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# Risk Factors for Pressure Ulcer Development in Medical Intensive Care Units: an Observational Study

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## 1.ABSTRACT

**Background:** Intensive care units have the highest prevalence and incidence of pressure ulcers (PUs) in the hospital setting. Identifying risk factors of PUs is very important for effective prevention. **Aim**: This study aimed to assess risk factors for PUs among critically ill patients in medical intensive care units. **Study design:** The study has an observational descriptive design. **Setting:** The study was conducted at medical intensive care units located in Medical Specialized Hospital in Egypt. **Subjects:** A convenience sample of 86 patients who were admitted to the previous predetermined setting were enrolled in this investigation. **Tool:** Pressure ulcer assessment tool was used to collect data for this investigation. **Results:** Anemia and hypoalbuminemia were the most common risk factors among the studied patients. A statistically significant correlation was found between the development of PUs, and gender, diabetes, and current smoking status. The non use of preventive care, hypoalbuminemia, altered level of consciousness, diagnosis of chronic liver disease, and high/very high risk score by the initial Braden Scale were statistically significant predictors of PUs. Statistically significant differences were noted between the group who developed PUs and the group who did develop PUs regarding hypoalbuminemia ($P$=0.029) and altered level of consciousness ($P$=0.012). **Conclusion:** Identifying PUs risk factors by critical care nurses is fundamental for implementing successful preventive protocols. **Recommendations:** Critical care nurses should identify high risk groups for PUs and implement preventive measures as a part of daily care for patients in intensive care units.

***Keywords***: *Pressure ulcers, Risk factors, Braden Risk Assessment Scale***.**

## 2.Introduction:

In a report published in 2002, the **World Health Organization (WHO)** underlined patient safety as a core value of all healthcare systems. It emphasized the need for implementing standards that will enhance patient care, placing special emphasis on product safety, safe clinical practice in accordance with appropriate guidelines, and encouraging patient safety research, including risk factors, efficient protective interventions, and assessment of associated costs of damage and protection (WHO, 2002). One of the adverse events in intensive care units (ICUs) that affects patient safety and quality of life is pressure ulcers **(de Almeida Medeiros et al. 2018).**

Pressure ulcers have been described as one of the most physically debilitating complications in the twentieth century and the third most expensive condition after cancer and cardiovascular diseases **(Hashad & Hassan, 2018)**. The first step in preventing hospital acquired PUs (HAPUs) is identifying the risk factors and patients at high risk. Although many risk factors have been identified, there is no general agreement on the most crucial risk factors for HAPUs among critically ill patients (CIPs) **(Deng, Yu & Hu, 2017)**.

Several factors can contribute to HAPUs development and the current risk assessment tools do not cover all related risk factors

(NPUAP, EPUAP, PPPIA, 2014). A critical review of 18 papers focusing on the risk factors for PUs among CIPs was carried out by Alderden, Rondinelli, Pepper, Cummins and Whitney (2017). They found that one of the most important risk factors was age. The second risk factor was mobility/activity limitations. The majority of patients in ICUs may experience this problem due to the use of anesthesia. The third major risk factor was poor perfusion which can be caused by hypotension or other associated diseases including diabetes, cardiovascular disease, or peripheral vascular disease.

Dry skin, low body mass index, altered mental status, urine and fecal incontinence, and malnutrition are other risk factors that have been linked to the development of PUs (Morton & Fontaine 2018). Other documented risk factors for PUs in ICUs include extreme obesity (Hyun, et al., 2014), decreased level of hemoglobin on admission to ICU and increased ICU length of stay (Ahtiala, Soppi & Tallgren, 2018). Moreover, significant risk factors for the development of PUs include age, lower Braden Scale scores, the timing of the operation, emergency admission, and a history of kidney disease (Tayyib, Coyer & Lewis, 2016). Male gender, vasopressor infusions, and days spent on mechanical ventilator can increase the risk of developing PUs in ICUs (Hyun, Moffatt-Bruc, Cooper, Hixon & Kaewprag, 2019). Failure to recognize PUs risk factors will result in the development of PUs and their associated complications (Cox & Schallom, 2021). On the other hand, successful prevention can be achieved by early detection of risk factors for PUs development among ICU patients and the implementation of appropriate measures.

## Aim of the study:

This study aimed to assess risk factors for pressure ulcers among critically ill patients in medical intensive care units.

## 3. Methed

### 3.1Research Design:

The study has an observational descriptive design.

### 3.2Setting

This study was conducted in four Medical ICUs in Medical Specialized Hospital, affiliated with Mansoura University in Egypt.

### 3.3Study Sample

A convenience sample of 86 adult patients who were ≥ 18 years old, and had at least 3 days length of stay in the selected medical ICUs were enrolled in this study. Patients who had PUs in the initial skin assessment or who were diagnosed with PUs within 24 hours of admission to the study setting were not included in this investigation.

### 3.4Tools

A pressure ulcer assessment tool was used to collect data for the current investigation. It included two parts:

**Part I: Patients' socio-demographic and health-relevant datasheet**

This part was developed by the primary investigator (PI) after reviewing relevant literature (Atyea, et al., 2013; Awad, Othman & Abdelmawla, 2019; El- Gilany, El - Wehedy & El – Wasify, 2012). It covered patients' personal information. It also addressed patients' medical data such as the date of admission to the ICU, length of ICU stay medical diagnosis, etc…..

**Part II: Braden Risk Assessment Scale**

This tool was adopted from Bergstrom, Braden, Laguazzo and Holman (1987). It was used to determine whether or not patients were at risk of developing PUs. Sensory perception, skin moisture, activity, mobility, nutrition, and friction/shear are the six subscales that make up this scale. Each subscale is given a numerical rating. The first five subscales were rated on a scale of 1 to 4, with a score of 4 indicating 'no problem' and a score of 1 indicating 'a major problem'. The only subscale with a score range of 1 to 3 was the friction and shear subscale. The results of each subscale were added together to provide a total score that ranged from 6-23. The lower the score, the bigger the risk. According to Bergstrom, et al. (1987), the reliability of the Braden Risk Assessment Scale ranged when used by registered nurses was r = .99.

### 3.5 Pilot Study

The pilot study involved 10 patients who were not included in the sample. It was done to test the applicability and simplicity of the tools.

### 3.6Ethical Considerations

This study was approved by the Research Ethics Committee of the Faculty of Nursing – Mansoura University. Approval to conduct the study was granted from the hospital's authority after giving a complete description of the nature of the study. Informed consent was obtained from the patient's next of kin after giving them the details of the study.

### Data Collection

On the first day of admission to the ICU, the PI collected the participants' socio-demographic and clinical data from the medical records using part I of the tool. Health-relevant data were collected including the patient's admission medical diagnosis, past medical history, and risk factors for PUs (the history of having diabetes, hypertension, obesity, cerebral stroke, or healed PUs). It also covered the patient's pre-hospitalization mobility level, nutritional status, and current smoking status. The length of ICU stay was also recorded. Additionally, the neurological function was assessed using the Glasgow Coma Scale. The Braden Risk Assessment Scale was utilized every other day, on the first, third, and fifth days of the patient's ICU stay to determine if the risk for the development of PUs was increased or decreased. Patients' skin was observed for the occurrence of PUs and was documented.

### 3.7Statistical analysis of data

The IBM-SPSS software was used to analyze the collected data (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Qualitative data were described as frequencies (n) and percentages (%). Rank Biserial Correlation was used to assess the association between one ordinal variable and one dichotomous variable (e.g., Braden Scale and sex). Kendall's tau_b was used to assess the association between two ordinal variables (e.g., Braden Scale and age groups). While to assess the strength and direction of the association/relationship between two continuous variables, Spearman's rank-order correlation was used.

Univariate (standard) logistic regression was used to evaluate the likelihood of a diagnosis with only one predictor. Multivariate logistic regression was used to create a prediction model of the likelihood of a diagnosis to identify the relevant "independent" factors. For data comparison, the Chi-Square test or Fisher's exact test was used for qualitative data and Monte Carlo significance was used when appropriate. For quantitative data in the case of two groups: Independent-Samples t-Test or its non-parametric equivalent; Mann-Whitney U- test was used when analyzing variables of an ordinal scale. If the $P$ value $\leq 0.050$, the data is considered statistically significant.

## 4. Results

Table 1 presents the socio-demographic characteristics of the studied patients. The results illustrated that 62.8% of the patients were males, with 57% of them being under or equall 60 years old and 43% being over 60. The majority of the patients were married (88.4%) and the biggest proportion had a secondary education (40.7%).

Table 2 illustrates the predisposing factors for PUs in pressure ulcer and non-pressure ulcer groups. In both groups, anemia and hypoalbuminemia were the most prevalent risk factors. Statistically significant differences were noted between the two groups regarding hypoalbuminemia and altered level of consciousness. However, no statistically significant differences were noted between the two groups in other parameters.

Table 3 describes the correlation between the development of PUs and the clinical-demographic data. It showed a statistically significant correlation between the development of PUs and gender (higher in males). The risk of PUs is present in both diabetic and non-diabetic patients, although it is higher in the non-diabetic group, based on the risk severity measured by the Braden

Scale. Additionally, there is a statistically significant correlation between the development of PUs and current smoking status (higher in current smokers).

Table 4 presents the predictors of the probability of the development of PUs. The binary logistic regression analysis was used to ascertain the non-use of preventive measures, presence of hypoalbuminemia, altered level of consciousness, use of MV, diagnosis of chronic liver disease, and high/very high risk by the initial Braden scale are predictors of PUs. The results of the univariable analysis revealed that all the predictors were statistically significant except for the MV. A multivariable binary logistic regression was also conducted to determine the impact of the five factors on the probability that participants will exhibit PUs. The model was statistically significant ($\chi^2$ [5] = 23.054, P<0.001). It explains that 36.1% of the variance in PUs occurrence (Nagelkerke $R^2$ = 0.361).

**Table 1** *Patients' Socio-Demographic Characteristics*

| Variables | N= 86 | |
|---|---|---|
| | n | % |
| **Gender** | | |
| • Male | 54 | 62.8 |
| • Female | 32 | 37.2 |
| **Age (years)** | | |
| • ≤60 years | 49 | 57 |
| • >60 years | 37 | 43 |
| ***Marital status** | | |
| • Single | 2 | 2.3 |
| • Married | 76 | 88.4 |
| • Widow | 8 | 9.3 |
| **Education level** | | |
| • Illiterate | 16 | 18.6 |
| • Read and Write | 12 | 14 |
| • Primary | 13 | 15.1 |
| • Secondary | 35 | 40.7 |
| • University | 10 | 11.6 |

Data are expressed as numbers (n) and frequency (%).

**Table 2** *Predisposing Factors for Pressure Ulcers in the Pressure Ulcer Group and Non-Pressure Ulcer Group*

| Variable | Pressure ulcer n (19) | | Non pressure ulcer n (67) | | Significance test | |
|---|---|---|---|---|---|---|
| | n | % | n | % | $\chi^2$ | *P* |
| **Diabetes** | 8 | 42.1 | 36 | 53.7 | 0.801 | 0.371 |
| **Hypertension** | 6 | 31.6 | 30 | 44.8 | 1.059 | 0.303 |
| ***Obesity** | 1 | 5.3 | 5 | 7.5 | - | 1.000 |
| ***Healed pressure ulcer** | 0 | 0 | 1 | 1.5 | - | 1.000 |
| ***Stroke** | 1 | 5.3 | 8 | 11.9 | - | 0.677 |
| **Current smoking** | 5 | 26.3 | 17 | 25.4 | .000 | 1.000 |
| ***Activity pre hospitalization**<br>Ambulatory<br>Bedridden / on wheelchair | <br>10<br>9 | <br>52.6<br>47.4 | <br>49<br>18 | <br>73.1<br>26.9 | 2.889 | 0.089 |
| **Anemia** | 17 | 89.5 | 55 | 82.1 | - | 0.726 |
| **Hypoalbuminemia** | 16 | 84.2 | 38 | 56.7 | 4.789 | **0.029** |
| **Altered level of consciousness** | 11 | 57.9 | 18 | 26.9 | 6.337 | **0.012** |
| **Mechanical ventilation** | 5 | 26.3 | 6 | 9 | - | 0.060 |

Data are expressed as numbers (n) and frequency (%). *P* value: Chi-Square test and *Fisher's Exact test. *P* value significant at < 0.05.

**Table 3** *Correlation Between PUs Development and Demographic and Clinical Variables*

| Variable | Coefficient | *P* value |
|---|---|---|
| **Dichotomous** | $r_{rb}$ | |
| • Gender ( male) | 0.223 | **0.035** |
| • Presence of hypoalbuminemia | 0.094 | 0.388 |
| • Presence of CLD | 0.104 | 0.339 |
| • Presence of DM | -0.230 | **0.033** |
| • Presence of hypertension | -0.110 | 0.313 |
| • Presence of obesity | 0.128 | 0.241 |
| • Presence of stroke | 0.026 | 0.811 |
| • Current smoker | 0.220 | **0.042** |
| • Presence of anemia | 0.018 | 0.872 |
| • Presence of pneumonia | 0.118 | 0.280 |
| • Presence of CKD | 0.179 | 0.100 |
| **Ordinal** | $r_{tb}$ | ***P* value** |
| • Age | 0.125 | 0.196 |
| **Continuous** | $r_s$ | ***P* value** |
| • Initial Temperature | -0.036 | 0.745 |
| • Initial Heart rate | 0.190 | 0.080 |
| • Initial Respiratory rate | 0.009 | 0.935 |
| • Initial MAP | 0.185 | 0.087 |
| • Initial SBP | 0.181 | 0.095 |
| • Initial DBP | 0.190 | 0.079 |

Chronic Liver Disease: CLD. Diabetes Mellitus: DM. Chronic Kidney Disease: CKD

Correlation Coefficient: $r_{rb}$ = Rank Biserial, $r_{tb}$ = Kendall's tau_b, $r_s$ = Spearman's correlation

**Table 4***Predictors of the Probability of Developing Pressure Ulcers*

| Predictor | Univariate | | | Multivariate | | |
|---|---|---|---|---|---|---|
| | *P* value | COR | 95% CI | *P* value | COR | 95% CI |
| **Intervention**<br>• Yes<br>• No (control) | **0.007** | R<br>5.2 | R<br>1.6-17.4 | **0.027** | R<br>5.3 | R<br>1.2-22.9 |
| **Hypoalbuminemia**<br>• No<br>• Yes | **0.038** | R<br>4.1 | R<br>1.1-15.3 | 0.210 | R<br>3.1 | R<br>0.5-18.1 |
| **ALOC**<br>• No<br>• Yes | **0.015** | R<br>3.7 | R<br>1.3-10.8 | 0.317 | R<br>2.3 | R<br>0.4-11.8 |
| **MV**<br>• No<br>• Yes | 0.056 | R<br>3.6 | R<br>0.97-13.6 | - | - | - |
| **CLD**<br>• No<br>• Yes | **0.035** | R<br>3.2 | R<br>1.1-9.5 | 0.914 | R<br>1.1 | R<br>0.2-4.8 |
| **Initial Braden Scale**<br>• Mild/Moderate<br>• High/Very high | **0.001** | R<br>7.2 | R<br>2.1-24.1 | 0.087 | R<br>4.1 | R<br>0.8-20.4 |

R=Reference category. COR=Crude odds ratio. CI=Confidence interval. *P* value: Binary logistic regression.

## 5. Discussion

The findings of the current study showed that the majority of the patients were males, and more than half of them were less than 60 years old. Similar findings were reported by **Tayyib, Coyer and Lewis (2015)** concerning gender. **Coyer et al. (2015)** investigated reducing of PUs in CIPs by the use of a patient skin integrity care bundle and reported that neurological trauma and bleeding were the most common diagnosis for patients with PUs in the studied groups. Their study setting was a general adult ICU in Australia, and the sample size was 207 participants. However, the current study was conducted in medical ICUs with 86 patients involved. Additionally, the findings of the current investigation illustrated that the common medical diagnoses among the PUs group were chronic liver disease and then melena and hematemesis. This could be because chronic liver disease is a common endemic disease in Egypt **(Elbahrawy et al., 2021; Mohamed, Naglaa & Mohamed, 2017)**.

Regarding the predisposing factors for PUs in the two groups (with and without PUs), the most common risk factors were anemia and hypoalbuminemia. This could be attributed to the common medical diagnosis of the studied patients (chronic liver disease then melena and hematemesis). This is supported by **Atyea et al. (2013)** who reported hypoalbuminemia as a common risk factor for developing PUs in the study and control groups. In the same line, **Deng et al. (2017)** showed that HAPU was independently predicted by an albumin level of less than 36 g/L. Similarly, **Cox and Schallom (2021)** reported anemia as a significant predictor for PUs.

The findings of the current study showed a statistically significant correlation between the risk of developing PUs and gender (higher in males), the presence of diabetes mellitus (severity of the risk was lower in the diabetic group than the non-diabetic group), and current smoking (higher in current smokers). These findings are aligned with other similar studies which illustrated that more than half of the patients were males **(Gonzalez, et al., 2018; Hyun et al., 2019; Sala, et al., 2021**) and at admission, nearly half of them had a total Braden Scale score that indicated a higher chance of acquiring PUs **(Sala, et al., 2021)**.

However, **Kılınc et al. (2021)** revealed that there was no statistically significant difference between the studied groups regarding the Braden Risk Assessment Scale measurements concerning gender. This discrepancy may be due to the difference in the cited study design and sample size as the researchers conducted a retrospective study that involved 200 patients.

The current study showed a statistically significant correlation between diabetes mellitus and the probability of developing PUs (severity of the risk was lower in the diabetic group than in the non-diabetic group). This could be explained by the presence of other risk factors that positively correlated with the Braden Scale, such as being male and smoking, as well as other related risk factors including altered level of consciousness and delayed enteral feeding, among patients who do not have diabetes. However, a recent investigation reported that diabetes and Braden Score were significantly associated with HAPUs **(Hyun, et al., 2019).** This discrepancy may be due to the different study design as a retrospective cohort study which involved a large number of patients (12,654).

The current study showed a correlation between the risk of developing PUs and smoking (higher in current smokers). This is harmonious with the findings of other investigations which found a significant association between smoking and an elevated risk of developing PUs **(de Azevedo Macena, et al., 2017; Nassaji, Askari, and Ghorbani, 2014)**.

The findings of the current study showed that the non-use of PUs preventative measures, hypoalbuminemia, altered levels of

consciousness, chronic liver disease, and a high/very high-risk score on the first Braden Scale were statistically significant predictors of PUs. Contrary to our findings, **de Almeida Medeiros et al. (2018)** investigated the PUs risk in ICUs patients and reported that the following factors are strong indicators for increased risk of PUs: previous history of PU, patients who had received treatment for comorbidities, and patients with a prolonged ICU stay, friction, dehydration, and elevated skin temperature by 1–2 degrees Celsius. This discrepancy may be due to differences in the study's design and the country as the cited study was a retrospective case-control investigation conducted in a major university hospital in northeast Brazil.

Our findings are also inconsistent with the results of **Sala et al. (2021)** who investigated the predictors of PUs development in CIPs. They found that MAP < 60 mmHg and low total Braden score two weeks prior to PUs development were the only predictors associated with increased risk for developing PUs. This inconsistency may be due to the different research design as their study was a retrospective cohort study to investigate risk factors after considering demographics such as age, gender, race/ethnicity, and length of ICU stay in adult ICUs within an urban academic medical center in the United States of America.

## 6. Conclusion

Critical care nurses should identify and understand all the factors that increase the risk of developing PUs among ICU patients to implement preventive interventions successfully.

## 7. Recommendations

Large-scale multicenter studies involving different ICU populations are required for further exploration of the potential risk factors for PUs development to strengthen the evidence related to patient safety and risk prevention and management.

## 8 Acknowledgment

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## 9. Conflict of interest

The authors have no conflicts of interest.

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