Risk Profile Characteristics Associated With Outcomes of Hospital-Acquired Pressure Ulcers: A Retrospective Review

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BACKGROUND Hospital-acquired pressure ulcers are a common problem. Although a number of risk factors have been identified, relationships among risk profile characteristics and pressure ulcer outcomes have not been described in hospitalized patients.

OBJECTIVES To describe patients’ characteristics and risk factors associated with pressure ulcer outcome.

METHODS A retrospective chart review was used to collect data on 87 patients in whom hospital-acquired pressure ulcers developed from May 2007 to November 2008. All pressure ulcers were staged by a certified wound nurse. Relationships among risk profile characteristics and pressure ulcer outcomes were determined via bivariate analysis and multivariate logistic regression.

RESULTS High severity of illness was present in patients with hospital-acquired pressure ulcers; 89% were intensive care patients. Vasopressor infusion, spinal cord injury, and age 40 or greater conferred risk for nonhealing pressure ulcers. Among pressure ulcer stages, suspected deep tissue injury ulcers were less likely to heal.

CONCLUSIONS Identification of characteristics and risk factors associated with development of nonhealing hospital-acquired pressure ulcers will allow nurses to recognize patients at risk for nonhealing and to take aggressive preventative measures. (Critical Care Nurse. 2011;31(4):30-43)

Hospital-acquired pressure ulcers (HAPUs), also known as bed sores and decubitus ulcers, develop when compression of soft tissue causes localized injury of the skin and/or underlying tissue; HAPUs occur in 3% to 12.7% of acute care and intensive care patients. HAPUs are even more prevalent among certain special populations, such as patients receiving mechanical ventilation and patients with multiple comorbid states.

Researchers examining HAPUs have identified characteristics that are associated with increased risk. The Braden scale, a widely used tool for quantifying pressure ulcer risk, encompasses mobility, moisture, friction and shear, nutrition, and activity. Among hospitalized patients, the parameters measured by the Braden scale are associated with increased risk for development of HAPUs. Longer length of hospitalization, vasopressor infusion, spinal cord injury, and more severe illness also contribute to a patient’s risk profile. Risk factors unique to specific populations, including surgical time and mechanical devices, have been identified among trauma and surgical patients. Characteristics present at hospital admission, including older age, low body mass index, diabetes, and renal insufficiency are also risk factors for HAPU.

Despite the high prevalence of risk factors among critical care patients, beginning on October 1,
2008, the Centers for Medicare and Medicaid Services implemented a 0% complication rate for a number of clinical diagnoses, one of which is a stage III or IV pressure ulcer acquired during a hospitalization. Consequently, hospitals are not reimbursed for the care, services, or resources associated with such a HAPU. Thus, interest and emphasis on pressure ulcer prevention, improving understanding of risk for HAPUs, and refining risk profiles are increasing.

Although the aforementioned characteristics associated with increased risk for HAPU have been identified, the specific risk factor profiles of acute care patients in whom HAPUs develop are not well understood. Moreover, no published report describes healing or nonhealing of HAPUs in hospitalized patients.

In this retrospective review of records, we describe characteristics of patients with HAPUs at Harborview Medical Center in Seattle, Washington. The specific aim of this study was to describe characteristics of patients and risk factors associated with pressure ulcer outcomes, which were defined as healed at discharge/death or present at discharge/death.

**Background**

HAPUs result in human suffering and increase the hospital cost of care. Pressure ulcers can result in infection, scarring, and the need for surgery, which increases personal and financial costs. Development of a HAPU increases the mean duration of hospitalization by 8 days with an associated US$15,000 increase in cost of care. Despite the high cost associated with them, HAPUs and pressure ulcers present on admission are an increasingly common problem. Data from 2003 show that pressure ulcers were present during 455,000 hospital stays in the United States. This represents a 63% increase from data collected in 1992.

**Pressure Ulcer Assessment**

The National Pressure Ulcer Advisory Panel (NPUAP), a group of experts who examine research literature and make policy decisions, held its first consensus conference in 1989. During this consensus conference, a widely used 4-stage classification system for pressure ulcers was developed. This system classifies each ulcer in order of increasing severity according to depth of tissue involvement from the outer epidermal layer of skin down into the underlying tissue and bone.

The traditional 4-stage system described ulcers that develop through damage of the skin and underlying tissue layers. However, in some pressure ulcers, the top layers of skin are intact but the underlying tissue is damaged. To address the problem of deep tissue injury under intact skin, in 2007 the NPUAP revised the pressure ulcer staging system to include suspected deep tissue injury (SDTI). Another classification, “unstageable,” describes ulcers that cannot be staged because of eschar or slough. The most recent NPUAP stages are shown in Figure 1.

**HAPU Risk Factors**

The research literature on HAPU development and associated risk factors contains considerable variation in pressure ulcer definition (some studies exclude HAPUs present on intact skin) and in characteristics of the sample population. Despite differences among studies, some risk factors are commonly identified. Table 1 shows HAPU risk factors that have been identified among acute care and intensive care patients. Pressure ulcer stages, when identified by individual studies, are also presented in Table 1.

**HAPU Prevention and Treatment**

Because patients in intensive care units (ICUs) are at high risk for pressure ulcer development, prevention and treatment are priorities for critical care nurses. Current strategies for prevention of pressure ulcers are presented in Figure 2. Treatment recommendations are...
beyond the scope of this article; however, resources for current treatment guidelines are available at the NPUAP Web site (www.npuap.org).

Methods

Design

This study is a retrospective review of characteristics of patients and risk factors associated with HAPU outcome. The study was approved by the institutional review board at Harborview Medical Center in Seattle, Washington. The research team consisted of 4 investigators: 3 certified wound nurses and 1 data analyst.

Setting and Patients

This study was conducted at a level I trauma center and safety net hospital, Harborview Medical Center in Seattle, Washington. A safety net hospital provides care to uninsured and vulnerable patients.

Eligible patients had HAPUs of stages I through IV, unstageable HAPUs, or SDTI HAPUs develop between November 1, 2007, and May 31, 2008. Eligible patients were identified by using the pressure ulcer database, which is described in more detail later. All HAPUs identified at this facility are staged by certified wound nurses and entered into the pressure ulcer database.

Patients aged 17 and younger were excluded from the study because HAPU risk factors in children are different from the risk factors in adult patients. Patients with pressure ulcers present at admission were not included in the study unless the patients had a HAPU...
## Table 1  Risk factors for development of hospital-acquired pressure ulcers (HAPUs) among acute care patients

<table>
<thead>
<tr>
<th>Study, year</th>
<th>Sample</th>
<th>Study design</th>
<th>Occurrence and stage of pressure ulcers</th>
<th>Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlson et al, 1999</td>
<td>136 general intensive care unit (ICU) patients</td>
<td>Prospective cohort</td>
<td>12% ≥ stage I; 36 pressure ulcers developed in 17 patients: 15 stage I, 20 stage II, and 1 stage III</td>
<td>Braden Scale score &lt;16 Decreased sensory perception</td>
</tr>
<tr>
<td>Theaker et al, 2000</td>
<td>286 ICU and high-dependency unit patients at a hospital in the United Kingdom</td>
<td>Prospective cohort</td>
<td>Pressure ulcer grading was based on the Lowthian score, a pressure ulcer grading scale that is similar to the National Pressure Ulcer Advisory Panel’s scale Among all acute care admissions: 4.5% ≥ grade 1 Lowthian score Among ICU admissions: 10% ≥ grade 1 Lowthian score Among patients with 3+ HAPU risk factors: 26.9% ≥ grade 1 Lowthian score</td>
<td>Norepinephrine infusion More severe illness Fecal incontinence Anemia Longer stay</td>
</tr>
<tr>
<td>Fife et al, 2001</td>
<td>186 neurological ICU and intermediate care patients</td>
<td>Prospective cohort</td>
<td>12.4% ≥ stage II Specific stages not addressed</td>
<td>Braden Scale score ≤13 Body mass index &lt;19</td>
</tr>
<tr>
<td>Eachempati et al, 2001</td>
<td>412 surgical ICU patients</td>
<td>Prospective cohort</td>
<td>8% ≥ stage II Specific stages not addressed</td>
<td>Emergent admission to the ICU Increasing age More days in bed More days without nutrition</td>
</tr>
<tr>
<td>Young et al, 2002</td>
<td>1394 acute care patients at an Australian teaching hospital</td>
<td>Chart review; subjects were identified from 3 single-day cross-sectional pressure ulcer prevalence studies</td>
<td>12.7% ≥ stage I HAPU 58.2% stage I, 36% stage II, 4.2% stage III, 1.7% stage IV</td>
<td>Age &gt;65 years Braden Scale score &lt;16</td>
</tr>
<tr>
<td>Pender and Frazier, 2005</td>
<td>40 ICU patients; all sample patients were receiving mechanical ventilation</td>
<td>Descriptive, correlational</td>
<td>20% ≥ stage I 8 HAPUs developed in 8 patients: 2 stage I, 5 stage II, and 1 stage III</td>
<td>This study examined oxygenation and perfusion variables. Braden Scale scores and selected perfusion and oxygenation variables did not differ significantly between patients who had HAPUs develop and patients who did not. The most significant factors related to a low Braden scale score were fluid shifts and fluid weight gain.</td>
</tr>
<tr>
<td>Baumgarten et al, 2006</td>
<td>3233 inpatient medical service patients admitted from the emergency department, age 65 and older</td>
<td>Prospective cohort</td>
<td>6.2% ≥ “possibly or definitely hospital acquired” 27% stage I, 54.1% stage II, 0.8% stage III, 5.6% unstageable, 12.4% not staged because dressing was in place</td>
<td>Increasing age Male sex Dry skin Incontinent of urine or feces Difficulty turning in bed Nursing home residence before admission Prior recent hospital stay Poor nutritional status</td>
</tr>
<tr>
<td>Frankel et al, 2007</td>
<td>820 surgical ICU patients</td>
<td>Retrospective chart review, 1 year of data</td>
<td>3% ≥ stage II Specific stages not addressed</td>
<td>Creatinine &gt;3 mg/dL Diabetes Age &gt;60 years Spinal cord injury</td>
</tr>
</tbody>
</table>
develop later (after admission) in another anatomic location.

**Instruments and Measures**

Data were collected by using a data collection tool developed by the research team (Table 2—available online only, at www.ccnonline.org). The data collection tool was reviewed by 2 certified wound nurses to determine the relevance of each item. The data collection form was used to record information about HAPU location and stage, patients’ characteristics, and HAPU risk factors. Relevant items identified patients’ characteristics and risk factors present in the literature or reflected potential risk factors that may be present in the population at a trauma center.

Patients with more than 1 HAPU identified on a single day and entered into the pressure ulcer database had pressure ulcer data recorded for each ulcer. However, if another HAPU developed later in the hospital course, then the presence of the additional HAPU was recorded only as the variable “additional HAPU.” Because this was a time-limited study, staging and healing data were not recorded about any additional HAPUs that occurred later in the hospital course.

The presence of HAPU risk factors was recorded on the data collection form only when those risk factors occurred between admission and development of a HAPU. This method was chosen so that data would capture patients’ risk profiles before HAPU development, in order to describe associations between risk profiles and HAPU outcome.

**Procedure**

All data were obtained via a review of patients’ records by the

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**Figure 2** Strategies for prevention of pressure ulcers.

Adapted from European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel.
primary investigator. Information on the stage and location of pressure ulcers was obtained by using the institution’s pressure ulcer database. This database is maintained by a certified wound nurse, who provided access for the current study. As noted earlier, eligible patients were identified by using the pressure ulcer database. Use of this database managed by a wound nurse was advantageous because published reports indicate that use of specially trained wound nurses to identify and stage pressure ulcers yields more accurate and reliable results.

Patients’ demographic data and risk factor data were obtained from review of electronic medical records (EMRs). HAPU outcome data were obtained from EMR sources, including wound nurses’ follow-up notes. (Per hospital protocol, wound nurse follow-up occurs at least weekly for patients with HAPUs.) In addition to wound nurse follow-up notes, information on healing outcomes was also obtained from other EMR sources including nurses’ and physicians’ notes and assessment forms. When presence of the HAPU was not documented in any EMR source, including the wound nurses’ notes, nurses’ and physicians’ notes, and assessment forms within the 2 consecutive days preceding discharge, that HAPU was considered “healed.” Therefore, HAPU with documented presence in the last 48 hours before discharge or death were identified as “present at discharge or death.”

**Data Analysis**

Data were cleaned and analyzed by using SPSS 16.0 (SPSS Inc, Chicago, Illinois). The relationship between the independent, categorical-level variables and the pressure ulcer outcome was analyzed by using the \( \chi^2 \) test of independence. A Student \( t \) test was used to analyze the relationship between independent continuous and interval level variables and pressure ulcer outcome. Next, multivariate analysis was used to examine relationships among independent variables and outcome. Multivariate logistic regression was conducted to identify which characteristics conferred risk for nonhealing at discharge/death. The variables were selected for the regression analysis to limit the effects of collinearity and on the basis of characteristics relevant to the trauma/ICU population of the study site.

**Results**

**Patients’ Characteristics**

A total of 91 patients in whom HAPUs developed from November 2007 through May 2008 were present in the pressure ulcer database. Of the 91 patients, 87 were included in the final sample; 4 were excluded from this retrospective review because of incomplete HAPU data (n = 1), unavailable medical record data (n = 1), and age less than 18 years at admission (n = 2).

Most participants were white men. Demographic, admission, and discharge characteristics of the sample are outlined in Table 3. Participants ranged in age from 19 to 84 years. The mean age was 50.9 years.
Admission (or first available) body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) ranged from 17.0 to 65.3. BMI percentages are shown in Figure 3. Two participants were underweight, defined as a BMI of 18.4 or less (2%). Twenty-six participants were normal weight with a BMI of 18.5 to 24.9 (30%), 25 participants were overweight with a BMI of 25 to 29.9 (29%), 14 participants were obese with a BMI of 30 to 34.9 (16%), and 20 participants were morbidly obese with a BMI of 35 or higher (23%).

Seventy-seven participating patients (89%) were admitted to the ICU. Length of stay in the ICU ranged from 0 to 93 days, with a mean of 17.0 days (SD, 16.5 days). Ten patients (11%) were not admitted to the ICU. Seventy-three patients (84%) received mechanical ventilation. Duration of mechanical ventilation ranged from 0 to 99 days. The mean was 14.2 days (SD, 15.3 days). One patient with quadriplegia received mechanical ventilation throughout his 99-day hospitalization.

Most participating patients (n = 65, or 75%) had undergone at least 1 surgical procedure. The number of surgical procedures per patient ranged from 0 to 16; the mean number of procedures was 1.9 (SD, 2.4). Cumulative operative time ranged from 0 hours to 28 hours (mean, 5.2 hours; SD, 5.9 hours), with the subjects’ longest single surgical intervention ranging from 0 hours to 14.5 hours (mean, 2.7 hours; SD, 2.5 hours).

Lowest Braden score values ranged from 6 to 16. Braden score data were present for 72 patients (83%) and missing for 15 patients (17%). The mean lowest Braden score was 9.9 (SD, 2). Abnormal laboratory values, including low lymphocyte counts, low hemoglobin, albumin, and prealbumin levels, and high levels of blood glucose and C-reactive protein were commonly present (Table 4).

**Pressure Ulcer Characteristics**

The patients in the study had a total of 111 HAPUs develop. Seventeen patients (20%) had more than 1 pressure ulcer identified on a single day. Eight patients (9%) had between 1 and 3 additional pressure ulcers develop later in their hospital course. Owing to time constraints, in this study additional risk characteristic and outcome data were not recorded for those pressure ulcers that developed later in the hospital course.

Among 111 HAPUs, 3 were stage I (2.7%), 50 were stage II (45%), 2 were stage III (1.8%), 1 was stage IV (0.9%), 32 were unstageable (28.8%), and 23 were SDTIs (20.7%). HAPUs occurred in 11 different anatomic locations; 67 HAPUs (60.4%) were located on bony prominences and 44 HAPUs (39.6%) were not located on bony prominences (Figure 4).

**Relationships Between Characteristics and Outcome**

Pressure ulcer outcomes were defined as either healed at discharge/death or present at discharge/death. Of the 111 pressure ulcers identified, 51 ulcers healed (45.9%), whereas 60 ulcers were present upon discharge or death (54.1%). Among 51 HAPUs with the healed outcome, 46 healing outcomes were documented in the wound nurse’s notes, and 5 HAPUs were assumed to be healed on the basis of the

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**Table 4** Laboratory data

<table>
<thead>
<tr>
<th>Laboratory value</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin, mg/dL (lowest value)</td>
<td>79</td>
<td>0.7</td>
<td>3.3</td>
<td>1.5</td>
<td>1.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Lymphocyte, x1000/mm³ (lowest value)</td>
<td>38</td>
<td>0.00</td>
<td>2.68</td>
<td>1.10</td>
<td>1.03</td>
<td>0.64</td>
</tr>
<tr>
<td>Hemoglobin, g/dL (lowest value)</td>
<td>87</td>
<td>5.4</td>
<td>11.6</td>
<td>7.6</td>
<td>7.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Creatinine, mg/dL (highest value)</td>
<td>87</td>
<td>0.5</td>
<td>14.9</td>
<td>2.8</td>
<td>1.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Blood glucose, mg/dL (highest value)</td>
<td>87</td>
<td>93</td>
<td>600</td>
<td>227.6</td>
<td>200.0</td>
<td>93.8</td>
</tr>
<tr>
<td>Prealbumin, mg/dL (lowest value)</td>
<td>66</td>
<td>2.5</td>
<td>33.4</td>
<td>9.9</td>
<td>8.0</td>
<td>6.1</td>
</tr>
<tr>
<td>C-reactive protein, mg/L (highest value)</td>
<td>68</td>
<td>4.8</td>
<td>445.6</td>
<td>182.2</td>
<td>186.0</td>
<td>113.6</td>
</tr>
</tbody>
</table>
absence of HAPU documentation in any source within 48 hours of discharge or death.

It was confirmed via the wound nurse’s notes and chart review that patients with more than 1 pressure ulcer (n=17) had the same outcome for each ulcer. Therefore, the relationship between outcome (healed or present at discharge) and patient’s characteristics has been described for each of the 87 patients instead of for each of the 111 HAPUs. Forty-one patients (47%) experienced healing of their pressure ulcer, whereas 46 patients’ (53%) HAPUs were still present at discharge or death.

Correlations between patients’ characteristics and pressure ulcer healing are described in Tables 5 and 6 (available online only, at www.ccnonline.org). One categorical variable, vasopressor infusion, showed a statistically significant association with HAPU healing at the $P<.01$ level, and 3 categorical variables showed a statistically significant association with HAPU healing at the $P<.05$ level (Table 7). One continuous variable, age, also showed a statistically significant association with HAPU healing at the $P<.01$ level, whereas 3 continuous variables showed a statistically significant association with HAPU healing at the $P<.05$ level (Table 7).

Vasopressor infusion, spinal cord injury, and age 40 years or older were entered simultaneously into a logistic regression model with HAPU outcome (not healed, present at discharge/death) as the dependent variable (Table 8). The variables for use in the regression analysis were selected in order to limit the collinearity of the associated variables. The final model was significant at the $P<.001$ level ($-2 \log$ likelihood=101.3, $\chi^2_8 \{N=115\}=51.7$, $P<.001$) and produced a Nagelkerke $R^2$ of 0.49. Review of the Hosmer and Lemeshow goodness-of-fit test revealed that the model was a good fit for the data ($\chi^2_8 \{N=115\}=9.5$, $P=.30$).

A review of odds ratios showed that the odds that a patient’s pressure ulcer was not healed at discharge/death increased nearly 5-fold when the patient had received a vasopressor infusion. Similarly, among patients with spinal cord injuries, the odds that a pressure ulcer did not heal increased 15-fold compared with patients without such injuries, and among patients aged 40 years or more, the odds that a pressure ulcer did not heal increased 7-fold compared with younger patients.
Pressure ulcer stage was also significantly associated with outcome (Table 9, Figure 5). Stage II HAPUs were more likely to be healed at discharge or death, whereas SDTI HAPUs were less likely to be healed at discharge or death.

### Discussion

In this study, we examined 87 patients in whom 111 HAPUs developed at a level I trauma center/safety net hospital. Demographic and risk profile characteristics for each patient, as well as pressure ulcer characteristics for each pressure ulcer, were examined to determine relationships with HAPU outcome, which was defined as either present at discharge/death or healed at discharge/death.

Risk profile data identified high severity of illness among patients in whom HAPUs developed. Most (89%) were ICU patients; in addition to their status as ICU patients, other indicators of severe illness including mechanical ventilation (84%), vasopressor infusion (37%), and renal failure (32%) were common. Laboratory data that confer pressure ulcer risk and indicate severe illness, including decreased hemoglobin, decreased albumin, increased blood glucose, and increased creatinine levels, were also present among patients with HAPUs (Table 4). Finally, increased severity of illness was reflected in the patients’ high inhospital mortality rate (13%).

Specific trauma-related data provide insight into the special population of patients with HAPUs at a trauma center. Nearly half (46%) of the patients in the current study were trauma patients. Among the trauma patients, 93% were placed in a cervical collar with spine precautions for variable amounts of time. Trauma patients may remain in full spinal precautions for hours or days until their spine can be cleared from injury. Such limited mobility is often recognized as a risk factor for HAPU development.

Physiological variables also contributed to the patients’ risk factor profiles. Hypotension, which results in blood shunting from the skin to the priority organs, confers risk for pressure ulcer development.

Patients in the current study often

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### Table 7

<table>
<thead>
<tr>
<th>Characteristics of Patients and Healing</th>
<th>P</th>
<th>Odds Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients who received vasopressors were less likely than other patients to experience healing of pressure ulcers.</td>
<td>.005</td>
<td>4.7 (95)</td>
</tr>
<tr>
<td>Older patients were less likely to heal than younger patients.</td>
<td>.02</td>
<td>15.1 (95)</td>
</tr>
<tr>
<td>Patients with sepsis were less likely to heal than patients who did not have sepsis.</td>
<td>.001</td>
<td>7.02 (95)</td>
</tr>
<tr>
<td>Patients with renal failure were less likely to heal than were patients without renal failure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with more days elapsed between identification of the pressure ulcers and discharge/death were more likely to heal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with longer total hospitalizations were more likely than other patients to heal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with lower creatinine levels were more likely than other patients to heal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with spinal cord injuries were less likely to heal than were patients without them.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Table 8

<table>
<thead>
<tr>
<th>Multivariate relationships among patients’ characteristics and outcome (N = 87)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Vasopressor infusion</td>
</tr>
<tr>
<td>Spinal cord injury</td>
</tr>
<tr>
<td>Age ≥40 years</td>
</tr>
</tbody>
</table>

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### Table 9

<table>
<thead>
<tr>
<th>Bivariate relationships between stage and outcome of hospital-acquired pressure ulcers (N = 111)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>I</td>
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<tr>
<td></td>
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<tr>
<td>IIa</td>
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<tr>
<td>III</td>
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<td></td>
</tr>
<tr>
<td>IV</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Unstageable</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Suspected deep tissue injurya</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

a P < .01.
required treatment for hypotension; 37% were treated with a vasopressor infusion, and 53% had more than 5 L of fluid replaced in 24 hours.

Data show that patients’ prehospital experience was unique to the population at a trauma center. Thirty-one patients (36%), most of them trauma patients, were admitted by air evacuation, and 39 patients (45%) were admitted from outside hospitals. Although no studies have been done specifically to examine the relationship between prehospital patient transport and its relationship to HAPU development, transport conditions may affect pressure ulcer risk. Transport of patients often involves use of hard surfaces, such as backboards or gurneys, that result in increased pressure. Additionally, trauma patients are at risk for hypothermia, necessitating use of warming devices. Warming devices result in increased skin temperature. Increased skin temperature, in turn, increases the metabolic demand of the warmed tissue, which may increase the risk of pressure ulcers. It is conceivable, therefore, that transport conditions such as exposure to hard surfaces and temperature fluctuations increased the risk of pressure ulcers developing.

An important finding of this study in terms of HAPU characteristics was that 20.7% of the pressure ulcers identified were SDTIs. This finding is important because it documents the high prevalence of SDTIs, a potentially severe type of ulcer by the current definition. The stage of HAPUs in this study was determined on the basis of the 2007 NPUAP classifications. In contrast, most HAPU studies were conducted before the new staging guidelines were implemented and therefore did not use the most recent NPUAP classifications. Therefore, in most recent studies, the system used to identify pressure ulcers did not include SDTI HAPUs.

An interesting finding was related to the anatomic locations where HAPUs occurred. In previous studies, most pressure ulcers (79.5%-100%) occurred on bony prominences. Although 60.4% of the HAPUs identified occurred in locations commonly associated with increased risk for pressure ulcers (sacrum/coccyx, heel, iliac crest, or occiput), 39.6% of the HAPUs occurred in locations that are considered low risk: the back, foot/leg, buttock, arm/hand, penis, head/neck, or tongue (Figure 4).

Several significant relationships among pressure ulcer healing and pressure ulcer or risk profile characteristics were identified. Results of multivariate analysis indicated that vasopressor infusion, spinal cord injury, and age at least 40 years conferred risk for pressure ulcers that were present at discharge or death.

![Figure 5: Stages of hospital-acquired pressure ulcers that occurred.](http://ccn.aacnjournals.org/Downloaded from)
Importantly, the current study identifies factors related to pressure ulcer healing among hospitalized patients, whereas existing studies that describe pressure ulcer healing as it naturally occurs are limited to long-term care or home care patients. The finding that patients who received vasoressor infusions were less likely to experience pressure ulcer healing is particularly important because vasoressor infusion is a treatment not previously examined in relation to healing of pressure ulcers.

Consistent with results of studies conducted among long-term care patients, HAPU stage was significantly related to healing. Analysis of stage II, unstageable, and SDTI HAPU outcomes showed significant differences between the 3 stages (Table 9, Figure 5). Specifically, stage II HAPUs were more likely than other HAPUs to heal, whereas SDTI HAPUs were least likely to heal. The finding that stage II pressure ulcers were more likely to heal was expected because stage II pressure ulcers are partial thickness wounds, whereas unstageable pressure ulcers are full-thickness wounds and SDTI pressure ulcers are potentially full-thickness injuries. The finding that SDTI pressure ulcers were less likely than others to heal is important because it shows that many of the SDTI ulcers were, in fact, deep tissue injuries. Statistically significant differences in healing among other stages could not be determined because samples of stage I (2.7%), stage III (1.8%), and stage IV (0.9%) HAPUs were too small.

Implications

Several nursing implications were identified from the current study. The nursing implications described below can help nurses identify the types of patients at risk for HAPUs, determine the skin locations to assess, and identify the types of pressure ulcers that will heal more slowly.

First, the patients in this study in whom HAPUs developed did not fit the typical description for patients who have pressure ulcers develop. Older patients and patients who are underweight are considered at high risk for HAPU development. However, patients in whom pressure ulcers developed in the current study were relatively young, with a mean age of 51 years. They were also mostly overweight (Figure 3). Only 2% were underweight at admission, whereas more than 66% were overweight or obese. Moreover, extreme obesity, defined as a body mass index greater than 35, was present in nearly 23% of the sample. It is important, therefore, for nurses to recognize that HAPUs can occur in patients of all ages and body types.

Another nursing implication relates to the anatomic locations where HAPUs occurred. Critical care patients, and trauma patients in particular, are often treated with devices that can apply pressure to skin. Pressure from devices is a particular risk for critical care patients, because these patients frequently experience major weight changes and edema from fluid shifts. In the current study, 39.6% of the HAPUs occurred in locations that are considered low risk: the back, foot/leg, buttock, arm/hand, penis, head/neck, or tongue (Figure 4). Some of these HAPUs occurred in places where devices, such as urinary catheters, endotracheal tubes, or casts/braces were located. This finding shows the importance of performing a complete head-to-toe assessment of skin and mucous membranes with special attention to any site where devices may increase pressure on tissue.

An important finding related to the healing of pressure ulcers was that patients who received vasoressor infusions were nearly 5 times less likely than other patients to have their pressure ulcers heal. This finding is important because vasoressor infusion is a treatment unique to critically ill patients; therefore, it has not been previously examined in relation to the healing of pressure ulcers. Because patients who receive vasoressors are at risk for slow-healing HAPUs, nurses can ensure that patients who are treated with vasoressors receive aggressive intervention to prevent development of HAPUs.

Another important finding related to the healing of pressure ulcers was that SDTI pressure ulcers were less likely to heal (Figure 5). This finding was important for 2 reasons. First, SDTI HAPUs were recently included in the updated staging guidelines and therefore they are a relatively new stage of which nurses should be aware. Second, more than one-fifth (20.7%) of the HAPUs identified in the current study were SDTI HAPUs. The high prevalence of SDTI HAPUs, a potentially severe type of pressure ulcer, underscores the importance of critical care nurses being familiar with the new staging guidelines. Detailed information about the updated staging guidelines is included in this article.

Researchers in previous studies noted that pressure ulcers occur...
most often among ICU patients and patients with high severity of illness.\textsuperscript{7,24} In the current study, 89\% of patients in whom HAPUs developed were ICU patients. Because ICU patients are at high risk for HAPU, it is particularly important for critical care nurses to be aware of the types of patients in whom HAPUs develop, including younger patients and overweight patients (Figure 3). Nurses also should be cognizant of the various anatomic locations where HAPUs occur (Figure 4) and be aware of factors that affect HAPU healing, including older age, spinal cord injury, vasopressor infusion, and pressure ulcer stage (Figure 5).

Limitations

One limitation of the current study was that the data gathered reflect only risk profile data; the data do not encompass events that occurred after HAPU development. This method was chosen so that data would capture a patient's risk profile before HAPU development in order to describe associations between risk profiles and HAPU outcome. Acknowledgment of this limitation is important because data for numerous intervening factors related to healing are not present (eg, specific nutritional information, dressings, bed and surface types, turning schedules, and physiological parameters), and it will be important to include relevant factors in future studies to better understand relationships among risk status, treatment, and outcome.

As previously described, pressure ulcer outcomes were recorded on the basis of whether the pressure ulcer was present at discharge or death or was healed at discharge or death. Another limitation of the study related to outcomes was the variability in length of hospitalization. This limitation is evidenced by differences in the mean time for healing: patients who healed were hospitalized a mean of 37 days longer than patients who had pressure ulcers present within 48 hours of discharge or death.

Another limitation of this study relates to the way HAPU healing was defined. When a HAPU was not documented in any EMR source, including nurses’ and physicians’ notes and assessment forms, within the 2 consecutive days before discharge, that HAPU was considered healed. Forty-six of the 51 “healed” outcomes were documented in the wound nurse’s follow-up notes. For the remaining 5 healed HAPUs, it is possible that some of those pressure ulcers were present within 48 hours of discharge or death but lacked documentation in the EMR within that period.

Implications for Future Research

The determination that SDTI HAPUs were less likely to heal underscores the importance of recognizing SDTI pressure ulcers. As previously described, most current studies that examined HAPUs were undertaken before the new staging guidelines were implemented and therefore those studies did not include the classification of SDTI pressure ulcers.\textsuperscript{4,5} Further study is needed to determine whether SDTI pressure ulcers are as prevalent among other populations as they were among patients in the current study.

Further study is also needed to determine relationships between events that occur after HAPU development and HAPU outcome, and to determine the relative importance of pre-HAPU data compared with events occurring after HAPU development in relation to HAPU outcomes. Additional factors related to healing, such as severity-of-illness scores, physiological parameters, and treatment information including specific nutritional information, dressings, bed and surface types, and turning schedules warrant increased attention in critically ill patients.

In the current study, 8 patients (9\%) had from 1 to 3 additional pressure ulcers develop later in their hospital course. Because this was a time-limited study, additional data on risk characteristics and outcomes were not recorded for those pressure ulcers that developed later in the hospital course. Further study examining patients in whom multiple ulcers develop throughout their hospital course will show how these patients are different from patients who do not experience multiple ulcers.

In addition, study is needed to determine why patients who receive a vasopressor infusion are less likely to experience pressure ulcer healing and whether effects vary depending on the specific vasopressor or dose/duration of vasopressor therapy. Potential hypotheses include microvascular changes associated with vasopressor infusion, increased

To learn more about pressure ulcers, read “Protecting Fragile Skin: Nursing Interventions to Decrease Development of Pressure Ulcers in Pediatric Intensive Care” by Schindler and colleagues in the American Journal of Critical Care, 2011;20:26-35. Available at www.ajcconline.org.
severity of illness among patients who receive vasopressors, underlying hypotension, or a combination of factors.

Finally, future research should focus on comparison of risk profile characteristics between patients in whom HAPUs develop and patients in whom HAPUs do not develop. This comparison is needed to determine factors that are different in patients in whom HAPUs develop and patients in whom they do not. Our data indicate a very high acuity of patients in whom HAPUs develop, and this high acuity appears to be related also to the final outcome of either healing or not healing. However, because we studied only those patients with ulcers, we cannot draw specific conclusions and recommend that future studies use methods in which patients are matched on important risk factors and ulcer development (or not) is evaluated. Comparison of differences among specific populations, such as surgical, trauma, and other acutely ill patients will also help to determine risk profiles. Further study is also warranted to determine associations between risk characteristics and specific pressure ulcer stages. This information will be helpful in refinement of risk evaluation in patients in acute hospital settings.

References

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None reported.

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1. The Braden Scale is a skin assessment tool that quantifies pressure ulcer risk by evaluating the patient based on which of the following?
   a. Hydration
   b. Friction and shear
   c. Appetite
   d. Range of motion

2. Which of the following risk factors is associated with hospital-acquired pressure ulcers (HAPUs)?
   a. Shorter length of stay
   b. Antidysrhythmia drug infusions
   c. Spinal cord injury
   d. Tube feeding

3. Which of the following patient characteristics are associated with an increased risk of HAPUs when present on admission?
   a. High body mass index
   b. Diabetes
   c. Young age
   d. Thyroid deficiency

4. Which of the following explains the 0% complication rate implemented by the Center for Medicare and Medicaid Services?
   a. Hospitals will no longer receive reimbursement for the care, services, and resources required to treat the complication.
   b. Hospitals will receive a bonus if they report 0 complications.
   c. Hospitals will not be reimbursed until discharge.
   d. Hospitals will be able to cost shift the care if a different diagnosis is recorded.

5. Pressure ulcers during hospitalization have increased by how much from 1992?
   a. 26%
   b. 52%
   c. 63%
   d. 100%

6. During initial assessment, a 4-cm area on the patient’s coccyx, with a hard, leathery dark area, should be documented as which of the following?
   a. Stage I
   b. Stage III
   c. Unstageable
   d. Suspected deep tissue injury

7. According to this study, which of the following is the number of ulcers documented for a patient who had 2 pressure ulcers identified on day 1, and 2 new ulcers identified on day 4?
   a. Four ulcers, each one is documented individually
   b. Three ulcers, the first 2 are documented as one, the 2 additional ulcers are documented individually
   c. Three ulcers, the first 2 are documented individually, the 2 additional ulcers are documented as one
   d. One ulcer episode per patient

8. Which of the following is the body mass index of the largest percentage of the 91 patients in the study?
   a. 18.4 or less (underweight)
   b. 18.5-24.9 (normal weight)
   c. 25-29.9 (overweight)
   d. 30-34.9 (obese)

9. In the study, which of the following laboratory abnormalities were reported in patients with HAPUs?
   a. Decreased blood sugar
   b. Elevated hemoglobin
   c. Decreased albumin
   d. Decreased C-reactive protein

10. The highest percentage of HAPUs in the study represented which of the following?
    a. Stage I or II
    b. Stage II or III
    c. Stage III or IV
    d. Unstageable or suspected deep tissue injury

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Risk Profile Characteristics Associated With Outcomes of Hospital-Acquired Pressure Ulcers: A Retrospective Review
Jenny Alderden, JoAnne D. Whitney, Shirley M. Taylor and Sunniva Zaratkiewicz

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