The National Pressure Ulcer Long-Term Care Study: Pressure Ulcer Development in Long-Term Care Residents

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OBJECTIVES: To identify resident, treatment, and facility characteristics associated with pressure ulcer (PU) development in long-term care residents.

DESIGN: Retrospective cohort study with convenience sampling.

SETTING: Ninety-five long-term care facilities participating in the National Pressure Ulcer Long-Term Care Study throughout the United States.

PARTICIPANTS: A total of 1,524 residents aged 18 and older, with length of stay of 14 days or longer, who did not have an existing PU but were at risk of developing a PU, as defined by a Braden Scale for Predicting Pressure Sore Risk score of 17 or less, on study entry.

MEASUREMENTS: Data collected for each resident over a 12-week period included resident characteristics (e.g., demographics, medical history, severity of illness using the Comprehensive Severity Index, Braden Scale scores, nutritional factors), treatment characteristics (nutritional interventions, pressure management strategies, incontinence treatments, medications), staffing ratios and other facility characteristics, and outcome (PU development during study period). Data were obtained from medical records, Minimum Data Set, and other written records (e.g., physician orders, medication logs).

RESULTS: Seventy-one percent of subjects (n = 1,081) did not develop a PU during the 12-week study period; the remaining 29% of residents (n = 443) developed a new PU. Resident, treatment, and facility characteristics associated with greater likelihood of developing a Stage I to IV PU included higher initial severity of illness, history of recent PU, significant weight loss, oral eating problems, use of catheters, and use of positioning devices. Characteristics associated with decreased likelihood of developing a Stage I to IV PU included new resident, nutritional intervention (e.g., use of oral medical nutritional supplements and tube feeding for >21 days), antidepressant use, use of disposable briefs for more than 14 days, registered nurse hours of 0.25 hours per resident per day or more, nurses' aide hours of 2 hours per resident per day or more, and licensed practical nurse turnover rate of less than 25%. When Stage I PUs were excluded from the analyses, the same variables were significant, with the addition of fluid orders associated with decreased likelihood of developing a PU.

CONCLUSION: A broad range of factors, including nutritional interventions, fluid orders, medications, and staffing patterns, are associated with prevention of PUs in long-term care residents. Research-based PU prevention protocols need to be developed that include these factors and target interventions for reducing risk factors. **J Am Geriatr Soc 52:359–367, 2004.**

Key words: pressure ulcers; prevention; nutrition; older adults; nursing homes

Pressure ulcers (PUs) are a significant, common, and costly medical problem in long-term care residents. Residents with PUs have decreased quality of life and increased morbidity and mortality rates.[1] Reported PU prevalence rates range from 2.3% to 28%, and reported PU incidence rates range from 2.2% to 23.9%[2] in long-term care facilities. Facilities that have implemented comprehensive PU-prevention protocols have demonstrated a decrease in incidence of PUs.[2–7] With implementation of PU-prevention protocols, long-term care facilities may also reduce costs associated with treating PUs, improve resident quality of life, and decrease risk of litigation.[4,8,9]

Development of PU-prevention protocols requires detailed knowledge of factors associated with PU development. Various investigators have identified some of these factors, such as immobility, incontinence, altered mental

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status, severity of disease, poor nutritional status, history of PU, and increased age, but many of these studies are limited by small sample size, by being conducted at only one facility, and by having a limited number of resident and treatment characteristics collected and few health outcomes examined.[10–19] Consequently, clinical judgment, intuition, or expert opinion, rather than research-based evidence, are often the basis for PU-prevention protocols.

The purpose of the National Pressure Ulcer Long-Term Care Study (NPULS) was to identify resident, treatment, and facility characteristics associated with prevention and treatment of PUs.[20] NPULS differs from previous studies in its large sample size and the quantity and comprehensiveness of data collected on resident and treatment characteristics and outcomes. This article will focus on variables associated with development of PUs. Knowledge of these factors will enable improved identification of at-risk residents and of prevention strategies associated with better outcomes.

METHODS

Residents

The methodology for the NPULS has been described elsewhere.[20,21] This study analyzed data from 1,524 residents living in 95 long-term care facilities associated with six long-term care providers. Providers were nonrandomly selected based on their willingness to participate, provide company personnel for the purposes of study coordination, and collect data from at least 150 resident medical records. All study residents were aged 18 and older, had a length of stay of 14 days or longer, and were identified as being at risk of developing, but not having, a PU at study start. Each resident was followed for up to 12 weeks. All residents were in the long-term care facility some time between February 1, 1996, and October 31, 1997.

Measurements

A multidisciplinary team designed a data collection instrument to include factors thought to be associated with the development of PUs. Further information regarding the data collection instrument and study methodology can be found elsewhere.[20] More than 500 variables were collected, including resident characteristics (e.g., demographics; medical history; Braden Scale scores;[22,23] severity of illness, using the Comprehensive Severity Index (CSI);[21,24–33] nutritional status; cognitive ability; incontinence status; and mobility), treatment characteristics (nutritional interventions, pressure management strategies, incontinence interventions, and medication use), and facility characteristics (staffing patterns, use of a skin care team and/or outside consultant wound care specialist, and use of a high-calorie/high-protein medical nutritional supplement to take medications instead of water). The development of a PU during the study period was collected as an outcome variable based on chart documentation of PU assessment or treatment.[20]

Definition of PUs

PU documentation was abstracted from assessments in the medical record. For residents with multiple ulcers, data abstractors assigned a specific number to each PU to differentiate multiple PUs on the same resident or location. Details about each PU were collected from all PU assessments during the 12-week study period, including length, width, and depth of the ulcer; tissue type, recorded as percentage eschar, necrotic, or granulation; drainage appearance and amount; undermining; tunneling; wound bed color; location; stage; and presence of infection at PU site. PUs with maximum area of less than 0.25 cm^2 and questionable locations (navel, chin, breast, penis, sole of foot, arm, shin) were not included in the present analyses. Time to develop a PU was the time from study start to the first assessment or treatment of the first PU for residents who developed one or more PUs and study end (12 weeks after study start) for residents who did not develop PUs.

Severity of Illness Measurement

The CSI system was used to adjust for resident severity of illness.[21] CSI is a disease-specific severity system that provides a consistent method to define grades of severity using more than 2,200 individual patient historical factors, physiological parameters, laboratory results, and physical findings. In CSI, severity is defined as the physiological and psychosocial complexity presented to medical personnel due to the extent and interactions of a patient's disease(s). The more abnormal the symptoms and signs, the higher the score, with Level 4 symptoms and signs being catastrophic, life threatening, or likely to result in organ failure.

The inputs to the CSI methodology for risk adjustment are the disease-specific and age-specific severity criteria at specified levels of abnormality in a resident's chart. The CSI logic combines the severity ratings for each separate diagnosis to obtain an overall patient severity level that is presented on a continuous scale with nonnegative integer values that are not subject to any preset maximum limit. Higher numbers indicate more-severe illness. Advantages of this approach are disease specificity, based on a concise, carefully chosen set of relevant physiological characteristics of the particular disease rather than based on a standard set of physiological factors applied to all diseases; comprehensiveness in scope, with more than 5,500 disease-specific severity criteria sets representing all diseases for which there is an *International Classification of Disease, Ninth Revision, Clinical Modification* code for adults; independence of treatments; and ability to measure severity during any time window in the care process.[21,24–33] CSI was measured separately for each of the 3 study months for a resident based on information in the resident's medical chart for that month. CSI has been validated for predicting various outcomes in a variety of settings in previous studies.[21,24–33]

Braden Scale for Predicting Pressure Sore Risk

The Braden Scale was used to select residents at risk for developing PUs. The Braden Scale is composed of six subscales representing the most commonly occurring risk factors for PUs and is scored from 6 to 23, with lower scores representing higher risk of developing PUs. A cutoff score of less than 18 generally is used to designate increased risk of PU development, but a cutoff score of 17 was used in this study to designate at-risk residents and was also common practice in many participating facilities. Facility personnel

prospectively completed the Braden Scale or study data abstractors scored it retrospectively from data in the medical record. The Braden Scale has demonstrated reliability and validity when used by clinicians and researchers who have been trained to use it.[22,23] The validity of rating residents from chart records is unknown, and because data abstractors were limited by the data in the chart, a best estimate was used to compute the Braden Scale score. To use the Braden Scale to predict risk and plan care, facility staff who know the resident should assess risk upon admission, again within 48 hours, and weekly for the first month.[34] Hence, the tool was only used in this study to select subjects who were at any level of risk at the outset of the study. The initial score was not used to plan care or test predictive validity up to 12 weeks later.

Facility Characteristics

Each facility reported data regarding staffing patterns (including registered nurse, licensed practical nurse (LPN), certified nursing assistant, and dietitian hours; staff turnover rates; use of agency nurses; staff overtime), use of a skin care team or outside consultant wound care specialist, and use of a MedPass program (use of a high-calorie/high-protein medical nutritional supplement to take medications instead of water). These facility-level variables were included in multiple regression analyses as possible predictors and are the same for all residents in a facility.

Data Collection Methodology

Nineteen data abstractors were trained to use the data collection instrument and CSI software system. Reliability was measured by comparison with experienced trainers to ensure accuracy in all aspects of data collection. If an abstractor had less than 90% agreement at the criterion level with a trainer, the abstractor was given additional training until 90% agreement was achieved.

Medical records, Minimum Data Set, and other written records (such as physician orders and medication logs) were reviewed retrospectively for a 12-week study period between February 1, 1996, and October 31, 1997. For newly admitted residents, this was from the admission date (study start date) to 12 weeks postadmission. For existing residents, the study period was 4 weeks before the at-risk designation or identification of a PU (study start date) to 8 weeks postidentification, for a total of 12 weeks. The CSI measured severity criteria during each 4-week period of the study. Each resident was entered into the study only once.

Conceptualization of Data Analysis

From this comprehensive data set, a multidisciplinary team composed of physicians, geriatricians, dietitians, physical therapists, pharmacists, outcomes researchers, risk managers, and nurses (including wound, ostomy, and continence nurses) identified variables thought to be associated with the development and prevention of PUs. Another group of consultants directed data analyses. The dependent variable was PU development during the 12-week study period for each at-risk resident.

Bivariate analyses, using cross-tabulation and chi-square tests for nominal data and two sample Wilcoxon tests for continuous data, were performed to compare each suggested predictor with the outcome: PU development. Multivariate logistic regression analyses were used to determine the association between resident, treatment, and facility characteristics and the outcome. One logistic regression model included ulcers of maximum Stages I to IV to define the outcome of PU, whereas another model excluded maximum Stage I PUs to define PUs. All predictor variables were checked for multicollinearity, and all correlations were less than 0.50. A stepwise selection procedure with an entry significance level of 0.07 allowed independent variables to enter and leave the model. The importance of each variable in affecting development of PUs was determined using the Wald chi-square statistic, and odds ratios with 95% confidence intervals were calculated.

Logistic regression analyses were performed in stages to examine the effects of patient, treatment, and facility variables and combinations of variables influencing PU development. First, only resident variables suggested by the multidisciplinary study team were allowed to enter the model; next, resident and facility variables; after this, only resident and treatment variables; and finally, all three categories of variables entered the regression analysis. In each of these stages, the multidisciplinary study team directed the analyses determining which variables to allow to enter and how the variables were defined. Treatment variables suggested for inclusion in prediction models included treatments for incontinence, nutritional problems, and mobility/activity problems, all of which are known risk factors for PU development. Antidepressant use was included because several study team members felt that residents on antidepressants were more active and hence might have fewer PUs. Facility variables were included to address differences in staffing patterns and other facility characteristics that might affect PU development. All variables allowed to enter the regression models are listed in Table 1.

Discrimination of logistic models was assessed using area under the receiver operator characteristic curve to evaluate how well the model distinguished residents who did not develop a PU from residents who did. In addition, the Hosmer-Lemeshow goodness-of-fit test was used to evaluate the degree of correspondence between a model's estimated probabilities of developing a PU and the actual development of PUs over groups spanning the entire range of probabilities (calibration). A nonsignificant *P*-value of this test indicates good fit.

Nested models were evaluated because clustering of individual resident observations within a facility potentially leads to correlation among those observations, and model-based analyses must account for that correlation to generate correct inferences. To determine whether these analyses needed to control for that correlation, two nested models (one with facility as a random effect and one without facility as a random effect) were fit. There was no evidence of a nonzero variance component for site, indicating that correlation among observations within a site was not an issue for inference. Consequently, individual data points were modeled as independent observations, and facility variables were allowed to enter into the regression models. In past clinical practice improvement analyses, when nested analyses were performed, the results did not change. It appears that the detailed patient, treatment, and facility

Table 1. Description of Resident, Treatment, and Facility Variables Allowed to Enter Regression Models

Variable	Description
Resident characteristic	
Age ≥ 85	Resident is aged 85 or older
Dementia/cognitive impairment	CSI cognitive impairment criteria; ICD-9 codes or MDS designation of Alzheimer's disease, dementia, or traumatic brain injury; or MDS indicators of delirium or periodic disordered thinking/awareness
Dehydration	CSI indicators of dehydration
Diet type	Therapeutic, mechanical, or fortified diet type
Diabetes mellitus	ICD-9 codes or MDS
History of tobacco use	History of tobacco use (MDS)
Initial CSI score	CSI score in the first 30 days of the study
Incontinence (bowel or bladder)	Braden Scale, MDS, and presence of incontinence treatments
History of pressure ulcer	Resident has a history of a pressure ulcer in the last 90 days (MDS)
Deterioration in ADLs	Decline in ADL function in the last 90 days (MDS)
Requiring assistance with >7 ADLs	Resident is dependent or requires extensive assistance with seven or more ADLs or MDS (transferring, bed mobility, locomotion on unit, dressing, eating, toilet use, personal hygiene, and bathing)
Mobility	Activity and mobility subscales of the Braden Scale or MDS
New residents	Resident was admitted fewer than 14 days before determination of at risk or having a PU
Significant weight loss	>5% in last 30 days, >10% in last 180 days, or >10 pounds in last 90 days
Oral problems with eating	Oral problems, mouth pain, or chewing problem (MDS)
Poor meal intake	>10 meals/month with <50% intake
Sex	Male or female
Nutritional treatments	
Oral standard medical nutritionals	1 kcal/ml*
Oral high-calorie/protein medical nutritionals	>1.5 kcal/mL or high protein*
Oral–disease specific medical nutritionals	Designed for specific disease states (diabetes mellitus, renal, pulmonary, etc.)*
Oral house supplements and shakes	Milk shakes made at the facility and commercial nourishments*
Snacks	Example: pudding, peanut butter, crackers, etc.*
Enteral standard medical nutritionals	1 kcal/mL*
Enteral high-calorie/protein medical nutritionals	>1.5 kcal/mL or high protein*
Enteral disease-specific medical nutritionals	Designed for specific disease states (diabetes mellitus, renal, pulmonary)*
Use of the MedPass program	Facility used a high-calorie/protein medical/nutritional supplement with which to take medications rather than water
Fluid orders (oral or intravenous)	Fluid order during first 30 days of study and before development of PU
Medications	
Antidepressant use	Resident received antidepressant during the study period
Incontinence treatments	
Disposable briefs	Resident was on disposable briefs at least 14 days before development of PU
Catheter use	Resident had a catheter >14 days before the development of a PU
Pressure management	
Repositioning schedule	Every 2 hours: yes/no
Pressure-relieving devices	Category I, II, or III beds
Positioning devices	Devices used to relieve pressure (wedge cushion, foot cushion, hand roll, pillows, heel protectors, etc.) used >14 days before the development of a PU
Staffing characteristics	
Use of wound consultant	Facility used an outside wound consultant
Use of nursing overtime	Facility had nursing staff working overtime hours
Registered dietitian hours per month	Number of registered dietitian hours per month
Use of nursing pool staff	Facility used pool nursing staff
High registered nurse hours	>15 minutes per resident/day
High nurse aide hours	>2 hours per resident/day
Turnover rates for nurses and certified nursing assistants	Facilities provided staff (registered nurse, licensed practical nurse, certified nursing assistant) turnover rates for the time period that residents were in the study

*Resident received >21 days before development of PU.

CSI = Comprehensive Severity Index; MDS = Minimum Data Set; ADL = activities of daily living; PU = pressure ulcers; ICD-9 = *International Classification of Disease, Ninth Edition*.

variables had already picked up the variation accounted for by differences in facilities. In addition to nested analyses, Cox proportional hazard regressions were applied to determine the association between resident, treatment, and facility characteristics and time to develop the first PU. SAS release 8.2 (SAS Institute, Inc., Cary, NC) was used for all analyses.

RESULTS

Of the 1,524 residents, 74% were female, and the mean age ± standard deviation was 81.3 ± 12.8 (range 18–104, median = 84). Residents who developed a PU were significantly older than those who did not (82.5 vs 80.8, $P = .010$) and slightly sicker during Month 1 (65 vs 62 average CSI score, $P = .026$). Average resident duration was 77.3 days ± 16.3 with median of 84 days whether or not a resident developed a PU.

Table 2 contains bivariate analyses for each variable that was a significant predictor of PU development in multivariate analyses. Two pairwise analyses that were not significant for association with PU development were those for enteral feeding (high-calorie/high-protein ($P = .144$) and disease-specific formula ($P = .202$)). Significantly higher mean severity scores during the first month of the study were found for residents who were enterally fed a high-calorie/high-protein (78.31 ± 45.23 vs 61.09 ± 37.66, $P < .001$) or disease-specific (96.18 ± 58.93 vs 62.01 ± 37.76, $P < .001$) enteral formula for 21 or more days. Because sicker residents are more likely to develop PUs, but enterally fed residents are less likely to do so, severity of illness was controlled to determine the effect of enteral feeding on PU development.

Table 3 shows the effects of various combinations of the three categories of predictor variables in logistic regression analyses. The c-statistics indicate better discrimination as more predictors are added to resident variables alone. The full logistic regression models have the largest c-statistics (c = 0.73 and 0.74 for Stage I to IV and Stage II to IV ulcers, respectively) and demonstrate the importance of a comprehensive assessment to prevent PU development.

Table 4 presents variables that were significant in full logistic regression models for prediction of PUs. None of the predictors had pairwise correlations greater than 0.50. When Stage I to IV PUs were included in the model, residents with a greater severity of illness ($P < .001$), history of a recent PU ($P < .001$), significant weight loss ($P = .008$), oral eating problems ($P = .010$), use of a mechanical device to contain urine ($P < .001$), and use of a positioning device ($P = .029$) were more likely to develop a PU. Variables associated with less likelihood of developing a PU were new admissions ($P < .001$), tube-fed residents receiving a disease-specific ($P = .009$) or high-calorie/high-protein ($P < .001$) formula for more than 21 days, orally fed residents receiving a standard oral medical nutritional supplement for more than 21 days ($P = .016$), use of antidepressants ($P = .027$), use of disposable briefs ($P = .005$), receiving more than 2 hours of nurses' aide care time ($P < .001$), more than 15 minutes of registered nurse care time ($P \leq .001$) per resident per day, and LPN turnover of less than 25% ($P < .001$).

When Stage I PUs were not counted as PUs, all significant resident, treatment, and facility variables predicting likelihood of developing a PU remained the same, except that fluid orders now became significantly associated with less likelihood of PUs ($P = .016$). Models with and without Stage I PUs discriminated well (c-statistic = 0.72 and 0.73, respectively) and calibrated well (Hosmer-Lemeshow $P = .41$ and .18, respectively), indicating that these models fit the data.

A Cox proportional hazard regression model was used for Stage I to IV and Stage II to IV PUs to predict time to develop PUs. Significant predictor variables were the same for the Cox proportional hazard regression models and the logistic regression models described in Table 4.

DISCUSSION

Previous studies have shown resident characteristics that have been important in the development of PUs. This study identified not only resident characteristics, but also treatment and facility factors associated with PU development in long-term care facilities.

Resident Characteristics

Residents newly admitted to the long-term care facility were less likely to develop a new PU than existing residents, confirming results previously reported,[35] but one study found that the majority of residents who developed a PU did so in the first 3 weeks after admission to the facility.[15] Results may differ because of the prospective versus retrospective study design. It is also important to note that results from this study and others indicate that new admissions were more likely to have an existing PU than existing residents.[13,20,36] This is most likely due to PUs that developed in the resident's previous residence or hospital stay.

A high initial CSI score was associated with an increased risk of PU development, suggesting that underlying medical conditions and severity of illness contribute to higher PU incidence.[1,14,35] Additional resident characteristics that predisposed residents to developing a new PU included history of a PU and requiring assistance with seven or more activities of daily living, confirming observations of others.[11,12,17]

As with previous studies, oral eating problems and weight loss were associated with a higher risk of developing PUs in this study. Residents experiencing oral problems with eating are likely to have a reduced dietary intake, leading to weight loss and the development of PUs.[12–15,18,37] Weight loss is a known risk factor for PU development and delayed wound healing.[13,16,18,19,38]

Treatment Characteristics

Pairwise analyses were not significant for high-calorie/high-protein and disease-specific tube-feeding formulas and the development of PUs, but residents receiving these formulas had significantly higher severity-of-illness scores during Month 1 of the study. The logistic regression models took severity into account, resulting in use of tube-feeding formula (high calorie/high protein and disease specific) and standard oral medical nutritional supplements for 21 days or more being associated with a significant decreased likelihood of developing a PU. Two studies have demonstrated

Table 2. Bivariate Analyses of Predictor Variables for 1,524 Residents, 443 of Whom Developed Pressure Ulcers

Variable	Residents Who Developed a Pressure Ulcer N (%)	Chi-square	*P*-value
Residents had a history of pressure ulcers			
Yes (n = 147)	68 (46.26)		
No (n = 1,377)	375 (27.23)	23.32	<.001
Residents are new admission			
Yes (n = 386)	65 (16.8)		
No (n = 1,138)	378 (33.2)	37.49	<.001
Residents experiencing weight loss			
Yes (n = 395)	138 (34.9)		
No (n = 1,129)	305 (27.0)	8.91	.003
Residents had oral problems with eating			
Yes (n = 774)	252 (32.6)		
No (n = 750)	191 (25.5)	9.29	.002
Residents received disease specific enteral formula			
Yes (n = 44)	9 (20.5)		
No (n = 1,480)	434 (29.3)	1.63	.202
Residents received high calorie/protein enteral formula			
Yes (n = 169)	41 (24.3)		
No (n = 1,355)	402 (29.7)	2.13	.144
Residents received standard oral medical nutritional supplement			
Yes (n = 134)	29 (21.6)		
No (n = 1,390)	414 (29.8)	3.93	.047
Residents had a fluid order			
Yes (n = 396)	99 (25.0)		
No (n = 1,128)	344 (30.5)	4.29	.038
Residents using antidepressants			
Yes (n = 432)	108 (25.0)		
No (n = 1,092)	335 (30.7)	4.84	.028
Residents using disposable briefs			
Yes (n = 438)	105 (24.0)		
No (n = 1,086)	338 (31.1)	7.74	.005
Residents had catheter			
Yes (n = 157)	72 (45.9)		
No (n = 1,367)	371 (27.1)	23.94	<.001
Residents using positioning devices			
Yes (n = 320)	98 (30.6)		
No (n = 1,204)	345 (28.7)	0.48	.490
Registered nurse time/resident/day >15 minutes			
Yes (n = 937)	226 (24.1)		
No (n = 587)	217 (37.0)	28.89	<.001
Certified nursing assistant time/resident/day >2 hours			
Yes (n = 395)	79 (20.0)		
No (n = 1,129)	364 (32.2)	21.27	<.001
Licensed practical nurse turnover ≤ 25%			
Yes (n = 855)	211 (24.7)		
No (n = 669)	232 (34.7)	18.20	<.001

a reduction in the incidence of PUs associated with the provision of oral nutritional supplements.[13,39] Residents receiving nutritional intervention are more likely to receive adequate calories, protein, fluid, vitamins, and minerals, thereby maintaining their nutritional status, preventing weight loss and subsequent PU development.

Residents with fluid orders (including oral or intravenous fluids) were less likely to develop Stage II to IV PUs. Dehydration is a known risk factor for PU development because of its effect on blood volume and circulation and skin turgor.

Use of a mechanical device for urine containment (e.g., catheter) for 14 days or longer was associated with an increased likelihood of developing a PU. The association between use of catheters and PU development has also been identified in other studies.[12,16,40] These findings conflict with traditional views that catheter use to manage urinary incontinence reduces exposure to moisture and therefore

Table 3. Discrimination and Calibration Statistics for Regression Models Including Various Categories of Predictors

Pressure Ulcer Stage	Discrimination C-Statistics	Hosmer-Lemeshow *P*-value
I to IV regression model		
Patient variables only	0.658	.429
Patient and facility variables	0.690	.716
Patient and treatment variables	0.698	.135
Full model	0.723	.410
II to IV regression model		
Patient variables only	0.657	.403
Patient and facility variables	0.696	.739
Patient and treatment variables	0.706	.579
Full model	0.732	.184

reduces PU development. A plausible explanation is that residents with catheters are at risk of developing low-grade bladder infections, and the physiological stress of these infections may predispose these individuals to developing a PU. In addition, residents with catheters may be turned and repositioned less frequently than recommended, which can lead to pressure injury and increased risk of developing PUs. In contrast, residents who used disposable briefs for 14 days or longer were more likely be turned and repositioned frequently because their briefs had to be changed regularly. This may help prevent pressure injury, a known risk factor for PU development.

Antidepressant use was associated with a decreased likelihood of PU development. Antidepressants may improve mental and physical functioning that could lead to improvement in food intake and mobility, thereby reducing risk of PU development.[11]

Facility Characteristics

Residents in facilities with care time by registered nurses of more than 15 minutes per resident per day and by nurses' aides of more than 2 hours per resident per day were less likely to develop a PU. These staffing ratios are similar to those proposed by the National Citizens' Coalition for Nursing Home Reform of 0.53 registered nursing hours per

Table 4. Resident, Treatment, and Facility Characteristics Associated with Developing a Pressure Ulcer

	Stages I–IV*				Stages II–IV†			
Variable	Wald Chi-Square	Odds Ratio	95% CI	*P*-value	Wald Chi-Square	Odds Ratio	95% CI	*P*-value
Resident characteristics								
Initial Comprehensive Severity Index score	23.75	N/A	N/A	<.001	20.43	N/A	N/A	< .001
History of pressure ulcer	14.54	2.08	1.43–3.04	<.001	10.75	1.90	1.30–2.80	.001
New residents	50.60	0.28	0.20–0.40	<.001	47.86	0.27	0.19–0.39	< .001
Significant weight loss	7.09	1.44	1.01–1.89	.008	8.30	1.51	1.14–1.99	.004
Oral problems with eating	6.69	1.38	1.08–1.76	.010	6.58	1.40	1.08–1.81	.010
Nutritional treatments								
Enteral disease-specific formula	6.78	0.35	0.16–0.77	.009	5.47	0.38	0.17–0.86	.019
Enteral high calorie/protein formula	12.20	0.48	0.32–0.72	<.001	12.92	0.45	0.29–0.70	< .001
Oral standard medical nutritional supplements	5.86	0.57	0.36–0.90	.016	10.23	0.43	0.25–0.72	.001
Fluid orders					5.81	0.68	0.50–0.93	.016
Medications								
Antidepressant use	4.90	0.74	0.56–0.97	.027	3.64	0.76	0.57–1.00	.057
Incontinence treatments								
Disposable briefs	7.95	0.67	0.51–0.89	.005	6.99	0.67	0.50–0.90	.008
Catheters	16.17	2.14	1.48–3.10	<.001	17.08	2.21	1.52–3.21	< .001
Pressure management								
Positioning devices	4.78	1.40	1.04–1.89	.029	4.75	1.42	1.04–1.94	.029
Staffing characteristics								
Registered nurse time >15 minutes per resident/day	13.74	0.62	0.48–0.80	<.001	10.49	0.65	0.50–0.84	.001
Certified nursing assistant time >2 hours per resident/day	13.40	0.57	0.42–0.77	<.001	14.79	0.53	0.39–0.73	< .001
Licensed practical nurse turnover <25%	14.05	0.62	0.48–0.80	<.001	16.00	0.59	0.45–0.76	<.001

* n = 1,524 residents, 443 ulcers; c-statistic = 0.723; Hosmer-Lemeshow *P*-value = .410.
† n = 1,524 residents, 394 ulcers; c-statistic = 0.732; Hosmer-Lemeshow *P*-value = .184.
N/A = not applicable; CI = confidence interval.

resident day and a minimum level of total direct nursing staff care of 1.6 hours per resident day.[41] The more time that registered nurses and nurses' aides are able to spend with a resident, the more likely the resident will receive adequate and appropriate care, including PU-prevention interventions.

Limitations

This study included only residents who were at some level of risk of developing a PU, as defined by a Braden Scale score of 17 or less, rather than the whole population of long-term care residents. By definition, the residents selected for this study had limitations in the following areas: sensory perception, incontinence, activity, mobility, nutrition, and friction/shear. Because the entire study population was at risk for PU development, there may not have been much variation in some resident characteristics. For this reason, several resident characteristics and processes of care that are usually associated with risk of PU development may not have been significant predictors of PU development in this study. For example, mobility is often a significant risk factor for PU development but was not identified as a significant predictor in this study, but being dependent or requiring extensive assistance in seven or more ADLs (which included locomotion, transfer, and bed mobility) was associated with PU development. Other limitations of this study have been described previously.[20]

CONCLUSION

Previous studies have shown resident characteristics that have been important in the development of PUs. This study has identified not only resident characteristics, but also treatment and facility factors that are associated with PU development and prevention in long-term care residents. Resident, treatment, and facility characteristics associated with a greater likelihood of developing a Stage I to IV PUs included higher initial severity of illness, history of a recent PU, significant weight loss, oral eating problems, use of catheters, and use of positioning devices. The following characteristics were associated with a decreased likelihood of developing a Stage I to IV PU: new residents, nutritional intervention (such as use of oral standard medical nutritional supplements and tube feeding for >21 days), antidepressant use, use of disposable briefs for more than 14 days, registered nurse hours of 0.25 hours or more per resident per day, nurses' aide hours of 2 hours or more per resident per day, and LPN turnover of less than 25%. Research-based protocols to prevent PUs can be developed based on these results. Specific resident characteristics and treatments associated with the prevention of PUs can be incorporated into these protocols. Identification of factors associated with PU prevention and the subsequent implementation of PU-prevention protocols based on these findings should help reduce the incidence of PUs in long-term care facilities.

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