Diabetes-Related Lower-Extremity Amputations Disproportionately Affect Blacks and Mexican Americans

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ABSTRACT

Background. We sought to identify the age-adjusted incidence of lower-extremity amputation (LEA) in Mexican Americans, blacks, and non-Hispanic whites with diabetes in south Texas.

Methods. We summarized medical records for hospitalizations for LEAs for 1993 in six metropolitan statistical areas in south Texas.

Results. Age-adjusted incidence per 10,000 patients with diabetes was 146.59 in blacks, 60.68 in non-Hispanic whites, and 94.08 in Mexican Americans. Of the patients, 47% of amputees had a history of amputation, and 17.7% were hospitalized more than once during 1993. Mexican Americans had more diabetes-related amputations (85.9%) than blacks (74.7%) or non-Hispanic whites (56.3%).

Conclusions. This study is the first to identify the incidence of diabetes-related lower-extremity amputations in minorities using primary data. Minorities had both a higher incidence and proportion of diabetes-related, LEAs compared with non-Hispanic whites. Public health initiatives and national strategies, such as Healthy People 2000 and 2010, need to specifically focus on high-risk populations and high-risk geographic areas to decrease the frequency of amputation and reamputation.

DIABETES MELLITUS is the most common underlying cause of lower-extremity amputation in the United States and Europe. Approximately 120,000 nontraumatic amputations are done each year in the United States. Of these amputations, 45% to 83% involve diabetes mellitus.[1-3] Diabetes-related amputations are an important public health issue because many amputations can be prevented when high-risk patients receive preventive medical care.[4-6] Prevention of diabetes-related amputations is a specific goal outlined by state and federal public health departments, as well as the Veterans Administration and the Health Resources and Services Administration. One objective of Healthy People 2000,[7] a national strategy to improve the health of the American people, is to reduce the incidence of diabetes-related amputations from 82 to 49 per 10,000 persons per year. One of the first steps to develop programs to prevent amputations is to identify high-risk populations,[8,9] so programs can be implemented where they are needed most.

Based on the disproportionately high prevalence of diabetes mellitus and diabetes-related complications such as retinopathy and nephropathy observed in minorities, we hypothesized that Mexican Americans and blacks with diabetes would have substantially more lower-extremity amputations than their non-Hispanic white counterparts. Since no data have been published on the incidence of diabetes-related amputations in Mexican Americans and little specific information regarding blacks at the time the estimates for Healthy People 2000 were developed, it would not have been possible to consider the excess risk of amputations in this segment of the population. As a result, public health planners may have underestimated the impact of diabetes-related amputations in south Texas and in other states with large minority populations. The purpose of this study is to identify racial/ethnic differences in the incidence of lower-extremity amputations in south Texas in 1993.

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TABLE 1. Sample Size and Demographics of Patients With Diabetes

	Mexican Americans	*Non-Hispanic Whites*	*Blacks*	*Total*
Total number of patients with amputations	815	157	71	1,043
Foot (%)	45.3	48.4	45.1	45.7
Leg (%)	34.4	25.5	23.9	32.3
Thigh (%)	20.4	26.1	31.0	22.0
Mean age in years (SD)	64.4 (12.1)	66.8 (13.6)	64.8 (13.4)	64.8 (12.5)
Male (%)	59.6	59.9	50.7	59.1
Insulin/oral/diet control (%)	50.7/36.4/8.3	52.2/26.8/8.3	54.9/26.8/5.6	51.2/34.3/8.1
No diabetes treatment before amputation (%)	4.6	12.7	12.7	6.4
Previous history of amputation (%)	49.3	39.5	43.7	47.5

SD = Standard deviation.

PATIENTS AND METHODS

We reviewed the medical records for each hospitalization for a lower-extremity amputation from January 1 to December 31, 1993, in six metropolitan statistical areas (MSAs) in south Texas: San Antonio, Corpus Christi, Brownsville, McAllen, Laredo, and Victoria. Each hospital in the study areas, including military and Veterans Administration Hospital facilities, provided a list of patients who had amputations in 1993. Each hospital recorded was abstracted by a primary reviewer, and data were then verified by a second reviewer. We also abstracted medical records at the nearest state hospital facility, University of Texas Medical Branch, Galveston, to verify that indigent or uninsured patients did not leave their local community hospital to receive care at a state facility. At the state hospital, only three amputees were identified as living in the geographic areas being evaluated.

Patients were identified from ICD-9-CM codes 84.11 to 84.18 and 84.30. Amputations were categorized by the level of amputation as foot (84.11 to 84.12), leg (84.13 to 84.16), or thigh (84.17 to 84.18).[10] The level of amputation was verified after reviewing the operative report. For the purposes of analysis, we categorized lower-extremity amputations into three levels: foot, leg, and thigh. Foot amputations included all amputations below the ankle. Leg amputations included procedures from the ankle to through-knee amputations, and thigh amputations involved levels proximal to through-knee procedures.

Race was identified by reviewing the admitting physician's history and physical examination, hospital admission database information, and the nurse's hospital admission notes. Previous history of ipsilateral or contralateral lower-extremity amputation and the level of amputation were identified from the physician's and/or nurse's admission notes. A diagnosis of diabetes mellitus was verified using World Health Organization (WHO) criteria.[11] Only 2.9% of amputees who had diabetes by these criteria did not have a diabetes-related ICD-9-CM code included in their discharge summary.

Estimates of the number of persons in the six MSAs with diabetes mellitus were obtained by applying age-specific and sex-specific prevalence of diagnosed cases of diabetes from the NHANES II and HHANES[12,13] to 1993 Texas population estimates for Hispanics, blacks, and non-Hispanic whites. Texas population estimates were obtained from the Texas State Data Center.[14] Amputees who lived outside the geographic boundaries of the metropolitan statistical areas listed were excluded from analysis. For each individual patient with multiple lower-extremity amputations during the study year, only the highest amputation was used in the data analysis.

Age-adjusted incidence rates per 10,000 persons with diabetes were calculated for each racial/ethnic group using a direct standardization method, with the 1990 United States population as the standard population. We used a Mantel-Haenszel chi-square test (χ^2_{MH}) to compare differences in the proportion of persons with amputations among racial/ethnic groups, previous lifetime lower extremity, multiple hospitalizations for an amputation for the same individual, and multiple amputations during a single hospitalization between racial/ethnic groups.[15] To calculate a 95% confidence interval (CI) for the relative risk, we used standardized criteria.[16]

RESULTS

A total of 1,323 patients in south Texas had a lower-extremity amputation in 1993. Of that

TABLE 2. Age-Adjusted Incidence by Race and Sex in the Diabetic Population in South Texas

	Male	*Female*	*Relative Risk for Males*
Mexican Americans	141.13 (123.75-158.51)	62.46 (53.65-71.28)	2.26* (2.14-2.39)
Non-Hispanic whites	119.55 (69.42-169.68)	34.69 (21.54-47.84)	3.45* (3.27-3.64)
Blacks	222.46 (138.44-306.49)	111.01 (71.16-150.86)	2.00* (1.93-2.08)
Total	133.19 (117.39-148.99)	56.57 (49.39-63.75)	2.35* (2.22-2.49)

Results as incidence rates per 10,000 diabetic persons (95% confidence interval).
*$P < .01$

population, 78.8% were in individuals with diabetes mellitus. Among residents with diabetes in the geographic areas studied, 1,944 amputations occurred during 1,228 hospital episodes in 1,043 subjects. Amputations associated with diabetes, previous lifetime amputation, multiple hospitalizations for an amputation in the same individual, and multiple amputations during the same hospitalization were common in this patient population. The proportion of amputations due to diabetes were higher among Mexican Americans (85.9%) compared with blacks (74.7%) (χ^2_{MH} = 8.65, $P = .003$) and non-Hispanic whites (56.3%) (χ^2_{MH} = 90.30, $P < .001$) after adjusting for age as a possible confounding variable. Similarly, there were more amputations associated with diabetes in blacks compared with non-Hispanic whites (χ^2_{MH} = 6.81, $P < .009$). These data are summarized in Table 1.

A total of 490 diabetic amputees (47%) had a history of a previous lifetime lower-extremity amputation of the same limb or contralateral extremity. Among those amputations associated with diabetes, Mexican Americans had a higher proportion of previous lower-extremity amputations (48.8%) compared with non-Hispanic whites (38.9%) (χ^2_{MH} = 4.69, $P < .03$). There was no such difference between Mexican Americans and blacks (43.7%) (χ^2_{MH} = 0.92, $P > .05$) or blacks and non-Hispanic whites (χ^2_{MH} = 0.16, $P > .05$).

During the study year, there were multiple hospitalizations for lower-extremity amputations in 17.7% of amputees. Some variation was noted among racial/ethnic groups (non-Hispanic whites, 14.0%; blacks, 16.7%; Mexican Americans, 18.3%), but there was not a significant difference in the proportion of these events among subpopulations after adjusting for age. In contrast, non-Hispanic whites had proportionally more episodes of multiple amputations during the same hospitalization during the study year (22.9%) compared with Mexican Americans (16.1%) (χ^2_{MH} = 4.96, $P = .026$). There was not a significant difference in the proportion of these events among blacks (18.3%) and non-Hispanic whites (χ^2_{MH} = .83, $P > .05$) or blacks and Mexican Americans (χ^2_{MH} = 0.32, $P > .05$).

We found considerable variation in the incidence of lower-extremity amputation due to diabetes in south Texas among men and women and among blacks, Mexican Americans, and non-Hispanic whites. Blacks had significantly higher age-adjusted incidence of diabetes-related lower-extremity amputation than Mexican Americans (146.59 vs 94.08, $P < .001$) and non-Hispanic whites (146.59 vs 60.68, $P < .001$). Also, the incidence in the Mexican American population was consistently higher than the incidence in the non-Hispanic white population (94.08 vs 60.68, $P < .001$). These phenomena continued to be true for every level and for both sexes (Tables 2 and 3). The risk of amputation was 2.41 times higher in blacks compared with non-Hispanic whites (CI = 1.94 to 3.01) and 1.56 times higher compared with Mexican Americans with diabetes (CI = 1.22 to 2.00). Mexican Americans were 1.55 times more likely to have an amputation than non-Hispanic whites (CI = 1.38 to 1.74). Overall, men with diabetes were 2.35 times more likely to have a lower-extremity amputation than their female counterparts. The risk of amputation was significantly higher for men of every racial/ethnic group (Table 2).

As expected, the risk of lower-extremity amputation in persons with diabetes was much greater than in persons without the disease in every racial/ethnic group. The relative risk of having a lower-extremity amputation was 32.55 (CI 31.43 to 33.72) for Mexican Americans, 29.09 (CI = 28.28 to 29.92) for blacks, and 29.46 (CI = 28.11 to 30.87) for non-Hispanic whites in south Texas. Overall, persons with diabetes in south Texas were 34.95 (CI = 33.62 to 33.72) times more likely to have an amputation than persons without diabetes.

DISCUSSION

This report identifies several striking differences in the frequency of diabetes-related

TABLE 3. Age-Adjusted Incidence Rates in South Texas per 10,000 Persons With Diabetes by Level and Race/Ethnicity

Race	*Foot*	*Leg*	*Thigh*	*Total*
Non-Hispanic whites	31.61 (19.61-43.61)	15.70 (7.67-23.73)	13.37 (5.65-21.09)	60.68 (44.34-77.03)
Mexican Americans	48.62 (41.70-55.54)	29.93 (25.39-34.48)	15.53 (12.81-18.24)	94.08 (85.39-102.77)
Blacks	68.66 (41.20-96.12)	35.32 (15.84-54.79)	42.61 (22.16-63.06)	146.59 (107.39-185.78)
Total	45.22 (39.40-51.03)	26.16 (22.34-29.97)	15.64 (12.97-18.30)	87.01 (79.58-94.44)

amputations between racial/ethnic groups within south Texas, as well as findings that sharply contrast previous reports involving populations within the United States. There are only a few studies in the medical literature that report amputation incidence in the general population in the United States, and most of these reports do not specifically evaluate minority populations. The incidence and proportion of lower-extremity amputations associated with diabetes are significantly higher in minorities than non-Hispanic whites in south Texas. The incidence of amputations in non-Hispanic whites with diabetes in south Texas was similar to previous reports in the general population. The age-adjusted incidence of diabetes-related amputations in the United States per 10,000 diabetic persons has been reported to be 56.0 in California in 1991,[17] 51.0 in Washington state in 1988,[18] and 76.8 in New Jersey between 1979 and 1981.[19] However, amputations in both blacks and Mexican Americans in south Texas were much higher than previous reports in minorities.[19,20] The risk of amputation in men with diabetes was also higher in south Texas than in previous reports. Men in south Texas were 2.00 to 3.45 times more likely to have an amputation than women. Previous reports in the United States have put the risk of amputation among men with diabetes at 1.40 to 1.82 times that of women.[2,19]

There are many potential explanations for the higher rates of diabetes-related amputations in minorities. Minorities are more likely to have physiologic risk factors for amputation. In general, they have diabetes mellitus at an earlier age, have higher serum glucose levels,[21] are more likely to be obese, and have more diabetes-related complications such as retinopathy[22,23] and nephropathy.[24] Obesity and blindness, for instance, may be important issues in self care for high-risk patients.[25,26] Patients who cannot reach and adequately visualize their feet cannot initiate self-care strategies or identify early warning signs of ulceration or infection. In addition, blacks have a significantly higher prevalence of peripheral vascular disease than non-Hispanic whites.[21,27] However, the prevalence of peripheral vascular disease in Mexican Americans has not been shown to be substantially more than in non-Hispanic whites.[28,29] Poor glycemic control, increased age, and duration of diabetes have been associated with peripheral vascular disease, an important component in the causal pathway to limb loss.[28,30-32] Peripheral vascular disease alone may help explain many excess amputations in blacks, as well as being the reason blacks with diabetes have substantially more proximal amputations than Hispanics or non-Hispanic whites and the highest amputation incidence among persons with and without diabetes.[17] Unfortunately, the quality of the data that we were able to identify when abstracting medical records during this study was not sufficient to adequately and consistently document many important variables. We were therefore unable to evaluate the role of ulcer severity, peripheral sensory neuropathy, vascular perfusion, duration of diabetes, or glycemic control.

Social and cultural issues may also affect amputation morbidity. Minorities are more likely to be poor and uninsured.[33,34] They are therefore more likely to have inadequate access to primary and specialty medical care[35-37] and therapeutic footwear and insoles. When medical care is available, they may be less likely to use this service.[38] In rural south Texas, issues of access and use may be more important because of the physical distance that exists to get to a physician. Language barriers, illiteracy, or acculturation issues may also present obstacles to early intervention or preventive care. In addition, Mexican Americans may initially rely on folk healers or alternative medicines, especially when access to more traditional medical care is limited. Traditional thinking in the Mexican American community often associates good health with the absence of pain.[39] The cultural misinterpretation of no sensation with no disease may lead many Mexican Americans with peripheral neuropathy to ignore early warning signs such as numbness or painless ulcerations until an amputation is inevitable. It is unclear if this phenomenon is more common in Mexican

Americans than in other populations, but it seems likely that it may influence populations that are less sophisticated, educated, and accustomed to modern medical practices. Culturally sensitive programs that evaluate the subtle issues related to high-risk beliefs and behaviors and provide intervention strategies that are culturally specific for patients and health care providers could have a substantial impact in the Mexican American and black community.

This study had several limitations. One of the most obvious problems was missing data from medical records related to important explanatory variables such as vascular disease, infection severity, and glucose control. In addition, the number of persons in south Texas was estimated from census information and the number of persons with diabetes was estimated from national prevalence data. These are similar to the techniques used in other population-based amputation studies. However, both factors may have introduced some error into the estimates of amputation incidence. Other data, such as level of amputation and the presence of diabetes (using WHO criteria), were consistently documented in medical records and easy to verify from operative reports or laboratory information, since both are standards of care in the communities we studied. Because diabetes is strongly associated with lower-extremity amputation, we were not surprised that only 2.9% of patients with diabetes were not correctly identified by ICD-9-CM code. Most of the existing literature in this area has relied on hospital discharge data that do not allow verification of any data and do not include Veterans Administration or Department of Defense hospitals. In addition, previous studies could only identify hospitalizations for amputation. Individual patients could not be evaluated because secondary data bases cannot provide unique patient identifiers. Therefore, previous studies probably underreported the number of men within the geographic areas under investigation and the proportion of reamputation could not be identified.

Many amputees in this study had a previous lifetime history of an amputation (47.0%), multiple amputations during the same hospitalization (17.3%), and multiple hospitalizations for the same individual during the study year (17.7%). Again, this is in contrast to previous studies that report that 9.0% and 10.9% of amputees had more than one hospitalization for an amputation per study year[19,40] and 13.6% of amputees had multiple amputations in the same hospitalization.[41] Perhaps the best predictor of amputation is a history of previous amputation. These individuals have shown that they already have the component elements in the causal pathway necessary to produce an amputation. Reamputation can be attributed to progression of the disease process, non-healing wounds, and the development of additional component factors in the pathway to limb loss that develop because of the first amputation. Amputation destroys normal locomotion function, and compensatory mechanisms and biomechanical deficits caused by an amputation add to the risk of additional amputation. Even a minor amputation of the great toe increases foot pressures on the amputated foot and contributes to the development of foot deformities, limited joint mobility, and ulceration.[8,42-44] All these factors have been identified as important risk factors for ulceration or amputation.[8,45]

Undoubtedly, some amputations never heal and subsequently become infected or gangrenous and require additional surgery. Unfortunately, there are not well-accepted, specific criteria to help surgeons and rehabilitation physicians select a definitive level of amputation that would provide the best functional result and the best chance for healing without additional surgery. Even a toe or partial foot amputation should be a pivotal event in the minds of health care providers. Amputees have a high risk of reamputation and need to be seen more frequently by their primary physician or at specialty foot clinics if they are available. Simply inspecting the feet of high-risk patients by every health care provider could have a significant impact. This simple, inexpensive screening practice does not require any additional equipment and little time, but it is still not done regularly.[9,46,47]

In the United States, blacks are the largest minority group, and Mexican Americans are the fastest-growing minority group,[48] and yet we do not understand many of the unique characteristics of each group, especially as they are related to amputation risk. Much of the work that addresses risk factors for amputations, ulcerations, and foot infections does not specifically include black and Mexican American populations. The objectives set forth in Healthy People 2000 need to be reevaluated for minority populations so realistic objectives can be established.[7] This is espe-

cially important for areas with large minority populations such as Texas, New York, California, and Illinois. Programs specifically designed to prevent amputations have reduced them by as much as 84%.[5,49-51] Public health initiatives need to specifically focus on high-risk populations and high-risk geographic areas such as south Texas to decrease the frequency of amputation and reamputation.

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