Factors Influencing Pressure Ulcer Healing in Adults Over 50: An Exploratory Study

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Objective: The purpose of this study was to determine which demographic, clinical, and treatment factors influenced chronic pressure ulcer healing, and to identify the implications for pressure ulcer care being delivered in skilled nursing facilities.

Design: A multisite retrospective chart review was conducted using a structured data abstraction form and protocol.

Setting: Data collection took place in 3 geographically disperse areas of the country, with subjects having received wound care in hospitals, clinics, nursing homes, and home care.

Participants: Subjects whose charts were reviewed were 50 years of age or older, had at least 1 diagnosed chronic pressure ulcer, and had 3 to 6 months of data available for abstraction. Stage I ulcers were excluded from the analysis.

Measures: The structured data collection form included demographics, clinical variables, wound characteristics, and outcomes. The variables ulcer size, exudate type and amount, and necrotic tissue type were combined into a single wound severity score.

Results: Bivariate analyses showed that insurance type, secondary diagnoses of cardiovascular disease and pulmonary disease, initial ulcer size and stage, dressing type changes, use of topical antiseptics, type of debridement, category of dressing, use of hydrocolloid or wet-to-dry dressings, antibiotic administration, and appropriateness of selected dressing and management of necrosis were all significantly associated with healing within 6 months. Logistic regression models identified the following as the most significant predictors of healing: Medicaid, secondary diagnosis of cardiovascular disease, dressing type changed, topical antiseptics, antibiotic administration, pressure relief device, lack of exudate management dressing for moderate or large exudate wound, and lack of debridement of wounds with yellow slough, all decreased the odds of healing; use of exudate management dressings on wounds with no documented exudate increased the odds of healing.

Conclusion: Pressure ulcer healing rates overall could be improved if clinicians better matched the characteristics of the wound with the decision to debride and the selection of the optimal dressing. Healing within nursing homes might be improved with less use of enzymatic debridement and antibiotics and more frequent application of hydrocolloid dressings. **(J Am Med Dir Assoc 2007; 8: 378–387)**

Keywords: Pressure ulcers; healing; older adults; skilled nursing facilities

Ulcer treatment recommendations include debridement of necrotic or sloughy tissue, repeated applications of dressings that further remove debris and induce the formation of granulation tissue, appropriate pressure-relieving surfaces, and a turning schedule.[1] Dressings have been described as the mainstay of treatment, with specific recommended dressings corresponding to the amount of wound exudate.[1] For example, Grey et al[1] recommend film for wounds with no or scant exudate; foams, hydrogels, or hydrocolloids for wounds with low to moderate exudate; and alginates or hydrofibers for wounds with moderate to high exudate. In practice, a wide

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range of dressings may be applied to chronic ulcers, including dry or moist gauze, antimicrobial or antiseptic agents, and moisture-management dressings such as described above.

BACKGROUND AND METHODS

Background

Most studies of pressure ulcer healing are focused on a particular treatment or intervention and recruit subjects from one clinical setting. The majority of these studies are randomized, controlled trials that employ stringent inclusion and exclusion criteria and follow subjects for 12 weeks or less. Although appropriate for evaluating efficacy of specific treatments, the results do not provide clinicians adequate guidance for effective management of all pressure ulcers.[2] Few studies have looked at pressure ulcer care being delivered to diverse populations representative of the general community.

The purpose of this study was to determine which demographic, clinical, and treatment factors influenced healing of pressure ulcers within 6 months of initiation of treatment. Our study is unique in that it included subjects from multiple settings, abstracted up to 6 months of data, and collected more detailed treatment information. The database consists of subjects receiving routine chronic wound care delivered by regular staff members using a range of therapies. Primary caregivers included long-term care staff in skilled nursing facilities (SNFs), assisted living facilities, and board-and-care residences; home health nurses and private home health aides; and family members or no identified caregiver.

METHODS

This was a retrospective, descriptive study using chart review and a structured data abstraction form and protocol. The data collection form contained the following categories and specific measures:

1. Ulcer type, number, date of occurrence, and whether healed.
2. Subject demographics—gender, age, marital status, race/ethnicity, education, insurance, residence, living arrangements, primary caregiver. Measured at beginning of data abstraction period only.
3. Diagnoses—all primary and secondary diagnoses documented in the medical record using primarily written diagnoses; also, specific comorbidities and impaired healing risk factors (smoking, obesity, malnutrition, other) using a list and check-off box. Data collectors checked a specific risk factor as present if it was documented in the medical record. Clinical expertise was used to assign some diagnoses to major diagnostic groups (cardiovascular disease [CVD], pulmonary disease, renal disease, and so on). Others were treated individually and not combined, such as congestive heart failure (CHF), cerobrovascular accident (CVA), diabetes mellitus (DM), and hypertension.
4. Selected laboratory data—albumin, protein, hemoglobin, hematocrit, glucose, HbA1c, lymphocytes; also height and weight. Measured at beginning of data abstraction period only. Because of the extent of missing data, laboratory values were not used in the analysis, except to note possible malnutrition, obesity, or anemia.
5. Braden scale scores (up to 6) or other risk assessment scale scores. Because of the extent of missing data, scores were not used in the analysis.
6. Wound assessment details—location, stage (if pressure ulcer), and shape were recorded at beginning of study. Size (length, width, depth) was recorded at each of the monthly assessments. Exudate type, exudate amount, skin color, edges, edema, undermining, induration, necrotic tissue type, necrotic tissue amount, granulation, and epithelialization were assessed. Data collectors selected from 5 descriptive choices for each characteristic, entering the number corresponding to the closest description of the wound as described in the medical record and recorded at each of the monthly assessments. Values at initial assessment for area, exudate type and amount, and necrotic tissue type were used to create wound severity score. Exudate amount and necrosis type values at each of the monthly assessments were used to assess appropriateness of selected dressing and debridement.
7. Signs of infection—yes or no to 6 questions (infection noted? redness? purulent exudates? induration? pain? increased temperature at site?) recorded at each of the monthly assessments. Analyzed as whether any signs of infection (SI) were noted, and as percentage of monthly assessments that SI were noted.
8. Antibiotics—whether any topical, oral, or intravenous antibiotics were administered (yes/no) recorded at each monthly assessment. Name of organism and confirmation method also recorded if noted. Analyzed as whether any systemic antibiotic was administered, whether any topical antiseptic was applied, percentage of monthly assessments at which any systemic antibiotics were administered, and percentage of monthly assessments at which any topical antiseptic was applied. Organism and confirmation were not analyzed because of the extent of missing data.
9. Debridement—for each monthly assessment, if any wound debridement was performed (yes/no) and type of debridement that was performed; analyzed as number and percentage of monthly assessments at which debridement was performed (0–6; 0%–100% possible), which specific types of debridement were performed at any of the monthly assessments (surgical/sharp/laser, enzymatic, autolytic, or mechanical), and number and percentage of monthly assessments at which a specific type of debridement was performed (0–6, 0%–100%).
10. Wound Treatment—for each of the monthly assessments, name of primary dressing, secondary dressing, fill/hydration product, graft or skin substitute, cleanser, and periwound protection product. Each ulcer had a maximum of 6 primary dressings, 6 grafts, and 6 secondary dressings recorded; analyzed as percentage of monthly assessments a particular dressing was applied; also grouped into the 3 major dressing categories of

gauze, moisture-management (modern), or antimicrobial dressing based on primary dressing; modern dressings were further analyzed as exudate management or moisture retentive and analyzed as percentage of monthly assessments at which that category of dressing was applied. Because of the extent of missing data, cleanser was analyzed as a categorical variable (commercial, normal saline, water, toxic agent, or none), and skin barrier product was omitted. Grafts and skin substitutes were recorded as secondary therapies.

11. Other Treatment—whether a particular secondary therapy was applied. One-time measures: grafts or skin substitutes, pressure relief product, nutritional support, hyperbaric oxygen, electrotherapy, hydrotherapy, infrared therapy, ultraviolet, low-laser irradiation, ultrasound, heat therapy, suction (VAC), pulsed high-frequency power, off-loading, and turning schedule. Growth factor was recorded at each of the monthly assessments.
12. Medication—fill in blanks: name, dose, frequency. With the exception of antibiotics, recorded at beginning of treatment only. Because of the extent of missing data, only use of antibiotics included in the analysis.

During coding and data entry, decision rules were used to improve the completeness of several measures, including noting obesity if the body mass index (BMI) was more than 29.9 and noting malnutrition if serum albumin was 3.2 or less. However, many subjects had neither weight nor serum albumin recorded in their medical record over the relevant time period. A severity score was also created, using the combined results of several wound characteristics as measured at the beginning of the study period. The measures and weights were as follows:

Size (area × width): Based on quartile distribution of sizes:

$< 1.10\ cm^2 = 0$
$1.20–3.84\ cm^2 = 1$
$4.00–14.8\ cm^2 = 2$
$> 15\ cm^2 = 3$

Exudate amount:
None = 0
Scant = 1
Small = 2
Moderate/large = 3

Exudate type:

None = 0
Sero-sanguinous = 1
Serous = 2
Purulent = 3

Necrotic tissue type:

None = 0
White/gray = 1
Yellow slough = 2
Black eschar = 3

This was analyzed as a continuous variable ranging from 0 to 12.

The study took place at 4 primary data collection sites located in the northeast, southeast, and western sections of the United States. Site 1 was an integrated care delivery system and included a clinic, nursing home, and home health agency; site 2 was a university hospital–based wound service and affiliated home health agency; site 3 was a university hospital–based wound service; and site 4 was a community hospital–based wound center.

Each of the 4 data collection sites had a master's or PhD-prepared nurse study coordinator with expertise in chronic wound care. The coordinators worked with their respective medical records departments to identify eligible charts for review, using discharge diagnoses for chronic wound, venous leg ulcer, pressure ulcer, or diabetic foot ulcer, and discharged between 1998 and 2004. After preliminary review, subjects were excluded from the study if their age was under 50, if they had a Stage I pressure ulcer, had been receiving dialysis, had an organ transplant, or were undergoing active cancer treatment (chemotherapy or radiation therapy). Trained data collectors abstracted the chart information at each site. Site coordinators were responsible for achieving and maintaining an inter-rater reliability level of 0.90 or better. The goal was to abstract an equal number of pressure, diabetic, and venous ulcers (50 each at each site). This number and distribution was not achieved because of saturation of some types of ulcers at some sites and running out of time to conduct further reviews at the fourth site.

Completed data collection forms were stripped of any personal identifiers, and sent to the central research office. Data were coded and entered into an SPSS database (SPSS Inc., Chicago, IL). Numerous checks were conducted to ensure reliability of entered data. Analytic methods included chi-square and F-tests for categorical variables, Student *t* tests for continuous variables, analysis of variance, and multivariate logistic regression modeling.

This study was approved by the institutional review boards at the parent institution and each of the study sites.

RESULTS

A large but undocumented number of charts were initially retrieved by the medical records departments; these included patients with acute wounds, arterial ulcers, and surgical wounds, as well as some cancer and dialysis patients. Submitted documentation recorded 517 charts that were retrieved for possible abstraction. Of these, 19 were omitted because of lack of treatment data, and 21 were excluded for failure to meet inclusion/exclusion criteria. Another 77 charts were excluded from the database because of having less than 3 months of data available for analysis. For this specific study, the 286 subjects with venous ulcers or diabetic ulcers were omitted, leaving 114 subjects with pressure ulcers. Of these, 32 subjects died, transferred to another facility, or were simply lost to follow-up, resulting in 82 subjects with 6 months of data or

Table 1. *Demographic Characteristics of the Pressure Ulcer Sample*

Variable	Percent/Mean
Age, y (SD)	78.1 (11.5)
Sex, % female	57.0
Marital, % married	32.4
Race, % White	59.3
Insurance coverage, %	
Medicare	42.1
Medicare + Medicaid	28.9
Medicare + Private	15.8
Medicaid	8.8
Other	4.4
Primary caregiver, %	
Nursing home	33.9
Assisted living	10.7
Home health	4.5
Home health aide	15.2
Family member	28.6
Self	7.1
Healing at 6 months, %	
Stage 2	76.5
Stage 3	33.3
Stage 4	13.3

having healed before this point. Only the primary pressure ulcer, as identified by the data collectors according to the study protocol (largest, most recent) was used for this analysis.

Demographic characteristics of the sample can be viewed in Table 1. The majority of subjects were female, white, and covered by Medicare. Slightly over a quarter of the sample was over 85 years old. Seventeen subjects (14.9%) were entered into the study from the nursing home site. Thirty-eight subjects (33.9%) had a nursing home as their primary caregiver, and 50 subjects (43.9%) had a nursing home, assisted living, or board-and-care facility listed as primary caregiver. Of the 114 subjects with pressure ulcers entered into the study, 24.6% went on to heal. The healing rate by month was as follows: 10.5% (12/114) at 3 months; 19.0% (19/100) at 4 months; 26.4% (23/87) at 5 months; and 34.2% (28/82) at 6 months. However, healing rates varied significantly ($P < .001$) by stage of the pressure ulcer. Stage 2 ulcer healing rates were 27.3% at 3 months and 76.5% at 6 months; Stage 3 ulcer healing rates were 10.2% at 3 months and 33.3% at 6 months; and Stage 4 ulcer healing rates were 2.6% at 3 months and 13.3% at 6 months.

Table 2 shows the results of the bivariate analyses examining the associations between demographic and clinical variables and 6-month healing. Only 3 variables achieved a statistically significant association with healing at the *P* less than .05 level. Type of health insurance coverage was associated with healing—those with Medicaid or Medicare plus Medicaid were significantly less likely to heal within 6 months. Subjects with a comorbid diagnosis of CVD were less likely to heal, while those with a comorbid diagnosis of pulmonary disease were more likely to be in the group that healed within the 6 months. No other demographic or comorbid conditions were associated with healing within 6 months. The risk factor of obesity approached statistical significance, with obese subjects being more likely to heal than nonobese subjects. The risk factors of smoking and malnutrition were not found to be significantly associated with healing in our analysis.

Table 3 shows the results of the bivariate analyses examining wound characteristics and treatment approaches and

Table 2. *Demographic and Clinical Variables Associated with 6-Month Pressure Ulcer Healing*

Variable	Heal	No heal	*P* Value
Age, y	78.3	78.1	.945
Sex, %			.552
Male		32.4	67.6
Female		31.3	68.7
Marital status, %			.146
Married		40.0	60.0
Not married		25.5	74.5
Race, %			.226
White		37.2	62.8
Non-white		26.5	73.5
Insurance, %			.004
Medicare		48.0	52.0
Medicare + Medicaid	13.3		86.7
Medicare + private	50.0		50.0
Medicaid		0.0	100
Other		66.0	34.0
Primary caregiver, %			.295
SNF	26.9		73.1
AL/B&C	50.0		50.0
Home health	20.0		80.0
Home health aide	14.3		85.7
Family		39.1	60.9
Self		57.1	42.9
Comorbid conditions (noted/not noted), %			
Congestive HF	22.2	77.8	.409
CVD	21.1	78.9	.045
Hypertension	33.3	66.7	.448
PVD/DVT	36.8	63.2	.388
Diabetes mellitus	33.3	66.7	.499
Cancer	50.0	50.0	.129
Arthritis	32.0	68.0	.582
Neuropathy	75.0	25.0	.092
Dementia	23.1	76.9	.188
MS/SCI/PD	35.3	64.7	.466
CVA	21.7	78.3	.172
Blood disorder	35.3	64.7	.466
Pulmonary disease	53.3	46.7	.049
GI disorder	30.0	70.0	.606
Depression	33.3	66.7	.591
Renal disorder	33.3	66.7	.591
Thyroid disorder	28.6	71.4	.610
Electrolyte imbalance	20.0	80.0	.510
Osteomyelitis	0.0	100.0	.313
Skin disorder	0.0	100.0	.683
Sensory disorder	50.0	50.0	.167
Total comorbids	4.31	4.18	.788
Risk factors, %			
Obesity	62.5	37.5	.062
Smoker	15.5	84.5	.145
Malnutrition	25.0	75.0	.374

Statistical Tests – Pearson chi-square, Fischer's Exact Test, Student *t* test.

SNF, skilled nursing facility; AL/B&C, assisted living/board and care; HF, heart failure; CVD, cardiovascular disease; PVD/DVT, peripheral vascular disease/deep vein thrombosis; MS/SCI/PD, multiple sclerosis/spinal cord injury/Parkinson's Disease; CVA, cerebrovascular accident.

Table 3. *Wound and Treatment Characteristics Associated with 6-Month Pressure Ulcer Healing*

Variable	Heal	No Heal	*P* value
Ulcer initial size, %			
<5 cm^2	45.9	54.1	.011
>5 cm$^2 < 10$ cm^2	20.0	80.0	.011
>10 cm$^2 < 20$ cm^2	16.2	83.8	.006
>20 cm^2	15.0	85.0	.054
Size (initial), mean cm^2	6.20	26.3	.001
Depth (initial), mean cm^2	.42	.97	.004
Severity score (initial)	5.15	7.93	.001
Location			.071
Ankle/heel, %	39.5		60.5
Sacrum, %	34.6		65.4
Iliac crest/trochanter, %	11.1		88.9
Stage			$<.001$
2, %	75.0		25.0
3, %	31.3		68.7
4, %	12.9		87.1
Exudate amount			$<.001$
None, %	62.5		37.5
Scant/small, %	35.9		64.1
Moderate/large, %	16.1		83.9
Exudate type			.099
None, %	62.55		37.5
Serous/SS, %	63.0		37.0
Purulent, %	11.1		88.9
Necrosis type			.299
None, %	36.8		63.2
White/yellow, %	31.7		68.3
Black, %	23.5		76.5
More than 1 wound			.150
Yes	38.1		61.9
No	25.0		75.0
Mean no. secondary ulcers	0.96	0.73	.428
Any secondary treatment			.374
Yes	25.0		75.0
No		33.3	66.7
Dressing type changed			.000
Yes	20.0		80.0
No	63.6		36.4
Growth factor applied			.591
Yes	33.3		66.7
No	31.5		68.5
Silver-based product applied			.624
Yes	33.3		66.7
No	31.5		68.5
Topical antiseptic applied			.007
Yes	15.2		84.8
No	42.9		57.1
Toxic cleanser applied			.140
Yes	0.0		100
No	33.8		66.2
Debridement performed			.084
Yes	28.2		71.8
No	54.5		45.5
Mechanical debridement performed			.077
Yes	9.1		90.9
No	35.2		64.8
Sharp debridement performed			.093
Yes	24.4		75.6
No	40.5		59.5
Enzymatic debridement performed			.016
Yes	19.5		80.5
No	43.9		56.1
Autolytic debridement performed			.142
Yes	46.7		53.3
No	28.4		71.6
Antibiotics given			.025
Yes	15.4		84.6
No	39.3		60.7
Nutritional supplements given			.011
Yes	6.3		93.7
No	37.9		62.1
Pressure relief device documented			.017
Yes	25.0		75.0
No	55.6		44.4
Turning schedule documented			.019
Yes	10.5		89.5
No	38.1		61.9
Assessments documented, %			
Infection	9.27	18.41	.061
Dressing type changed	19.1	29.1	.052
Modern dressing	58.5	34.8	.021
Hydrocolloid dsg	7.2	6.11	.020
Hydrogel dsg	5.77	13.2	.181
Gauze/no dressing	31.2	47.9	.063
Wet-to-dry gauze dsg	1.27	5.64	.046
Impregnated gauze dsg	0.96	5.84	.060
Antimicrobial dsg	10.3	17.4	.318
AM dsg, iodine	2.6	8.0	.170
AM dsg, silver	0	0.36	.500
AM dsg, other	7.7	11.0	.590
Exudate man. dsg	44.7	17.1	.007
Moisture-retentive dsg	12.8	16.9	.533
Growth factor	8.96	4.64	.381
Toxic cleanser	.00	3.75	.072
Topical antiseptic	12.2	22.2	.150
Topical silver	7.0	2.0	.320
Topical non-silver	5.1	17.1	.013
Mechanical DB	1.27	6.09	.037
Sharp DB	10.4	12.3	.708
Enzymatic DB	18.1	29.1	.144
Autolytic DB	9.3	6.9	.568
Debrided	38.8	54.2	.058
M/L exudate/ No EMD	5.77	35.5	$<.001$
No Ex/EMD	22.3	2.23	.002
Eschar, no DB	1.92	1.34	.766
Slough, no DB	1.92	13.2	.005
No nec, DB	7.31	7.48	.959

Statistical Tests: Chi-square analysis, Fischer's Exact Test, Student's t-test. Yes and No values are percentages.

dsg, dressing; AM, antimicrobial; DB, debridement; M/L, moderate/large; Ex, exudate; EMD, exudate management dressing; nec, necrotic tissue.

their association with 6-month healing. Many wound characteristics had extensive levels of missing data, including the Braden score, depth, tunneling, color, edema, edges, induration, undermining, granulation, and epithelialization. The most frequently collected wound information across the sites was ulcer size, stage, and location; exudate type and amount; necrosis type; and signs of infection. Stage 4 pressure ulcers were significantly less likely to heal (12.9%) after 6 months of

Table 4. *Forward and Backward Conditional Logistic Regression Models to Identify Best Models for Predicting Healing Within 6 Months*

Predictor	Beta	Wald	*P*	Odds Ratio
Backward Conditional Model				
Medicaid	−1.71	2.94	.087	0.181
CVD comorbid	−1.95	3.44	.063	0.143
Dressing type changed	−2.99	5.94	.015	0.050
Topical antiseptic	−2.57	3.42	.064	0.077
Antibiotics administered	−3.82	6.56	.010	0.022
Pressure relief device	−3.22	4.35	.037	0.040
Mod/large Ex, No EM dsg*	−0.044	5.52	.019	0.957
No Ex, EM dsg applied*	0.040	3.06	.080	1.041
Slough, not debrided*	−0.050	4.04	.044	0.951
Constant	7.454	9.84	.002	0.173
Forward Conditional Model				
Medicaid	−1.97	5.26	.022	0.140
CVD	−1.83	4.81	.028	0.160
Dressing type changed	−3.07	8.62	.003	0.047
Antibiotics administered	−2.70	6.58	.010	0.067
Mod/large Ex, no EM dsg*	−0.037	5.07	.024	0.963
No exudate, EM dsg applied*	0.040	4.40	.036	1.041
Constant	3.89	9.40	.002	48.76

Forward Conditional Model: 6 steps; Chi-square=54.5; $P < .001$; *R*-square = 68.1%; percent predicted correctly=84.1.
Backward Conditional Model: 9 steps; Model Chi-square=63.8; $P < .001$; *R*-square = 75.8%; percent predicted correctly = 91.5.
CVD, cardiovascular disease; EX, exudate; EM, exudate management; dsg, dressing.
* Measured as percent of assessments.

treatment as compared with Stage 3 (31.3%) and Stage 2 (75.0%) ulcers. Wounds with moderate or large amounts of exudate were significantly less likely to heal than wounds with scant or small drainage. Initial ulcer size, depth, and number of infections were also associated with healing. Ulcers that did not heal were larger in diameter and deeper in depth initially than ulcers that healed. The more monthly assessments at which signs of infection were noted, the less likely the ulcer would heal within the 6 months. Finally, the subjects who healed within 6 months had significantly lower severity scores (5.15) at the beginning of treatment compared with subjects who did not heal (7.93).

Several treatment variables were found to have a significant association with 6-month healing. Initially, the treatment variables were analyzed as categorical measures (eg, performed/not performed; administered/not administered). Our analysis showed that if the selected type of dressing was changed after the initial assessment, subjects were less likely to go on to heal. The application of topical antiseptics, use of enzymatic debridement, and administration of antibiotics significantly reduced the chances of healing. More detailed analysis of topical antiseptics and antimicrobial dressings showed no differences in healing across subcategories of antimicrobial dressings, but less healing with the use of non-silver topical antiseptics. In addition, if a subject was receiving nutritional supplements, had a pressure-relieving device, or had a turning schedule documented, they were significantly less likely to heal within the 6 months. We then analyzed the treatment variables as continuous measures, calculating the percentage of recorded monthly assessment times (up to 6 assessments possible) that a treatment was performed/administered. Pressure ulcers that healed had a significantly lower percentage of assessments that the dressing type was changed, a higher percentage of assessments that "modern" dressings were applied, a higher percentage of assessments that exudate management dressings were used, a lower percentage of assessments that mechanical debridement was performed, and a lower percentage of assessments that any type of debridement was performed. In addition, wounds that healed had a higher percentage of assessments that appropriate wound management practices were carried out. More specifically, subjects whose ulcers healed had a lower percentage of assessments that their wounds had documented moderate or large amounts of exudate but no exudate management dressings were applied; and they had a lower percentage of assessments that their wounds had yellow slough documented but the wound was not debrided. Interestingly, ulcers that healed had a higher percentage of assessments that no exudate was documented, but an exudate management dressing was applied. This might reflect inadequate documentation, or alternatively suggest that any moisture-management dressing may be better than gauze or antimicrobial dressings in promoting healing.

We next ran several logistic regression analyses to determine the factors that were most important in predicting pressure ulcer healing within 6 months, holding other factors constant in the models. We first ran a regression model that included only the demographic and clinical factors that were significant in the bivariate analysis. Only 2 variables were statistically significant in the model: Medicaid insurance and cardiovascular disease. These variables were retained for use in the models that added wound and treatment characteristics. We used forward and backward conditional selection models to determine the most important variables and the most parsimonious model for predicting healing by 6 months.

We tested models that entered treatment variables as categorical factors (dressing type changed after treatment initiation, topical antiseptic applied during course of therapy) and then as continuous variables (percentage of assessments that dressing type was changed; percentage of assessments that topical antiseptics were applied). We then selected the best models based on explained variance and percentage of cases predicted correctly by the model. These results are shown in Table 4. The categorical variables performed better than the continuous variables in these analyses.

The backward conditional logistic regression model employed 9 steps. The model was significant ($P < .001$), had an explained variance of 75.8%, and predicted correctly 91.5% of the cases. The variables retained in the model were Medicaid coverage, CVD, dressing type changed, topical antiseptic applied, antibiotics administered, pressure relief device used, moderate or large amount of exudate with no exudate management (EM) dressing applied, yellow slough documented with no debridement performed, and no exudate documented but an exudate management dressing applied. All but the last measure (no exudate but EM dressing used) reduced the odds of healing. The forward conditional logistic regression model had 6 steps. The model was significant ($P < .001$), had an explained variance of 68.1%, and predicted 84.1% of the cases correctly. The variables selected for inclusion in the model were Medicaid coverage, CVD, dressing type changed, antibiotics administered, moderate or large amounts of exudate but no EM dressing applied, and no exudate documented but an EM dressing applied. The direction of the relationships remained the same as the other logistic regression model. We ran these same models with the wound severity score, but severity did not achieve statistical significance, and the values for the other variables remained essentially unchanged.

Primary Caregiver: Skilled Nursing Facility

Thirty-eight (33.9%) of the subjects in our sample resided in SNFs. We examined whether any of the demographic, clinical, treatment, or outcome variables differed significantly between the subjects residing in an SNF compared with subjects in other settings and with other primary caregivers. None of the outcome variables was significantly different across groups. The 3-, 4-, 5-, and 6-month healing rates, nonhealing after 5 to 6 months, deterioration after 6 months, and final resolution (healed, no healed, lost to follow-up) were all similar across primary caregiver categories. As shown in Table 5, only 1 demographic factor was different: there were significantly more males with pressure ulcers in the nursing home setting compared with other settings. Several comorbid conditions were found more frequently in the nursing home subjects, including dementia, CVD, pulmonary disease, CHF, and CVA, and nursing home subjects had a higher total number of comorbid conditions. A few treatment variables were also significantly different across settings. Subjects in nursing homes had a significantly lower percentage of monthly assessments at which hydrocolloid dressings were applied and a higher percentage of monthly assessments at which no dressing was applied to the wound. Subjects residing in nursing homes had a higher percentage of monthly assessments at which wound debridement was performed (60.0% vs 45.5%, $P = .030$), and nursing home subjects were more likely to have received enzymatic debridement than subjects in other settings (73.7% vs 44.6%, $P = .003$). There were no significant differences in stage, size, or severity of ulcers, although the percentage of Stage 4 pressure ulcers was higher in the nursing homes (47.1% vs 30.6%, $P = .108$). In addition, there were no differences in documentation of infections across settings, but a higher percentage of nursing home subjects received antibiotics (44.7% vs 23.0%, $P = .016$), and they were administered antibiotics at a higher number of monthly assessments over the course of documented therapy (0.53 vs 0.28, $P = .054$). On the other hand, growth factor was not used at all in nursing homes, and there was significantly less use of any secondary therapies (VAC, grafts) in this setting. Examining appropriateness of therapy, subjects in nursing homes had a higher percentage of monthly assessments at which black eschar was noted but not debrided (4.6% vs 0.45%, $P = .057$), but a lower percentage of monthly assessments at which yellow slough was noted but not debrided (3.53% vs 11.5%, $P = .020$). Finally, there were no significant differences between the groups in percentage of subjects receiving nutritional support, having a pressure relief device, or having a turning schedule documented, even though a lower percentage of subjects in the nursing home setting had pressure relief (57.9% vs 70.3%) or a turning schedule (13.2% vs 24.3%) documented.

Table 5. *Significant ($P < .10$) Differences: Primary Caregiver is Skilled Nursing Facility ($N = 38$) Compared to Other Primary Caregivers*

Variable	SNF	Other	*P*
Sex			.025
Male, %	57.9	36.5	
Female, %	42.1	63.5	
Dementia, %	42.1	25.7	.060
CVD, %	60.5	43.2	.062
Pulmonary disease, %	34.2	17.6	.043
CHF, %	31.6	13.5	.023
CVA, %	39.5	24.3	.075
Total comorbids	5.3	4.2	.010
No dressing applied, %*	14.6	4.4	.065
Hydrocolloid dressing, %*	4.8	18.1	.008
Debridement, %*	60.0	45.5	.030
Enzymatic debridement, %*	36.7	24.2	.054
Enzymatic debridement, any, %	73.7	44.6	.003
Growth factor, any, %	0	14.9	.008
Growth factor, %*	0	8.0	.003
Antibiotics administered, any, %	44.7	22.9	.016
Antibiotics administered, %*	0.53	0.28	.054
Secondary therapy, any, %	10.5	23.0	.087
Eschar, not debrided, %*	4.61	0.45	.057
Slough, not debrided, %*	3.53	11.53	.020

Statistical tests: Chi-square analysis, Fischer's exact test, Student *t* test.

SNF, skilled nursing facility; CVD, cardiovascular disease; CHF, congestive heart failure; CVA, cerebrovascular accident.

* Calculated as the percentage of assessment points (up to 6 maximum) that the therapy was noted as performed or inappropriate management was documented.

DISCUSSION

Pressure ulcers are a common and costly problem in acute, long-term, and home care settings.[3] In spite of the availability of national guidelines, pressure ulcer treatment remains inconsistent across facilities.[4] A gold standard for pressure ulcer treatment is currently lacking, reflected by the broad range of products and interventions for treating these ulcers and by the absence of a superior treatment with a clearly demonstrated efficacy in the Cochrane database.[5,6] However, the following general principles of treatment have been identified to guide clinicians: assess severity of the wound (stage); reduce pressure, friction, and shear forces; optimize local wound care; remove necrotic debris; manage bacterial contamination; and correct nutritional deficits.[6]

Evidence does exist to support the use of dressings that maintain a moist environment at the wound/dressing interface.[7,8] Dry gauze dressings are recognized as potentially damaging to granulation or healing tissue[9]; however, the most common dressing for pressure ulcers is dry gauze.[10] Use of dry gauze persists in spite of clear data suggesting it delays healing.[10,11] In our study, moisture management (modern) dressings in general and exudate management dressings specifically were associated with 6-month healing, while gauze dressings were associated with nonhealing after 6 months of treatment. Bergstrom et al,[2] in their national study of pressure ulcers within the nursing home setting, also found that the use of moist dressings as compared to dry dressings improved the healing rates of the pressure ulcers.

Major category of dressing (modern, gauze, or antimicrobial) did not, however, turn out to be a significant predictor of healing in our multivariate models. This might have been related to clinical decision making regarding which dressings to apply to which wounds—clinicians at times seemed to be indiscriminately applying and switching dressings. As a result, more frequent changes in type of dressing being applied to the wound led to less likelihood of healing. A possible alternative explanation is that dressing type was being changed in response to observed lack of progress in wound healing. However, closer examination of our data does not support this conclusion. First, number of dressing-type changes was significantly correlated with number of inappropriate dressing selections (type of dressing not matching amount of exudate). Secondly, some clinicians began with gauze or antimicrobial dressings, then switched to another gauze or antibacterial dressing, regardless of whether the ulcer had increased or decreased in size. The selected dressing was also sometimes changed in spite of the ulcer showing progress in healing with the original dressing. Bergstrom et al[2] also noted large variations in treatment practices in their national study of 882 nursing home residents. Treatments for individual pressure ulcers and for similar stage pressure ulcers across residents were highly variable, making it unlikely, according to these researchers, that treatments were being changed from assessment to assessment based on the assessed condition of the pressure ulcer. The extent to which the indicated use of particular dressing types did not match the characteristics of the wounds to which they were being applied in our study suggested to us that clinicians have limited knowledge about the specific wound care products, have limited access to the most appropriate materials, or are facing reimbursement limitations.

Thomas[9] notes that the current literature does not indicate significant advantages of any single dressing product over another. Our analysis suggests that one specific dressing type might be more effective in promoting healing compared to other dressings. Ulcers in our study that healed were more likely to have had a hydrocolloid dressing applied. On the other hand, ulcers that did not heal were more likely to have had wet-to-dry gauze or impregnated gauze applied. A meta-analysis of 5 research reports compared hydrocolloid dressings with traditional wound care, and found a significant improvement in healing with the use of hydrocolloid dressings.[12] Hydrocolloid dressings may indeed represent the gold standard of pressure ulcer care.[13,14]

Another principle of chronic ulcer care is the removal of necrotic tissues and debris through debridement. Rodeheaver[15] had previously noted a positive correlation between aggressive wound debridement and improved wound healing. However, a recent meta-analysis failed to show improvement in wound healing with debridement.[16] It thus remains unclear whether wound debridement is a beneficial process that results in a greater frequency of complete wound healing.[6] Our results demonstrated a negative association between the repeated use of debridement in the management of the pressure ulcers and ultimate healing. The evidence is also mixed regarding the most effective approach to wound debridement. Many authors have recommended sharp debridement as being both effective and efficient. However, it can also damage healthy tissue and fail to completely clean the wound. Enzymatic debridement can dissolve necrotic debris but may also harm healthy tissue.[6] Enzymatic as well as autolytic debridement approaches require days to weeks to achieve results,[6,17] thus contributing to delayed healing. The use of both mechanical and enzymatic debridement in our study was associated with failure to heal within 6 months. A systematic review of 5 trials did not show that enzymatic debriding agents increased the rate of complete healing compared to the control treatment.[16] However, another study found that autolytic debridement using a hydrogel dressing achieved a quicker and less costly healing as compared to enzymatic debridement.[18] Although some clinical practice guidelines include wet-to-dry dressings as an acceptable method of debridement, there is now general agreement that mechanical debridement provides nonselective removal of both healthy tissue as well as devitalized tissue when it is performed.[17] We found that only 8.3% of the subjects undergoing mechanical debridement in our study went on to heal within 6 months.

Subjects with more frequently noted signs of infection were less likely to heal in our study, while the administration of oral antibiotics and topical antiseptics were also associated with greater odds of not healing. It is possible that the use of antibiotics was serving as a proxy for systemic infections, and thus reflecting the difficulty encountered in healing infected wounds. Alternatively, the administration of oral antibiotics might have been an inappropriate approach to treatment of the patient. Use of systemic antibiotics without specific indi-

cations can result in bacterial resistance and host toxicity.[17] Lewis et al[19] stated that systemic antibiotics are indicated for controlling bacterial levels only in the presence of bacteremia, sepsis, advancing cellulites, or osteomyelitis and are not required for signs of local infection. In addition, the Wound Ostomy and Continence Nurses (WOCN) Clinical Practice Guideline states that topical antiseptics should be used cautiously and selectively in managing pressure ulcers, and that cytotoxic topical agents should be avoided.[20] We noted occasional use of Dakins solution, hydrogen peroxide, betadine, and acetic acid in our study, as well as more frequent application of agents such as polysporin, bacitracin, bactroban, and silvadene. The application of topical antiseptics was negatively associated with healing in both our bivariate and multivariate analyses.

A somewhat unexpected finding was the negative association we found between provision of nutritional support, use of pressure-relieving devices, and having a documented turning schedule, and 6-month healing. The negative relationship between use of a pressure-relieving device and healing remained in the multivariate model. One might conjecture that use of a pressure-relieving device and having a documented turning schedule might be serving as a proxy for reduced mobility, functioning, and ability to perform activities of daily living. In that case, one would expect to see greater documentation of pressure-relieving devices and turning schedules in the nursing home subjects compared with subjects in the more ambulatory sites of care delivery. Surprisingly, fewer subjects in the nursing home had documented devices or a turning schedule compared with the other subjects. One partial explanation might relate to lack of implementation of written orders for these interventions. For example, one study showed that nursing home residents were not routinely repositioned every 2 hours, although 2-hour repositioning was documented for nearly all the residents.[21] Hence, our finding might be in part the result of lack of repositioning or provision of a special device in spite of documentation of these interventions.

We are not, however, the first researchers to report these unexpected relationships. In a national random sample of 2425 hospitalized Medicare beneficiaries, older adults who had documentation of receiving a pressure-reducing device and/or having been turned every 2 hours had a higher incidence of pressure ulcer development.[22] Kramer and Kearney[23] also found in a study of nursing home residents that less time on a pressure-relieving bed was associated with improved healing of pressure ulcers. Perhaps the documentation of these interventions is correlated with greater severity of the pressure ulcer and resulting difficulty in achieving healing. Further analysis of our data revealed the existence of this relationship, showing that subjects with a pressure-relieving device, a turning schedule, and/or nutritional supplements had significantly higher wound severity scores than subjects without such an order. It might also help explain why severity was not a significant predictor variable in our analysis.

In addition, the new F-Tag 314 for pressure ulcer prevention and management issued by the Centers for Medicare and Medicaid Services (CMS) notes that there are no wound-specific nutritional interventions and that the frequency of optimal repositioning is unknown.[9] Several trials have attempted to increase healing by the use of nutritional supplements—none have influenced the healing rate of pressure ulcers.[6] A systematic review of 15 studies was not able to find a significant association between ONS (oral nutritional supplements) and ETF (enteral tube feedings) and pressure ulcer healing.[24] A Cochrane Review[25] also reported an inability to draw any firm conclusions on the effect of enteral and parenteral nutrition on the prevention and treatment of pressure ulcers.

NURSING HOME AS PRIMARY CAREGIVER

Few demographic differences were noted between subjects being cared for in a nursing home setting and subjects being cared for in other settings. It would be expected that more residents in nursing homes would have comorbidities such as dementia, CVD, pulmonary disorders, and CHF, and a higher number of comorbid conditions in total. Although various comorbid conditions occurred more frequently in the nursing home setting, only CVD was found to have a significant negative association with 6-month healing. We did find a significantly higher percentage of men with pressure ulcers in the nursing home setting. Thomas[26] has reported that in long-term care facilities with a low incidence of pressure ulcers, male gender was associated with a higher risk of developing a pressure ulcer. Men in nursing homes might be more at risk because of their leaner body masses. In fact, obesity in our study was positively associated with healing, suggesting that subjects who are lean or underweight might represent a greater risk of both developing a pressure ulcer and delayed healing. Kramer and Kearney[23] also found a significant association between higher weight and quicker pressure ulcer healing.

Although average severity score (reflecting size, exudates, and necrosis) and stage of the pressure ulcer at the beginning of treatment did not differ significantly between nursing home subjects and others, there were more Stage 4 ulcers in the nursing home setting. Furthermore, ulcer stage was significantly associated with ulcer healing, with Stage 4 ulcers being much less likely to heal compared to Stages 2 and 3. Perhaps more emphasis needs to be placed on creating strategies in all health care settings to prevent the development of pressure ulcers when possible, and failing that, to identify the presence of pressure ulcers at an earlier stage, through the use of more frequent and comprehensive skin checks.

There is also a need to help staff select the most appropriate dressing and approach to debridement. Subjects residing in nursing homes were more likely to have had gauze dressings used for their pressure ulcers, while the subjects who healed within 6 months were significantly less likely to have had gauze dressings. There was significantly less use of hydrocolloid dressings in the nursing home setting, the only dressing type that was associated with ulcer healing. Instead, more subjects in the nursing homes had no dressing documented, which allows the wound to dry out and delays healing. Subjects in nursing homes were also more likely to have received enzymatic debridement as compared to subjects in other settings; enzymatic debridement was also associated with non-

healing ulcers in our study. Although surgical or sharp debridement may not be an option in the nursing home setting, subjects with black eschar covering the wound might benefit by a referral to a setting where sharp debridement could be performed using curettes or scalpels. Additionally, greater use of autolytic debridement rather than enzymatic debridement for those with yellow slough might also be considered.

It is interesting to note that, although the percentage of subjects with signs of infection did not differ significantly between nursing homes and other settings, subjects in nursing homes were significantly more likely to have received systemic antibiotics. This requires further exploration, as it must be assumed that at least some of this represents inappropriate administration of antibiotics.

CONCLUSION

Recommendations for the treatment of pressure ulcers have often been based more on dogma and personal beliefs than on evidence-based results.[11,13,27] Our study suggests that a few key changes in pressure ulcer treatment may improve healing rates in all settings. These include reducing the use of topical antiseptics and cytotoxic cleansing agents, improving the matching of wound characteristics to the selection of dressings and the use of debridement, and limiting administration of systematic antibiotics to individuals with specific indications for their use. The finding that type of insurance coverage was an important predictor of healing warrants further investigation. Very few Medicaid patients went on to heal within 6 months of treatment. A number of factors might be implicated, including subject nonadherence, environmental stressors, poor diets, lack of money for out-of-pocket expenses, lack of reimbursement for certain products, or other reasons. Given the impact of nonhealing wounds on quality of life, it is important that any nonclinical factors be addressed and remedied as quickly as possible.

LIMITATIONS

This study has several limitations. Chart reviews are associated with errors of omission and commission: treatments might have been carried out but not documented, and treatments might have been documented but not carried out. Only one of the data collection sites had a standardized wound database, while the others documented minimal data and not always in a consistent fashion. Several variables that might have been important predictors, such as duration of the ulcer and results of wound cultures, were present on too few charts to include in the database. Subjects were seen on varying schedules across data collection sites, from weekly to every 1 to 2 months. The quality of data abstractors might have varied across sites as well, although explicit protocols and training requirements were provided to site coordinators. The small number of data collection sites (4) and low number of subjects residing in skilled nursing facilities (38) reduces the generalizability of the findings and strength of any conclusions.

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