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Original Article

Association between pressure injury prediction and biochemical markers

Associação entre predição para lesão por pressão e marcadores bioquímicos

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Objective: to verify the association of pressure injury prediction with albumin, hematocrit and hemoglobin levels. **Methods**: documentary study, developed in an Intensive Care Unit for Adults with records of eligible patients (n=255). Sociodemographic and clinical characterizations lesion, development of pressure injury and region; a score of the Braden scale and results of biochemical markers were extracted. There was a descriptive and inferential statistical analysis, adopting a significance level of 5.0%. **Results**: there was a prevalence of males (64.7%) and surgical patients (69.8%). There was no significant association between hematocrit and hemoglobin markers with the pressure injury prediction, unlike albumin levels (p=0.023). **Conclusion**: there is an injury pressure prediction association in the albumin. The protein intake of the patient should be seen in greater detail by the health team.
Descriptors: Pressure Ulcer; Biomarkers; Patient Safety; Nutrition Assessment; Nursing Care.

Objetivo: verificar a associação da predição de lesão por pressão com os níveis de albumina, hematócrito e hemoglobina. **Métodos**: estudo documental, desenvolvido em uma Unidade de Terapia Intensiva para Adultos com prontuários de pacientes elegíveis (n=255). Foram extraídas variáveis de caracterização sociodemográfica e clínica, desenvolvimento de lesão por pressão e região; escore da escala de Braden e resultados dos marcadores bioquímicos. Fez-se análise estatística descritiva e inferencial, adotando-se nível de significância de 5,0%. **Resultados**: houve prevalência do sexo masculino (64,7%) e de pacientes cirúrgicos (69,8%). Não houve associação estatística significativa entre os marcadores de hematócrito e hemoglobina com a predição de lesão por pressão, diferentemente dos níveis de albumina (p=0,023). **Conclusão**: há associação de predição de lesão por pressão no que se refere à albumina. O aporte proteico do paciente deve ser visto com maior rigor pela equipe de saúde.
Descritores: Úlcera por Pressão; Biomarcadores; Segurança do Paciente; Avaliação Nutricional; Cuidados de Enfermagem.

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Introduction

The scientific and technological advances linked to health care have contributed to improving the quality of care. However, especially in hospital settings, the risk of damage to patients associated with care is still very evident. In this sense, the institutions need to adopt strategies that favor the reduction of adverse events, understood as failures in care that result in real damage, of a different magnitude to the patient[1].

Despite the range of occurrence, a pressure injury is an adverse event of significant epidemiological and clinical importance, defined as injuries located in the skin and/or underlying dermal tissue, usually over a bony prominence, as a result of pressure or in combination with pressure and shear[2].

Pathophysiology of pressure injury is a multifactorial product due to the sum of clinical factors (nutrition, hydration, skin and mucosal conditions, etc.), demographic factors, especially represented by old age, and aspects related to care[1-2]. When occurring a pressure injury, it may be clinically classified into stages, which represent categories I through VI and manifested as: not bleachable erythema (I); Partial thickness skin loss (II); total loss of skin thickness (III), and total loss of tissue thickness (VI) with exposure of adjacent tissues such as muscles and even bone structures[2].

Based on its harmful potential, a pressure injury is an adverse event that deserves attention from the health team, especially the nursing interventions, because prevention involves direct and individualized care to the hospitalized patient, such as decubitus change, skin care, hydration; nutrition and bony prominences protection[3]. Furthermore, the literature indicates that 90.0% of pressure injuries can be prevented through proper care, and about a hundred risk factors have been reported for the development of this type of wound[4].

The occurrence of pressure injury triggers financial resources expenses to the health organization, which could be avoided with rational use of prevention resources[5], and it is characterized as a disruption to patient safety[1]. Therefore, it is evident that pressure injury is a problem to be seen at a dual optic, but harmonic: in the view of management, as an intervening element to the organizational goals as well as in the security perspective in direct patient care[1- 5].

Despite the importance of pressure injuries prevention for the patient safety, it should be noted that the use of institutionalized protocol has been recommended on a national level[1-2]. According to the National Health Surveillance Agency, this protocol should have six stages: assessment of pressure injury (of risk and skin) in the admission of all patients; daily revaluation of pressure injury risk development of all hospitalized patients; daily inspection of skin; dry patient maintenance and the skin moisturized; optimization of nutrition and hydration; and pressure reduction[2].

As regards the evaluation of prediction for the development of pressure injuries, it is recommended the use of systematic risk measurement scales, especially[2] the Braden Scale. The scale determines the risk for the development of the disease under a score which can range from 6 to 23 points, distributed as follows: Low Risk: 19 to 23 points; Average risk: 15 to 18 points; Moderate risk: 13 to 14 points; High risk: 10 to 12 points; and Very high risk: 9-6 points[6].

In addition to the application of the Braden scale, followed by the rational planning of individualized and qualified care, prevention of pressure injury also involves the optimization of nutrition and hydration in the patient, which may contribute greatly to this desired action[1-2]. In this regard, researchers[7] have inferred that the level of serum albumin, which is an important protein intake to nutritional status of human beings, is a parameter which deserves to be correlated with the risk of pressure injury development because the nutritional conditions, especially related to protein, have a direct impact on cell proliferation, and thus in skin integrity maintenance[8].

In addition to the above, there are other parameters/biochemical markers that should also be considered for the risk evaluation for the development of pressure injury. As an example, there are the hematocrit and hemoglobin levels that cover the volume of red blood cells and the vehicle for the transport of oxygen and carbon dioxide by the red blood cells[9] respectively. Thus, knowing that the oxygen also interferes with cell proliferation and life[8], it is observed that these parameters may be of interest in connection with the development of adverse events.

Based on the above-explained and considering that a research on risk measures to pressure injuries may mean to strengthen the role of the nurse as a care manager, through evidence-based practice, and that the construction of knowledge about biochemical parameters associated with such risk is a possibility of glimpse for improvement of care, it is believed that the studies on this issue are relevant.

Facing this justification, the question is: Is there an association of pressure injury prediction verified from the calculation of the Braden risk score, albumin, hematocrit and hemoglobin levels? It was aimed to determine the association of pressure injury prediction with albumin levels, hematocrit, and hemoglobin to answer this question.

Methods

This is a documentary study, developed with records of patients admitted to the intensive care unit for adults of a public school hospital in the state of Paraná, Brazil.

The study included all medical records of patients admitted from January to July 2013 in the intensive care unit studied, which met the following criteria: age 18 years old or older and without pressure injury in the admission register of the unit. The records without scoring results on the Braden Scale and/or biochemical tests of albumin, hematocrit and hemoglobin were excluded.

Data were collected from January to June 2014 by a single researcher who first recruited all records of patients admitted to the unit through electronic hospital system, using software for this purpose. After the recruitment of pre-eligible data, there was an individual access to each record printed on the file Medical and Statistical Service to gather all the pertinent information to the investigation. Based on the eligibility of records (n=255), it proceeded to the extraction of the study variables by a specific form prepared for the purpose of research.

The variables of interest to the study corresponded to the socio-demographic and clinical characteristics of hospitalized patients; development or not at admission of the pressure injury and place (if present), checked according to the records of the nursing staff in the medical records, as well as scores of the Braden scale and biochemical albumin, hematocrit and hemoglobin exams. After the extraction of information from medical records, data were compiled in spreadsheets Microsoft Office Excel software, version 2010.

After the tabulation, data were transported to the R® software. Through this software, there was descriptive analysis in proportions for categorical variables and central tendency (average) and variability (standard deviation) for continuous variables. To test the association between the score of the Braden Scale and the biochemical data of hematocrit, hemoglobin, and albumin, the nonparametric chi-square with Yates correction and Monte Carlo simulation were used. In all inferential statistics, the significance level of 5.0% was adopted.

It is worth noting that to comply with the contingency table - analytical phase before described - the data of the Braden scale were dichotomized between "High" in cases of 6 to 12 points; and "Low" with a score ≥13[6]. Moreover, the pursuit of the relationship between the scores and values of the hematocrit and hemoglobin levels were also segregated by gender by the knowledge of the difference between the reference values of these biochemical parameters. That is, for the hematocrit,

the normal reference values in women are 36.0%-48.0% or 0.36 to 0.48 and in men are 42.0%-52.0%, or 0.42 to 0.52; in hemoglobin 12-16g/dL for women and 13-18g/dL for men[9]. The albumin levels were also interpreted according to reference standards for adults: 3,5-4,8g/dl or 35-48g/l, and the alarm range was <1.5 g/dL or <15 g/l[9].

The study complied with the formal requirements contained in the national and international regulatory standards of research involving human beings.

Results

The average age was 49.5 years old for males (SD±19.7) and 52.4 years old for females (SD±21.3). Other characterization data of the participants are shown in Table 1.

Table 1 - Characterization data of the participants (n=255)

Variable	n (%)	IC* (95%)
Gender		
Male	165 (64.7)	64.7 (58.7–70.3)
Female	90 (35.3)	35.3 (29.7–41.3)
Medical specialty		
Neurology	70 (27.5)	27.5 (22.3–33.2)
Medical clinic	67 (26.3)	26.3 (21.3–32.0)
Pneumology	35 (13.7)	13.7 (10.0–18.5)
Orthopedics	22 (8.6)	8.6 (5.8–12.7)
infectious disease	22 (8.6)	8.6 (5.8–12.7)
Cardiology	11 (4.3)	4.3 (2.4–7.6)
Nephrology	5 (2.0)	2.0 (0.8–4.5)
Gynecology	3 (1.2)	1.1 (0.4–3.4)
Psychiatry	1 (0.4)	0.4 (0.0–2.2)
Otorhinolaryngology	1 (0.4)	0.4 (0.0–2.2)
Other**	18 (7.1)	7.0 (4.5–10.9)
Surgical intervention		
Yes	178 (69.8)	69.8 (63.9–75.1)
No	77 (30.2)	30.2 (24.9–36.0)
Braden score (points)		
Low (19 - 23)	4 (1.6)	1.6 (0.6–4.0)
Average (15 - 18)	65 (25.5)	25.5 (20.6–1.2)
Moderate (13 - 14)	22 (8.6)	8.6 (5.8–12.7)
High (10 - 12)	73 (28.6)	28.6 (23.4–34.5)
Very high (< 9)	91 (35.7)	35.7 (30.0–47.8)

*Confidence Interval between proportions; **Diseases related to the development of a tumor type

As for the score of the Braden Scale by gender, there was an average obtained of 11.96 (SD±3.31) for males and 11.7 (SD±3.3) for females.

Table 2 shows the results of data on pressure injuries developed during the hospital stay and their place.

Table 2 - Pressure injury development during hospitalization

Variable	n (%)	IC* (95%)
Pressure injury		
Yes	44 (17.2)	17.3 (13.1 – 22.4)
No	211 (82.7)	82.7 (77.6 – 86.9)
Place		
Sacrum	26 (59.0)	10.2 (7 – 14.5)
Calcaneus	8 (18.1)	3.1 (1.6 – 6)
Occipital	6 (13.6)	2.4 (1 – 5)
Other regions	4 (9.0)	1.6 (0.6 – 4)

*Confidence Interval between proportions

Table 3 shows the association between the test scores of the Braden scale and biochemical markers of interest to the study.

Table 3 - Association between the scores of the Braden scale and biochemical data of hematocrit, hemoglobin, and albumin

Exams \ Braden scale	High risk	Low risk	p-value
Hematocrit (female)			0.184[a]
Low	43	26	
Ideal	9	12	
Hematocrit (male)			1.000[b]
Low	105	49	
Ideal	7	4	
Hemoglobin (female)			0.253[a]
Low	41	25	
Ideal	11	13	
Hemoglobin (male)			0.562[b]
Low	103	47	
Ideal	9	6	
Albumin			0.023[c]
Alarm	19	4	
Low	28	7	
Average	31	20	
Normal	69	50	

[a] χ2 test with Yates correction; [b] X2 test with Monte Carlo simulation; [c] χ2 test. Association of low-grade (V Cramer = 0.20)

Discussion

The data characterization of hospitalized patients in the intensive care unit investigated was consistent with another study since there was the presence of more adult males (64.7%)[10]. Also, the profile of hospitalization in intensive care units held recently[11] pointed to respiratory failure and hemodynamic instability as the main conditions that generate such admission, which is diseases that are often assisted by specialties inherent in clinical management, found in this study.

A greater proportion of patients undergoing surgery corroborated other research that found the nursing staff workload in a unit of adult intensive care teaching hospital and pointed out that 81.3% of the investigated patients underwent surgical treatment[12]. It is also noteworthy that people undergoing surgical procedures lasting longer than two hours have a high risk for developing pressure injuries. Therefore, it is reaffirmed that the patient in need of such intervention deserves preventive care in the transoperative period, which should be in the moments after to his hospitalization[13].

The high prediction for the incidence of pressure injury evidenced in this study was also obtained in a recent systematic review studies that applied the Braden Scale in an intensive care unit[13], which is consistent with the risk of incidence of pressure injuries in that sector. This probably comes from the fact that, in clinical practice, it is known that patients in intensive care units have little or no mobility and activity, which can determine areas of tissue exposure to high pressures, vital factor to the development of adverse events in the study.

By analyzing the reference values of the Braden scale, it is observed that scores below 12 points indicate a high risk of pressure injuries development[6]. Thus, considering that the average score for gender varies around 11 points, in general, patients are at high risk of injury development. It is noteworthy that patients at high risk of pressure injury incidence obtained by scores of the Braden scale showed 25.5 times more likely to develop the adverse event than the low and moderate risk patients[10]. This data should be considered as a warning to the health team in providing safe care, which can be used care management tools, such as the Braden Scale, for its quality.

As regards the use of the Braden scale as a management tool for safe care, it deserves to be carried out by the nurse, since this professional is historically recognized as the care manager. Therefore, it is recommended that nurses regularly rate the risk for developing pressure injury and, together with the multidisciplinary team, plan rational actions of prevention of this disease[2].

Another study carried out in an intensive care unit of a hospital school had average Braden score of 12 points, with 20.6% of patients having a score less than nine points, which also determines high risk for developing pressure injuries[14]. In this perspective, it is clear that critical patients are at high risk for developing this adverse event, especially due to the increased use of treatment devices, hemodynamic instability and vasoactive medications[15], among others.

In the area investigated, 44 (17.2%) patients of 255 developed pressure injuries after the hospitalization, which is consistent with investigations in other intensive care units for monitoring inpatients and found an incidence rate of interlocutory 23.1%[10] and 22.2%[16]. Thus, it is noted that the incidence found is not far from other realities with similar service characteristics, which leads to the reflection that, in intensive care, prevention of pressure injury should be even more rigorous to reach indices increasingly reduced event, since the risk for development is evident.

Based on these results and the literature, it is reiterated that despite the increase of promotion and prevention of technologies of care related to pressure

injuries[5], its impact persists in the hospital routine. By this fact, it is considered important that health staff to monitor the quality of care indicators, the example of the incidence of pressure injuries, because this can be a valuable tool for decision making and (re) planning care, with a focus on safety and quality.

It was found that the most affected places by pressure injuries are similar to previous research pointing to sacral and calcaneus region as the main pressure injuries development regions, often related to prolonged periods of stay in the supine position[10,16], common to patients in intensive care units, as prolonged use of devices that sometimes prevents frequent changes of position.

In addition to the immobility, a common characteristic of the patient in intensive care, it is known that extrinsic factors such as pressure or friction and intrinsic factors as older age can determine the incidence of pressure injury[5]. Thus, it is clear that knowing the health condition of the patient is an essential factor for the assessment of risk of developing these injuries because some diseases determine the limitation of movements; it can interfere with blood flow and hence the supply of nutrients and oxygen to the tissues; or it may affect the immune response of the patient, making it more susceptible to infections[17]. In this perspective, Table 3 associates the risk score obtained in the Braden scale with the data of biochemical markers.

Although the mentioned biochemical markers are not statistically associated with the Braden scale, it is emphasized the importance of maintaining good levels of hematocrit and hemoglobin for the maintenance of skin integrity and wound healing. This is because the hematocrit corresponds to the number of cells in the total blood volume and hemoglobin consists of an amino acid containing atoms of iron and it works as a vehicle for transporting oxygen and carbon dioxide in the blood; and both, when impaired, can indicate a cell nutritional status deficit[9].

It is known that low levels of hematocrit and hemoglobin markers are related to the pathological condition of anemia, which involves a lower transport of nutrients and oxygen to the tissues, and they are a significant obstacle to the maintenance of skin integrity[8]. In this sense, although no statistically significant association, the results of the study bring out a factor that can contribute to evidence-based nursing practice to prevent wounds such as pressure injuries, as if arming of knowledge about the indicators biochemists, careful planning can be even more assertive. This is important because the example of the institution study, treatment, and prevention of wounds have been scored as greater potential aspects to professional autonomy of the nurse.

It is noteworthy that, checking nutritional factors involved in the development of pressure injuries, it was found that patients with the recognizable disease had lower mean hematocrit and hemoglobin compared to patients without injury[17]. Not least important, anemia was observed as an intrinsic risk factor to the patient for the development of pressure injuries in another research conducted a systematic literature review to develop new nursing diagnosis related to the development of this disease[18]. Still, anemia, diabetes, and heart failure were the main comorbidities that resulted in increased risk of developing pressure injuries since their sensory changes, mobility and tissue oxygenation[19].

Albumin is another important biochemical marker for the assessment of nutritional support of patients. It is known that serum albumin level can be considered as a criterion for identifying the risk of pressure injury, especially in the intensive care unit, as their analysis allow the nutritional control of the patient[15]. In this study, the positive statistical association was obtained ($p=0.023$), where the higher the level of albumin, the lower the risk of developing pressure ulcers. Thus, it can be said that according to the sample data at levels considered “alarm” and

"low," the risk of incidence of this disease is high and in the levels "average" and "normal," the risk is low.

It has been shown by the research in five European countries that the serum albumin levels were valid in determining the risk of pressure injuries development[20]. A systematic literature review also found low levels of serum albumin as an intrinsic risk factor to the incidence of this disease[18]. Thus, these data related specifically to the nutritional status of the patient, in line to what has already been consolidated in the literature is a fact to be considered in clinical practice intensivist as an inherent factor to pressure damage prevention plan.

This research has limitations by its study design, such as the cross-sectional cutting and survey region, which makes their results to be generalized to other realities, as well as non-compliance with records relating to the care demanded to patients and the time to onset of pressure injuries. Nevertheless, it is believed that the study contributes greatly to the knowledge of some pressure injuries prevention because it envisioned aspects and measures that deserve closer attention to search for patient safety.

Conclusion

There is an association between pressure injury prediction with serum albumin levels. Therefore, the protein intake of the patient should be seen in greater detail by the health team, which did not exclude the need of monitoring the other markers studied, because of their relevance to clinical practice already consolidated.

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Collaborations

Fernandes LM, Silva L, Oliveira JLC and Nicola AL collaborated in the design of the research project, analysis, and interpretation of data, article writing, relevant critical review of the intellectual content and final approval of the version to be published. Souza VS collaborated in the writing of the article and final approval of the version to be published.

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