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Original Article

Predictive Validity of the Braden Scale for Pressure Ulcer Risk in Critical Care Patients

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This methodological study aimed to evaluate the predictive validity of the Braden scale in critical care patients. The study was conducted in four intensive care units of a general private hospital. After approval of the project by the Hospital Ethics Committee, during six months, adult patients admitted to ICUs with a Braden score ≤18 and without PU were assessed upon admission and at 48-hours intervals as long as the patient remained at risk or until the development of PU, patients' discharge, death or transfer from the ICU. The cut-off scores of the Braden scale in the first, second and third assessments were 12, 13 and 13, respectively. Sensitivity was 85.7%, 71.4% and 71.4% and specificity was 64.6%, 81.5% and 83.1%, respectively. Areas under the ROC curves revealed very good accuracy for the cut-off scores. The Braden cut-off score 13 in the third assessment showed the best predictive performance in critical care patients.

Descriptors: Pressure Ulcer; Intensive Care; Predictive Value of Tests; Sensitivity and Specificity.

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Validade preditiva da escala de Braden para o risco de desenvolvimento de úlcera por pressão, em pacientes críticos

Este estudo metodológico foi desenvolvido em quatro unidades de terapia intensiva de um hospital geral, com o objetivo de avaliar a validade preditiva da escala de Braden em pacientes críticos. Após aprovação do projeto pelo Comitê de Ética em Pesquisa, da instituição, durante seis meses, pacientes adultos com escore total de Braden ≤18 e sem úlceras por pressão (UP) foram avaliados na admissão e a cada 48 horas, enquanto permaneceram em risco ou até o desenvolvimento de UP, alta, morte ou transferência da UTI. Os escores de Braden 12, 13 e 13, respectivamente na primeira, segunda e terceira avaliação apresentaram sensibilidade de 85,7, 71,4 e 71,4% e especifidade de 64,6, 81,5 e 83,1%. As áreas sob a curva ROC (Receiver Operating Characteristics) revelaram acurácia muito boa para os escores de corte obtidos. O escore de corte da escala de Braden igual a 13, na terceira avaliação, apresentou a melhor performance preditiva em pacientes críticos.

Descritores: Úlcera por pressão; Cuidados intensivos; Valor Preditivo dos Testes; Sensibilidade e Especificidade.

Validez predictiva de la Escala de Braden para el riesgo de úlceras por presión en pacientes críticos

Se tuvo por objetivo evaluar la validez predictiva de la Escala de Braden en los pacientes críticos. Se trata de un estudio metodológico, en cuatro unidades de cuidados intensivos de un hospital general. Después de la aprobación del proyecto por el Comité de Ética de la Institución, durante seis meses, los pacientes adultos con puntuación total de Braden ≤18 y sin úlceras por presión (UP) fueron evaluados en la admisión y a cada 48 horas, mientras permanecieron en riesgo o hasta: el desarrollo de UP, el alta, la muerte o removidos de la UCI. Las puntuaciones de Braden 12, 13 y 13, respectivamente en la primera, segunda y tercera evaluaciones presentaron sensibilidad de 85,7%, 71,4% y 71,4% y especificidad de 64,6%, 81,5% y 83,1% respectivamente. Las área bajo las curvas ROC muestrearon muy buena precisión de las puntuaciones obtenidas. Se concluye que la puntuación de Braden 13, en la tercera evaluación, presentó el mejor desempeño predictivo en los pacientes críticos.

Descriptores: Úlcera por Presión; Cuidados Intensivos; Valor Predictivo de las Pruebas; Sensibilidad y Especificidad.

Introduction

Intensive care units (ICUs) receive patients with single or multiple organ failure, who often require life support measures like mechanical ventilation, continuous sedation and vasoactive drugs, in addition to multiple types of devices, such as catheters, drains, probes and immobilizers. These measures significantly impair one of the most important mechanisms for the maintenance of skin integrity, i.e. bed mobility, making patients highly vulnerable to the development of pressure ulcers (PU)[1-2].

The National Pressure Ulcer Advisory Panel[3] defines a PU as an area of localized damage to the skin and/or underlying tissue, generally located above a bone prominence, which is caused by pressure or pressure

in combination with shear and friction. Various factors have been associated with the development of PU[3]. Specifically in the case of ICU patients, these factors include nutritional deficits, moisture, artificial ventilation, circulatory disturbances, altered tissue perfusion and, mainly, increased exposure to pressure, age, sepsis, prolonged hospitalization, some chronic diseases or conditions like diabetes, nephropathies and spinal cord injury and emergency admission[1-2,4].

In the international scenario, the implementation of guidelines for PU prevention has brought down their incidence in critical care patients from 43% to a current incidence of 28%[2]. In a recent literature review, however, the authors found higher incidence rates, from 38% to 124%, in the studies examined[5]. In Brazil, concern regarding the incidence of PU in ICU patients has also been increasing, with studies conducted in Rio de Janeiro and São Paulo, reporting incidences from 26.83% to 62.5%[6-8].

Risk assessment scales for PU development have been studied and implemented in vulnerable groups or groups more exposed to skin integrity alterations. A study[9] reported the existence of more than 40 scales, but only six have been tested for predictive validity. Norton, Gosnell, Waterlow, Braden and Bergstrom significantly contributed to these studies[10-11].

The Braden scale was published in 1987, and has mainly been used in the United States[11]. This instrument was adapted and validated for the Brazilian culture in 1999[12] and has been applied since then by some institutions in Brazil. The Braden scale consists of six subscales: sensory perception, moisture, activity, mobility, nutrition and friction/shear. The total score can range from 6 to 23 and patients are classified as follows: very high risk (score ≤ 9), high risk (score ranging from 10 to 12), moderate risk (score ranging from 13 to 14), low risk (score ranging from 15 to 18), and no risk (score ranging from 19 to 23)[13].

In their initial study[11], the authors found a sensitivity and specificity of 83% and 64%, respectively, for cut-off score 16. More recently, the same authors recommended score 18 as more appropriate, so that elderly patients as well as physiologically unstable white and black patients could be included[14]. Since then, many research groups worldwide have tried to establish the best cut-off score of the Braden scale, i.e. to define a score that best indicates risk for the development of PU. In 2003, it was concluded that the cut-off scores authors presented could not be precisely reproduced in all units, a fact that supported the need for further studies, evaluating the sensitivity and specificity of the scale in different areas, based on the distinct characteristics of the patients in each specialty[15].

Since ICU patients have peculiar characteristics and in view of the scarcity of Brazilian studies evaluating the performance of the Braden scale in general, the aim of the present study was to analyze the predictive validity of the Braden scale in critical care patients.

Methods

A methodological study was conducted, using the database from the study by Serpa and Santos[16]. In the original study, the data were collected at four ICUs (two neurology ICUs, one cardiology ICU and one general ICU, comprising a total of 80 beds) of a large, nonprofit charitable general hospital. Data were collected between January and July 2006. Although the nursing staff of the hospital uses the nursing care process, there are no institutional protocols for the prevention and treatment of PU and risk assessment scales are not used routinely.

Data were collected after approval of the research project was obtained from the Institutional Ethics Committee. After being invited to participate in the study, the patients or their legal representative received detailed information about the study objective and, after agreeing to participate, signed two copies of the informed consent form, with one copy remaining with the patient and the other with the researchers.

All patients hospitalized at the selected ICUs during the period of data collection were evaluated and those complying with the following criteria were included in the sample: age ≥ 18 years, absence of PU in the first assessment, hospitalization for a minimum period of 24h and a maximum period of 48h, a total Braden score ≤ 18, and consent to participate in the study. According to the criteria of the original study, patients with chronic renal failure, patients under dialysis for more than one month and patients with liver insufficiency accompanied by ascites were excluded. From a total of 82 patients admitted to ICUs consecutively during six months, 72 composed the final sample according to the inclusion and exclusion criteria. Seven patients were discharged, two refused to participate and one died before completing data collection.

Two instruments were used for data collection: the first consisted of socio-demographic and clinical data and was applied in the first assessment; and the second contained the validated Braden scale[12] and was applied in the first assessment and at 48-h intervals, as long

as the patient remained at risk or until the following outcomes: development of PU, discharge, death or transfer from the ICU. Only data from patients with at least three consecutive assessments were used for the analyses.

Since the beginning of the study, all healthcare team members were informed about patients who were at risk of developing PU and preventive measures were the responsibility of the institution. Once a PU was detected, the same procedure was adopted and the nursing staff was responsible for the adoption of the necessary therapeutic measures, without interference from the researchers.

To analyze the predictive validity of the Braden scale, sensitivity and specificity of the cut-off scores were calculated using receiver operating characteristic (ROC) curves, in addition to their likelihood ratios.

When interpreting the results of a diagnostic test as the probability of occurrence of a disease/phenomenon, the positive predictive value of the Braden scale indicates the probability of a patient to develop PU when classified as being at risk by the scale, whereas its negative predictive value refers to the probability of a patient not to develop PU when classified as not being at risk by the scale.

Authors[17] defined sensitivity as the proportion of individuals with a positive test who develop a disease, and specificity as the proportion of individuals with a negative test who do not develop a disease.

The ROC curve is a graphic plot of true positive values (sensitivity) on the ordinate and false positive values (1 – specificity) on the abscissa as a function of each cut-off point. Tests with a good discriminatory power are concentrated in the upper left corner of the ROC curve. There is an approximately linear quantitative-qualitative relationship between the area under the curve (AUC) and accuracy, which can be classified as follows: excellent (0.80-0.90), very good (0.70-0.79), good (0.60-0.69), and poor (0.50-0.59)[17-18].

The likelihood ratio is another method used to correlate specificity and sensitivity. In the present study, the likelihood ratio was used to express the higher (or lower) chance of finding a PU in patients at risk when compared to those classified as not being at risk. A positive likelihood ratio (LR+) of the Braden scale refers to the ratio between the proportion of patients who develop PU and who are classified as being at risk and the proportion of patients who do not develop PU and who are classified as being at risk. A negative likelihood ratio (LR-) of the Braden scale is obtained when the result of the test is negative, i.e. the proportion of patients who develop PU and who are not classified as being at risk divided by the proportion of patients without PU and who are not classified as being at risk[18]. These results are represented by Fagan Nomograms.

MS Excel software, version 2000, was used to construct the database, SPSS for Windows, version 13.0, for statistical analyses and elaboration of the graphs, and MS Word, version 2003, to construct the tables. P-values below 5% were considered significant. The patients' socio-demographic and clinical data (age, days of hospitalization, Braden score) were submitted to descriptive statistics.

Results

Out of 72 patients, 48 (66.7%) were men and the average age was 60.9 ± 16.5 years; 72.2% of the patients were classified as surgical. The minimum length of stay was 6 days and 20.8% of the patients were hospitalized for more than 31 days, mean 17.1 ± 9.0 days. The most frequent diseases were related to the cardiovascular system (83.3%).

Initial evaluation classified the patients of the sample as low risk (30.5%), moderate risk (40.3%) and high risk (29.2%). Eight patients developed PU, with an incidence of 11.1%. PU were diagnosed since day 2 of hospitalization and were classified as stage I (42.9%) and stage II (57.1%).

A cut-off score 12 was identified in the first assessment, which showed 85.7% sensitivity and 64.6% specificity. In the subsequent two assessments, cut-off score 13 was obtained, with a sensitivity of 71.4% in the two assessments and specificity of 81.5% and 83.1% in the second and third assessment, respectively (Table 1).

Table 1 - Predictive values of the Braden scale cut-off scores in critical care patients, according to the assessment

	Cut-off	Sensitivity	Specificity	PPV	NPV	AUC(95%CI)	+ LR(95%CI)	– LR(95%CI)
1st Assessment	12	85.7%	64.6%	20.7%	97.7%	78.8 (0.29-1)	2.42 (1.55-379)	0.22 (0.04-1.37)
2nd Assessment	13	71.4%	81.5%	29.4%	96.4%	78.9 (0.27-1)	3.87 (1.93-7.74)	0.35 (0.11-1.14)
3rd Assessment	13	71.4%	83.1%	31.3%	96.4%	80 (0.28-1)	4.22 (2.07-8.62)	0.34 (0.11-1.12)

PPV: positive predictive value; NPV: negative predictive value; AUC: area under the ROC curve; + LR and – LR: positive and negative likelihood ratio, respectively; 95%CI: 95% confidence interval.

Analysis of the AUC showed excellent accuracy (0.8) in the third assessment and very good accuracy in the first and second assessment (0.78). All of the three curves showed a good discriminatory power (Figure 1).

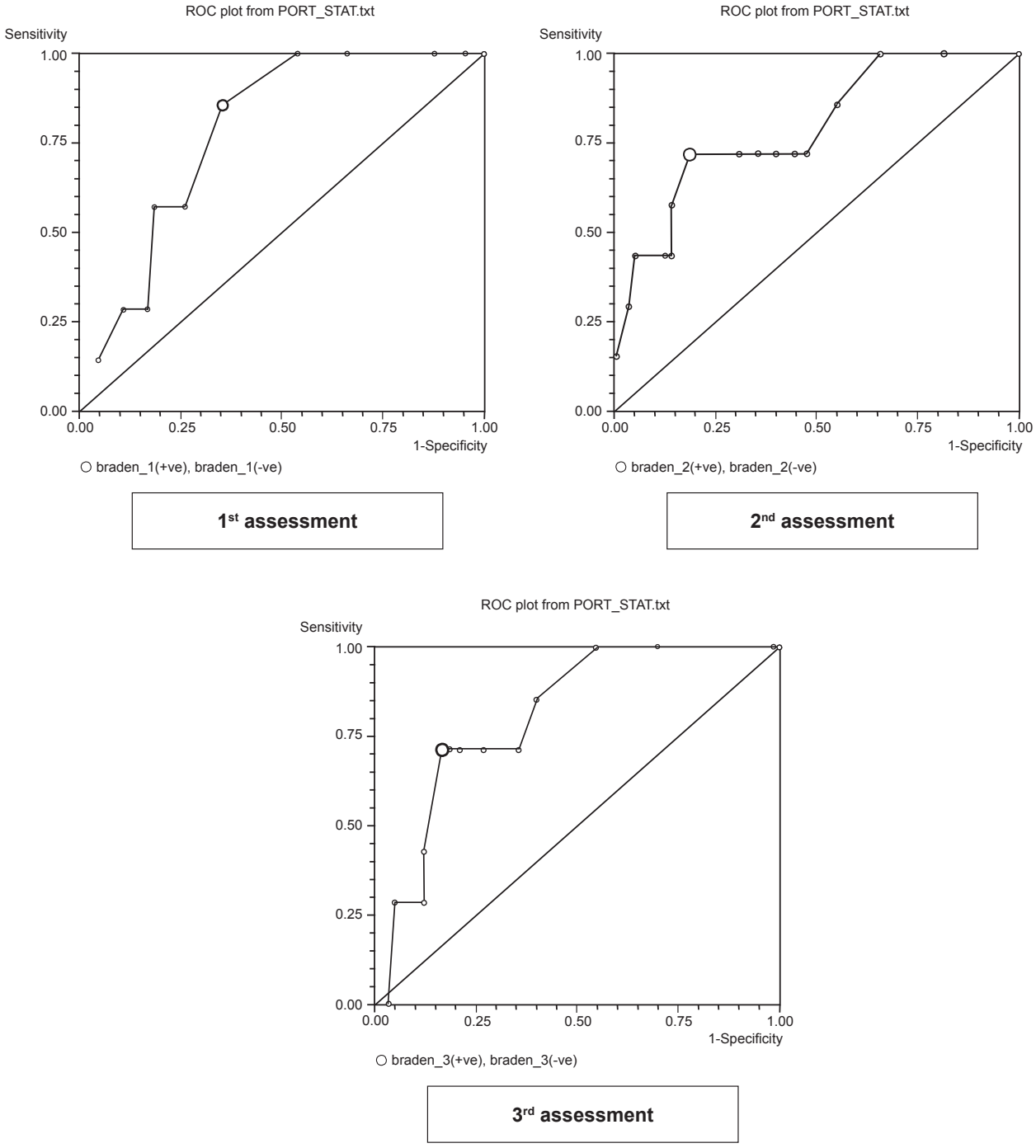

Figure 1 - ROC curves of the Braden scale cut-off scores in critical care patients, according to the assessment

LR+ was higher in the third assessment, with patients with score 13 presenting a 4.22 times higher chance of developing PU, compared to a 3.87 and 2.42 times higher chance in the second and first assessment, respectively. The lowest LR- was observed in the first assessment (0.22) and the highest in the second assessment (0.35). Thus, in the third assessment, using score 13, the probability of developing PU was 31% when the test was positive and 4% when the test was negative. In the other assessments, the cut-off scores yielded lower probabilities of 29% and 21% for positive tests and 4% and 2% for negative tests in the second and first assessments, respectively (Figure 2).

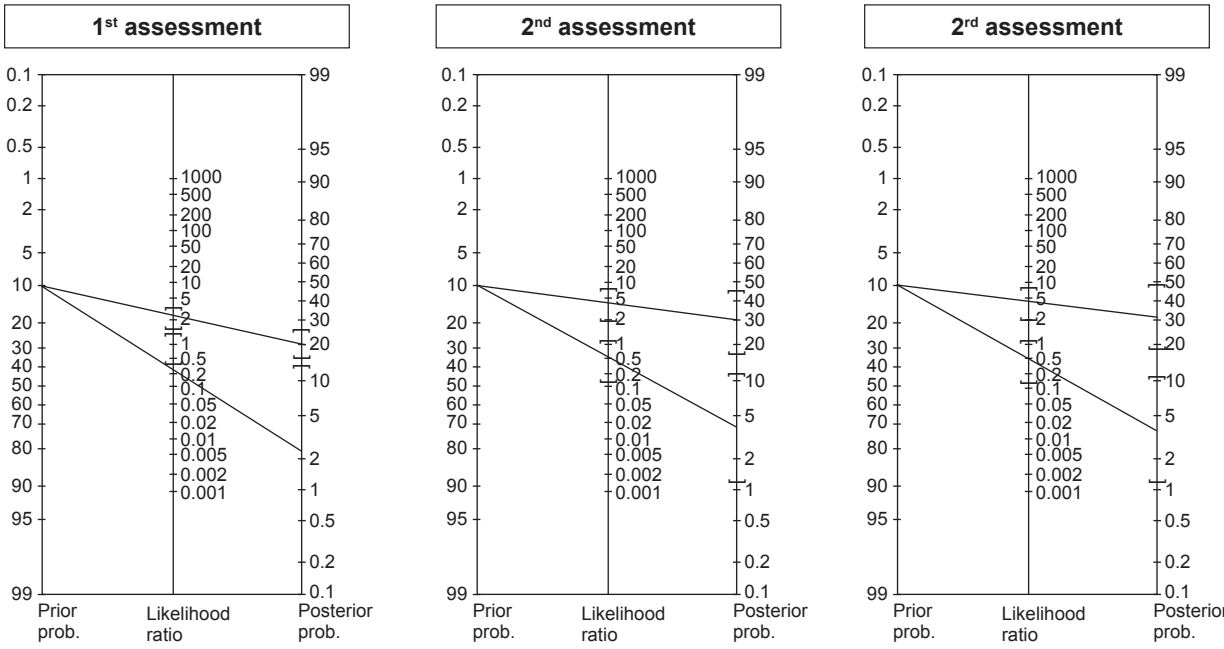

Figure 2 - Fagan nomograms of the Braden scale cut-off scores in critical care patients, according to the assessment

Discussion

PU are a socioeconomic and educational problem that has an important financial impact, with their prevention being less costly than their treatment. PU treatment ranks third among the most expensive health treatments, less expensive only than cancer treatment and heart surgery[19]. In addition, when the patient develops a PU, the nursing team becomes intensive, showing an increase by about 50%. Thus, the prevention of PU is of primary relevance for patient care, with consequent benefits for the health system[12,20-21].

In order to prevent the development of PU and optimize resources and measures, risk assessment scales have been studied in detail worldwide[22-23], and also more timidly in Brazil[12]. In these studies, sensitivity and specificity vary, resulting in different cut-off scores, mainly, as expected, when considering different specialties. These differences between cut-off scores are due to extrinsic and intrinsic characteristics of the specific patient groups, a fact that motivated the present investigation regarding the predictive validity of the Braden scale applied to critical care patients in Brazil.

Similar to our findings, other Brazilian authors[12] found a higher balance between sensitivity (52%) and specificity (80%) for critical care patients when score 13 was used in the third assessment. The same score was obtained, investigating 186 patients from a neurology ICU, which classified 41.4% of the patients as being at risk in the first assessment, with a sensitivity of 91.4%, a positive predictive value of 27.3% and 1.8% of false-negative results[24].

In another study[25], score 14 was also identified in 337 patients submitted to heart surgery from the first till the third postoperative day during ICU hospitalization. This score showed the best performance on the third day, with 57.1% sensitivity and 92% specificity.

The frequency of application of the Braden scale continues to be a controversial issue. Although Waters[15] recommended its application upon admission and 48 hours later, no consensus is available for intensive care patients. In its most recent revision about PU Prevention, the National Pressure Ulcer Advisory Panel (NPUAP)[26] recommended that institutional protocols of risk assessment and re-assessment should be developed according to the characteristics of the clinical areas where the patient is attended.

Restrictions of mobility, the presence of incontinence and nutritional status are rarely identified upon admission to the ICU. Thus, the cut-off score can be established in subsequent assessments, like in the present study and in another research[25]. Applying the Braden scale at 24-h intervals seems to be reasonable in view of critical

care patients' frequent instability and the identification of a subsequent assessment as one of the best PU risk predictors in ICUs. In a recent literature review, the author stated that the ideal time for this evaluation varies according to the characteristics of the patients. In general, the first assessment should be performed 72 h after admission, when the risk for the development of PU is elevated[27].

In the present study, considering all three consecutive assessments, score 13 in the third assessment obtained the most adequate predictive values, showing the best balance between sensitivity and specificity, and excellent accuracy and best LR, in agreement with other studies' findings[12,24-25]. These results confirm score 13 as the best to identify the risk for the development of PU in critical care patients.

Limitations and recommendations

Despite the prospective character of the present study, including rigorous and controlled data collection, limitations were related mainly to the number of ICU involved and the fact that they belonged to a single hospital.

In spite of its limitations, the study contributes with important data to the national and international literature by confirming or contrasting obtained results, using the same tool. On the other hand, it adds a new statistical strategy to analyze the predictive validity of risk assessment scales, which was the LR.

Further studies are necessary to analyze the Braden scale's performance in a bigger sample, in different ICUs and according to specialty, such as bed immobility, a characteristic of neurology and trauma units, nutritional deficits in surgery and digestive tract units, and circulatory involvement in cardiology units, among others.

Conclusion

In the present study, the Braden cut-off score 13 in the third assessment showed the best predictive performance in critical care patients.

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