A Prospective, Descriptive Study of Risk Factors Related to Pressure Ulcer Development Among Patients in Intensive Care Units

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Abstract

Many risk factors for the development of pressure ulcers (PUs) in the general hospital population have been identified, but consensus is lacking on specific PU risk factors for critical care patients. A prospective, descriptive study was conducted to determine the incidence of and risk factors for PU development among high-risk patients (Braden risk scale score <12) admitted to an intensive care unit (ICU) of a university hospital in Turkey. Demographic variables, APACHE II scores, serum albumin, hemoglobin, and glucose levels were obtained, and patients’ skin was assessed daily until discharge. Data were analyzed using percentage distributions, Student’s t-test, chi-square, and logistic regression analysis. Seventy (70) patients (22 women, 48 men), average age 56.2 (SD 19.2) years, mean albumin level 2.86 (median: 2.86, SD 2.73), and mean APACHE II score 17.2 (SD 6.48), completed the study. During an average length of stay of 17.2 days (SD 4.2), PU incidence was 28.6%. Of the 23 ulcers that developed, 12 (52.1%) were Stage I, eight (8, 34.8%) were Stage II, and three (3, 13.1%) were Stage III; no patient developed a Stage IV ulcer. Multivariate logistic regression analysis showed that being female (OR = 0.15, [95% CI:0.03- 0.71] P <0.05) and having a lower serum albumin level (OR=11.6, [95% CI:1.92- 70.4] P <0.01) were independent risk factors for PU development. Patient gender and serum albumin levels should be considered as risk factors for PU development in ICU patients. Larger prospective studies examining these risk factors in ICU patients are warranted.

Keywords: clinical study, logistic regression, pressure ulcer, risk factors, intensive care

Index: Ostomy Wound Management 2013;59(7):22–27

Potential Conflicts of Interest: none disclosed

Pressure ulcers (PUs) are a common problem in healthcare and represent a substantial burden on patients, their relatives, and caregivers. Descriptive studies involving patients who acquire PUs while in the hospital have demonstrated that these wounds not only cause pain and discomfort, but also have a great impact on quality of life. In addition, PUs are expensive and can result in a prolonged hospital stay.

Gunningberg et al’s prospective study reported that almost 90% of PUs can be prevented by accurate prediction and appropriate nursing interventions. Previous prospective studies have shown a PU incidence of between 1% and 56% in intensive care units (ICUs). However, only a limited number of studies have been conducted to determine the prevalence and incidence of PUs in Turkey. The prevalence of PUs at a university hospital in Turkey was found to be 7.2%, and the incidence rates among postoperative surgical and neurology ICU patients were 54.8% and 18.3%, respectively.

More than 100 risk factors for the development of PUs in a general hospital population have been identified in the literature. According to a prospective cohort study, critical care patients usually have multiple risk factors for PUs. Prompt and accurate identification of risk factors associated with PU development is the first step in effective prevention. Various risk assessment tools such as the Braden, Norton, and Waterlow scales have been developed to aid in this process; however, consensus is lacking regarding the specific risk factors for PU development. Moreover, the current risk assessment scales do not address some of the risk factors unique to the critical care population, such as severity of disease and serum albumin and glucose level. In addition, findings on the effect of these risk factors on PU development are contradictory.

Although in the authors’ experience the severity of disease...
and blood glucose level upon hospital admission might be the most important factors in predicting PU development in a critical care setting, they are not included in any risk assessment scale. Prospective studies of serum albumin have shown conflicting results. For example, serum albumin has been found in a few studies to be a positive predictive factor in PU, but other studies show no predictive value. Therefore, it is important to study these predictors further among critical care patients using multiple regression techniques designed to identify the most important predictors for PU development and to develop a new risk assessment scale for this population.

The objective of this study was to determine the incidence of, and risk factors for, PU development in intensive care patients at risk of PU development according to their Braden scale score.

**Methods**

**Study design and sample.** This prospective, descriptive study was conducted in the ICU of an anesthesia and reanimation clinic of a university hospital in Izmir, Turkey. All patients admitted to this unit at the start of the study and who met the study criteria were eligible to participate. The inclusion criteria for the study were 1) 18 years of age or older, 2) an expected hospital stay of at least 7 days, 3) absence of a PU on admission to the unit (patients with existing PUs at admission were excluded for the incidence measure), and 4) a Braden score of <12, which indicates high risk. The data were collected between June and December 2011.

All patients received standard nursing interventions per hospital protocols for PU prevention: their position was changed every 2 hours, a pressure-relieving mattress or air bed was used, they were protected from friction and moisture, and bed baths were given daily.

**Instruments.** Data were collected using a three-part instrument: 1) patient demographic data, including information on age, gender, body mass index, serum hemoglobin, albumin and glucose values, and time between admission and PU development, was recorded to determine PU incidence, defined as the number of persons who develop a new PU within a particular time period in a particular population; 2) Braden risk assessment scale score; and 3) Acute Physiology and Chronic Health Evaluation II (APACHE II) score.

**Braden Risk Assessment Scale.** The Braden Scale is one of the best known and widely used tools for evaluating PU risk in adults; its psychometric properties in assessing risk have been validated. The scale consists of six subscales: mobility, activity, sensory perception, skin moisture, nutrition state, and friction/shear. Each subscale is rated from 1 to 3 or 4, and the summative scores range between 6 and 23. A lower score indicates a lower level of functioning and, therefore, a higher level of risk for PU development. A cutoff score of <12 was used to designate patients as being at high risk for PU development. Braden scale assessment occurred immediately following admission.

**APACHE II.** The severity of disease was evaluated using APACHE II. The APACHE II model utilizes the worst values of 12 physiological variables during the first 24 hours following ICU admission along with an evaluation of the patient’s chronic health and admission diagnosis to calculate the APACHE II predicted mortality. The APACHE II model has been widely validated and used by many ICUs to classify the severity of illness and to predict hospital mortality. The total score in APACHE II is 71; higher values in the APACHE systems represent a higher risk of death.

**Data collection.** All information relating to the patient was recorded once daily from the day of admission to the unit until the development of a PU or until being discharged from the unit. Serum hemoglobin, albumin, and glucose values of the patients were collected daily from the medical records; other data, such as Braden scale and APACHE II scores, were calculated and recorded by the research nurse. If a PU developed, it was assessed and recorded as Stage I through Stage IV, as defined in the National Pressure Ulcer Advisory Panel. Data were de-identified for patient anonymity.

**Data analyses.** The daily values for all variables were recorded and then their means were determined. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 13.0 (SPSS Inc, Chicago, IL). The data were expressed as the mean and standard deviation (SD). Descriptive statistics were utilized in order to examine the distributions of demographic and clinic data of patients. The relationship between the risk factors and PU development was evaluated using univariate analysis. Student’s *t*-test was used for comparisons such as age, hemoglobin, albumin, and blood glucose levels between patients with and without PU; gender relationships were assessed using Fisher’s exact test. Risk was expressed as odds ratio with 95% confidence interval. *P* <0.05 was considered statistically significant. Variables indicating a *P* <0.20 in the univariate analysis were included in a forward stepwise logistic regression analysis to identify the risk factors associated with PU development.

**Ethical considerations.** Study approval was obtained immediately following admission.
from the appropriate ethics committee. Informed written consent was obtained from all participants or their families.

**Results**

**Sample.** A total of 98 patients was enrolled after meeting the initial study inclusion criteria. Of those, 28 were hospitalized for <7 days, leaving a total sample of 70 patients. Eighty-eight (48, 68.6%) patients were male; patient age ranged from 21 to 87 years, mean age 56.2 (SD 19.2) years. The mean length of stay in the ICU was 17.2 (SD 4.2) days, and the mean APACHE II score was 17.2 (SD 6.48). Diagnoses for ICU admissions included respiratory failure (37.2%), postoperative complications (32.8%), trauma (15.7%), and organ failure (14.3%) (see Table 1). The average Braden scale score was 10.4 (SD 0.9).

A total of 23 PUs developed in 20 of the 70 patients; three (3, 15%) of the patients had more than one PU. The incidence of PU in this population of ICU patients was 28.6%. Of the 23 ulcers, 12 (52.1%) were Stage I, eight (34.8%) were Stage II, and three (3, 13.1%) were Stage III; no patient developed a Stage IV ulcer. Ten (10, 50%) of the ulcers were observed between 1 and 5 days after admission to the unit, five (5, 25%) between 6 and 10 days, and three (3, 15%) between 11 and 15 days after admission. The most common areas for the PUs were the coccyx (39.8%) and sacrum (32.7%).

**Data analysis.**

**Univariate analysis.** Ten (10, 45.5%) women and 10 (20.9%) men developed PUs ($P < 0.05$). Patients who developed a PU were significantly older (66.8 ± 15.1 years) than nonpressure ulcer patients (52.1 ± 20.1 years) ($P < 0.05$). The mean hemoglobin levels were slightly lower in patients who developed a PU (9.44 ± 0.99 versus 9.99 ± 1.40), but this difference was not statistically significant. Similarly, blood glucose levels were higher in patients with PUs (209.9 ± 51.2 versus 184.9 ± 48.5), but this difference was not statistically significant. In contrast, mean serum albumin levels were significantly lower (2.49 ± 0.40 versus 3.01 ± 0.56) and the mean APACHE II score was significantly higher for patients who developed a PU (19.9 ± 5.48 versus 15.1 ± 4.12) than for those who did not develop a PU ($P < 0.05$) (see Table 2).

**Multivariate logistic regression analysis.** Variables indicating a statistically significant relationship with PU development at $P < 0.20$ in the univariate analysis were considered potential risk factors for inclusion in the multivariate logistic regression analysis. Also, because anemia is considered an important risk factor in the development of PU, hemoglobin levels were included in multivariate analysis. In the multivariate logistic regression model, gender ($OR = 0.15, [95\% CI: 0.03–0.71]; P < 0.05$) and low serum albumin levels ($OR = 11.6, [95\% CI: 1.92–70.4]; P < 0.01$) were significant risk factors for PU development (see Table 3).

**Discussion**

The incidence of PUs in this study was 28.6%. No comprehensive research study of PU incidence in Turkey was found. The PU incidence reported in two previous studies in ICUs was 16.7% to 18.3%. Therefore, the incidence of 28.6% observed in this study was higher than that reported in previous studies. This may be explained by the fact that the current study was performed in an anesthesia and reanimation clinic, and patient prognosis in this unit may be much worse than in other settings. Also APACHE scores of the patients indicated that patient acuity in this unit was high.

In the current study, women developed PUs to a greater extent than men. Results relating to gender in previous PU studies are conflicting. In a retrospective, cohort study involving 2,120 home care patients, Kelly reported men developed more ulcers. However, in Tannen et al’s descriptive study of 11,566 patients in acute care hospitals, the majority of patients with PUs were women, similar to Lindgren et al’s prospective study of 286 patients. Therefore, data on gender needs to be interpreted with care. In the current study, gender

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**Table 1. Patient characteristics**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Pressure ulcer (n=20)</th>
<th>No pressure ulcer (n=50)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gendera</td>
<td>10 (45.5%)</td>
<td>12 (55.5%)</td>
<td>0.034c</td>
</tr>
<tr>
<td>Female</td>
<td>22 (31.4%)</td>
<td>52 (79.1%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48 (68.6%)</td>
<td>28 (20.9%)</td>
<td></td>
</tr>
<tr>
<td>Age (Mean, SD)</td>
<td>56.2 years ± 19.2</td>
<td>52.1 ± 20.1</td>
<td>0.02c</td>
</tr>
<tr>
<td>Length of stay</td>
<td>17.2 days ± 4.2</td>
<td>184.9 ± 48.5</td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>26 (37.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative complications</td>
<td>23 (32.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma n (%)</td>
<td>11 (15.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organ failure n (%)</td>
<td>10 (14.3%)</td>
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</tbody>
</table>

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**Table 2. Characteristics of patients who did and who did not develop a pressure ulcer (N = 70)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Pressure ulcer (n=20)</th>
<th>No pressure ulcer (n=50)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gendera</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>10 (45.5%)</td>
<td>12 (55.5%)</td>
<td>0.034c</td>
</tr>
<tr>
<td>Male</td>
<td>10 (20.9%)</td>
<td>38 (79.1%)</td>
<td></td>
</tr>
<tr>
<td>Ageb</td>
<td>66.8 ±15.4</td>
<td>52.1 ±20.1</td>
<td>0.02c</td>
</tr>
<tr>
<td>Hemoglobin levelb</td>
<td>9.44 ±0.99</td>
<td>9.99 ±1.40</td>
<td>0.115</td>
</tr>
<tr>
<td>Serum albumin levelb</td>
<td>2.49 ±0.40</td>
<td>3.01 ±0.56</td>
<td>0.000d</td>
</tr>
<tr>
<td>Blood glucose levelb</td>
<td>209.9 ±51.2</td>
<td>184.9 ±48.5</td>
<td>0.06</td>
</tr>
<tr>
<td>APACHE II scoreb</td>
<td>19.9 ±5.48</td>
<td>15.1 ±4.12</td>
<td>0.000d</td>
</tr>
</tbody>
</table>

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*Fisher exact test; Student’s $t$-test; $cP < 0.05$; $dP < 0.001$
itself might not be the real risk — the women were older than the men, and this may have made them more vulnerable.

In this study, the patients who developed a PU had lower serum albumin levels, results that support previous studies. In a descriptive, analytic trial involving 60 patients by Kurtulus and Pınar, serum albumin level was significantly lower in patients who developed PUs. Similarly, Anthony et al’s observational study of 773 elderly hospital inpatients reported serum albumin was a significant predictor of PU (<0.001). In a longitudinal cohort study among 2,771 acute care patients, Reed et al confirmed that low albumin is a PU risk factor. Senturan et al’s descriptive-observational study with 30 ICU patients found that persons who develop PUs were more likely to have significantly higher (P = 0.028) serum pH values than patients who remained free of PUs. Conversely, in one prospective study by Berlowitz and Wilking involving 301 patients in a chronic care hospital, it was determined that the presence of hypoalbuminemia was not associated with PU development. In a quasi-experimental study using ANOVA among 36 postoperative patients by Jerusum et al, the APACHE II score was higher in patients who developed a PU. In a prospective, cohort trial by Kaitani et al at a 606-bed tertiary care hospital involving 98 patients, no relationship was found between PU development and APACHE II score. However, in the current and previous studies, patients with and without PU had APACHE II scores <18. This means they had not been critically ill when they were admitted to the ICU. These conflicting results could be explained by the different nursing care delivered to the patients, other factors arising from the patient, or different statistical methods used in the studies. Therefore, a study should be conducted on patients who have higher APACHE II scores in order to generalize the results.

In the present study, mean blood glucose level was not associated with PU development. Although the mean blood glucose level was higher in patients with PUs, this difference was not statistically significant. Although these results differ from some published studies that reported a relationship between glucose level and PU development, they are consistent with those of Kurtulus and Pınar. Similarly, in a prospective study with 369 surgical intensive care patients, Slowikowski and Funk reported a diagnosis of diabetes may represent a clinically relevant PU risk factor in the surgical intensive care population. It has been hypothesized that in patients with diabetes, microangiopathy and abnormal hemorheology that occur due to hyperglycemia could increase the risk of developing PUs. These differences perhaps may be explained by the various types of study designs and methods used to collect information, but additional research is needed before definitive conclusions can be reached.

Previous studies have reported hemoglobin levels were related to PU development. In a nonexperimental prospective study among 337 patients by Lewicki et al, reduced hemoglobin was significantly associated with PU development (P <0.05). Also, Stordeur et al found hemoglobin level in 163 patients undergoing cardiac or vascular surgery was a significant predictor for PU development; Olson et al’s prospective study of 149 patients found similar results. However, the current study found no such relationship. Similarly, several studies have found that hemoglobin level was not associated with PU development. In descriptive studies ranging in sample size from 46 to 142, no relationship was noted between hemoglobin levels and PU development. Low hemoglobin levels may be associated with PU development due to reduced oxygen content in the tissues. Nevertheless, in the

<table>
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<tr>
<th>Table 3. Logistic regression analysis</th>
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<tr>
<td>β</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Serum albumin level</td>
</tr>
<tr>
<td>Blood glucose level</td>
</tr>
<tr>
<td>Hemoglobin level</td>
</tr>
<tr>
<td>APACHE II</td>
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</tbody>
</table>

^P <0.05; ^P <0.01; Hosmer and Lemeshow test; P = 0.702.
current study, the mean hemoglobin levels in both patients who did and did not develop a PU was <10 g/dL. Research including patients with a wide variety of hemoglobin levels should be conducted.

Limitations

The most important limitation of this study was sample size. The mean APACHE score was not an independent risk factor for PU development, but this might be the result of the low average score [17.2 (SD 6.48)] of the study population. Therefore, further research should be conducted on patients with a wide variety of APACHE II scores. In this study, all patients received preventive measures that may have been intensified as a result of the study potentially affecting the results. This study highlights the need for further research with larger and more diverse patient populations. In addition, although the sample included patients determined to be at high risk for PUs according to the Braden scale, PUs developed in only 20 patients. Therefore this instrument may not be ideal for measuring risk in intensive care patients.

Conclusion

In this patient population of acutely ill patients, blood glucose level, hemoglobin level, and severity of disease were not found to be independent risk factors for PU development. However, lower serum albumin levels and being female significantly increased the risk of developing a PU. Based on this study, the odds of having a PU were almost twice as high in women as men, and PUs developed in 35% of patients with serum albumin levels below 3.3g/dL. Therefore, particular attention should be paid to female patients and persons who have lower serum albumin levels; new risk prediction scales including these predictor factors should be developed and tested.

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