

**Feature:**

**Chronic Wounds: Factors Influencing Healing Within 3 Months and Nonhealing After 5–6 Months of Care**

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Chronic wounds affect approximately 2.5 million to 4.5 million people in the US and are particularly a problem for the elderly. Nonhealing or slow healing wounds represent a major health burden and drain on resources, contributing to substantial disability, morbidity, and costs. This study was conducted to identify factors that influence the healing of chronic wounds within 3 months of starting treatment, compared to factors influencing nonhealing wounds after 5 or 6 months of treatment. A retrospective review of medical records of subjects with chronic pressure, diabetic, or venous ulcers using a structured data collection form and protocol was conducted at 4 sites located in disperse geographic areas. The sample consisted of 400 subjects with at least 3 months of data. Demographic, case mix, wound characteristics, and treatment characteristics were analyzed. Consistent with the literature, wounds that were larger, deeper, infected, draining larger amounts of exudate, and/or covered with slough or eschar were significantly less likely to heal within 3 months and more likely not to heal after 5–6 months of treatment. Medicaid insurance coverage and being non-white were also associated with poorer healing. A lower percentage of antimicrobial dressings was associated with faster healing, while a lower percentage of moisture-management dressings was associated with nonhealing after 5–6 months. The analysis also showed that inappropriate management of wound exudate and necrotic tissue was associated with poorer healing outcomes. While the influence of insurance coverage and race on healing needs further exploration, healing rates could improve in certain centers through better adherence to evidence-based wound management recommendations.

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Chronic lower extremity ulcers affect approximately 2.5 million to 4.5 million people in the US.<sup>1</sup> In addition to pressure ulcers, this growing clinical problem is most prominent among the elderly. Nonhealing or slow healing wounds represent a major health burden and drain on resources<sup>2</sup> and contribute to substantial disability, morbidity, and costs.<sup>3</sup> Multiple factors have been identified as contributors to impaired wound healing, such as, ischemia, infection, advanced age, malnutrition, diabetes, and renal disease.<sup>2</sup> Other conditions, such as cardiac and lung disease, decreased cognitive function, endocrine disease, GI disease, hematologic disorders,

incontinence, musculoskeletal problems, neurological disease, alcohol/drug abuse, immunosuppressives, chemotherapy, steroids, smoking, as well as inadequate wound care have been implicated.<sup>4</sup>

Malnutrition has been specifically associated with the extent and severity of pressure ulceration.<sup>5</sup> Appropriate nutritional support, pressure relieving surfaces, turning schedules, and debridement of slough or necrotic tissue are recommended to promote the healing process.<sup>5</sup> Healing rates depend on pressure ulcer stage with approximately 59% of Stage III ulcers and 33% of Stage IV ulcers healing at 6 months.<sup>6</sup> Thomas<sup>6</sup> reports that as few as 13% of pressure ulcers heal within 2 weeks in acute care settings.

Failure to heal diabetic ulcers has been attributed to infection, tissue ischemia, ill-fitting shoes, and poor management.<sup>7</sup> Standard treatment of diabetic ulcers consists of pressure offloading, correction of nutritional deficits, moist wound dressings, and sharp debridement to remove callus.<sup>8</sup> Management principles also include treating infections and preparing the wound bed by topical applications. Brem et al<sup>9</sup> add to these the need for optimal glucose control and the use of adjunctive therapies such as cell and/or cytokine therapy. However, the evidence supporting use of vigorous sharp debridement, enzymatic or autolytic debridement, iodine-based or silver-based antiseptics, and hyperbaric oxygen remains limited.<sup>10-13</sup> Reported healing rates vary across studies. Piaggese et al<sup>14</sup> reported a 79% healing rate at 25 weeks after conventional treatment. In contrast, the healing rates in large multicenter trials are reported at 24% at 12 weeks and 31% at 20 weeks.<sup>15</sup> This meta-analysis also concluded that wound duration, area, and size did not significantly affect the percentage of wounds healed at 20 weeks.

The published rates of venous ulcer healing vary widely, ranging from 30%<sup>16</sup> to 83%<sup>17</sup> after 24 weeks of treatment. Healing rates of 42%–67% at 12 weeks were reported following introduction of specialized wound clinics staffed with nurse specialists.<sup>18,19</sup> The lowest healing rates are reported from studies performed outside of ulcer-oriented clinics.<sup>17</sup> Other factors associated with poor venous ulcer healing include larger ulcer size<sup>20,21</sup> and longer ulcer duration,<sup>20</sup> age,<sup>22</sup> poor limb joint mobility, and poor general mobility.<sup>23</sup> Sharp debridement in combination with a standard venous ulcer treatment regimen is said to be an effective method to expedite healing of intractable venous leg ulcers.<sup>24</sup> Venous ulcer healing rates when using compression therapy have been reported to range from 40% to 70% over 3 months and from 50% to 80% over 6 months.<sup>25,26</sup> Several authors report that multilayer elastic compression bandaging, leg elevation, and exercise along with specialist nurse led clinics, achieve venous ulcer healing rates of 68%–83% after 24 weeks of treatment.<sup>18,22,27</sup>

## Methods

To date, no studies have been conducted to examine overall healing rates for subjects experiencing different types of chronic ulcers

(pressure, diabetic, or venous) and receiving routine wound care as delivered by typical staff across a variety of healthcare delivery settings. This study was conducted to identify factors that influence the healing of pressure, diabetic, and venous ulcers within 3 months of the initiation of therapy (fast healers) and the factors that influence the nonhealing of pressure, diabetic, and venous ulcers after 5 or 6 months of treatment (nonhealers), for typical patients and providers. The intent was to determine whether factors within the control of the clinicians and health care system are associated with these variations in healing rates, and thus might be targeted to improve care delivery and overall wound healing. The specific aims were to:

1. Identify which demographic factors, clinical variables, wound characteristics, and treatment variables had a statistically significant association with fast healing ulcers (defined as 12 weeks or sooner after initiation of treatment)
2. Identify which demographic factors, clinical variables, wound characteristics, and treatment variables had a significant association with nonhealing ulcers (defined as not healed after 20–24 weeks of treatment)
3. Identify the extent to which nonoptimal management of wound exudate and necrotic tissue influenced healing within 3 months and nonhealing after 5–6 months of therapy
4. Explore the contribution that selected organizational variables (data collection site, admission setting, and primary caregiver) made to healing rates.

**Study design.** The study was conducted at 4 geographically disperse sites across the country using retrospective medical record reviews and a standardized data abstraction protocol. Wound care specialists at each site served as project coordinators, and worked with their medical records departments to identify and retrieve the closed charts of subjects who had received care for 1 of the 3 types of chronic wounds within the previous 4 years. Site 1 collected data in an integrated care delivery system, which included clinics, a hospital, a nursing home, and a home health agency. Site 2 collected data at a large teaching hospital, its affiliated clinics, and a home health agency. Sites 3 and 4 both collected data at a hospital-based wound care center. Some of these patients, however, resided in nursing homes or assisted living facilities, or were receiving home health care services while wound center staff managed their wounds. Inclusion criteria were age 50 or older and presence of at least 1 documented, relevant chronic ulcer. Exclusion criteria were Stage I pressure ulcer, active cancer treatment, and ESRD being treated by hemodialysis or transplantation.

The research team and site coordinators developed detailed study protocols. The data abstraction tool was extensive and included the

Table 1

Table 1 Continued

validated Solutions for Outcomes Guide for assessing wound characteristics derived from the Bates-Jensen Pressure Sore Status Tool (PSST).<sup>28,29</sup> In addition to the wound characteristic details (location, shape, size, depth, exudate type, exudate amount, necrotic tissue type, necrotic tissue amount, granulation, epithelialization, undermining, color, edema, induration, edges), the data collection categories included subject demographics, secondary diagnoses and comorbid conditions; risk factors, such as smoking and malnutrition; signs of infection; selected blood values; medications including antibiotics; treatment approaches (dressings, debridement, pressure relief, compression, offloading, cleansers, skin barrier solutions); and secondary therapies (growth factors, living skin equivalents, vacuum-assisted closure). Even though the original intent was to document the wound and its treatment in 2-week increments, inconsistencies across sites in frequency of visits ranging from weekly to every 6–8 weeks, led to a decision to document wound information on a monthly basis.

Site coordinators and wound care specialists prepared at the masters or doctoral level hired and trained research assistants to help with the chart reviews and data abstraction. Site coordinators were instructed to conduct initial and periodic checks on inter-rater reliability, maintaining a minimum of 90% agreement. Research assistants were nurses or graduate nursing students. Completed data collection sheets were stripped of personal identifiers and then sent to the study research office. Data were coded and entered into an SPSS database. Analytical methods included chi-square analysis for categorical variables and student *t*-tests for continuous variables. Comparisons across sites of care delivery were conducted through ANOVA.

## Results

A total of 400 subjects with at least 3 months of data available for data entry and analysis were included in the analysis of ulcers that healed within 3 months. A total of 347 subjects were included in the analysis of nonhealing ulcers, while 53 subjects were excluded due to incomplete data. There were 114 pressure ulcers, 103 diabetic ulcers, and 183 venous ulcers in the initial sample. The sample demographics included: mean age 72.7 ( $\pm 12$ ), 56.5% women, 60.6% white, 34.7% married, and 72.7% insured by Medicare. Only 1 wound per subject (the primary wound, as specified by the data collector according to definitions in the study protocol) was used for this analysis. Out of the 400 subjects only 51 (12.75%) had their wound healed within 3 months of initiating therapy. Of the 347 subjects that had data available for the analysis of 5 or 6 months nonhealing, 195 subjects did not heal (56.2%) in comparison to the 152 subjects (43.8%) that healed at some point over the 6-month period.

Table 2  
Continued

**Ulcers healing within 3 months.** Table 1 shows the bivariate analysis of demographic and clinical factors that were believed to be associated with chronic ulcer healing. Subjects with Medicaid alone, or combined with Medicare insurance, were significantly less likely to be in the fast healing group compared to those with Medicare or private insurance. Subjects with more than 1 ulcer

Table 2

Table 2 Continued

more likely to be in the fast healing group, although mean number of secondary ulcers was not significant. Only 1 comorbid condition was associated with fast healing. Subjects with a diagnosis of PVD or DVT were more likely to heal within 3 months. PVD and DVT are often associated with venous ulceration of the lower leg, as is the presence of multiple ulcers, which might help explain this finding. Obesity was also associated with healing within 3 months, while malnourishment reduced the chances of quicker healing. Although subjects with venous ulcers were more likely to heal faster than those with pressure or diabetic ulcers, and subjects over age 85 were less likely to heal quickly, these last 2 variables did not achieve statistical significance.

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Table 2 shows the results for the bivariate relationships between ulcers healing within 3 months and wound characteristics and treatment approaches. Although the data abstraction form contained many categories of wound characteristics as described above, only size and depth, exudate amount and type, and necrotic tissue type were documented often enough to be included in the analysis. Wound size, depth, exudate amount, and necrotic tissue type all had a significant association with healing within 3 months. In addition, the number of infections, percent of antimicrobial dressings applied, type of wound cleanser, number of months antibiotics were administered, wound debridement, and number of months debridement was performed were all associated with healing within 3 months. More specifically, smaller wounds and more shallow wounds were more likely to heal quickly, while wounds with moderate or large amounts of exudate, yellow slough, or black eschar were less likely to heal faster. The more often (in months) signs of infection were noted, the less likely the subject was healed within 3 months. Interestingly, the more months subjects were given antibiotics, the less likely they were to heal quickly. Greater use of antimicrobial dressings in the first 3 months of treatment was also associated with lower healing rates. However, further analysis did not show a significant relationship between the application of antimicrobial dressings and the presence of infection documentation in those subjects. Wounds that were cleansed with commercial products were more likely to heal within 3 months compared to all the other cleanser categories. Subjects undergoing debridement of their wounds and subjects that were debrided more frequently over the first 3 months were less likely to be in the fast healing group.

Next, the appropriateness of the selected therapies being applied

to wounds with different types of characteristics was examined. *Inappropriate exudate management* was defined as documentation of moderate or large amounts of exudate (with no exudate management dressing applied) or documentation of no or a scant amount of exudate (with an exudate management dressing applied to the ulcer). *Inappropriate necrotic tissue management* was defined as documentation of yellow slough or black eschar (with no debridement performed), or documentation of no necrotic tissue present (with debridement performed). As shown in Table 3, the more frequently inappropriate exudate management or inappropriate necrotic tissue management was documented, then the less likely the subject was to be in the fast healing group.

**Nonhealing ulcers.** As shown in Table 1, there were some differences between fast healing and nonhealing ulcers in terms of which demographic and clinical variables were important. Subjects more than 75 years old and subjects who were white were less likely to be in the nonhealing group compared to subjects less than 75 years old and nonwhite. Similar to those healing within 3 months, subjects with Medicaid coverage (either alone or in combination with Medicare) were more likely not to heal after 5–6 months of treatment. Chronic wound type made a difference as well—subjects with pressure ulcers were most likely to be in the nonhealing group, followed by diabetic ulcers, and then venous ulcers. Those who had a diagnosis of malnourishment and those with multiple risk factors were more likely to be in the nonhealing group, although these associations did not reach statistical significance. Three comorbid conditions were statistically significant—subjects with a history of CVA or dementia were more likely to be in the nonhealing group, while those with a diagnosis of neuropathy were less likely to be in the nonhealing group.

As shown in Table 2, the wound characteristics associated with nonhealing were very similar to those important for healing within 3 months. As expected, larger and deeper wounds were more difficult to heal. Wounds with moderate to large amounts of exudate and with yellow or black necrotic tissue were also less likely to heal. A greater number of documented infections was associated with nonhealing. Wound location was also important. Ulcers on the lower leg, toes, and ankle were least likely to be in the nonhealing group, while ulcers on the iliac crest or trochanter were most likely to be in the nonhealing group. The use of a greater percentage of modern dressings in the first 3 months of therapy was associated with reduced likelihood of nonhealing, as was use of a greater percentage of moisture-management dressings over the entire treatment period. In contrast, the use of a greater percentage of antimicrobial dressings over the entire treatment period was associated with higher likelihood of being in the nonhealing group. Although frequency of dressing type changes was not significant in the analysis of healing within 3 months, it was significant in the analysis of nonhealing ulcers. The more clinicians altered the selected dressing, the more likely the subject was to be in the nonhealing group. Subjects being treated with a toxic cleanser (betadine, hydrogen peroxide, Dakin's solution), receiving antibiotics or nutritional support, being debrided, and being debrided repeatedly,

were more likely to not heal. In addition, those wounds being mechanically debrided (wet-to-dry dressings, whirlpool) were less likely to heal. Inappropriate wound management was also significantly associated with chronic, nonhealing ulcers. The more frequently inappropriate exudate management dressings were applied, and the more frequently inappropriate necrotic tissue management was noted, the more likely the subject was to be in the nonhealing group.

Influence of site of care, admission setting, and primary caregiver. Table 4 shows the results of the analysis examining the relationship of several organizational factors on healing within 3 months and nonhealing after 5–6 months of treatment. Site 1 is seen to have significantly more subjects that healed within 3 months compared to the other three sites. In contrast, sites 2 and 3 have significantly more subjects in the group that did not heal after 5–6 months of treatment. Subjects that were admitted from the hospital setting were less likely to heal within 3 months, while subjects admitted from home health care were more likely to heal in this time period. Finally, subjects in assisted living facilities or with a family caregiver were less likely to be in the nonhealing group compared to subjects with other types of primary caregivers.

Variations in case mix, wound characteristics, and treatment approaches across data collection sites. Given the significant differences across sites of care in the likelihood that an ulcer would heal within 3 months or not heal after 5–6 months of treatment, the authors explored which case mix differences, wound severity differences, or treatment approaches might have been contributing to these site-specific outcome variations. Such information would be useful in developing recommendations for improving wound management and subsequent healing outcomes at those sites. Site 1 had the highest percentage of subjects that healed within 3 months. As seen in Table 5, this site was delivering care to a more socioeconomically advantaged group in terms of insurance coverage. Fewer subjects had wounds with necrotic tissue that required debridement, and fewer subjects experienced wound infections. Treatment factors possibly contributing to the positive outcome included greater use of moisture-management dressings and commercial cleansers. However, this site also had the highest percentage of subjects with dementia, the highest percentage of subjects with documented purulent drainage but receiving no antibacterial therapy, and the highest percentage of subjects having their wounds cleansed with cytotoxic agents. In contrast, Sites 2 and 3 had the highest percentages of subjects whose wounds did not heal within 5–6 months of treatment. Site 2 had the highest percentage of subjects who were malnourished. It also had the highest percentages of subjects with wounds > 5 cm<sup>2</sup>, infections, and necrotic tissue. In addition to these case mix and wound severity variables, Site 2 used moisture-management dressings infrequently, applied antimicrobial dressings to most wounds, and most frequently used mechanical debridement. Interestingly, Site 2 also had the lowest percentage of inappropriate exudate management documentation. Site 3 had several case mix and wound severity variables that most likely contributed to

poorer outcomes. It had the highest percentages of Medicaid and nonwhite subjects and subjects receiving nutritional support. The wounds of subjects at Site 3 were the largest on average at initiation of treatment and were more likely to have moderate or large amounts of exudate. This site had the highest percentage of gauze dressing use, and the highest percentage of inappropriate exudate and necrotic tissue management documented at 3 months and 6 months after treatment initiation.

Tables 3-4

The image shows two tables, Tables 3-4, which appear to be data tables from a research study. The tables are partially obscured and difficult to read due to low resolution and blurring. They likely contain statistical data related to wound healing outcomes, such as percentages of subjects achieving timely healing versus nonhealing, and possibly demographic or clinical characteristics of the subjects.

## Discussion

This study examined subjects with 1 of 3 types of chronic ulcers to identify those factors that influenced the rate of healing, both timely healing (within 3 months of start of treatment), and nonhealing (after 5 to 6 months of treatment). The subjects, all more than 50 years old, were receiving wound care in a variety of settings with different constellations of staff members, care delivery processes and organization, and treatment preferences.

Few sociodemographic factors were associated with healing in the subject sample. Most notable were the influence of Medicaid coverage and non-white race/ethnicity on nonhealing of wounds. The majority of nonwhites and Medicaid recipients were cared for at one site (Site 3), so it is difficult to distinguish the independent effects of race and insurance on healing. It is possible that reimbursement policies, adherence to recommended therapies, environmental factors, social stressors, and so forth have been contributing to the measured relationships with healing, but we were unable to capture these types of measures in a chart review study. Lack of ability to cover out-of-pocket expenses, difficulty assessing wounds in darker skinned individuals, less ability to self-advocate for high quality care, and overt or unconscious discrimination related to treatment choices, might also have played a role in our findings. Older age was not found to have a significant association with nonhealing in our study, although age has been implicated in other studies.<sup>2</sup>

No strong relationship was found between most of the comorbid conditions and the healing outcomes. Diabetes, renal disease, cardiac disease, pulmonary disease, endocrine disorders, GI disease, blood disorders, neurological disease, and smoking<sup>2,4</sup> were not associated with poor wound healing in the present study, while it was found that diagnoses of malnutrition, infection, CVA, and dementia were important. History of stroke and presence of cognitive impairment are likely to be related to poorer functional status and reduced activity levels, making healing more difficult to achieve.<sup>5</sup> Nutritional status has been linked to the development of pressure ulcers, and is considered an important factor in successful healing of chronic wounds.<sup>2,5</sup> Subjects who received nutritional support can be assumed to have poorer nutritional status and lowered healing capacity, and thus less ability to

heal their wounds. Having more than one ulcer and being obese were both associated with healing within 3 months. These factors may have been associated with type of ulcer (venous), which was likely to heal faster than diabetic or pressure ulcers. However, further analyses showed that the percentage of obese patients was similar between diabetic and venous ulcer patients, and the percentage of subjects with more than 1 wound was similar between pressure and venous ulcer patients. Currently, the explanation to support these findings is uncertain

It is not surprising that specific wound characteristics were associated with healing or nonhealing of chronic wounds. Larger, deeper wounds take longer to heal than shallow, smaller wounds.<sup>30</sup> Although exudate type did not influence healing in the present study, amount of exudate was associated with both healing and nonhealing of wounds. A major focus of chronic wound care in recent years has been the development of dressings that promote a moist environment to assist healing.<sup>2</sup> Wounds with moderate to large amounts of drainage require absorptive dressings while dry wounds require dressings that add or retain moisture.<sup>31</sup> Recommended dressings include films, foams, hydrogels, hydrocolloids, alginates, and hydrofibers.<sup>5</sup> Dressing materials differ in their properties of permeability and wound protection—understanding these differences is key to planning for wound management in individual patients. The many available dressing choices may confuse clinicians who are making these decisions. In addition to these moisture-management dressings, there are topical antiseptic agents being used with gauze, as well as antimicrobial dressings. Although rationale exists for use of these types of dressings, data are limited on their ability to enhance healing.<sup>32-34</sup> The findings did not support their use, with antimicrobial dressings having a negative impact on healing within 3 months and a positive association with nonhealing after 5–6 months of treatment. Because of the possibility that use of antimicrobial dressings might be related to presence of infection, we conducted further analyses which revealed no association between presence of infection and use of these types of dressings. Greater use of moisture-management dressings in the first 3 months of treatment, and over all 6 months of treatment, reduced the chances of not healing. The use of moisture-management dressings is consistent with evidence-based recommendations. According to NICE<sup>35</sup>, moisture-management dressings create the optimum wound environment rather than gauze. Interestingly, the use of gauze dressings in the present study did not influence healing at either 3 or 6 months.

Debridement of the amorphous material from the wound bed of chronic ulcers has been used for many years to enhance healing, using surgical, sharp, autolytic, enzymatic or mechanical approaches.<sup>24</sup> Although evidence supports the efficacy of debridement of chronic wounds,<sup>36,37</sup> none of the specific approaches has gained universal acceptance.<sup>24</sup>

Debridement in the present study was associated with poorer healing outcomes. It may be partly due to the fact that necrotic debris increases the possibility of bacterial infection and delays wound healing.<sup>38</sup> It may also reflect use of non-recommended approaches,

**inadequate skill, and inadvertent damage to healthy granulating tissue. Mechanical debridement is contraindicated because it is nondiscriminant, removing both healthy and dead tissue. As might be expected, the repeated use of mechanical debridement over time was found to be associated with the nonhealing of the chronic ulcers. Although widely recommended, it remains unclear whether wound debridement is a beneficial process that results in greater frequency of complete wound healing.<sup>11,38</sup>**

**The literature has described the negative impact of wound infections or bacterial burden on wound healing.<sup>39</sup> The authors of the present study were able to document the negative influence of infectious processes on healing as well. However, infection was not well documented in the medical records (very few cultures were performed), so infections were noted through documented signs of infection, identification of purulent drainage, and/or orders for systemic antibiotics. Ulcers that healed within 3 months had significantly fewer data collection points over these 3 months at which infections or potential infections were noted, while nonhealing ulcers had significantly more data collection points at which actual or potential infections were documented. We also found that greater use of systemic antibiotics was associated with nonhealing ulcers. This of course is correlated with the documentation of signs of infection and might also reflect more severe infectious processes. There is a possibility that antibiotics were overused in some cases.<sup>39</sup>**

**The present study unexpectedly found that the use of a commercial cleansing agent as compared to water, normal saline, toxic agent, or no cleanser, was associated with faster healing. The use of specific cleansing agents varied significantly across sites of care delivery. The 2 sites with the most positive healing outcomes both used commercial cleansing agents, although for a rather small percentage of their subjects (14% and 9%), while neither of the other two sites with poor healing outcomes used any commercial agents. It is therefore difficult to sort out the independent effects of commercial cleansing agents from other site effects, and requires further investigation. The use of cytotoxic cleansing agents, such as Dakin's solution, acetic acid, and hydrogen peroxide, was associated with the nonhealing of wounds. As early as 1994, AHCPR clinical practice guidelines warned against using these cytotoxic cleansers, but their application persists to this day in spite of the evidence-based recommendations against their use.<sup>40-42</sup>**

**A higher number of dressing type changes was also found to influence nonhealing of the wound. Subjects who had their dressing type changed 4 or 5 times were less likely to have wounds that eventually healed. There are several possible explanations for this finding. Clinicians might be altering dressings to determine what might work best for a difficult to heal wound. Alternatively, clinicians might be altering treatment without a good understanding of what type of dressing should be applied to wounds with specific characteristics. A review of the authors' data supports the second possibility. Dressing approach was often changed even when the wound was healing with the previous dressing. At other times, wounds would be deteriorating but the dressing type not changed for several months. Sometimes the**

change consisted of one type of gauze to another or from no dressing to gauze dressing.

The possibility that the changing of dressing types may not be related to progress or lack of progress in wound healing is further supported by the present findings related to the suitability of the selected dressing for the amount of wound exudate and whether or not the use of debridement was appropriately related to the presence of necrotic tissue. Although the key principal of chronic wound management is to maintain a moist environment, the findings suggest that many clinicians are either unaware of what dressings are optimal—given amount of drainage—or do not have access to the appropriate dressings in their setting. Furthermore, even though there is evidence that wounds covered with necrotic tissue are unable to heal, many of the wounds with eschar or slough were not debrided for long periods of time.

Table 5



### Limitations

Given its retrospective nature, many of the desired variables were not included in the medical records of most subjects, including duration of the wound, adherence to treatment recommendations, serum albumins, and wound cultures and sensitivity. Many subjects had missing data for 1 or more data collection points. In addition, documentation regarding wound characteristics and treatment approaches was sparse for many subjects. The loss of a significant number of subjects after 3 months of data collection might have biased the results if they were systematically different from the subjects that remained in the sample. The limited number of data collection sites and settings of care delivery is also a limitation. Although the multiple comparisons increased the chances of finding significant associations, the authors believed it was important to explore each of the major categories of potential predictors to identify factors that seem to make a difference in chronic wound healing.

### Conclusion

Multiple factors influence the healing of chronic wounds. Some of these factors are not easily influenced by the wound care providers, such as comorbid conditions, obesity, and malnutrition. Other factors suggest that earlier identification and referral for treatment might lead to improved healing rates for some patients. Remaining factors require the attention of those delivering wound care services. These include more carefully matching wound characteristics to selected dressings, and eliminating the use of mechanical debridement and cytotoxic agents. The results also demonstrate the need for more complete documentation of wound characteristics for selection of appropriate interventions and for better monitoring of healing progression.

**The role of infections and antibiotic therapy is an important factor to consider. Few subjects had documented cultures of their wounds to guide antibiotic selection. The use of topical antiseptics and antimicrobial dressings did not seem to be associated in any consistent manner with infection or potential infection of the wounds. The role of Medicaid coverage, race, the use of commercial cleansers, and the effect of repeated debridement on chronic healing outcomes require further exploration.**

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