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Identification of Risk Factors for the Development of Pressure Ulcers Despite Standard Screening Methodology and Prophylaxis in Trauma Patients



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PURPOSE:

To present information about a study of risk factors for development of pressure ulcers (PrUs) in trauma patients.

TARGET AUDIENCE:

This continuing education activity is intended for physicians and nurses with an interest in skin and wound care.

OBJECTIVES/OUTCOMES:

After participating in this educational activity, the participant should be better able to:

1. Describe the previous PrU research, scope of the problem, and methodology of the study.
2. Explain the results of the study identifying PrU risk factors for trauma patients.

ABSTRACT

OBJECTIVE: Pressure ulceration prevention has been emphasized over the past several years in inpatient hospital settings with subsequent decreases in the development of pressure ulcers (PrUs). However, there remains a subset of trauma and burn patients that develop PrUs despite standard screening methodology and prophylaxis. This study determines the conditions that predict development of pressure ulcers (PrUs) despite conventional prophylaxis and screening.

METHODS: Demographic and PrU data were collected over a 5-year period from June 2008 to May 2013. Patients diagnosed with PrUs upon arrival in the trauma bay were excluded from analysis. An ordinal logistic regression of PrU stage was used to estimate odds ratios (ORs) and associated 95% confidence intervals (CIs) for the association between characteristics of interest and odds of a PrU. A backward selection process was used to select the most parsimonious model.

RESULTS: During the study period, 14,616 trauma patients were admitted and had available data. A total of 124 patients (0.85%) that met inclusion criteria went on to develop PrUs during their hospital course. Factors associated with the development of PrUs included spine Abbreviated Injury Scale (AIS) >3 (OR, 5.72; CI, 3.63–9.01), mechanical ventilation (OR, 1.95; CI, 1.23–3.10) and age 40 to 64 (OR, 2.09; CI, 1.24–3.52) and age ≥ 65 (OR, 4.48; CI, 2.52–7.95). Interestingly, head injury AIS >3 was protective from the development of PrUs (OR, 0.56; CI, 0.32–0.96). Hypotension and shock defined as systolic BP <90 mm Hg and base deficit less than –6 were not associated with the development of PrUs. In addition, body mass index was not associated with PrU development.

CONCLUSIONS: Spinal injuries, older than age 40, and mechanical ventilation predict the development of PrUs for a subset of patients, despite conventional prophylaxis and screening. Advanced prevention methods, such as low-air-loss mattresses for these patient subgroups should be considered immediately upon identification of these risk factors during the hospital course.

KEYWORDS: pressure ulcers, prophylaxis, risk factors, trauma

ADV SKIN WOUND CARE 2016;29:329–34.

of medical and surgical patients.^{1,2} Pressure ulcers are expensive to treat; may lead to multiple surgical procedures, including repeated debridements, flaps, and diverting ostomies; and are associated with increased hospital length of stay, readmission rates, and mortality rates.¹ The development of PrUs has also been incorporated into quality care measures and can be grounds for patient litigation.^{3,4} In addition, the development of serious PrUs (such as full-thickness skin loss or full-thickness skin and tissue loss) is considered a hospital-acquired condition and a “never event” by the Centers for Medicare & Medicaid Services.⁵ As a result, over the past several years, PrU screening and prevention have been emphasized within inpatient hospital settings with subsequent decrease in the overall incidence.^{1,2}

Multiple validated screening scales have been developed to assist with identification of patients at high risk for the development of PrUs. Numerous studies have evaluated the effectiveness of the Braden, Norton, Risk Assessment Pressure Score, Waterlow, and Cubbin-Jackson scales at predicting the development of PrUs.^{4,6–10} Unfortunately, there is no clear consensus as to which scale is most reliable or predictive. Multiple studies have also attempted to identify more specific risk factors associated with the development of PrUs. The length of hospital stay, age, increased blood urea nitrogen, hemoglobin level, C-reactive protein, skin type, organ dysfunction, sepsis, circulatory impairment, body temperature, history of smoking, mental status, history of malignancy, need for intravenous nutrition, recent fracture, and surgery, to name a few, have all been identified as potential risk factors.^{11–18} Once a high-risk patient has been identified, aggressive measures for prevention can be initiated early. Bedside skin care, skin protective pads, nutritional optimization, frequent repositioning, and equipment such as low-air-loss mattresses are routinely used to help prevent or treat PrUs.

Even with improvement in the recognition of high-risk patients, there remains a subset of individuals who develop PrUs despite standard screening and prophylaxis. Trauma patients in particular have many of the known risk factors and are prone to the development of PrUs. There are limited studies that focus on this high-risk population. Thus, the purpose of this study is to identify specific risk factors for trauma/burn patients that will help predict the development of PrUs so that more aggressive preventive measures can be instituted early, hopefully reducing the morbidity, mortality, and increased cost associated with PrUs.

METHODS

A retrospective evaluation of all trauma patients was performed at the University of Alabama at Birmingham (UAB) from data

INTRODUCTION

Despite the implementation of aggressive preventive measures, pressure ulcers (PrUs) remain a common problem in the inpatient hospital setting. Previously reported incidence rates for the development of PrUs during acute hospitalization have ranged between 0.86% and 4.5% for an all-encompassing group

collected over a 5-year period from June 2008 to May 2013. The UAB Hospital is an American College of Surgeons–verified level I trauma center that evaluates approximately 5000 patients per year, admitting 3200 within the last calendar year. Approval was obtained from the UAB Institutional Review Board for Human Use before initiation of the study.

During the evaluation of trauma patients, all were screened as a component of the advanced trauma life support secondary survey for PrU present on admission. Patients who were admitted and had any PrU on arrival in the trauma bay were excluded from analysis. An ordinal logistic regression of PrU stage was used to estimate odds ratios (ORs) and associated 95% confidence intervals (CIs) for the association between characteristics of interest and odds of PrUs. Characteristics of interest were based on previously published risk factors for the development of PrUs. A backward selection process was used to select the most parsimonious model.

RESULTS

During the study period, 14,616 trauma patients were admitted and had available data. A total of 294 patients were excluded from analysis because of presence of PrU on admission. Of the remaining 14,322, a total of 124 patients (0.87%) who did not have any sign of pressure ulceration upon presentation did develop a PrU during the course of their hospitalization despite routine screening and prophylaxis (Table 1). Factors associated with the development of PrUs included spine Abbreviated Injury Scale (AIS) greater than 3 (OR, 5.72; CI, 3.63–9.01), mechanical ventilation (OR, 1.95; CI, 1.23–3.10), and age 40–64 years (OR, 2.09; CI, 1.24–3.52), and increased further with age 65 years or

older (OR, 4.48; CI, 2.52–7.95) (Table 2). Interestingly, head injury AIS greater than 3 was protective from the development of PrUs (OR, 0.56; CI, 0.32–0.96). Hypotension and shock defined as systolic blood pressure less than 90 mm Hg and base deficit less than -6, respectively, were not associated with the development of PrUs. Likewise, body mass index (BMI) for underweight (BMI ≤ 18.5 kg/m²), overweight (BMI 25–29.9 kg/m²), and obese (BMI ≥ 30 kg/m²) was not associated with PrU development.

DISCUSSION

The development of PrUs leads to increased patient morbidity and mortality, increased hospital length of stay, increased hospital readmission rates, and higher healthcare costs. As such, there has been considerable emphasis on identification and modification of patient risk factors, frequent nursing assessment, development of risk assessment scales, and early aggressive prophylaxis and treatment.^{14–17} Prior studies have focused on hospitalized general medicine and/or surgical patients, but no studies have evaluated risk factors specific to the high-risk trauma population. Even with screening for known associated risk factors, standard management algorithms, and good nursing care, a subset of trauma patients will still develop PrUs. The authors' study identified several independent risk factors that signify an increased risk of PrU development despite routine screening and prophylaxis.

Immobilization as seen with severe spinal cord injury (SCI) has been well validated as a risk factor for the development of PrUs.^{19–24} Results of these studies have indicated that an increased age, increased BMI, cervical lesions, and motor-complete lesions are associated with an increased frequency of complications. However, the majority of studies that have examined SCI as a prominent risk factor have been gathered from the rehabilitation setting or, at the earliest, the subacute hospitalization. This is an important distinction as the development of PrUs occurs more frequently in the rehabilitation and later convalescing stages than in the acute phase of hospitalization, which draws into question the interpretation of some of these studies in the acute phase of care.

A recent study by Wilson et al¹⁹ evaluated the frequency of various acute inpatient complications after cervical SCI, demonstrating that more severe SCIs were more predictive of development of all complications. Of the 240 complications noted in that study, 11 (4.6%) were the development of a PrU. Similarly, a 5-fold increase was seen in patients in the authors' study when spine AIS was greater than 3. Although not surprising, this is one of very few studies that has determined that spinal injuries are associated with acute PrU development.

Table 1.
INCIDENCE OF PRESSURE ULCERS BY INJURY
MECHANISM AND MAXIMUM ULCER STAGE

	Blunt (n = 11,931)	Penetrating (n = 2685)
Ulcer, n (%)		
Yes	106 (0.89)	18 (0.67)
No	11,825 (99.11)	2667 (99.33)
Maximum ulcer stage, n (%)		
Stage I	19 (17.92)	3 (16.67)
Stage II	38 (35.85)	2 (11.11)
Stage III	7 (6.60)	3 (16.67)
Stage IV	8 (7.55)	2 (11.11)
Unstageable	34 (32.08)	8 (44.44)

Table 2.
ODDS RATIOS^a AND 95% CONFIDENCE INTERVALS FOR
THE ASSOCIATION BETWEEN DEMOGRAPHIC, INJURY,
AND CLINICAL CHARACTERISTICS AT ADMISSION AND
PRESSURE ULCER SEVERITY AMONG TRAUMA PATIENTS

	Full Model	Most Parsimonious Model
Demographics		
Age group, y		
<40	Reference	Reference
40–64	1.76 (1.03–3.01)	2.09 (1.24–3.52)
≥65	3.63 (1.96–6.72)	4.48 (2.52–7.95)
Race		
White	1.55 (0.83–2.89)	—
Black	Reference	—
Hispanic	0.60 (0.08–4.61)	—
Other	2.53 (0.31–20.53)	—
Male sex	1.31 (0.78–2.20)	—
BMI		
Underweight	1.39 (0.41–4.70)	—
Normal	Reference	—
Overweight	0.76 (0.42–1.38)	—
Obese	1.27 (0.74–2.18)	—
Injury		
Mechanism		
Blunt	1.15 (0.53–2.49)	—
Penetrating	Reference	—
AIS 3+ injury		
Head	0.53 (0.30–0.93)	0.56 (0.32–0.96)
Neck	2.25 (0.77–6.52)	—
Spine	5.50 (3.41–8.87)	5.72 (3.63–9.01)
Thorax	1.03 (0.64–1.66)	—
Abdomen	1.23 (0.65–2.32)	—
Upper extremity	0.61 (0.31–1.17)	—
Lower extremity	0.41 (0.10–1.71)	—
Clinical		
Transfer status		
Nontransfer	Reference	—
Within 24 h of injury	1.24 (0.73–2.12)	—
>24 h of injury	0.93 (0.37–2.37)	—
ED SBP <90 mm Hg	1.15 (0.52–2.53)	—
Base deficit	1.09 (0.59–2.01)	—
<-6 at admission		
ETT	2.05 (1.22–3.44)	1.95 (1.23–3.10)
Abbreviations: AIS, Abbreviated Injury Scale; ED, emergency department; ETT, endotracheal tube; SBP, systolic blood pressure.		
^a Estimated from ordinal logistic regression.		

Increased age has also been associated with the development of PrUs in many studies. This is related to chronic immobility due to neurologic compromise from neurovascular events, dementia, overall poor health, and poor functional capabilities.²⁵ Wilson et al¹⁹ determined a slight increased risk in older patients in the development of PrUs in multivariate analysis; however, older age was not an independent variable that had statistical difference for PrU development in SCI patients.¹⁹ Likewise, Krassioukov et al²¹ did not determine age older than 60 years to be an independent predictor of PrU development, although other preexisting comorbidities were associated with secondary complications overall in patients with SCI.²¹ This study does demonstrate ages 40 to 64 years as an independent predictor of PrU development with a 2-fold increase in risk for the overall trauma population compared with those patients younger than 40 years. An age older than 65 years was associated with PrU development 4-fold higher than patients younger than 40 years.

Interestingly, BMI and admission hypotension/shock (systolic blood pressure <90 mm Hg and base deficit <-6) were not associated with the development of PrUs in this study. A study by Hyun et al²⁶ revealed that addition of BMI to the Braden scale did not improve predictability, also suggesting that BMI is not an independent risk factor for development of PrUs. In addition, a study by Compton et al¹³ compared objective parameters, such as presence of shock and subjective nursing assessment evaluating local skin factors, with an established risk assessment scale (Waterlow). With univariate analysis, the presence of organ dysfunction, sepsis, and circulatory impairment were significantly associated with the development of PrUs. However, with multiple logistic regression analysis, subjective nursing assessment comprised mostly of skin-related parameters yielded stronger predictive value than the previously mentioned objective data. This suggests that the presence of shock, although a potential risk factor, is not as strong a predictor of PrU compared with local skin factors, such as moisture and friction or shear.¹³

Prior studies have not specifically referenced mechanical ventilation as a risk factor for PrUs. The risk of PrU development was nearly double for intubated patients versus nonintubated patients. Yet, given that frequent repositioning and rolling for sacral wound care can be riskier in these patients (given the potential for accidental extubation or endotracheal tube migration), it is possible that mechanically ventilated patients are not treated as aggressively as nonventilated patients for PrU prevention. Although the authors did not specifically evaluate length of time of mechanical ventilation, it is likely to contribute to PrU development in the acute phase of care as inability to mobilize would predispose the patient to prolonged risk.

The authors note several limitations to consider for this study. This was a single-center, retrospective study that relied on data entry into the database. Coders may have misclassified present-on-admission PrUs. Although a large sample of patients were assessed, a relatively small group of patients met inclusion criteria; a large number of patients had a Stage 1 PrU on presentation to the trauma bay as a consequence of prolonged transport on a hard spine board, and these patients were excluded from the study. This comprises a large proportion of this high-risk population, and these patients will need to be evaluated in future studies as they may benefit the most from early and aggressive prophylaxis and intervention.

CONCLUSIONS

In conclusion, trauma patients are potentially at high risk for the development of a PrU, as they have a significant number of risk factors that predispose them to skin breakdown. Despite routine care and prophylaxis, a subset of these patients will still develop a PrU. Trauma patients with severe spine injury (AIS >3), mechanical ventilation, and age older than 40 years should be treated early with aggressive preventive measures and constant vigilant surveillance. Such preventive measures could include placing SCI patients on low-air-loss specialty beds as soon as the associated spine fracture has been stabilized. In addition, future studies should evaluate the benefit of early treatment in the high-risk trauma patient population.

PRACTICE PEARLS

- Despite screening for known associated risk factors, standard management algorithms, and good nursing care, a subset of trauma patients will still develop PrUs.
- Spinal cord-injured patients have a greater than 5-fold increase of PrU development in the acute care setting. The authors suggest placing all spinal cord-injured patients on low-air-loss specialty beds, as soon as the associated spine fracture has been stabilized.
- Age older than 40 years is associated with a 2-fold increased risk of PrUs in trauma patients compared with younger trauma patients; this risk increases to a 4.5-fold risk once the age increases to older than 65 years.
- Mechanical ventilation is an independent risk factor for PrU development, with a 2-fold risk versus nonintubated patients, suggesting increased vigilance regarding screening and preventive measures is warranted in these patients.
- Body mass index and admission hypotension/shock are not associated with the development of PrUs

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