacteremia as well as the needs for dialysis, transfusions, prolonged mechanical ventilation, and polyneuropathy. However, ICU glycemic control is still controversial. A recent study[9] showed that strict glycemic control increased the absolute risk of death by 2.6% after 90 days; furthermore, this increase remained after adjusting for possible confounds. Thus, these authors did not recommend using a control as strict as the one the current guidelines have established for patients who are critically ill.

The present study did not find a high prevalence of hyperglycemia within the first 48 hours after admission. We might attribute this finding to the profile of patients admitted to ICUs in private hospitals. This profile might have differed if hyperglycemia had been assessed in urgent care hospitals where patients are attended during the acute phase (i.e., when metabolic stress is accentuated). Moreover, the low prevalence of hyperglycemia might reflect the appropriate prescription of NT after a nutritionist assessment and the proper application of the insulin protocol at the ICU.

One of the limitations of the present study is the lack of information regarding patient status. The severity of acute diseases influences the clinical progression of patients. Thus, the application of these scores is of paramount importance in the ICU. Therefore, the following line of reasoning might be valid: the patients who were the most clinically ill were the least likely to receive early nutrition because their gastrointestinal tracts were not functioning; consequently, their prognosis was poorer and their risk of death was higher. To minimize the limitation due to this lack of information, a more robust statistical analysis was performed to examine the effects of possible confounds such as age, nutritional status, and underlying disease. An additional limitation was the univariate design of the present study that required numerous patients to be assessed to ensure result consistency. The absence of variables such as septic shock and mechanical ventilation (which increases the consumption of oxygen) also limits the discussion of the present study's findings. These limitations are typical of study designs that use archival data.

CONCLUSION

The data of the present study demonstrate that the patients who did not receive early nutrition were more likely to die than those who began NT within the first 48 hours after admission, regardless of other factors related to mortality. This finding might be related to the severity of patient status because nutrition cannot begin as long as the gastrointestinal tract does not function. Nutritional status

and the presence of hyperglycemia did not increase the likelihood of death in the present sample. Therefore, the presence of a multi-professional NT team is of paramount importance to the care of patients who are critically ill, the continued training of related healthcare professionals, and the proper application of established protocols.

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RESUMO

Objetivo: Tendo em vista que pacientes internados em unidade de terapia intensiva estão em risco nutricional, e que a terapia nutricional nem sempre é iniciada no momento adequado, o objetivo deste estudo foi associar o estado nutricional, a nutrição precoce e a hiperglicemia com a mortalidade de pacientes internados em unidade de terapia intensiva.

Métodos: Trata-se de um estudo de coorte histórica com utilização de banco de dados secundários de 453 pacientes que, após permanecerem durante um período mínimo de 48 horas na unidade de terapia intensiva, foram acompanhados até o 8º dia de internação. O estado nutricional foi classificado de acordo com índice de massa corporal. Considerou-se nutrição precoce a oferta de energia nas primeiras 48 horas de internação, independentemente da via. A glicemia foi monitorada com glicosímetro.

Resultados: A maioria dos pacientes era do gênero masculino (54,2%) e quase a metade apresentava excesso de peso (48,4%). Ao final das primeiras 48 horas, 69,4% dos pacientes já estavam sendo alimentados, e apenas 13,5% ainda apresentavam hiperglicemia. Os pacientes que receberam terapia nutricional precoce apresentaram menor risco de mortalidade (p=0,002), independentemente de possuir outros fatores associados com a mortalidade.

Conclusões: A associação significativa entre a terapia nutricional precoce e a sobrevivência ressalta a importância da nutrição para pacientes graves. A baixa frequência de hiperglicemia pode ser um indicador da adequada prescrição da terapia nutricional e aplicação do protocolo de insulina na unidade de terapia intensiva da instituição.

Descritores: Hiperglicemia; Estado nutricional; Cuidados críticos/métodos; Terapia nutricional

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