JRRD Volume 43, Number 2, Pages 227–238
March/April 2006
Journal of Rehabilitation Research & Development

Personal and treatment factors associated with foot self-care among veterans with diabetes

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Abstract—We developed and validated a survey of foot self-care education and behaviors in 772 diabetic patients with high-risk feet at eight Department of Veterans Affairs medical centers. Principal components analysis identified six subscales with satisfactory internal consistency: basic foot-care education, extended foot-care education, basic professional foot care, extended professional foot care, basic foot self-care, and extended foot self-care (alpha = 0.77–0.91). Despite high illness burden, adherence to foot self-care recommendations was less than optimal; only 32.2% of participants reported looking at the bottom of their feet daily. Independent predictors of greater adherence to basic foot self-care practices included African-American or Hispanic background, perceived neuropathy, foot ulcers in the last year, prior amputation (beta = 0.08–0.12, $p < 0.04$–0.001), and provision of greater basic and extended education (beta = 0.16, $p < 0.004$, and beta = 0.15, $p < 0.007$). The survey subscales can now be used for evaluating foot care and education needs for persons with high-risk feet.

Key words: diabetes, diabetic foot, healthcare quality, health education, minority, outcome assessment, podiatry, primary healthcare, self-care, veterans.

INTRODUCTION

Lower-limb complications impose a serious burden on persons with diabetes and affect 15 percent of individuals during their lifetime [1]. Diabetes-related foot ulcers and amputations lead to increased risk of hospitalization, infection, amputation, lowered quality of life, and mortality as well as high medical and societal costs [2–6]. Risk factors for lower-limb complications include loss of sensation, peripheral arterial disease, and anatomic deformities [7–8]. These risk factors are easily detected in primary care by a simple screening examination [9–10]. Recommended self-care practices include regular inspection of feet, selection of appropriate footwear, and avoidance of risks such as sharp instruments and abrasives [11–12]. Well-coordinated preventive foot care can reduce diabetes-related lower-limb complications [13–15]. Consensus on methods of care for the diabetic foot is emerging internationally, and cost-effectiveness projections indicate that guideline-based

Abbreviations: BMI = body mass index, IRB = institutional review board, MCMC = Markov Chain Monte Carlo, MI = multiple imputation, SAS® = Statistical Analysis Software, VA = Department of Veterans Affairs, VAMC = VA medical center.

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DOI: 10.1682/JRRD.2005.06.0106

treatment for diabetic foot problems may improve clinical outcomes and decrease total costs [16].

The U.S. Government has established a national goal of a 55 percent decline in the rate of diabetic amputation, with concomitant reductions in racial disparities, as described in *Healthy People 2010* [17]. In the aging population served by the Department of Veterans Affairs (VA), the burden from diabetic foot ulcers and amputations is particularly heavy [18]. The VA has made prevention of diabetes-related foot complications a priority, with policy directives mandating multidisciplinary foot care at each VA medical center (VAMC) [19].

Decreased lower-limb morbidity will require improved quality of foot care, including earlier recognition of patients at risk (screening), extensive patient education for promotion of recommended foot self-care practices, and improved access to relevant care [20]. Monitoring of the quality of foot care is needed for identification of opportunities to improve the processes that foster maintenance of healthy feet. Heretofore, rates of simple foot screening have been ascertained in certain states through the Behavioral Risk Factor Surveillance Survey [21] and in VA systems through chart abstraction [22]. However, although previously validated surveys have included items related to foot self-care [23], no surveys specific to foot care have been available for assessment of the quality of care provided to or the quality of foot self-care by patients at high risk for foot complications. A more specific survey could lead to improved foot care.

The present study describes the development, internal reliability, and predictive validity of a survey of the quality of foot-care services and self-care practices among veterans with diabetes and high-risk foot conditions. Internal structure and reliability will be discussed first. A multivariate model was used for evaluation of predictive relationships between foot-care services and foot self-care, including demographic birth factors (age and race/ethnicity) and factors that reflect history and enduring conditions (education, obesity, neuropathy, prior amputation, history of foot ulcers). Results of this study will increase the understanding of educational, service, and self-care needs of people with diabetes.

METHODS

Survey Development

To construct the survey, we searched MEDLINE and contacted experts to evaluate existing surveys. Health transitions, physical function, and overall health were assessed with the use of items from the Short Form-36 and the Medical Outcomes Study [24]. Relevant questions on the topics of risk factors, self-care behaviors, and education were taken from the Diabetes Patient Outcome Research Team Survey [25], an observational trial of diabetes care [12], and the VA's Diabetes Quality Improvement Project Survey [26]. We also developed questions on these topics and on provision of foot care by professionals, including screening, routine foot care, and provision of durable equipment and footwear. In the past, quality indicators have been based on basic care, education, and self-care, so our priority was assessment of these indicators. We also included more specialized, extended items to explore their potential utility.

Study team members and consultants, including clinical experts in foot care, survey design experts, and psychometricians, reviewed survey items for question structure and clarity. During pilot testing, patient focus groups reviewed drafts of the questionnaire for clarity and difficulty. The final survey was machine-readable, although detailed checking and corrections were still required for improvement of data quality.

Sampling and Data Collection

Eight VAMCs obtained institutional review board (IRB) approval and fielded the survey. A diabetes registry for veterans at each facility was constructed according to the health employer data and information set criteria for diabetes (at least two outpatient contacts or at least one inpatient admission with a diabetes-specific International Classification of Diseases, Ninth Revision, code [i.e., 250.0–250.9, 357.2, 362.0, 362.01, 362.02, or 366.41]) [27]. Additional cases were identified through records of prescriptions for insulin or oral agents. High-risk patients were identified by selection of cases with a diagnosis of peripheral neuropathy, peripheral arterial disease, significant structural abnormalities, prior foot ulcer, or amputation of the foot. These cases comprised 17 percent of all patients with diabetes in the registry. A target random sample of 230 patients was selected from each site.

The survey was administered by mail with the use of a modified version of Dillman's total design method [28].

The survey was accompanied by a cover letter that provided information regarding the purpose of the study and the importance of the subject's response to the success and usefulness of the study. Nonrespondents received a reminder letter and follow-up survey 4 weeks after the initial mailing.

Scaling Analyses

We performed scaling analyses on survey items to ensure that they met basic standards for reliability and internal validity [29]. These analyses were performed on the corrected data set with Statistical Package for the Social Sciences 11.0 (SPSS Inc, Chicago, Illinois) with the Factor and Reliability routines. Items and subscales were examined for mean, variability, distribution shape, and possible ceiling or floor effects that might interfere with conventional analysis techniques.

We performed a principal components analysis on groups of related ratings (e.g., items describing professional foot care, foot-care education, and foot self-care) with standard Varimax rotation to identify subgroups of items that might comprise a factor or subscale. Cronbach α was computed for evaluation of the internal reliability or homogeneity of potential additive subscales. We examined correlation and covariance matrices to identify individual items that might degrade Cronbach α. After dropping items, we reanalyzed the improved subscales.

Missing Data

Missing responses are ubiquitous in survey research. Most returned surveys in the current study had missing data. The median percentages missing were 7.4 percent for individual foot self-care items, 9.5 percent for education items, and 7.8 percent for professional foot-care items (excluding "not applicable" responses for care not received at VA or no care received). Methods of imputation have been developed and refined in recent years [30]. We used multiple imputation (MI) procedures because estimates from simple imputation provide artificially reduced estimates of error variance and/or unstable parameter estimates [30–31]. Markov Chain Monte Carlo (MCMC) techniques were used because the missing data pattern did not follow a clear rule (e.g., interrelationships of missing data were not strictly monotonic, regression estimation was not clearly justified). MCMC assumes that data are missing at random but not necessarily completely at random [32]. An MI data set with five imputed values was created with Statistical Analysis Software (SAS®) 8.2 (SAS Institute Inc, Cary, North Carolina) "PROC MI;" SAS® 8.2 "MI ANALYZE" then computed statistical estimates [33]. We compared results of the MI analysis with listwise and pairwise deletion analyses, which provided results that were similar to those presented here (e.g., strong predictors in MI tended to be strong in listwise and/or pairwise analyses) but were different in detail. We report the MI analysis because it avoids the gross loss of sample size and information that older listwise deletion procedures would produce but does not bias results; thus, it is a more robust and justifiable method.

Predictors of Foot Self-Care

We used both bivariate and multivariate analyses to identify factors associated with foot self-care behaviors. A number of factors were hypothesized a priori as predictors of foot self-care:

- Demographic birth factors: age, race/ethnicity (African American or Hispanic versus Caucasian/other).
- Items reflecting long-term patient history, foot disease, and risk factors: years of schooling, body mass index (BMI), prior amputation, ulcer in the last 12 months, and neuropathy symptoms that reflect a slowly developing pathology.
- Factors describing the nature or extent of more recent care, including basic and extended foot-care education and basic and extended professional foot care. Items comprising these factors were identified with the preceding scaling analysis procedures and are listed in the Results. The survey is available from Dr. Johnston.

Correlations between these factors and foot self-care scales were first tested with simple Pearson correlations (r). Multiple statistical testing increases the chance of Type II error. We used the Benjamini-Hochberg method of controlling for the false discovery rate for multiple comparisons [34].

We used multiple regression analysis (β) to obtain an overview of predictors and identify variables that correlate with foot self-care independent of other predictors [32,35]. This analysis provides a more parsimonious model than a list of bivariate correlations. Original multiple regression analyses were hierarchical. The hypothesized predictors were ordered into the three groups just listed based on temporal priority and were entered in that order. Such hierarchical entry order can elucidate possible causal relationships and clarify effects of multicolinearity [32]. In this study, however, the coefficients that

resulted at each regression-analysis step were similar to those in the final model, so we report only the results of the final step that incorporates all a priori predictors.

While focused analysis requires specification of predictors a priori, the possibility always exists that important factors have been left out of an a priori analysis. To investigate this possibility, we explored the correlations of additional variables thought to be possible predictors post hoc. Like the a priori variables, these additional variables are self-report items asked in the survey. The nine variables chosen for this post hoc analysis are described in the "Results" section. Given the large number of predictors, results of these post hoc analyses should be interpreted as suggestive rather than confirmatory; the purpose of this analysis was to assist future research.

RESULTS

Sample Response Rate and Characteristics

The original roster for the eight operational VAMC sites totaled 1,624 diabetic patients (excluding patients reported as deceased or whose diabetes could not be confirmed). Of the 815 returned surveys, 43 were unusable because most data were missing. Usable surveys were returned by 772 individuals for a 47.5 percent response rate.

Demographic, illness, and foot-risk characteristics of the population are described in **Table 1**. Respondents were almost entirely male. The majority were Caucasian seniors (average age 67 years). The percentage of African Americans (12.3%) was very similar to that in the general U.S. population, while the percentage of Hispanics (16.5%) was higher [36]. Respondents had long-standing diabetes with a high disease burden and frequent comorbid conditions. The great majority (67.4% to 83.4% depending on item) reported personally perceived symptoms of foot neuropathy. About two-thirds reported that their health was fair or poor. Amputations and ulceration were frequent. Although about three-quarters reported symptoms of claudication, 94 percent were ambulatory.

Table 1.
Demographic, illness burden, and foot-risk characteristics of participating veterans with diabetes (n = 558 to 772). Values shown are % unless otherwise indicated.

Characteristic	%
Demographic Descriptors	
Age, mean ± SD (yr)	67.0 ± 10.3
Male	98.8
Current smoker	24.2
Race/Ethnicity	
African American (non-Hispanic)	12.3
Caucasian	77.2
Other	10.5
Hispanic	16.5
Education, median (yr)	12.0
Income, median ($)	10,001 to 15,000
Illness Burden and Foot-Risk Indicators	
Nerve damage in feet or legs	47.3
Diabetes duration, mean ± SD (yr)	16.0 ± 12.5
Problems with circulation in legs	74.2
Ulcers in last 12 months	18.3
Lower-limb amputation: nontraumatic	10.0
Lower-limb amputation: traumatic/military	3.3
Neuropathy Symptoms: Always/Sometimes	
Numbness in feet	83.4
Tingling sensation in feet	82.1
Burning pain in feet	67.4
General Health and Comorbid Conditions	
Heart attack	33.8
Congestive heart failure	24.5
Peripheral bypass surgery	12.3
History of depression	33.2
Body mass index, mean ± SD	30.4 ± 6.4
Health Indicators	
General health rating: fair/poor	64.0
Health compared with last year: same/worse	77.0

SD = standard deviation.

Foot Self-Care, Foot-Care Education, and Professional Foot Care

Patient-reported frequencies of foot self-care, education, and professional care are described in **Table 2**. Items are grouped according to results of scaling analyses.

The survey included 14 items about the frequency of foot self-care activities in the past 4 weeks; responses were scored on a scale from 1 (not at all) to 5 (daily). Respondents reported performing substantial, but still suboptimal, foot self-care activities. About one-half (51.4%) reported looking at the bottom of their feet more than once a week, but only 32.2 percent reported daily checks for cuts, calluses, or sores. The mean score of 3.60 for basic foot self-care activities implies that respondents did these activities between once (score of 3) and several times (score of 4) each week. Extended self-care items were usually performed only about once or twice each month (score of 2). Barriers to foot self-care (data not shown) included inability to see the bottom of the feet

Table 2.
Reports of basic and extended foot self-care (n = 705 to 728), foot-care education (n = 668 to 711), and professional foot care (n = 166 to 511): Factor analysis subscales and items.

Foot-Care Domain and Survey Question	Factors and Items	%
Foot Self-Care: In the past 4 weeks, how often have you (item)? (Values shown are % of participants who reported performance of items >1 a week.)	**Basic**	
	Looked at bottom of feet	51.4
	Checked between toes	56.6
	Washed feet	88.2
	Tested water temperature	53.5
	Dried between toes	81.1
	Checked shoes	47.9
	Mean score ± SD*	3.60 ± 0.98
	Extended	
	Soaked feet 10 min	22.0
	Used lubricants on feet	44.2
	Filed own calluses	7.3
	Trimmed own nails	3.9
	Mean score ± SD*	2.14 ± 0.86
Foot-Care Education: How much have you been taught about (item)? (Values shown are % of participants who reported receipt of enough education.)	**Basic**	
	Checking feet regularly	49.5
	Keeping feet clean	69.6
	Choosing proper shoes	42.9
	Always wearing shoes/slippers	57.2
	Keeping skin moist	39.7
	Mean score ± SD†	3.07 ± 0.85
	Extended	
	Use Mirror to see bottom of feet	23.1
	Avoid very hot and very cold	46.3
	Gently filing calluses	30.6
	Cutting nails	38.3
	Cutting corns or calluses	42.2
	Not using drugstore chemicals	39.1
	When to call	43.3
	Whom to call	45.1
	Mean score ± SD†	2.77 ± 1.29
Professional Foot Care: During the last 12 months, did the professional you saw for your foot care at the VA (item)? (Values shown are % of participants who reported that professional performed items at least once in past year.)	**Basic**	
	Ask about numbness	88.3
	Look at feet with socks off	95.9
	Examine tops/bottoms of feet	93.6
	Look between toes	87.9
	Test feeling in feet	73.0
	Mean score ± SD ‡	2.45 ± 0.54
	Extended	
	Shave calluses	26.8
	Trim toenails	54.9
	Look at shoes	59.2
	Describe how to select proper shoes	44.6
	Mean score ± SD ‡	1.75 ± 0.65

Note: Percentages based on valid participant responses.
*Scale: 1 (not at all), 2 (once or twice a month), 3 (once a week), 4 (several times each week), 5 (daily).
†Scale: 1 (nothing), 2 (a little bit), 3 (some but would like more), 4 (enough).
‡Scale: 1 (no), 2 (once), 3 (more than once).
SD = standard deviation.

(53%) because of joint problems (77%), excess weight (42%), decreased vision (34%), or lack of a mirror (13%) or footstool (10%).

Thirteen survey items assessed amount of foot-care education; responses were scored on a scale from 1 (nothing) to 4 (enough). Respondents typically reported that they had received "some but would like more" basic foot-care education (mean score = 3.07). About half (49.5%) reported that they had received "enough" education on checking feet regularly, and most had also received "enough" education on keeping feet clean (69.6%) and on always wearing shoes/slippers (57.2%). The majority, however, reported that they had not received enough education on the other 10 items, including care for nails, calluses, or corns; keeping skin moist; drugstore chemicals; and using a mirror to see the foot. Many reported that they had not received education on when (29.3%) or whom (28.7%) to call if they had a foot ulcer, but only 18 percent rated lack of knowledge as the barrier to foot self-care.

The majority of respondents (69.1%) received VA foot care exclusively. Another 15.2 percent received non-VA foot care or mixed VA/non-VA foot care, and 15.5 percent reported no foot care in the past year.

The frequency of professional foot care in the last 12 months was assessed by nine items; responses were scored on a scale from 1 (no) to 3 (more than once). Basic professional foot-care services were delivered at high rates, although room for improvement was evident: 27 percent, for instance, reported that they had not had a test for feeling (with a "tuning fork or a bendable nylon wire on a handle") in their feet during the last 12 months. Extended professional (largely podiatric) foot care was delivered much less frequently than basic professional foot care.

A minority of respondents (20%) expressed at least slight dissatisfaction with their foot care, and 36 percent indicated that they could not coordinate foot care with diabetes-care visits (data not shown).

Scaling Analyses

Results of principal components and internal reliability analyses of foot-care items are reported in **Table 3**. Each of the three foot-care domains (self-care, education, and professional care) was divided by principal components analysis into two subscales: basic (more frequent, easier items) and extended (less frequent items that require more training, effort, or specialization). Thus, a total of six foot-care subscales emerged from principal components analyses, as described below.

Principal components analysis of the 14 items on foot self-care identified a basic foot self-care subscale (6 items) and an extended foot self-care subscale (4 items). Internal consistency for the basic foot self-care subscale—our primary dependent variable—was acceptable (0.77). For the extended foot self-care subscale, internal consistency was weak (0.55). The number of items in this subscale, however, was small, and because extended foot self-care may be necessary for improving foot self-care in some patients, we chose to continue exploratory analyses of these items.

Principal components analysis of the 13 foot-care education items identified a basic foot-care education subscale (5 items) and an extended foot-care education

Table 3.
Summary of factor analyses and internal consistency of foot-care subscales.

Foot-Care Domain (No. Original Items)	Component Items (No.)*	Component Loadings†	Eigenvalue	Variance (%)	Cronbach α
Foot Self-Care (14 Items)‡					
Basic	6	0.46–0.83	3.59	25.6	0.77
Extended	4	0.40–0.74	1.42	10.2	0.55
Foot-Care Education (13 Items)					
Basic	5	0.56–0.84	1.14	8.8	0.84
Extended	8	0.64–0.81	7.05	54.2	0.91
Professional Foot Care (9 Items)					
Basic	5	0.62–0.89	4.23	47.0	0.85
Extended	4	0.67–0.78	1.38	15.3	0.75

*Principal components analysis with Varimax rotation applied to relevant item set from original survey. Rotated loading > 0.40 for selected items; if item loaded > 0.40 on two components, it was placed in component with larger loading.
†Range is given for items selected for investigation as summary subscales. Minimum loading is 0.40.
‡Four items (two on walking barefoot and two on wearing stockings/shoes) were not used because they were poorly related to other variables in set.

subscale (8 items). Internal consistency for both subscales was very good.

Principal components analysis of the nine professional foot-care items identified a basic professional foot-care subscale (five basic items that primary care practitioners commonly perform) and an extended professional foot-care subscale (four items that are commonly provided in a specialty clinic or by a podiatrist). Internal consistency for the subscales was acceptable given the small number of items.

Predictors of Foot Self-Care

Our main a priori hypotheses posited 12 variables as predictors of basic foot self-care. These predictors are displayed in the first column of **Table 4**. Nine variables had nominally significant bivariate correlations with basic foot self-care, eight of which had truly significant correlations with basic foot self-care when we controlled for the impact of testing multiple hypotheses. (When we applied the Benjamini-Hochberg method [34] and ordered the significance levels of the 12 variables, years of schooling did not reach a sufficient level of statistical significance to keep the long-term false discovery rate below 0.05.) Patient factors significantly associated with greater basic foot self-care then included lesser age, African-American background, greater education, greater foot neuropathy, and a foot ulcer in the last year. Greater foot education and basic professional foot care were also associated with better foot self-care. BMI was uncorrelated with foot self-care.

Multiple regression analysis commonly provides a parsimonious overview of independent predictive factors. African-American and Hispanic veterans reported performing somewhat more foot self-care than other (almost entirely Caucasian) veterans, independent of other factors. Years of schooling dropped out as a significant independent predictor, but after we controlled for other predictors, amputation emerged as a significant predictor of basic foot self-care. Symptoms of foot neuropathy, foot ulcer in the last 12 months, basic and extended education, and basic (but not extended) professional care were independently related to basic foot self-care. The omnibus predictive model was clearly significant ($p < 0.001$).

Extended foot self-care practices were somewhat less predictable than basic foot self-care practices (**Table 4**), as one might expect from their lesser variation and internal homogeneity. The significant predictors of extended

Table 4.
Bivariate and multiple imputation (MI) regression analyses of basic and extended foot self-care predictors.

Predictor	Basic Foot Self-Care			Extended Foot Self-Care		
	Bivariate Correlation		MI Regression	Bivariate Correlation		MI Regression
	n	*r*	β	*n*	*r*	β
Age	629	**–0.16***	–0.08	632	–0.03	0.08
African American	653	**0.12**†	**0.10**†	650	**0.19***	**0.19***
Hispanic	653	0.07	**0.12***	650	0.70	**0.17***
Years of Schooling	625	**0.08**‡	0.06	624	0.05	0.05
Body Mass Index	538	–0.05	–0.04	532	0.03	0.06
Prior Lower-Limb Amputation: Nontraumatic	635	–0.03	**–0.08**‡	630	0.01	–0.01
Foot Neuropathy Symptoms	552	**0.20***	**0.11**†	559	**0.15***	**0.08**‡
Foot Ulcers Within 12 Months	603	**0.16***	**0.10**†	612	**0.18***	**0.14***
Basic Education Factor	629	**0.27***	**0.16**†	626	**0.17***	**0.15**†
Extended Education Factor	629	**0.27***	**0.15**†	626	**0.17***	0.04
Basic Professional Care	457	**0.25***	**0.14**†	454	**0.20***	0.07
Extended Professional Care	447	**0.13**‡	–0.05	450	**0.23***	0.06
Model Summary, Adjusted R^2 (F, p-value)	0.17–0.19 (10.9, $p < 0.001$)			0.14–0.15 (9.1, $p < 0.001$)		

Note: Probabilities < 0.05 are bolded.
* $p < 0.001$.
† $p < 0.01$.
‡ $p < 0.05$.

foot self-care identified in bivariate and multivariate analyses were the same as those for basic foot self-care, except that fewer variables attained statistical significance. Again, African-American and Hispanic veterans tended to engage in more extended self-care, as did veterans with foot ulcers in the last year and perhaps those with greater perceptible neuropathy. Extended foot self-care was also related to basic foot-care education but had no significant independent relationship to extended foot-care education or to either basic or extended professional foot-care.

Post hoc analyses of additional possible predictors, beyond those already examined, are presented in **Table 5**. Items are yes/no dichotomies unless otherwise noted. Six variables had nominally significant (bivariate) correlations with basic foot self-care. Three items—ability to complete survey without help, ability to see the bottom of own feet, and no drug or alcohol problem—added to the predictability of basic self-care in preceding multiple regressions. Four factors had nominally significant relationships with extended foot self-care, but only one of these—number of visits to a primary care practitioner for foot care—added to predictability of extended foot self-care beyond the a priori set of variables. Six additional factors (general health, change in health compared with 12 months ago, rated timeliness of care, told by doctor had heart attack, told by doctor had stroke, and told by doctor had depression) were tested but had nonsignificant and tiny correlations or β values with foot self-care (median = 0.04, range = 0.01–0.12, data not shown). Future research on foot self-care should test the strongest predictors found in this study (e.g., assistance needs in survey completion, inability to see soles of feet, perceived provider involvement).

DISCUSSION

Foot-care education is widely recommended for persons with diabetes [11–13,20], and items related to foot care have been included in surveys of diabetes self-management [23]. However, no validated, widely accepted instruments have been dedicated to the assessment of foot-care quality, related professional foot services, or resulting foot self-care practices. Factors associated with foot self-care had been studied but remained poorly understood [37–38]. In this study, we identified measurable person- and system-level factors associated with adherence to recommended foot-care practices. Our results demonstrate the reliability and

Table 5.
Additional predictors of basic and extended foot self-care: Post hoc analyses.

Predictor	Basic Foot Self-Care			Extended Foot Self-Care		
	Bivariate Correlation		Multiple Regression*	Bivariate Correlation		Multiple Regression*
	n	*r*	β	*n*	*r*	β
No. of Years Smoked (Age Stopped – Age Started)	337	**–0.11**†	–0.01	341	–0.04	0.05
No. of Visits to Primary Care Physician for Foot Care	406	–0.02	–0.03	407	**0.17**‡	**0.09**†
No. of Visits to Foot Doctor for Foot Care	310	0.11	–0.07	313	**0.13**†	–0.04
Do Not Need Help with Survey	625	**0.11**§	**0.09**†	625	0.06	0.06
Know When to Call for Help with Foot Problem (5-Point Rating)	373	**–0.12**†	–0.04	377	0.08	–0.01
Cannot See Soles of Feet	623	**–0.18**‡	**–0.17**‡	621	–0.05	–0.04
Told By Doctor Have Drug/Alcohol Problems	653	–0.03	**–0.13**†	650	0.02	–0.02
Provider Involved in Foot-Care Decisions	498	**0.16**‡	–0.02	495	**0.15**‡	0.01
Provider Recommended Type of Shoe	642	**0.09**†	–0.01	642	**0.09**†	–0.05

Note: Probabilities < 0.05 are bolded.
*β and probabilities are for addition to multiple imputation regressions shown in **Table 4**.
†$p < 0.05$.
‡$p < 0.001$.
§$p < 0.01$.

validity of a survey of the quality and extent of foot self-care practices and related professional foot care and education. The basic and extended subscales identified from this survey had satisfactory internal consistency (with the exception of extended foot self-care, in which reliability was constrained by the small number of items and by lesser item variance) and were substantively interpretable.

Patient Characteristics Associated with Foot Self-Care

A number of patient characteristics were associated with greater foot self-care. Prior ulcers and symptoms of neuropathy were associated with greater basic and extended foot self-care. Prior amputation also showed independent effects on basic foot self-care even though few respondents had had amputations. These findings are consistent with prior reports that associated easily perceived symptoms with adherence to recommended foot-care practices [37].

Although the study was not designed primarily to study racial/ethnic factors, the findings address the quality of foot care in minority groups. In this VA study, African Americans and Hispanics engaged in somewhat more and better basic and extended foot self-care than Caucasians or others. Because African-American men have higher rates of foot complications and frequently experience disparities in care [1,39], this finding was unexpected. The finding may reflect the fact that minorities have equal access to care within the VA [40]. Heisler and colleagues recently identified racial disparities in certain diabetes care processes in the VA but no differences in other care processes or intensity of treatment [41]. These results show that minority status is not necessarily a barrier to good foot self-care.

A number of hypothesized predictors had weak, inconsistent, or nonsignificant relationships with foot self-care (e.g., BMI, age). Years of schooling had nonsignificant correlations with foot self-care; thus patients can learn foot self-care regardless of formal educational background. Post hoc analyses suggest that future studies of foot self-care should address assistance needs in tasks such as survey completion and ability to see the soles of feet.

Care-System Factors

Greater provision of foot care, especially basic foot-care education, was associated with better foot self-care. These findings extend previous reports that education and primary preventive measures provided by a podiatrist result in improved patient knowledge and foot self-care [42]. The finding that professional foot care and foot-care education are related to patient foot self-care probably reflects the professional's typical integration of the two. Increased professional foot care and education may facilitate not only information provision but also empathy and partnership between professional and patient, which will lead to greater foot-care compliance [43–45].

Opportunities for Quality Improvement

Despite a high risk of foot complications, a substantial proportion of respondents reported inadequate adherence to recommended foot-care practices. Only about one-half of respondents performed basic foot self-care practices, such as examination of feet and shoes, more than once a week. Adherence to more specialized self-care recommendations, such as not using sharp instruments for care of corns and calluses, was even less frequent.

Our results suggest strategies for the improvement of foot care. High-risk patients with lower levels of adherence to recommended foot self-care can be identified and targeted by outreach efforts. High-risk patients who have received lower levels of professional care or education can also be identified and provided increased care.

Limitations

The scales developed in this study were tested in a population of veterans. Generalizability has not been established. Correlational patterns may differ in other groups. Discrepancies in the quality and extent of foot care may be greater in the private sector in which patients face economic barriers not experienced by VA patients.

Other problems were the limited (47.5%) response rate to the mailed survey and missing data. Because of IRB interpretations of the Health Insurance Portability and Accountability Act confidentiality requirements, we were unable to compare responders with nonresponders (who did not consent), so the representativeness of the sample cannot be empirically determined. What can be said is that survey responders included a range of veterans with diabetes and high-risk foot conditions and a fraction of minorities that was similar to the VA population in general. Analysis was also complicated by missing data. We recommend that future research include additional contact by telephone or other means for increasing response rates and that linkage of survey data with variables in medical records be permitted for testing survey biases and adjusting probability weights by sampling biases.

Voluntary surveys entail little risk, and databases can be linked with the use of encrypted identifiers that minimize confidentiality risks.

Patient self-reports are limited by difficulties recalling particular care events, especially when embedded in other complex events, and by other biases. Nonetheless, patient reports have helped identify numerous healthcare needs and patient reports of diabetes self-care are associated with better blood sugar control as measured by hemoglobin A_{1c} [46].

We have provided basic information on the reliability and validity of foot-care scales using conventional methods [47] and standards [29], but additional work could enhance knowledge of the psychometric properties, generalizability and validity of the scales as well as shorten them.

Finally, the scales need to be employed in operational quality improvement efforts designed to decrease foot morbidity. Randomized clinical trials of podiatric care in England have shown a degree of effectiveness among elderly individuals [45], but more research is needed to understand connections among professional care, education, patient self-care, and ulceration outcomes [46]. To demonstrate their real-world validity, we must associate indicators of quality of care with actual health outcomes in quality improvement initiatives [48].

CONCLUSIONS

Tools are needed for assessing not only the general quality of care systems but also care and self-care for specific health problems. This study has identified both individual and system-level factors associated with better foot self-care among individuals with diabetes. Scales are now available for gauging the quality and extent of foot self-care, professional foot care, and foot-care education for high-risk patients with diabetes. With the use of these tools, quality improvement efforts can target remediable deficiencies in foot care and decrease the associated morbidity to patients and costs to society.

ACKNOWLEDGMENTS

Dr. Johnston is now with the University of Wisconsin–Milwaukee.

We would like to thank Gerald Hawley, RN, MSN, for assistance in creating the facility-specific diabetes registries and Andrea Vincenti for assistance in manuscript preparation.

This material was based on work supported by the VA Health Services Research and Development Service, grants SDR 99-037 (Drs. Pogach and Reiber) and IMA 04-164 (Dr. Pogach), and the HH Kessler Foundation.

The authors have declared that no competing interests exist.

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Submitted for publication June 23, 2005. Accepted in revised form November 3, 2005.