A Cost Analysis of Diabetic Lower-Extremity Ulcers

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OBJECTIVE — Our objectives were to *1*) estimate the prevalence of diabetes and diabetic lower-extremity ulcers in the Medicare population, *2*) characterize Medicare population-specific costs for lower-extremity ulcer episodes, and *3*) evaluate potential cost savings associated with better healing of lower-extremity ulcers.

RESEARCH DESIGN AND METHODS — Prevalence and costs of diabetic lower-extremity ulcers were obtained by an analysis of Medicare claims data from 1995 and 1996 Standard Analytic Files (5% sample).

RESULTS — Medicare expenditures for lower-extremity ulcer patients were on average 3 times higher than those for Medicare patients in general ($15,309 vs. $5,226). Lower-extremity ulcer-related spending accounted for 24% of total spending for lower-extremity ulcer patients. Most of the ulcer-related costs accrued on the inpatient side (73.7%); proportionately smaller amounts went to physicians and nursing home facilities. To determine the potential effect of better diabetic ulcer management, a model was created that estimated the impact on costs with improved healing rates. Improving the 20-week healing rate from 31 to 40% would save Medicare $189 per episode.

CONCLUSIONS — Lower-extremity ulcers cost the Medicare system $1.5 billion in 1995. Any wound care intervention that could prevent even a small percentage of wounds from progressing to the stage at which inpatient care is required may have a favorable cost effect on the Medicare system.

Diabetes Care 23:1333–1338, 2000

Diabetes affects nearly 15% of the Medicare population, or ~6 million people >65 years of age. Foot or lower-extremity ulcers, one of many complications of diabetes, occur in ~7% of diabetic individuals each year (Lewin Group, unpublished data). The incidence of lower-extremity ulcers is expected to increase substantially over the next several years as the incidence of diabetes increases in the population.

Foot or lower-extremity ulcers are cutaneous wounds resulting from a combination of factors including neuropathy, vascular insufficiency, and impaired wound healing. They have the potential to cause severe morbidity and high treatment costs. A recent retrospective study of men 40–64 years of age in a managed care population (1) found that for 2 years after diagnosis, the attributable cost for foot ulcer care was $27,987. In the year after the foot ulcer diagnosis, the cost of care for foot ulcer patients had increased to 5.4 times greater than that for the control subjects, suggesting substantial wound-related costs in patients with lower-extremity ulcers.

Some foot ulcers demonstrate poor response to treatment and develop into chronic problems (2). The underlying tissue and/or bone of an unhealed ulcer is at a higher risk for developing an infection or other complications. Lower-extremity ulcers are the major risk factor for amputation; ~84% of the 50,000 lower-extremity amputations performed annually in diabetic individuals alone are preceded by an ulcer (3). Clearly, continued improvement in wound care treatment is likely to benefit patients and may reduce the high costs associated with treatment.

This article focuses on the scope of diabetic lower-extremity ulcers in the Medicare population. The objectives of this study were to *1*) estimate the prevalence of diabetes and lower-extremity ulcers in the Medicare population, *2*) characterize the Medicare population-specific costs of care for lower-extremity ulcer episodes, and *3*) model the potential effect of improved healing rates on Medicare costs.

RESEARCH DESIGN AND METHODS

Data sources

To investigate the prevalence, episodes, and costs of lower-extremity ulcers, we conducted an analysis of Medicare claims data from the 1995 and 1996 Standard Analytic Files (SAF) 5% sample. The Medicare SAF 5% Sample is a scalable database containing the complete claims representative of 5% of the Medicare population. There are 7 separate files that comprise the data set: hospital inpatient, hospital outpatient, physician/supplier, durable medical equipment, skilled nursing facility (SNF), home health care, and hospice. Spending in hospice was negligible and thus not included in this study. Although the Health Care Financing Administration (HCFA) removes patient identifiers from the file to preserve confidentiality, one is able to construct episodes of care for individuals with certain diseases by examining claims for unique individuals using encrypted identifiers. The 5% Sample uses ICD-9-CM (*International Classification of Diseases, Ninth Revision, Clinical Modification*), CPT-4 (*Current Procedural Terminology, Version 4*), and HCPCS (HCFA

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Received for publication 1 February 2000 and accepted in revised form 31 May 2000.

C.H., J.C., and J.K. are paid consultants of and M.J.Z. is employed by the Johnson & Johnson Company.

Abbreviations: CPT-4, *Current Procedural Terminology, Version 4*; ICD-9-CM, *International Classification of Disease, Ninth Revision, Clinical Modification*; HCFA, Health Care Financing Administration; SAF, Standard Analytical Files; SNF, skilled nursing facility.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Common Procedural Coding System) coding, which when combined, are precise enough to suggest that the claims database captures the majority of true charges generated by the illness.

Design

The data analysis used a comprehensive algorithm to identify diabetic individuals with lower-extremity ulcers using combinations of codes for diabetes, wounds, complicating illnesses, and corroborating procedures. This analysis was a further refinement of identification algorithms first introduced by Systemetrics (unpublished data) and Holzer et al. (4). By requiring claims evidence of a procedure to corroborate less precise ulcer diagnosis codes, the patient sample was further narrowed from that which had been studied previously. Table 1 summarizes the process of defining the lower-extremity ulcer population and compares the current study's algorithm with those of selected previous analyses. The diabetic population was identified using corresponding codes in section A of Table 1. The ICD-9-CM methodology used to identify likely cases of diabetes with a lower-extremity ulcer appears in section B of Table 1, and the list of corroborating procedures used in the study is in section C of Table 1. We purposely excluded revascularization procedures from our list of corroborating procedures to avoid the likelihood of including false positives. Ischemic disease is a significant cause of lower-extremity ulcers in this population; however, patients with a revascularization procedure may have received the service independent of their lower-extremity ulcer because of large vessel disease.

The algorithm was first applied to the 1995 SAF for diabetes and lower-extremity ulcers to estimate prevalence and to determine average payment levels. The 1996 Medicare SAF was used to analyze patterns of spending ("episodes") for patients meeting the criteria of the algorithm. An episode is defined as a lower-extremity ulcer claim observed after a 90-day period, during which no claims for ulcers were observed. The episode analysis evaluates the resources and costs incurred for a particular patient in a given period after the appearance of claims for a lower-extremity ulcer. Lower-extremity ulcer spending, by type of service, over an episode was analyzed for *1*) all lower-extremity ulcer patients, *2*) chronic lower-extremity ulcer patients, and *3*) 4 subgroups based on a predefined site of treatment, the presence of complicating factors, treatments, and age.

Lower-extremity ulcer patients were identified by applying the algorithm to the physician file with the rationale that most lower-extremity ulcer patients see physicians. All episodes continued to year's end by definition. With the exception of the physician file, the SAF does not include month and day of service but instead has quarter of discharge. To distribute the data, dates were assigned randomly, with the restriction that a service could not occur before the first lower-extremity ulcer physician date of service in that quarter. Lower-extremity ulcer claims data from the 5 other claims files (less hospice) were collected and aggregated at the patient and episode level in this fashion.

An analysis of episodes defined as "chronic" was also conducted by removing patients with an initial lower-extremity ulcer claim from the analysis who were not followed-up in weeks 2–4 with at least 1 other physician visit (a methodology consistent with the approach used by Holzer et al. [5]). Subgroup analyses were performed for patients with lower-extremity ulcer claims for inpatient hospital use, osteomyelitis, and debridement and by age group ($<$65, 65–74, 75–84, and $\geq$85 years). Of identified lower-extremity ulcer patients, 40% were excluded because they had inpatient hospital use in the first calendar quarter (e.g., began the year already in an episode). Data from those patients were assessed independently. We collected data on amputations, but the number of patients with an amputation was too small to analyze.

A recent meta-analysis of studies (5) found that the baseline healing rate of new ulcers is 31% in 20 weeks (a linear rate of healing up to 31% for the first 20 weeks and no additional healing thereafter). Using the meta-analysis combined with the cost per episode from our study, we devised a simple model to project the effect of improved healing rates on expected lower-extremity ulcer-related Medicare claims. Lower-extremity ulcer costs were assumed to affect unhealed patients only. Using the episode data, we computed weekly cost estimates and combined them with the expected healing rates and determined the cumulative cost of treating ulcers, which was adjusted for healing. The model examined the potential cost impact of improvement in healing from 31 to 40, 50, and 60% of patients.

RESULTS

1995 Medicare claims analysis

Our analysis revealed that aggregate Medicare spending among lower-extremity ulcer patients was $1.45 billion (disease attributable), with patients spending an average of $3,609 per year (Table 2). Over 400,000 Medicare beneficiaries with lower-extremity ulcers were identified, representing 7.3% of diabetic Medicare beneficiaries and 1.1% of all Medicare beneficiaries. The majority of lower-extremity ulcer-related spending was for inpatient hospital stays (74%). Much smaller amounts were spent in the outpatient (11.9%), home health (11.4%), and SNF/hospice setting (4%). Total Medicare expenditures per year for lower-extremity ulcer patients (for any reason or type of care) were on average 3 times higher than that of other Medicare patients ($15,309 vs. $5,226). We did fully explore the excess costs among ulcer patients for non–ulcer-related disease.

1996 Medicare episode analysis of lower-extremity ulcer spending

All lower-extremity ulcer patients. Figure 1 shows the mean cumulative spending over 1 year by 3 types of service. Spending was higher during the early weeks of the episode, averaging $450 in the first week of treatment. Hospital spending represented the majority of paid claims for every week. Spending on physician care in the first week accounted for 32% ($110) of spending over the course of the episode, but dropped sharply by the second week ($22). This pattern of decline in spending over the course of the episode held for all subgroups analyzed, although the speed of the decline and distribution of spending by type of service varied by subgroup.

Chronic lower-extremity ulcer patients. Examination of the length of episodes revealed that 30% of episodes in all patients were actually $<$2 weeks in duration and usually a single encounter. Another 30% met our definition for chronic patients. The chronic group had a very similar pattern of use to the overall study population in terms of the distribution of spending across both the episode and service types.

Costs for chronic patients were considerably higher than that for all patients: $6,278 vs. $3,999, respectively (1996

Table 1—*Identification algorithms for diabetes*

	ICD-9-CM or CPT-4*	Systemetrics	Holzer et al. (4)	Present study
Section A: Diabetes diagnosis				
Conditions specific to diabetes				
Diabetes, unspecified	250	—	—	✓
Other diagnoses for diabetes	250.0–250.9	✓	✓	✓
Hypoglycemic coma	251.0	—	—	✓
Other conditions or procedures related to diabetes				
Diabetic retinopathy	362.01–362.02	✓	✓	✓
Use of insulin		✓	—	—
Diabetic polyneuropathy	357.2	✓	✓	—
Potential diabetes as evidenced by repeated tests				
Insulin chemistry, toxicology, or antibody	83,525–83,526, 86,337–86,338	✓	—	—
HbA_{1c}	83,036	✓	—	—
Abnormal GTT	790.2	✓	—	—
Glycosuria, proteinuria, and ketonuria	790.2, 791, 791.5	✓	—	—
Exclusion criteria				
Hyperglycemia NOS	790.6	✓	—	
Neonatal diabetes	775.1–775.0	✓	—	
Abnormal GTT (isolated claim)	790.2	✓	—	
Gestational diabetes	648.0	✓	—	
Section B: Lower-extremity ulcer diagnosis				
Ulcer of lower limbs, other skin ulcer, excluding decubitus	707.1, 707.8–707.9	✓	✓	✓
Carbuncle and furancle of foot	680.7*	✓†	—	✓†
Cellulitis and abcess of toe or foot	681.1, 681.9*, 682.7*	✓†	✓	✓†
Other local infection of skin and subcutaneous tissue	686.0–686.1, 686.8–686.9	✓†		
Gangrene	785.4*	✓†	✓	✓†
Infectious myositis, myalgia and myositis, unspecified	728, 729.1	✓†		
Osteomyelitis	730.06–730.09, 730.16–730.19*, 730.26–730.29*	✓†	✓	✓†
Periostitis without mention of osteomyelitis	730.36–730.39	✓†		
Other infection involving bone in diseases classified elsewhere	730.86–730.89, 730.96–730.99	✓†		
Fascitis	729.4	✓†		
Section C: Corroborating procedures				
Simple repair of superficial wound	12,001–12,002, 12,004–12,007	✓	—	✓
Debridement	11,040–11,044	✓	—	✓
Lower-extremity radiographic techniques	73,620–73,630, 73,650–76,660	✓	—	✓
Angioscopy; arteriography; angiography	75,710, 75,716	✓	—	✓
Lower-extremity CAT or MRI scanning	73,700–73,702, 73,720–73,721	✓	—	✓
Incision, arthrotomy of ankle/lower leg	27,600–27,604, 27,607–27,610, 29,897–29,898	✓	—	
Incision or excision of foot	28,001–28,008, 28,111–28,160	✓	—	✓
Revascularization or bypass surgery	38.08, 38.09, 38.48, 38.49	✓	—	—
Unna boot application	29,540, 29,550, 29,580	—	—	✓
Amputation/resection:				
Foot	84.10–84.12, 28,800–28,825	✓	—	✓
Ankle/leg	84.13–84.15, 27,880–27,889	✓	—	✓
Knee and above	84.16–84.17, 27,590–27,598	✓	—	✓
Late amputation stump complication	997.62, 997.69, 997.60, 997.61	✓	—	✓
Arthropathy	28,020, 28,024	✓	—	—
Synovectomy	28,070, 28,072, 28,086, 28,088	✓	—	—
Faciectomy	28,060	✓	—	—

*ICD-9-CM was used for sections A and B, and ICD-9-CM or CPT-4 was used for section C ; †methodology required a corroborating procedure code. GTT, glucose tolerance test; NOS, not otherwise specified; CAT, computerized axial tomography; MRI, magnetic resonance imaging.

data). Weekly spending during chronic episodes actually peaked ($600) in week 2, opposed to week 1, among all lower-extremity ulcer patients. Weekly spending remained above $200 for the first 11 weeks—3 weeks longer than that among all patients. The mix of services was very similar, with chronic patients demonstrating a comparable proportion of inpatient spending (73.6 vs. 75.7%) and physician spending (9.3 vs. 8.2%) compared with the total group.

Table 2—*Key findings from 1995 Medicare claims analysis*

Medicare spending	Lower-extremity ulcer-related Medicare spending among lower-extremity ulcer patients	All Medicare spending among lower-extremity ulcer patients	All Medicare spending among all Medicare patients
Aggregate spending	$1.45 billion	$6.16 billion	$159.0 billion
Average spending per patient	$3,609	$15,309	$5,226
Spending distribution by service type			
Inpatient hospital (%)	73.7	52.5	49.7
Physician/supplier/DME and outpatient hospital (%)	10.9	27.2	35.9
Home health (%)	11.4	14.7	9.5
SNF and hospice (%)	4.0	5.6	4.9

There were a total of 402,280 Medicare beneficiaries with lower-extremity ulcers. The prevalence of lower-extremity ulcer among all Medicare beneficiaries is 1.1%, and the prevalence among diabetic Medicare beneficiaries is 7.3%. DME, durable medical equipment.

Lower-extremity ulcer subgroups. *Patients with lower-extremity ulcer-related inpatient use.* Nearly 24% of all lower-extremity ulcer patients and 28% of chronic patients had lower-extremity ulcer-related inpatient care. The subgroup of patients with inpatient claims was the most expensive, with per episode costs of $14,641 for all patients and $17,096 for chronic patients. Weekly spending for these patients again began very high (mean weekly claims were $1,580 and $1,590 in the first 2 weeks, respectively). Claims cost decreased from week 3 to week 11, but weekly spending remained above $200 through week 15. For chronic patients, these numbers were somewhat higher but with similar patterns. Weekly spending was $1,629 and $1,731 in the first 2 weeks, stayed above $1,000 for 6 weeks, and remained above $200 through week 18.

Patients with osteomyelitis. Osteomylelitis occurred in 7% of all lower-extremity ulcer patients and in 11% of chronic patients. This subgroup was the second most expensive identified ($8,942 for all, $13,758 for chronic patients). Although inpatient spending decreased over the course of the episode, physician spending later in the episode was nearly as high as in the beginning. Although overall episode spending for this group was much higher than for all lower-extremity ulcer patients, the spending distribution by type of service was similar to that of all lower-extremity ulcer patients.

Patients with debridement. Debridement was a relatively common procedure among lower-extremity ulcer patients, with just over one-third of all patients having claims for debridement. Nearly one-half of the chronic patients had debridement claims. Treatment for patients with a debridement was only somewhat more expensive than average costs ($5,064 vs. the overall average of $3,999 [1996 data)] or $7,104 vs. an average of $6,278 for chronic patients).

Patients by age-group. Spending consistently decreased with an increase in age, with the most expensive group compromising those patients <65 years of age ($5,756). The same was true of spending in chronic patients, with $9,404 representing the average episode of spending for the under 65 group. Episode spending dropped to $4,327 for the 65–74 years age-group, $3,412 for the 75–84 years age-group, and $2,943 for the ≥85 years age-group ($4,509 in the chronic ≥85 years age-group).

Subacute services accounted for a much higher proportion of spending among the 75–84 and ≥85 years age-groups (18.2 and 18.4%, respectively) compared with the <65 and 65–74 years age-groups (8.7 and 13.1%, respectively). This trend was also reflected in the chronic population, because these services constituted a much higher share of spending for the 75–84 years and ≥85+ years age-groups (20.1 and 21.5% of lower-extremity

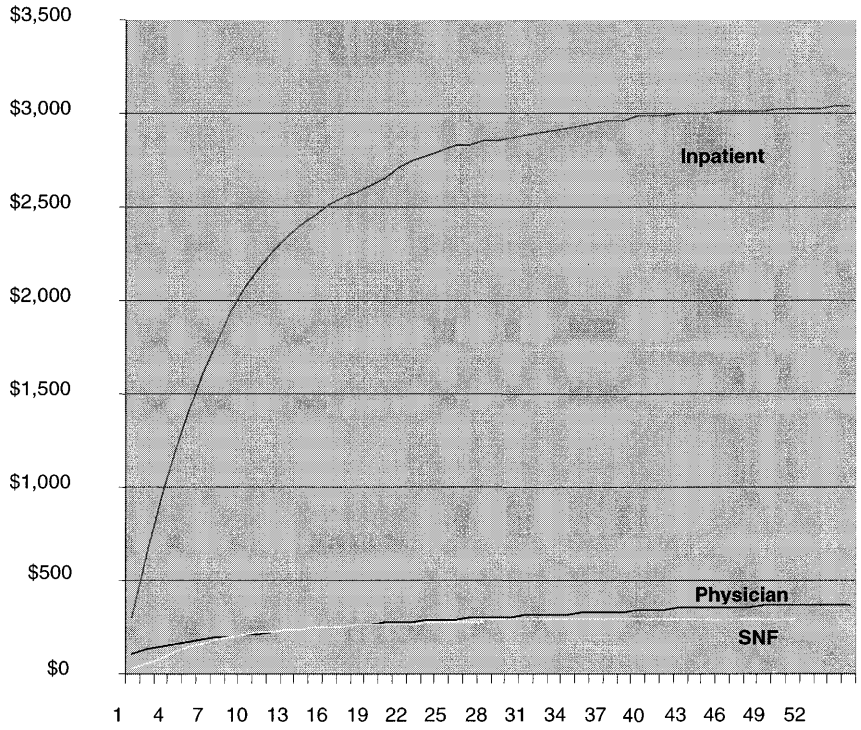

Figure 1—*Cumulative spending for all lower-extremity ulcer patients.*

ulcer spending, respectively) than that for the <65 and 65–74 years age-groups (11.4 and 12.1%, respectively).

Patients excluded from episode analysis. We examined the records of beneficiaries excluded from the episode analysis because they had a lower-extremity ulcer episode already in process before the beginning of the calendar year. This group had dramatically lower inpatient expenditures than individuals included in the episode analysis ($878 vs. $2,985, respectively). This is consistent with findings from the preceding analyses in which the majority of spending was found to occur at the beginning of the episode.

Claims model for healing rates at 20 weeks. Assuming treatment costs decrease as healing rates improve, the results of the simple claims projection model for different rates of healing were computed. Baseline healing in this population was assumed to be 31%, with baseline costs set equal to the cost of claims already discussed previously for all patients ($3,999). For this analysis, it was assumed that costs were accrued by patients having unhealed ulcers. Patient costs were followed for a maximum of 9 months.

By holding the weekly cost of claims for caring for an unhealed ulcer constant and by increasing the number of healed patients to 40% at 20 weeks, claims would be projected to decrease from $3,999 to $3,810. There are additional decreases in claims corresponding to higher rates of wound healing (improving to a 50% healing rate would reduce costs to $3,604 and a 60% healing rate would lower costs to $3,399). Total expected reductions in claims ranged from just under $200 to $700, depending on the assumptions used.

CONCLUSIONS

— A few limitations and assumptions were used in our study design. For example, building episodes across all 7 claims files would have resulted in added complexity; therefore, we chose to identify lower-extremity ulcer patients based on physician/supplier files only. However, we are confident that this methodology captured most of our target patients because most patients have physicians. In addition, an episode was defined as a lower-extremity ulcer claim observed after a 90-day period, during which no claims for ulcers were observed. This interval was selected not only to match Medicare's quarterly inpatient data reporting but also to represent a reasonable maximal follow-up period.

Important generalizations can be made from our analyses. Spending, driven by inpatient use, is most concentrated in the beginning of the episode. The setting of care for >25% of patients with a lower-extremity ulcer episode included an inpatient institution (e.g., hospitals and SNFs). Management of lower-extremity ulcers in these settings creates high costs, with an average cost per episode of $14,420 for individuals hospitalized.

We hypothesize that the heavy use of inpatient services and the high instance of hospitalization as the initial claim for an ulcer episode indicate that outpatient management can be improved. Medicare spending may be high for these individuals with lower-extremity ulcers because inadequate outpatient treatment results in intermittent acute treatment. It is probable that more regular care for these chronic wounds might lead to fewer instances of high acute care costs and create better outcomes.

Variations in costs among the different subpopulations analyzed may be attributable to many factors. In looking at discrepancies across age-groups, there is a trend of decreased spending with increased age. Because people <65 years of age receive Medicare because of disability, these higher costs are a direct result of the younger cohort being sicker than their older counterparts. Additionally, we can speculate that either less aggressive or less expensive treatments are offered to older patients. Our data seems to support the latter notion because it suggests that among the oldest patients, subacute services (i.e., SNFs and home health) may substitute for hospital services.

Lower-extremity ulcers are often in part the result of diabetic neuropathy, a major complication of diabetes. Although lower-extremity ulcers are treatable, many individuals delay in seeking professional care because of an inability to sense that a wound has developed. Furthermore, when patients finally do seek medical attention, treatments are not always entirely effective, sometimes preventing the ulcer from healing quickly or properly. Although our analysis shows that significant numbers of lower-extremity ulcer patients appear to develop complications that require specialty care, only 30% of patients had more than 1 visit for lower-extremity ulcer-related care in their first month of treatment for the episode. Clearly, a single physician encounter in the first month of care is not consistent with optimal wound care practice.

The lack of follow-up may be partly attributable to noncompliant patients who have had lower-extremity ulcers in the past and may be skeptical of the medical care system's ability to solve their problems. In addition, whereas many patients seem to have very short episodes, another subset of lower-extremity ulcer patients seem to present early in their episode directly to the inpatient setting. This phenomenon again leads to questions about the quality of outpatient foot and wound care received previously for this condition.

With respect to the healing rates for lower-extremity ulcers, 31% represents the healing noted for patients receiving standard wound care either as a control subject in a clinical trial or as part of an observational study. Medicare patients are likely to fail to achieve even these low rates of healing, so the potential for better outcomes and lower costs might be even greater in this population given better healing. There are many reasons why some wounds may not heal; however, we suspect that many patients are not receiving a program of good wound care aimed at healing chronic wounds. Often, patients are not educated or informed about the cause of their condition or what may be done to prevent it.

Lower-extremity ulcers significantly affect patient resource use and costs, especially among diabetic Medicare beneficiaries. People with lower-extremity ulcers incur costs at a much higher rate than an average Medicare patient. Some of these costs are due to treatment of other conditions associated with diabetes. However, a majority of the excess cost (more than one-third) is attributable to ulcer-related services ($3,609 average expenditure for ulcer-related costs divided by the difference in average total spending of $15,309 minus $5,226 for all other Medicare patients). Ulcer treatment is important, and good wound care is expected to both decrease time to heal and increase rates of healing, which in turn would reduce cost of care. Emerging wound care technology and practice guidelines that improve current wound care treatments are likely to benefit patient outcomes, and they may decrease the high costs associated with repeated and extensive lower-extremity ulcer treatment.

Acknowledgments — This study was financed in part by Johnson & Johnson.

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