Risk Factors for Pressure Ulcers Development in Intensive Care Unit Patients

Riesgo de úlceras por presión (UPP) en pacientes internados en las unidades de cuidados intensivos

Risco para lesão por pressão em pacientes de unidade de terapia intensiva

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Abstract

Introduction: Limited sensory perception, immobility, sedation, mechanical ventilation, tissue hypoperfusion, edema and moisture are considered predisposing factors for the development of pressure injury in critically ill patients. **Objective:** To characterize pressure injuries in critically ill patients, determine the association with demographic variables, hospitalization and clinical conditions, and identify risk factors for the development of pressure injuries. **Materials and Methods:** A cross-sectional study was conducted with a sample of patients aged 18 years and older who had no pressure injury on admission and had been hospitalized > 24 hours in the Intensive Care Unit. The association of pressure injury with each of the variables was assessed using the Mann-Whitney U test, chi-squared test, likelihood ratio, and Fisher's exact test. Risk factors were identified by multivariate logistic regression. **Results:** Among 324 patients, 46 patients (14.2%) developed pressure ulcers most frequently in sacral and calcaneal regions. Risk factors for pressure injury development were age, length of stay and hospital stay before admission to the Intensive Care Unit. **Discussion:** Such high incidence, location and stage of the identified pressure injury expose the vulnerability of intensive care unit patients to this type of injury. Risk factors for pressure injury development include aspects related to the patient, hospitalization and illness severity, and their combination should be assessed as part of the daily assessment of the critically ill patient. **Conclusions:** The occurrence of pressure injury in critically ill patients is a multifactorial phenomenon, for which the recognition of risk factors can contribute to the early rapid adoption of measures for their prevention.

Keywords: Pressure Ulcer; Risk Factors; Intensive Care Units; Nursing Care.

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Resumen

Introducción: Las limitaciones de la percepción sensorial, la inmovilidad, la sedación, la ventilación mecánica, la hipoperfusión tisular, el edema y la humedad se consideran factores que predisponen la aparición de úlceras por presión en pacientes en estado crítico. **Objetivo:** Caracterizar las úlceras por presión en pacientes críticos, determinar la asociación con variables demográficas, la hospitalización y las condiciones clínicas, e identificar los factores de riesgo para la aparición de úlceras por presión. **Materiales y Métodos:** Se realizó un estudio transversal mediante una muestra de pacientes > 18 años que no presentaban úlceras por presión al ingreso y habían estado hospitalizados >24 horas en la Unidad de Cuidados Intensivos. La asociación de las úlceras por presión con las variables se verificó a través de la prueba U de Mann-Whitney, prueba de chi-cuadrado, razón de verosimilitud y el test exacto de Fisher. Los factores de riesgo se identificaron mediante regresión logística multivariada. **Resultados:** De 324 pacientes, 46 (14.2%) desarrollaron úlceras por presión con mayor frecuencia en las regiones sacra y calcánea. Los factores de riesgo para la aparición de úlceras por presión fueron la edad, la duración de la hospitalización y la estancia hospitalaria antes de ingresar a la Unidad de Cuidados Intensivos. **Discusión:** La alta incidencia, la localización y el estadio de las úlceras por lesión observadas revelan la vulnerabilidad del paciente de la unidad de cuidados intensivos a este tipo de lesiones. Entre los riesgos de las úlceras por presión se encuentran factores relacionados con el paciente, la hospitalización y la gravedad de la enfermedad, y su combinación debe valorarse en la evaluación diaria del paciente crítico. **Conclusión:** La aparición de úlceras por presión en pacientes críticos es un fenómeno multifactorial, para la que el reconocimiento de factores de riesgo puede contribuir a una rápida adopción de medidas para su prevención.

Palabras clave: Úlcera por Presión; Factores de Riesgo; Unidades de Cuidados Intensivos; Atención de Enfermería.

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Resumo

Introdução: As limitações na percepção sensorial, a imobilidade, sedação, ventilação mecânica, hipoperfusão tecidual, edema e umidade são fatores que predispõem o aparecimento da lesão por pressão no paciente crítico. **Objetivos:** Caracterizar as lesões por pressão em pacientes críticos, verificar sua associação com as variáveis demográficas, da internação, condições clínicas e identificar fatores de risco para lesão por pressão. **Materiais e Métodos:** Estudo transversal que incluiu na amostra pacientes com idade ≥18 anos, ausência de lesão por pressão à admissão e internação ≥24 horas na Unidade de Terapia Intensiva. Associação da lesão por pressão com as variáveis foi verificada com testes de Mann-Whitney, Qui-quadrado, razão de verossimilhança ou teste exato de Fischer. Fatores de risco foram identificados pela Regressão Logística Multivariada. **Resultados:** Dos 324 pacientes, 46 (14,2%) desenvolveram lesão por pressão, sendo mais frequente nas regiões sacral e calcânea. Fatores de risco para lesão por pressão foram idade, tempo de internação e permanência na enfermaria antes da Unidade de Terapia Intensiva. **Discussão:** A incidência elevada, a localização corpórea e o estágio da lesão por pressão observados mostram a vulnerabilidade do paciente de Unidade de Terapia Intensiva a este tipo de lesão. Os riscos para lesão por pressão abrangem fatores relacionados ao paciente, à hospitalização e à gravidade da doença, sendo que a combinação entre eles deve ser valorizada na avaliação diária do paciente crítico. **Conclusão:** A lesão por pressão no paciente crítico é multifatorial e o reconhecimento dos fatores de risco pode contribuir para implementação precoce de ações para evitar essa lesão.

Palavras-chave: Lesão por Pressão; Fatores de Risco; Unidades de Terapia Intensiva; Cuidados de Enfermagem.

Introduction

The severity and instability of the patient's clinical status in the Intensive Care Unit (ICU) increases their vulnerability to adverse events. One of the most common events is pressure injury (PI), which is the involvement of the skin or underlying tissue resulting from the action of pressure, shearing or friction on this structure, developing mainly in regions of bony prominences or under medical devices[1].

Sensory perception limitations, immobility, sedation, mechanical ventilation, tissue hypoperfusion, edema, and humidity are factors that predispose to the appearance of PI, especially in the presence of sepsis, advanced age, malnutrition, and comorbidities[2]. In Brazil, the incidence of PI in the ICU of university and public hospitals ranges between 19.2% and 44%, which requires strict surveillance by the multiprofessional team for patient safety[3].

PI is usually associated with a worsening of the patient's clinical condition, increasing levels of discomfort, risk of infection and pain, and can also worsen the patient's emotional state, which leads to a delay in recovery. Being an injury of multifactorial origin, which implies several therapies and behaviors, it generates high costs and increases the work demand of the nursing team. It should be noted that the absence of PI is an indicator of the excellence of nursing care[4]. The identification of patients at risk of PI and the recognition of their risk factors are essential to reduce the incidence.

The absence of PI is an indicator of the excellence of nursing care[4].

In addition to causing harm to the patient, it can also be an economic problem for health institutions. Prevention is less expensive and sustainable and nursing stands out in this role, since it has an important action in several prevention measures, such as: skin hydration, patient mobilization every two hours or according to the need defined by the nurse and that it should be applied as early as possible, unless contraindicated, adequate nutritional support, daily inspection of the skin, use of viscoelastic or pneumatic mattress, maintenance of bedding without folds, change of diapers and pads always that are wet, use of comfort pads, among others[5,6]. Individualized preventive care can also be defined according to the condition of the patient's skin together with the group of specialized nurses.

Nurse assessment guides specific interventions in skin care, which can prevent PI by up to 50%[7]. PI risk assessment in the ICU is a challenge due to the complexity of the clinical and therapeutic status of critically ill patients[8].

Considering the critical patient's susceptibility to PI, this study aims to present the characteristics of these injuries, analyze the association between PI and demographic variables, hospitalization and clinical conditions, and identify independent risk factors for his occurrence.

Materials and methods

This is a secondary analysis of data from the Research Project: "Cross-cultural adaptation and psychometric analysis of the Current Assessment Scale of the Risk of developing Pressure Ulcers in Intensive Care (EVARUCI)", approved by the Institutional Ethics Committee (CAAE: 36679514.2.0000.5505 opinion nº: 887.590). The study was conducted in the ICUs of a University Hospital, located in the city of São Paulo, Brazil. The three ICUs had 35 beds to care for adult clinical and surgical patients.

The sample consisted of the patients who participated in the primary study of cross-cultural adaptation and the psychometric analysis of the EVARUCI. The sample inclusion criteria were: age ≥ 18 years, absence of PI on admission, admission to the ICU for more than 24 hours, and signing of the informed consent. Patients with a diagnosis of brain death at admission were not included.

The sample size was defined considering the original EVARUCI score of 10 as the cut-off point for the risk of PI[2], a power of 80% of the test, a confidence interval of 95% and a standard deviation of 2.58 (from the point cut-off), observing a difference of at least 3 points more and less on the scale for patients who may or do develop PI. The calculation of the sample indicated the number of at least 12 patients with PI, based on an approximate incidence of 15% in the service, in a total of 80 patients. To guarantee a greater power of the sample and meet the objectives, we decided to evaluate a greater number of patients, collecting data over a period of six months, from May to November 2015.

PI, the dependent variable, was classified according to the National Pressure Injury Advisory Panel (NPIAP), considering: stage 1, intact skin with non-blancheable erythema; stage 2, partial-thickness skin loss with exposed dermis; stage 3, full-thickness skin loss; stage 4, full-thickness skin loss and tissue loss; unstageable, obscured full-thickness skin and tissue loss, and deep tissue loss: persistent non-blanchable deep red, maroon or purple discoloration and mucosal PI. PI related to medical devices were also classified following the same criteria.

Variables related to clinical conditions included: the severity of illness measured by the *Simplified Acute Physiology Score* 3 (SAPS3)[9] and the risk of PI measured by the EVARUCI.
The SAPS3 is a mortality prediction scale, composed of 20 different variables, subdivided into: demographic, physiological and reasons for admission to the ICU. It is easy to measure and reflects the degree of acute physiologic alterations and the evaluation of the state of health before hospital admission. The scale can vary from 16 to 217 points and the higher the score, the worse the patient's prognosis[9]. SAPS3 considers data from the first hour of patient admission to the ICU.

The EVARUCI consists of four items: consciousness, hemodynamics, breathing, and mobility with scores from 1 to 4. A point is added if axillary temperature > 38°C, oxygen saturation < 90%, systolic blood pressure < 100 mmHg, the presence of skin maceration, moisture, edema, cyanosis and/or prone position. The length of stay in the ICU is also taken into account, adding 0.5 to the total score for each week that the patient remains in the ICU, up to a maximum of two points. The final score ranges from 4 to 23 points, with low scores indicating a lower risk and high scores a higher risk of PI. Along with the scale, there are guidelines for its use, which detail the scoring criteria for each area[2]. In the sample studied, EVARUCI was applied once a day during the patient's stay in the ICU. The choice of the score of the first day of admission in this analysis, called EVARUCI D1, was due to the fact that there were no statistical differences between the mean scores, the D1 scores, the worst scores and the scores of the day immediately before the onset of the injury. The D1 score is an important risk assessment for PI, as it allows early application of preventive measures.

The data entered in the Microsoft Office Excel 2007® for Windows® were processed with the Statistical Package for the Social Science® (SPSS) 20.0. The association between PI and continuous variables was verified with the Mann-Whitney test; categorical variables, with Chi-square or likelihood ratio tests or Fisher's exact test. The identification of risk factors for PI was carried out using multivariate logistic regression, considering PI as the dependent variable. The level of statistical significance considered was 5% and the confidence interval was 95%.

Results

The sample consisted of 324 patients, 50.6% men and a mean age of 58.0 years (SD 19.25). The reason for admission of the patients was more frequent for surgical reasons (61.5%), with elective surgeries being the most frequent (38.0%). Patients with comorbidities predominated (91.0%) and 67.8% had two or more comorbidities. The mean SAPS 3 of the study sample was 43.7 (sd 13.6), the mean ICU stay was 9.5 days (sd 11.4) and the observed mortality was 13.3%.

The mean EVARUCI of the patients in the sample was 8.4 points (SD 3.86) and the incidence of PI was 14.2%. Among the 46 patients with PI, 65.7% had one lesion, 21.4% two lesions, 10.0% three, and 2.9% four, for a total of 70 lesions. The mean time to onset of PI was 10.6 days (sd 10.7).

According to Table 1, the location of the PI was more frequent in the sacral region (35.7%), followed by the calcaneus (30.0%) and the occiput (12.9%). The first PIs were more frequent in the sacral region (47.7%) and the later ones (2nd and 3rd) in the calcaneus, 60.0% and 42.8%, respectively. PI were more frequently classified as stage 2 (47.1%) and deep tissue injury (22.8%), observing that the first (52.2%) and second (46.6%) PI were more frequent in stage 2 and the third (42.8%) as a deep tissue injury. Among the PIs in Table 1, 5 were related to medical devices, being two deep tissue injuries related to the use of skin traction (dorsum of the foot and plantar), one stage 2 PI in the scrotum related to the use of a external fixator and two stage 2 PI related to fixation of the orotracheal tube (ear D and ear E).

Table 1. Sequence of appearance of PI according to body location and category. HU, São Paulo, Brazil, 2015.

Variables	PI sequence				Total %
	1st PI %	**2nd PI %**	**3rd PI %**	**4th PI %**	
Localization					
Sacral	22 (47.7)	2(13.3)	1 (14.3)	-	25 (35.7)
Calcaneus	9 (19.6)	9 (60.0)	3 (42.8)	-	21 (30.0)
Occipital	5 (10.9)	2 (13.3)	1 (14.3)	1 (50)	9 (12.9)
Gluteal	6 (13.0)	-	-	-	6 (8.6)
Ear	1 (2.2)	1 (6.7)	-	-	2 (2.9)
Trochanter	1 (2.2)	-	-	1 (50)	2 (2.9)
Plantar	1 (2.2)	-	-	-	1 (1.4)
Knee	1 (2.2)	-	-	-	1 (1.4)
Scrotum	-	1 (6.7)	-	-	1 (1.4)
Dorsum of the foot	-	-	1 (14.3)	-	1 (1.4)
Back	-	-	1 (14.3)	-	1 (1.4)
Category					
Stage 1	4 (8.7)	3 (20)	1 (14.3)	2 (100.0)	10 (14.3)
Stage 2	24 (52.2)	7 (46.6)	2 (28.6)	-	33 (47.1)
Stage 3	2 (4.3)	-	1 (14.3)	-	3 (4.3)
Stage 4	1 (2.2)	1 (6.7)	-	-	2 (2.9)
Deep Tissue Injury	9 (19.6)	4 (26.7)	3 (42.8)	-	16 (22.8)
Unstageable	6 (13.0)	-	-	-	6 (8.6)

The association between the presence of PI and the study variables (Table 2) was observed in male patients, whose frequency of PI (18.3%) was statistically higher (p=0.0325). The operating room patients had a lower percentage of PI (7.5%; p=0.0048) and the presence of PI was statistically (p<0.0001) more frequent in clinical patients (24.0%). The difference in the mean length of ICU stay with and without PI stands out, 27.5 and 6.5 days, respectively (p<0.0001) and also the frequency of death in those with PI (32.6 %; p<0.0001).

Table 2. Patients according to the variables sex, age, location before admission to ICU, reason for hospitalization, length of stay, discharge status. HU, São Paulo, Brazil, 2015.

	PI		Total	Value P
	Yes	**No**		
Gender				
Male	30 (18.3)	134 (81.7)	164 (100.0)	0.0325*
Female	16 (10.0)	144 (90.0)	160 (100.0)	
Age				
Mean (DP)	60.67(20.73)	57.58 (18.99)	58,02 (19.25)	0.2322‡
Median	63.5	59	60	
Minimum-Maximum	18-94	18-95	18-95	
Location before admission to ICU				
Emergency Room	15 (20.3)	59 (79.7)	74 (100.0)	0.0048†
Operating room	13 (7.5)	161 (92.5)	174 (100.0)	
Ward	11 (24.4)	34 (75.6)	45 (100.0)	
Others	5 (20.0)	20 (80.0)	25 (100.0)	
Another hospital	2 (33.3)	4 (66.7)	6 (100.0)	
Reason for ICU admission				
Surgical - elective	6 (4.9)	117 (95.1)	123 (100.0)	0.0001*
Surgical-urgent	10 (13.2)	66 (86.8)	76 (100.0)	
Medical	30 (24.0)	95 (76.0)	125 (100.0)	
Length of ICU stay (days)				
Mean (DP)	27.5 (18.3)	6.5 (5.9)	9.49 (11.4)	<0.0001‡
Median	24	4	5	
Minimum - maximum	2-77	1-46	1-77	
ICU discharge conditions				
Discharge/Transfer	31 (67.4)	250 (89.9)	281 (86.7)	<0.0001*
Death	15 (32.6)	28 (10.1)	43 (13.3)	

*Chi-square; test †Odds ratio; ‡Mann Whitney.

According to Table 3, patients with PI achieved a higher mean SAPS3 (p<0.0001), which indicates greater severity. The EVARUCI mean was higher (12.3) for those who developed the lesion (p<0.0001), and of the 46 patients with PI, 70% obtained scores indicative of risk (>10).

Table 3. Patients according to comorbidity, SAP3, EVARUCI D1. HU, São Paulo, Brazil, 2015.

	PI		Total	Value P
	Yes	**No**		
Number of comorbidities				
No comorbidities	5 (17.2)	24 (82.8)	29 (100.0)	0.5862†
1	11 (11.6)	84 (88.4)	95 (100.0)	
2	10 (11.2)	79 (88.8)	89 (100.0)	
3	13 (17.1)	63 (82.9)	76 (100.0)	
4 or more	7 (20.0)	28 (80.0)	35 (100.0)	
Comorbidities				
No	5 (17.2)	24 (82.8)	29 (100.0)	0.5815*
Yes	41 (13.9)	254 (86.1)	295 (100.0)	
SAPS 3				
Mean (DP)	51.78 (12.69)	42.31 (13.33)	43.66 (13. 63)	<0.0001‡
Median	52.5	41	42	
Minimum -Maximum	23-90	16-88	16-90	
EVARUCI D1				
Mean (DP)	12.3 (4.09)	7.8 (3.43)	8.44 (3.86)	<0.0001‡
Median	11.5	7	7	
Minimum -Maximum	4-19	2-18	2-19	

*Fisher's exact test; †Odds ratio; ‡ Mann-Whitney.

The independent risk factors that were associated with the development of PI were age, length of ICU stay, and location before admission to ICU when referred from the ward (Table 4).

Table 4. Multivariate logistic regression model considering PI as the dependent variable. HU, São Paulo, Brazil, 2015.

	Estimation	Value P	OR	95% CI
Constant	-6.40	**<0.0001**		
Age (Years)	0.03	**0.0248**	1.03	[1.004: 1.06]
Location before admission to ICU				
(Ward vs Operating room)	1.16	**0.0481**	3.20	[1.01: 10.15]
Length of ICU stay	0.20	**<0.0001**	1.22	[1.16: 1.29]

Discussion

The incidence of PI in many the study sample was high, which indicates the vulnerability of the ICU patient. In the systematic review that analyzed eighteen studies focused on predictive risk factors for PI in critically ill adult ICU patients, from Europe, Asia, the United States of America, South America, and the Middle East, the frequency of PI observed was disparate around the world. The lowest percentage of PI frequency was 3% and the highest 60%, with discrepant percentages occurring in US surgical ICUs. Despite this wide variation in the frequency of PI, seven studies in this systematic review showed incidences close to the results of our study[10], as

well as that found in a study conducted in the medical and surgical ICU of a tertiary hospital in Thailand, with a sample of 288 patients, whose percentage of PI was 11.1%[11].

Due to therapies to treat organ dysfunction and hemodynamic instability, the physical mobility of critically ill patients is impaired, causing pressure on various bony protruding areas, in addition to pressure exerted by medical devices, which can cause PI. It should be noted that some patients in the sample of our study had more than one PI, which may be due to the fact that they had spent more time in the ICU. Several institutions have protocols for the prevention of PI, but some external factors not related to the patient can directly interfere with PI preventive care, such as: ineffective team communication, insufficient number of nursing professionals, lack of specialized nurses and lack of support for continuing education[12].

Some external factors not related to the patient can directly interfere with PI preventive care, such as: ineffective team communication, insufficient number of nursing professionals, lack of specialized nurses and lack of support for continuing education[12].

In the sample of this study, most patients with PI developed the lesion in the sacral and calcaneal region, especially in stage 2 and deep tissue lesions. An American retrospective study that analyzed the factors associated with PI in 57 patients in a surgical ICU showed that the location and classification with the highest percentages were sacral and gluteal, with deep tissue injury and stage 2, respectively. These findings were related to a higher risk of PI in the mobility and friction/shear items on the Braden[13] scale. Another study on the incidence and risk factors associated with the development of PI in critically ill patients in Saudi Arabia revealed that, of 84 patients, 33 developed PI, with the calcaneal region and the stage 1 classification being the most frequent[14]. The development of PI in the calcaneal region is noteworthy because injury to this area is potentially preventable, considering that it is a body region of easy implementation of pressure relief strategies, such as the use of a cushion in the calf region to elevate the lower limbs, avoiding exacerbated pressure on the calcaneus.

In the Brazilian study that analyzed 9605 ICU patients in 2016 to validate and improve the Braden scale, 138 patients developed PI, most of them in the sacral region and classified as stage 2[15]. The anatomical vulnerability of the sacral region to PI in ICU patients, due to being in dorsal decubitus with the head elevated, requires the early application of preventive measures.

The anatomical vulnerability of the sacral region to PI in ICU patients, due to being in dorsal decubitus with the head elevated, requires the early application of preventive measures.

The analysis of the risk factors associated with the stage of PI carried out in 19,893 patients admitted to hospitals in the United States between 2011 and 2016 showed that advanced age, ambulatory status, ICU stay, presence of an ostomy or presence of a fecal management system increase the chances of developing PI regardless of the stage[16].

Age has been an independent risk factor for PI[11,17] also observed in the present study. In addition to the cell turnover rate slowing with the reduction of the vascular and glandular network in the aging, other systemic factors and reduced cognition and mobility contribute to skin susceptibility to PI[18].

The results of the analyzes on PI development in critical patients according to sex have varied. Some studies indicate differences in incidence and prevalence between men and women,

but others do not[3,4,13,16]. In studies where men had more PI, the likely explanation is the man's reluctance to seek health services. Therefore, it is observed that care for this population is carried out in the emergency, specialized care and urgent care in less favorable clinical conditions [19,20]. The development of PI has been observed in these conditions associated with the severity of illness and hemodynamic instability[3,13,21].

PI has been associated with the severity of illness[15,21]. Some factors that indicate the severity and vulnerability of ICU patients described in a North American study were: cardiac arrest, protein-calorie malnutrition before developing PI and the use of vasopressor drugs 48 hours before the onset of PI. Intrinsic and extrinsic risk factors were frequent: immobility, septic shock, head elevation above 30 degrees, sedation and mechanical ventilation for more than 72 hours[13].

Thus, a good clinical condition and patient stability are expected to achieve better results. In this study, the incidence of PI was lower in elective surgery patients and in those coming from the operating room. Elective surgeries foresee an early preparation of the patient to avoid complications.

The length of ICU stay for patients with PI, in this study, was four times greater compared to those without PI, and it was observed that for each additional day of hospital stay the risk increased by 22%. In a systematic review of independent and predictive risk factors for PI in critically ill patients, length of stay was identified as a risk factor in six of the 11 studies analyzed[11].

The length of stay favors the appearance of adverse events, identifying it as the main risk factor[22]. In another study on the influence of nursing workload and the risk of incidents without injuries and adverse events in the ICU, those related to the skin, such as dermatitis, rashes and PI were the most frequent, and the occurrence of incidents increased the days of stay in the ICU[23].

The results of this study confirm the multifactorial characteristic of PI in ICU patients pointed out in other studies. However, the limitation of this study is that the results were observed in a single center, and it is important to consider new multicenter studies with methods that allow the analysis and understanding of the complex interaction of risk factors in the development of PI. , taking into account the routinely adopted preventive measures.

Conclusion

Multiple factors were associated with the development of PI, either from the critical patient himself, his hospitalization and his clinical status. The independent risk factors associated with the development of PI indicate that in the critical care patient assessment, advanced age, hospitalization prior to admission to the ICU, whose worsening of the clinical state indicated the need for intensive care, and the prolonged ICU stay should be taken into account to the prevention of PI, so that preventive care can be applied early, especially in the region of the sacrum and calcaneus.

We emphasize the importance of PI prevention care and the fact that nursing professionals are in direct contact with patients 24 hours a day during their stay in the health institution, which allows assessing and monitoring the clinical conditions that may require changes or intensification of care in terms of prevention of PI.

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