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ORIGINAL CONTRIBUTION
Predictors of Pressure Ulcer Recurrence in Veterans With Spinal Cord Injury

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Abstract

Background/Objective: To predict recurrence of pressure ulcers (PrUs) in a high-risk population of veterans with spinal cord injury (SCI).

Design: Cross-sectional observational design.

Participants: A convenience sample of 64 subjects from 6 Department of Veterans Affairs (VA) SCI Centers who had been admitted to the hospital for the treatment of stage III–IV pelvic PrUs and were healed at the time of discharge back to the community.

Main Outcome Measures: Primary outcome measures were pelvic PrU recurrence, defined as self-reported new skin breakdown (stage II or greater) in the pelvic area (not necessarily in the same location as previous ulcer) and time to recurrence.

Results: There were no differences between those with/without recurrences with regard to age, age at/level of injury, number of previous ulcers or surgery, rate of or time, to recurrence. Mean age was 56 years; most were white and men, lived at home, and had some college education. Mean time since SCI was 22 years; 28% had tetraplegia; mean number of prior pressure ulcers was 3; and almost one half had a previous ulcer in the same location. The strongest predictor of recurrence in a multivariate logistic regression was African American race (odds ratio = 9.3). Additional predictors included higher scores on the Charlson Co-Morbidity Index (indicating a higher burden of illness), the Salzburg PrU Risk Assessment Scales, and longer sitting time at discharge.

Conclusion: Identifying individuals at highest risk for recurrence and developing effective prevention programs are essential rehabilitation goals. We recommend that the unique findings of this exploratory study be considered preliminary until replication of these results is published.

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Key Words: Pressure ulcers, recurrence; Spinal cord injuries, traumatic; Department of Veteran Affairs; Veterans; Rehabilitation

INTRODUCTION

Preventing development and recurrence of pressure ulcers (PrUs) in the spinal cord injury (SCI) population is important for several reasons. First, because of factors such as lack of sensation and immobility, all individuals with SCI are at an increased risk of developing PrUs (1). Second, having had 1 severe PrU is one of the strongest predictors of developing recurrent ulcers (2,3). Third, the overall costs of treating PrUs are very high (4). Finally, there is little strong empirical evidence to guide clinical management of PrUs (5).

There are approximately 250,000 persons with SCI in the United States today and an estimated 11,000 new injuries per year (6). Veterans make up almost 12% of the SCI population. Multidisciplinary teams at 23 regional SCI Centers located in Department of Veterans Affairs (VA) medical centers (VAMCs) deliver primary care, acute rehabilitation, disability management, ongoing rehabilitation, health maintenance, and lifelong health care for veterans with SCI. SCI is the most costly medical condition for veterans (~$26,735/person/y), and more than one half of all VA hospital stays for veterans with SCI are attributable to PrUs (4). The costs of caring for PrUs in veterans with SCI are substantial. In VAMCs in FY 2005, 1,586 unique patients had 2,350 admissions for PrUs

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(about one third of all VA SCI admissions). In a chart review conducted by Garber and Rintala (7), they found that stage IV PrUs were the most prevalent as the worst ulcer documented.

PrUs are a serious, costly, and life-long complication of SCI. Factors such as lack of sensation and immobility increase the risk of PrU development in persons with SCI (8,9). In a study examining reasons for hospitalization after SCI, Cardenas et al (10) found that PrUs were the second most frequently cited reason at most time intervals after SCI (1, 10, 15, and 20 years) and was the most common reason for hospitalization 5 years after SCI.

Although risk factors for PrU are widely agreed on, the relative weight of these factors and their importance with respect to recurrence have not been established and probably vary across patient groups (11). Most of the published research on PrU risk factors has been done on either elderly nursing home (NH) residents or in the Model SCI System population. (The Model SCI System program is sponsored by the National Institute on Disability and Rehabilitation Research [NIDRR], Office of Special Education and Rehabilitative Services, US Department of Education.) The degree to which these risk factors apply to the VA SCI population has not been established. One reason to believe that risk factors may differ between these populations is that the VA system has a high proportion of individuals with long-term, chronic SCI (median time since injury, $\geq$20 years), whereas Model SCI System programs focus primarily on individuals with acute SCI.

Clinical observations and research have shown staggering costs and human suffering caused by PrUs, including profound negative impact on general physical health, socialization, financial status, body image, and level of independence and control (12,13). Reported prevalence rates are high (17–33%) and remain unchanged in populations of persons with SCI residing in the community (4–7,14–16). High rates of recurrence also have been reported, ranging from 31% to 79% (17–21). Recurrence has also been associated with sex (male), age (younger), race (African American), unemployment, nursing home residence, and previous PrU surgery (8,22,23).

Although recurrence rates are significant, and data exist on possible risk factors for recurrent PrUs, there is little information on characteristics of recurrent PrUs either in the SCI population or in other populations such as frail nursing home residents. Existing articles on PrU recurrence come primarily from the surgical literature, where the primary focus is on case studies and descriptions of surgical techniques. Recurrence rates of individuals whose ulcers were surgically treated have ranged from 11% to 29% in cases with postoperative complications and 6% to 61% in cases without postoperative complications (12,24–30). Krause and Broderick (31) reported that 13% of their sample of 633 subjects with SCI had one or more recurrent PrUs per year. Their study suggested that lifestyle, exercise, and diet were protective mechanisms against PrU recurrence. Chen et al (11) studied the effects of age, period (1994–2002 vs 1984–1993), and SCI duration on PrUs. These investigators found that, although during the first 10 years after SCI, PrU risk was relatively stable, there was a significant trend toward increasing PrU prevalence between 10 and 15 years after injury, possibly because of the effects of aging.

A major problem in understanding PrU recurrence is a lack of clear terminology and procedures for evaluating and classifying ulcers that develop in the same anatomic region as a prior PrUs. When this type of ulcer develops, it could represent incomplete healing of the original ulcer, breakdown within previously healed scar tissue where the prior ulcer was located, or breakdown within adjacent tissue that was unaffected by the initial ulcer. In addition, the lack of precise measures for factors such as undermining (typically assessed as present vs absent) make it difficult to assess the degree of even uninvolved tissue. In general, we found that the term "recurrence" has been applied to all of these possibilities. In our study, we defined recurrence as any new skin breakdown (eg, stage II or higher) in the same or different pelvic location as the healed study ulcer for which the subjects in our sample were admitted to the hospital. This study examined factors that are associated with PrU recurrence and used data from veterans admitted for treatment of severe (eg, stage III/IV) pelvic PrUs who were discharged from 6 VA SCI units with healed ulcers.

METHODS

Data were derived from a prospective randomized controlled trial (RCT) at 6 VA SCI Centers. Inclusion criteria included 1 or more years of post-traumatic SCI, age $>$18 years, a healed stage III/IV pelvic ulcer, and access to a phone. Exclusion criteria included a terminal diagnosis and/or significant psychiatric comorbidities (eg, schizophrenia and other active psychoses) or cognitive impairments that limited their ability to participate in the telephone counseling intervention. The study sample included 64 veterans with healed PrUs. The study received approval from all the participating institutional review boards at each VA Medical Center (VAMC) and affiliated universities. Study enrollment began in November 2003 and follow-up ended in June 2005. All eligible patients were approached by the local study Site Coordinator (SCs) to obtain consent to participate in the study. SCs interviewed participating patients who consented to obtain demographic, clinical, SCI, and ulcer histories. Information on comorbid conditions and ulcer characteristics was obtained from the patient's electronic medical records and verified by their primary care provider. All participants received usual care (ie, medical and/or surgical treatment) for their existing PrUs. The determination of whether the ulcer was healed was a clinical decision made by the patient's

Table 1. Risk Factors for the Development and Recurrence of Pressure Ulcers

Demographic Characteristics	Medical Factors	SCI Characteristics	Ulcer Characteristics	Patient Factors
Age	Current co-morbid medical conditions	Time since SCI	Number of prior ulcers	PrU knowledge
Marital status	Diabetes	Etiology	Number of prior ulcer surgeries	Health beliefs
Race	Hypertension	Injury level	Number of current ulcers	Control beliefs
Living arrangement	Incontinence	Completeness of injury	Ulcer location	Tobacco use
Education	Autonomic dysreflexia	ASIA score	Ulcer stage	Alcohol use
Service-connected status	Cardiovascular disease		Ulcer duration	PrU risk
	Pulmonary disease		Ulcer size	Functional status
			Infection of ulcer	
			Presence of undermining	
			Surgical treatment of ulcer	
			Sitting time after healing	

primary care provider at each VAMC. Subsequent VA health care utilization was obtained using administrative data.

Selection of Risk Factors

More than 200 risk factors for PrUs have been reported in the literature. Most of these risk factors were derived from studying elderly NH residents. Although factors such as immobility and incontinence increase PrU risk in both populations, treatment, neurologic dysfunction (eg, lack of sensation), and relationship factors may be quite different. Persons with SCI are expected to oversee or direct their daily care and take responsibility for prevention. The existing literature is often contradictory with respect to the effect of a particular risk factor or set of factors on PrU development or recurrence because interpretation and generalization of risk and prevention research are limited by studies that focus on different populations (eg, acute vs chronic SCI), have poor or uncontrolled study designs, often with inadequate sample sizes, and/or have different ways of operationalizing the dependent measures (12,13).

Despite these limitations, a number of mostly disease and patient risk factors for the development of PrUs specific to SCI have been identified and described in the literature (32,33). Byrne and Salzberg (13) listed the following as the major risk factors for persons with SCI: (a) severity of SCI (eg, immobility, completeness of SCI, urinary incontinence, and severe spasticity); (b) preexisting conditions (eg, advanced age, smoking, lung and cardiac disease, diabetes and renal disease, impaired cognition, and residing in a NH); and (c) nutrition (eg, malnutrition and anemia). Garber et al (34), studying disease and patient factors, included not only demographic factors (eg, age, sex, race, marital status, and education) and physical/medical and SCI-related factors (eg, level and completeness of SCI, activity and mobility, bladder, bowel, and moisture control, and co-morbidities such as diabetes and spasticity), but also psychological and social factors (eg, psychological distress, financial problems, cognition, substance abuse, adherence, and health beliefs and practices).

The model we used to identify predictors of recurrence is shown in Table 1. Because this was an exploratory study, there were no a priori hypotheses. Information collected from participants was put into the following categories: (a) demographic characteristics, (b) medical factors, (c) SCI characteristics, (d) ulcer characteristics, and (e) patient factors.

Measures

Independent Variables. Investigators conducted a comprehensive assessment of all study participants at baseline. Our analysis began with a list all of the factors addressed in the Consortium for Spinal Cord Medicine's PrU Clinical Practice Guideline (CPG) and other literature (5). The CPG recommends that a comprehensive PrU assessment include characteristics of the person in addition to characteristics of the ulcer and treatment.

All the characteristics that were not expected to change over the course of the study (eg, demographic, medical, SCI, and ulcer history) were collected at the time of admission to the hospital for treatment of a stage III/IV ulcer. Treatment details, health care utilization, recurrence, and time to recurrence were all collected as they occurred or after the fact using administrative data.

Race was self-reported by the patient. Categories were collapsed into African American and white (including Hispanic).

Treatment Variables. Each site implemented its own postwound healing protocol for building sitting tolerance. The amount of sitting time posthealing was determined by the patient's primary care provider and/or surgeon. The measure used in our analysis reflects the "amount of sitting time that had been achieved at the time of discharge." This information was obtained from either the patient's nurse, occupational therapist, physical therapist, or his primary care provider.

Functional status was measured using the Functional Independence Measure (FIM) (35) and the SF-12. SF-12 scores were collected using the Medical Outcomes Study Veterans Short Form (SF-12) Health Survey (36). The SF-12, which consists of the physical component summary (PCS) and mental component summary (MCS), has been used to measure functional status and health-related quality of life. We used only the physical function score of the SF-12 to measure functional status.

Charlson Index Scores (37,38), a measure of comorbid chronic illnesses, were calculated using VA administrative data for the 3 years before the participant's admission into the study. The Charlson Index contains 19 categories of comorbidity derived from ICD-9-CM diagnosis codes. The overall Charlson Score (which can range from 0 to 7) reflects the cumulative likelihood of 1-year mortality, so a higher score reflects a greater burden of illness.

The Salzburg PrU Risk Assessment (39), an instrument developed for SCI, was obtained from participant self-report and confirmed by review of the participant's electronic medical record.

The Multidimensional Health Locus of Control Scale was used to measure the extent to participants believed that their destiny was controlled by internal vs external forces (40).

The Pressure Ulcer Knowledge Test has been used in a number of previous studies and is described more fully in Garber et al (41).

Dependent Variables. The primary outcome variable was recurrence, defined as a new skin breakdown in the pelvic area (defined for this study as occurring in the sacrum, coccyx, trochanter, or ischium). A secondary outcome of the study was the time from discharge to recurrence among those participants with skin breakdown.

Recurrence was identified through a 2-step process in which participant's reports of any skin breakdown were confirmed by clinician observations using a valid wound severity tool. Self-reported information about new skin breakdown was collected from participants on a quarterly basis by a telephone interviewer. Recurrences also could be reported to study or clinical personnel. The severity of all recurrences was verified by clinical assessment within 3 days of the veteran's report of skin breakdown.

All veterans reporting skin breakdown were assessed using the Bates-Jensen Wound Assessment Tool (BWAT) (42). Participant self-report of new skin breakdown was verified by clinical examination; however, no specific severity cut-off was used. Skin breakdown that was assessed as stage II and above was considered a recurrence or a new pressure ulcer. The BWAT, formerly the Pressure Sore Status Tool, evaluates 13 wound characteristics, rates each on a scale from 1 (best) to 5 (worst), and can be summed for a total score ranging from 13 to 65, with higher scores indicating more severe tissue damage. Inter-rater reliability of the BWAT has been reported as $r = 0.92$ for 2 observers in hospitalized patients.

Our rationale for defining recurrence as new skin breakdown was (a) it was unclear whether patients could reliably report on stage I ulcers and (b) because many participants lived too far away from the SCI Center from which they were recruited, it was deemed impractical to bring them back to the hospital or clinic setting to verify stage I ulcers in a timely way. We believed that participants could reliably report new skin breakdown (consistent with stage II PrUs), and therefore, they were encouraged to contact their provider or study personnel when they noticed new skin breakdown.

Time to recurrence was calculated from the date of discharge to the date when skin breakdown was reported.

Data Analysis

Data analysis proceeded in several steps. First, descriptive statistics were calculated. *t* tests and Fisher exact tests were used to compare means and proportions. The distributions of independent variables and dependent variables were examined for outliers and skewed distributions. Bivariate correlations were conducted using Spearman ρ. For variables that were significantly correlated with recurrence, we calculated odds ratios and 95% confidence intervals (CIs) using logistic regression. The study was originally powered to detect differences in outcomes between the treatment and control arms of the study. The generally accepted rule of thumb that the sample size limits the number of independent variables that can be included in the model was followed. Therefore, based on the sample size of 64, the regression model was limited to 6 independent variables.

The model was developed by running a series of stepwise multivariable logistic regressions. The final model was limited to those variables that were statistically significant ($P \leq 0.05$) in prior analyses. Because the Charlson Index Score and the SF-12 were highly correlated, only the Charlson Index Score was included in the final regression model. Kaplan-Meier survival estimates were obtained and plotted to better understand the predictors of recurrence. Univariate comparisons of survival distributions were performed using the log-rank statistic. All statistical analyses were conducted using SAS (SAS Institute, Cary, NC) or Stata (StataCorp, College Station, TX).

RESULTS

Demographic and Spinal Cord Injury Characteristics as Predictors of Recurrence

A total of 37.5% of our sample (24/64) reported new skin breakdown. Median time to skin breakdown across all subjects was 4.5 months. No statistically significant differences were observed between those with vs those without skin breakdown based on age, marital status, education, place of residence, time since SCI, level of

Table 2. Demographic and SCI Characteristics

	Recurrence (n = 24)	No Recurrence (n = 40)	*P* Values
Demographic characteristics			
Mean age (range, 31–77 y)	55.7	56.7	NS
African American race (%)	50.0	20.0	0.01
Married/significant other (%)	29.2	40.0	NS
Lives in own apartment (%)	87.5	92.5	NS
Finished high school or with some college (%)	95.7	97.5	NS
SCI characteristics			
Mean time since SCI (years) (range, 1–53 y)	20.5	22.9	NS
Etiology of SCI (%)			
MVA	33.3	55.0	
Gunshot	16.7	12.5	
Fall/dive	25.0	15.0	NS
With paraplegia (%)	62.5	70.0	NS
ASIA A classification (%)	83.3	70.0	NS

NS, $P > 0.05$.

injury, ASIA impairment scale, or treatment group status (Table 2). However, those reporting recurrences were significantly more likely to be of African American race compared with those with no recurrences ($P = 0.01$).

PrU Characteristics as Predictors of Recurrence

No significant differences were observed between those with and without recurrences based on PrU characteristics (Table 3). No significant differences in rates of recurrence were observed associated with the number of prior ulcers or surgeries, whether the current ulcers were in the same location as previous ulcers, ulcer size, stage of the ulcer (III vs IV), and presence/absence of undermining.

Other PrU Risk Factors as Predictors of Recurrence

Patients with recurrences had significantly higher comorbidity scores (mean = 3.1 vs 2.3, $P = 0.04$) and had a longer amount of sitting time at discharge compared to those without recurrences (4.4 vs 2.6 hours; $P = 0.04$; Table 4). There was a nonsignificant trend for those with recurrences to have 3+ ulcers at baseline ($P = 0.06$). The mean duration of the study ulcer in those with recurrences was not significantly different but was almost twice as long as those without recurrences (1.83 vs 0.73; $P = 0.09$). No significant differences were observed between those with and without recurrences with respect to their Salzburg or FIM scores, by whether they were incontinent or not, by the number of alcoholic drinks they had in a week or in a typical sitting, by smoking status, by inpatient length of stay, or by PrU Knowledge scores.

Odds Ratios of Bivariate Predictors of PrU

To understand the impact of individual independent variables on recurrence, we calculated the odds ratios for all variables that were significant predictors of recurrence. Table 5 shows the odds ratios (in rank order) of the predictors of recurrence.

Multivariable Prediction of Recurrence

Results of a multivariable logistic regression predicting recurrence are presented in Table 6. African American

Table 3. Study Ulcer Characteristics

Ulcer Characteristics	Recurrence (n = 24)	No Recurrence (n = 40)	*P* Values
Mean number prior ulcers	3.5	3.3	NS
Mean number prior ulcer surgeries (range, 0–15)	2.1	2.1	NS
Mean number ulcers during index hospitalization	1.75	1.33	NS
In same location as ulcer treated during index hospitalization (%)	50.0	45.0	NS
Stage IV ulcer (%)	70.8	65.0	NS
Infection of ulcer treated during index hospitalization (%)	30.0	16.7	NS
Undermining of ulcer treated during index hospitalization (%)	45.8	50.0	NS
Mean time of ulcer treated during index hospitalization (range, 0–13 y)	1.83 y	0.73 y	0.09
Mean size of ulcer treated during index hospitalization (range, 1–504 cm)	53.5	39.2	NS

NS, $P > 0.05$.

Table 4. Pressure Ulcer Risk Factors

Risk Factors	Recurrence (n = 24)	No Recurrence (n = 40)	*P* Values
Mean Charlson Index Score	3.1	2.3	0.04
Mean Salzburg Risk Score	7.6	7.1	NS
Mean FIM Score	59.3	57.3	NS
Bowel incontinence (daily, weekly, or monthly) (%)	41.7	42.5	NS
Bladder incontinence (daily, weekly, or monthly) (%)	33.3	27.5	NS
Drinks alcohol (%)	50	52.5	NS
Current smoker (%)	20.8	27.5	NS
Mean sitting time at discharge from index hospitalization (hours)	4.35	2.63	0.04
Mean LOS of index hospitalization (days)	151.58	110.43	NS
PrU Knowledge Score (14 items) (%)	83.7	81.3	NS

NS, $P > 0.05$.

race, Charlson Index Score, Salzburg Risk Score, and sitting time at discharge were all significant predictors of recurrence. The PrU Knowledge Score was not a significant predictor of recurrence.

Time to Recurrence

As shown in Figure 1, the Kaplan-Meier survival curve indicates that the time to recurrence for African American participants is considerably shorter than for white participants (log rank test, $P = 0.02$). Subsequent analyses found no significant differences between African American and white participants on any of the variables shown in Tables 2–4 that explain these differences.

To address whether differences in time to recurrence were an artifact of the method of reporting (as described above, some study participants were only contacted on a quarterly basis, whereas others were contacted monthly), we conducted further analyses to assess quarterly recurrence rates. However, the rates of recurrence by quarter showed no significant differences by the method of reporting (data not shown).

Table 5. Odds Ratio of Independent Variables Predicting Recurrence

Variable	Odds Ratio	95% CI
African American race	3.38	1.109; 10.327
Ulcer duration	1.69	0.863; 3.310
Service-connected disability status	1.58	0.538; 4.654
Charlson score	1.56	1.027; 2.431
Received medical treatment for ulcer	1.50	0.494; 4.552
Number of ulcers	1.31	0.799; 2.150
Stage IV	1.31	0.438; 3.905
Sitting time (hours)	1.25	1.021; 1.518
Salzburg score	1.13	0.876; 1.455
SF-12 physical function score	1.07	1.002; 1.134
LOS for ulcer treatment (days)	1.01	0.999; 1.011
Ulcer size	1.00	0.996; 1.009
Distance to VA (miles)	1.00	0.998; 1.002
History of previous ulcers	0.98	0.495; 1.931
Knowledge score	0.97	0.924; 1.023
Income	0.89	0.715; 1.116
Ulcer location	0.85	0.523; 1.368
Undermining of ulcer	0.66	0.072; 6.103

DISCUSSION

We examined a large number of factors that have been found to be significant predictors of PrU development in other populations. It seems that many of the risk factors cited in the literature do not predict recurrence of severe PrUs in this population.

Subjects who experienced recurrences had longer mean sitting times at discharge and longer mean lengths of stay (LOSs) than did those without recurrences. The differences in these variables may reflect the providers' concern about their higher risk of recurrence or variability in ulcer management practices. Further research into the relationship between sitting time and recurrence is needed.

It seems reasonable to assume that all of the factors that might cause the development of a PrU are also factors that might predict recurrence. However, there is considerable research that has found that having had a previous ulcer is predictive of future ulcers. It is unclear whether this association is caused by existing physiologic, medical, and/or behavioral factors that put the individual at risk of developing PrUs in the first place or whether

Table 6. Multivariable Predictors of Recurrence

Independent Variables	Odds Ratio	Confidence Intervals	*P* Value
African American race	9.31	1.63; 53.13	0.01
Charlson Index Score	1.97	1.19; 3.27	0.009
Salzburg Risk Score	1.47	1.00; 2.15	0.05
Sitting time at discharge from index hospitalization	1.34	1.00; 1.79	0.05
PrU Knowledge Score	0.99	0.91; 1.07	NS

NS, $P > 0.05$.

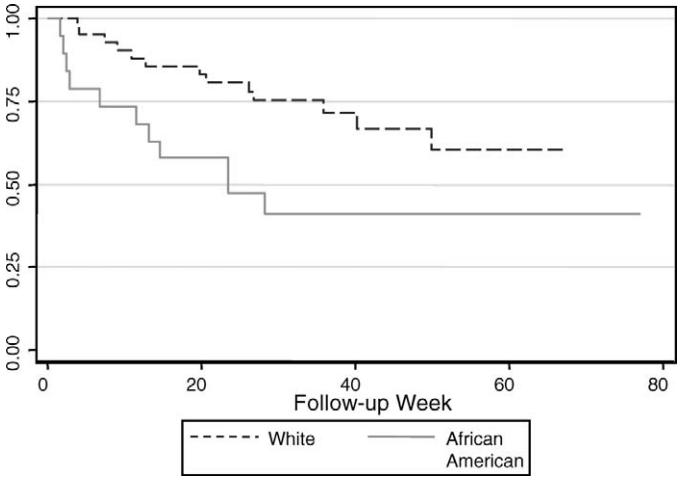

Figure 1. *Time to recurrence by race.*

changes to the skin as a result of the previous ulcer put an individual at increased risk. However, there are few articles that address the issue of recurrence per se. For one thing, recurrence does not seem to be as much of an issue in the nursing home population (where most PrU research has been done) as seems to be the case in the SCI population.

Of the factors that predicted recurrence (eg, comorbid medical conditions, ulcer characteristics, and treatment variables) in the multivariable analysis, race was the strongest predictor of recurrence. However, because we thought it was possible that race was a proxy for something else (eg, being sicker, income, availability of social support), we conducted additional analyses of all the variables presented in Tables 2–4 by race. No other significant differences between the 2 groups were found. It remains unclear whether race plays a role in whether patients are offered or accept surgical treatment. Reliance on visual inspection techniques to identify erythema (or stage I ulcers) in individuals with darkly pigmented skin has been shown to be problematic) (17,43–52) More reliable strategies for early identification of skin problems (eg, stage I PrUs) in individuals with darkly pigmented skin need to be developed. Our plans include a future paper with a more detailed assessment of those experiencing recurrences to determine whether there are other factors that need to be assessed in future studies.

Our results are based on a small cross-sectional sample of veterans with chronic SCI treated for severe PrUs. It is possible that our sample size and associated power limited our ability to detect differences. This study is best described as exploratory. We recommend that our unique findings be considered preliminary until replication of these results are published.

CONCLUSION

This paper describes factors predicting recurrence of severe PrUs among a high-risk population of individuals with SCI. While it is clear that patient characteristics are related to recurrence, many of the strongest patient predictors of recurrence are not amenable to intervention. Those factors that could be modified (smoking, diabetes mellitus, and other comorbid conditions) are not easily modifiable in the short term. They do, however, point out the importance of preventive care and helping subjects manage their health before long-term chronic problems develop.

Reliance on visual inspection techniques to identify skin problems has been shown to be ineffective in those with darkly pigmented skin. Our finding that African American race was a strong predictor of recurrence supports the need to develop better methods for early identification of skin breakdown in those with darkly pigmented skin. We identified several important areas that warrant additional study, including (a) the role of subject characteristics (eg, race, comorbid illness) and (b) variability in ulcer management (eg, LOS, type of treatment, amount of sitting time) (53).

The high incidence and short time to new breakdown we found in this population emphasizes the necessity of developing stronger, more effective interventions to prevent PrUs. Significant variation in patient characteristics and ulcer management (based on lack of strong empirical evidence) hinders systematic clinical observation and research to improve the prevention and treatment of PrUs in this population (47). Our experience in identifying modifiable risk factors and more effective treatment delivery models will help us and others to better address these complex issues in future prevention trials.

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