

What are the risk factors for pressure injuries in intensive care? An observational retrospective study in an Italian intensive care

Quali sono i fattori di rischio per le lesioni da pressione in terapia intensiva? Uno studio retrospettivo osservazionale in una terapia intensiva italiana

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RIASSUNTO

Objective: the present study aims to identify the risk factors for the development of pressure ulcers in an Italian intensive care unit.

Materials and Methods: a retrospective observational study was carried out through the analysis of computerized medical records of patients hospitalized in an Italian multipurpose intensive care unit (ICU) in 2019. All patients admitted to the ICU in 2019 had no pressure ulcers at the time of admission and stayed in the hospital for at least 72 hours. Patients who developed ulcers during the first 72 hours of their stay and pediatric patients were excluded.

Results: of the 256 patients analyzed, 53 (20.7%) developed at least one pressure ulcer during hospitalization in the ICU. The lesions developed on the eighth day on average.

Conclusion: the univariate analysis revealed that age, ($p=0.025$) length of stay ($p=0.001$), mechanical ventilation ($p=0.035$), serum albumin ($p=0.006$), and the Simplified Acute Physiology Score (SAPS II) ($p=0.023$) were the most influential risk factors for the development of pressure ulcers in our intensive care unit.

Parole chiave: intensive care, pressure sore, pressure ulcer, risk assessment, risk factor.

ABSTRACT

Obiettivo: lo scopo del presente studio è identificare i fattori di rischio per lo sviluppo di ulcere da pressione in un'unità di terapia intensiva italiana.

Materiali e Metodi: è stato condotto uno studio osservazionale retrospettivo attraverso l'analisi delle cartelle cliniche informatizzate dei pazienti ricoverati in un'unità di terapia intensiva (ICU) polifunzionale italiana nel 2019. Tutti i pazienti ricoverati in terapia intensiva nel 2019 non presentavano ulcere da pressione al momento del ricovero e sono rimasti in ospedale per almeno 72 ore. Sono stati esclusi i pazienti che hanno sviluppato ulcere durante le prime 72 ore di degenza e i pazienti pediatrici.

Risultati: dei 256 pazienti analizzati, 53 (20,7%) hanno sviluppato almeno un'ulcera da pressione durante il ricovero in terapia intensiva. Le lesioni si sono sviluppate in media all'ottavo giorno.

Conclusioni: l'analisi univariata ha rivelato che l'età, ($p=0,025$) la durata della degenza ($p=0,001$), la ventilazione meccanica ($p=0,035$), l'albumina sierica ($p=0,006$) e il Simplified Acute Physiology Score (SAPS II) ($p=0,023$) erano i fattori di rischio più influenti per lo sviluppo di ulcere da pressione nella nostra unità di terapia intensiva.

Key words: terapia intensiva, piaga da decubito, ulcera da pressione, valutazione del rischio, fattore di rischio.

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Introduction

A pressure ulcer is a localized lesion to the skin and/or underlying tissue, usually situated on a bony prominence, as a result of pressure or pressure combined with shear forces.¹ Pressure ulcers are considered a common and costly problem in patient care,² and their incidence in a unit indicates the quality of nursing care and the facility.³

Pressure ulcers can be found across all care settings—from paediatrics⁴ to elderly patients⁵ up to units that provide end-of-life care,⁶ just as they can be found among bedridden patients at home.⁷ The primary cause contributing to the development of lesions is limited mobility in bedridden and/or wheelchair-bound patients.¹ Almost all these factors are present in ICU patients, but the typicality and intensity of care may lead to additional ICU-specific risk factors absent in other operating units, so much so that scales are developed for specifications, such as RAPS-ICU⁸ and EVARUCI.⁹ Due to the typical severity of patients' conditions, the highly invasive treatment, and the intensity of care, ICUs have a specialized environment within hospitals, with risk factors for developing pressure injuries typical of these hospital units. Furthermore, there are different types of ICUs (neurosurgical, cardiological, trauma, postoperative, polyvalent, etc.), and each admits diverse types of patients, depending on the country in which it operates for which they can be considered, each has unique specificities for treatments, types of patients and operators who work. Indeed, the intrinsic risk factors are unique and specific, making 'ICU populations too varied to identify general pressure injury risk factors'.¹⁰

After a comprehensive literature review, we decided to study the risk factors most often responsible for injuries in intensive care and others that we decided to investigate to find any correlation: age,¹¹⁻¹³ length of stay,¹⁴⁻¹⁸ diabetes,¹⁹ body mass index (BMI),^{20,21} type of hospitalization, cardiological issues,²² elective surgery, urgent surgery, neurological, medical disease, comorbidity, oncological pathology, acquired immunodeficiency syndrome (AIDS), chronic obstructive pulmonary disease,^{20,23} peripheral vascular disease,²⁴ cirrhosis, vasopressors (*e.g.*, adrenalin, noradrenalin, dobutamine),^{23,25-27} sedatives (*e.g.*, propofol, midazolam), muscle relaxants (*e.g.*, rocuronium), dialysis,^{28,29} mechanical ventilation,^{26,29-31} SAPS II,^{32,33} albumin,^{34,35} hemoglobin, and sodium.

The hospital provides multipurpose intensive therapy where all patients with severe impairment requiring vital parameters are hospitalized, regardless of the causes. Hence, the study aims to describe the incidence of pressure injuries, examine the risk factors specific to the context, and adopt behaviors that prevent the development of pressure ulcers. The study also intends to identify which factors have the greatest impact on the development of pressure ulcers in a specific care setting and adopt more targeted and effective prevention measures by improving care and reducing the consumption of protective products.

Materials and Methods

Study design, population, and setting

The study, known as Factors Risk Injury Pressure in INTensive Care Unit (FRIPINCU), is a retrospective observational study conducted from January 1st, 2019 to December 31st, 2019. It included all patients between the ages of 18 and 90 admitted to the ICU of Infermi Hospital, a public hospital in northern Italy within one year, who did not have pressure ulcers at the time of admission and who had had a hospital stay for at least 72 hours. All nurses were trained in the management of pressure ulcers, and there were two nurses specialized in wound care.

Patients who developed pressure ulcers within the first 72 hours of admission were excluded because the lesions could be caused by factors present in their previous care settings.

There were 713 potentially eligible patients hospitalized during the study period.

Among the 713 patients, 399 patients were excluded because they did not exceed the minimum 72 hours of hospitalization, 13 patients were excluded because they were minors, 6 already had lesions at the time of admission, and 38 were excluded because they developed lesions in the first 72 hours.

Of the 257 patients included in the study, 1 patient was not included because the data were incomplete (Table 1).

Table 1. Descriptive analysis.

Patient characteristics	Mean (SD)	Median (IQR)	Total number of patients, N (%)
Age (years)	63.7 (15.9)	66 (54–77)	256
Length of stay (days)	12.4 (11.0)	8 (6–14)	256
Gender (male)			149 (58.2)
Patient with dialysis			25 (9.7)
Treatment	Mean (SD)	Median (IQR)	Total number of patients
Amine (days)	4.6 (5.4)	3 (2–5)	133
Midazolam (days)	5.2 (7.9)	4 (2–6)	149
Propofol (days)	4.9 (6.4)	3 (2–6)	155
Rocuronium (days)	2.3 (2.1)	2 (1–2)	59
Ventilation (days)	8.8 (8.3)	6 (4–10)	200
Ventilation days/total hospitalization days (%)		71.4 (48.5–87.5)	200
SAPS		45 (34–60)	240

SAPS, Simplified Acute Physiology Score.

Data collection

Software tool for data collection

The study involved an analysis of the computerized medical records, which had been filled out using the software Innovian® (owned by Drägerwerk AG & Co. KGaA, Lubeck, Germany) by doctors and nurses of the study's selected patients.

Innovian® is a software created by Draeger, a European business leader in producing mechanical ventilators. The software can communicate with the clinical dossier and it includes computerized therapy notes. In the clinical dossier doctors and nurses can write clinical information, and there are evaluation scales about pressure ulcers, fall risk, delirium risk, and consciousness level.

Variables evaluation

The analysis was performed from August 2021 to February 2022. All injuries of unclear pressure origin were discarded. All patients who received a protective dressing at the hospitalization were excluded. All patients that not received a protective dressing were enrolled in the study until the end of the hospitalization or from the onset of the ulcer.

The days of drug infusion and ventilation were calculated by adding the infusion days between breaks (if present). The number of days not completed has not been considered. For the patients in mechanical ventilation, the percentage of days was also calculated until the end of hospitalization or from the onset of the lesion (Table 2). Non-invasive ventilation with a helmet or mask was not counted as mechanical ventilation. Laryngeal tubes were not used in the ICU of the hospital. Pressure ulcers from endotracheal tubes or non-invasive ventilation interfaces were not considered, because it was already clear the cause of the onset.

The length of stay of those with ulcers was calculated up to the day of the illness's onset. The revision started in August 2021, following approval by the ethics committee. Each operator responsible for data acquisition collected and transcribed the needed data, which the operators had recorded during hospitalization in a spreadsheet.

Data management

The quality and integrity of the reported data were checked. Ambiguous data relevant to the study was verified by the primary investigator, with approval from the whole research team.

The stage of the lesion was analyzed based on the National Pressure Ulcer Advisory Panel (2014) definition. The classification was extrapolated from the clinical dossier and the ulcer pressure staging was calculated from the pressure ulcer risk scale.

To simplify data and analysis collection, the body was divided into six different parts, namely: lower limbs, which included the thighs, knees, and ankles, upper limbs, which included the elbows and shoulders, back, which included the shoulder blades and dorsal spine, sacral area, heels, and nape

Missing data

Only 164 patients out of 256 had albumin data because the data of some patients was not available in the computerized medical records. **Simplified Acute Physiology Score (SAPS)** was also missing for 16 patients because the doctors did not report it.

Statistical analyses

A total of 256 records were evaluated during the data gathering. All the recorded variables were analyzed using the following statistics: frequency, mean (M), standard deviation (DS), median (Mdn), range, and percentiles.

The statistical relationship between the different factors and the outcomes (the onset of the injury) was investigated using the chi-square test, the *t*-test for independent groups, and/or the Kruskal-Wallis H test as a non-parametric method, depending on the type of variable in the studio, and Kaplan–Meier analysis. For all statistical tests, the significance threshold was 0.05. The analysis was performed using the statistical software STATA 14.2, a general-purpose statistical software package (StataCorp LLC, 4905 Lakeway Drive, College Station, Texas, USA).

Declarations

The study was approved by the Ethics Committee of Emilia Romagna (Italy) on July 28, 2021 (opinion no. 3059). All data was collected anonymously, and the most rigorous privacy standards were followed under the European Regulation on the Protection of

Table 2. Ulcers found.

Day	Mean (SD)		Median	IIQ
	N	8.7 (5.0) %		
Injury area				
Lower limbs	9	16.9		
Upper limbs	3	5.6		
Back	13	24.5		
Nape	2	3.7		
Sacred	8	15.0		
Heels	18	33.9		
Injury stadium				
Eschar	3	5.6		
Deep tissue injury	4	7.5		
I stage	11	20.7		
II stage	35	66		
III stage	0	0		

Personal Data (Regulation 2016/679, part of GDPR), and the provisions were issued by the guarantor for the protection of personal data on the subject.

Results

Table 1 presents the 256 participants of the study. The descriptive analysis of the patients' records revealed that 53 (20.7%) developed at least one pressure ulcer during their stay in the ICU. The highest number of lesions occurred on the heels (18, 33.9%), followed by those on the back (13, 24.5%). Eight first- and second-stage lesions appeared on the sacrum (15%), while three lesions appeared on the elbows (5.6%). Only two nape lesions were recorded (3.7%).

Of the lesions that appeared, 35 (66%) were stage II, 11 (20.7%) were stage I, 3 (5.6%) were identified as eschar, and 4 (7.5%) were deep-tissue injuries. The lesions developed on the eighth day on average (M 8.7) (DS 5.0, Mdn 7, interquartile range 5-11).

The data obtained was processed through univariate analysis. The following factors were identified as the most statistically significant in the development of pressure ulcers in our ICU.

Age

The data collected shows that age appears to be a statistically significant element in our sample. The mean age was 63 years for the entire sample, while the 53 patients who developed ulcers had a mean age of 68 (SD 13; 95% CI 64-71). Hence, the mean age was 62 for those who did not develop ulcers (SD 16; 95% CI 60-64) ($p=0.025$).

Length of stay

As frequently reported in the study's literature review, length of stay contributes to the development of pressure ulcers. The study's findings indicated that those who developed pressure ulcers had a mean hospital stay of 20 days (Mdn 17, IQR 10-26) (OR 1.07; 95% CI 1.04-1.10) ($p=0.001$) versus 10 days (Mdn 7, IQR 5-11) for those whose skin remained ulcer-free.

SAPS

The SAPS index was calculated for almost all patients in the sample under examination (240 patients, 16 missing). The median SAPS score of patients who did not develop lesions was 43 (mean 45.6; IQR 33-60; SD 7 18.3), while injured patients' median SAPS score was 53 (mean 51; IQR 38-62; SD 17.5), with a median difference of 10 ($p=0.023$).

Albumin

Collecting the albumin data of 164 patients (92 missing) is possible. The findings revealed that the average value of albumin on admission was 29.8 (SD 6.2) for the 130 uninjured patients, while the value of albuminemia on admission was, on average, lower than 3 points (26.3; SD 7.4; $p=0.006$) in the 34 patients who developed pressure lesions, demonstrating its protective factor.

Mechanical ventilation

A total of 200 patients received mechanical ventilation, of whom 46 developed a pressure ulcer on the eighth day (M 8.7, Mdn 7, IQR 5-10, SD 7.3) ($p=0.035$). This supported other studies' findings that reported mechanical ventilation as a vital factor in the development of ulcers in the ICU.

Discussion

Intensive care unit patients are at increased risk for pressure ulcers development, because of the complexity of the critical illness, as well as the multiplicity of advanced devices and technologies used. Study findings revealed that the heels area was the most common location of pressure ulcers.

The study's results demonstrated that age, length of stay, mechanical ventilation, serum albumin, and SAPS are crucial elements in pressure ulcer development in ICU patients. However, other factors analyzed in the study were also dangerous, but no statistically significant relationship emerged in our sample. The limited sample size may have influenced the results of some risk factors.

Hence, it is essential to note that several factors can coexist in the same patient such as frailty, clinical instability, polytherapy, and comorbidities, and can make it difficult to identify a single risk factor because the various elements add up, and interact with and influence each other. For example, a direct histological effect on pressure ulcer development is that which occurs after the administration of high-dose inotropes. This is because they create areas of low blood flow, with consequent superficial tissue hypoxia, by causing peripheral vasoconstriction.

Other drugs, such as the sedatives midazolam and propofol, analyzed in this study, contribute to the development of pressure ulcers without having a direct histological effect, but ulcers are caused by patients' reduced mobility, lower sensitivity, and skin perception.

The study's results are consistent with Oot-Giromini's (1993) findings where the etiology of pressure ulcers is a 'causal network' of risk factors that influence each other and it is similar to the results that emerged in the study conducted in our ICU.

Therefore, it is vital to identify the specific risk factors of each intensive care unit to initially determine patients at risk of developing pressure ulcers and improve their treatment based on the estimated risk during their hospital stay. This is because the aforementioned factors and the multiple types and means of treatments that can be carried out in ICUs vary from one country or region to another.

It would be interesting for further studies to examine why the risk seems to increase with multiple treatments, and whether this is related to a more serious condition or the reduced possibilities for skin inspection and pressure injury prevention.

Limitations

The study had several limitations

The analyzed files were retrieved from the hospital's archive and compiled without specific data collection for the study, which led to numerous missing items. Some patients with pressure ulcers at the time of admission were excluded from the study, even though they developed ulcers in the following days in different areas, to ensure the high specificity of the data on injuries and avoid the risk of enrolling patients who had suffered risk factors in previous hospital settings.

Another limitation of the study is the low number of patients enrolled, which did not allow us to standardize the data at par with most of the studies reported in the literature. Furthermore, it was impossible to establish a single type of hospitalization for all patients because some had several coexisting pathologies. For example, if cardiac patients had sepsis, they were assigned two or more types of hospitalization.

In the end, in this study, we did not distinguish between different inotropic drugs, such as adrenaline, noradrenaline, and dobutamine, or whether the patient was given more than one of these drugs.

Conclusions

Age, length of stay, mechanical ventilation, serum albumin, and SAPS are critical in the development of pressure ulcers in the ICU. The most critically ill patients are those with the highest risk of developing ulcers due to the simultaneous presence of multiple risk factors, without any risk factor predominating over the others. Thus, it is imperative to identify each ICU's most specific and frequent risk factors. It is also relevant to undertake preventive measures immediately upon admission to determine patients' criticality. This is because most critically ill patients are subject to more treatment-related risk factors and consequential long hospital stays that increase the risk of developing pressure ulcers.

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Conflict of interest: the authors declare no potential conflict of interest, and all authors confirm accuracy.

Ethics approval: the study was approved by the Ethics Committee of Emilia Romagna (Italy) on July 28, 2021 (opinion no. 3059). The study is conformed with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights.

Informed consent: all patients participating in this study signed a written informed consent form for participating in this study.

Patient consent for publication: written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

Availability of data and materials: data will be available at <https://data.mendeley.com/>

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