Reduction in Diabetes-Related Lower-Extremity Amputations in the Netherlands: 1991–2000

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OBJECTIVE — Lower-extremity amputation is a common complication among patients with diabetes throughout the world. However, few data exist on the actual impact of the recent moves to improve the management of diabetic foot ulcers to reduce the incidence of lower-extremity amputations. The aim was to determine the incidence of lower-extremity amputations among diabetic patients from 1991 to 2000 in the Netherlands.

RESEARCH DESIGN AND METHODS — A secondary database containing information regarding all hospital admissions in which a lower-extremity amputation occurred for the years 1991–2000 was obtained from the Dutch National Medical Register. Because a patient-unique identifier was included, multiple amputations and hospitalizations for a single individual could be identified. Furthermore, age- and sex-specific diabetes prevalence rates were calculated using a 3-year average for every year, calculating the total diabetic population in the Netherlands at risk for every year.

RESULTS — In 1991, a total of 1,687 patients with diabetes had been admitted 1,865 times for 2,409 amputations. In 2000, a total of 1,673 patients with diabetes were admitted 1,932 times for 2,448 amputations. The overall incidence rates of the number of patients who underwent lower-extremity amputation decreased over the years from 55.0 to 36.3 per 10,000 patients with diabetes ($P < 0.05$). Both in men (71.8 vs. 46.1, $P < 0.05$) and women (45.0 vs. 28.0, $P < 0.05$) with diabetes, a significant decrease could be observed. Mean duration of hospitalization decreased from 45.0 days (SD 44.4) in 1991 to 36.2 days (SD 38.4) in 2000; decreases were observed for both men and women.

CONCLUSIONS — Over the years observed in this study, the incidence rates of diabetes-related lower-extremity amputation in the Netherlands was found to decrease in both men (36%) and women (38%) with diabetes. Furthermore, the duration of hospitalization decreased over time.

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Diabetes-related lower-extremity amputations are still common. Throughout the world, many reports have appeared showing the incidence of lower-extremity amputations among patients with diabetes, although there is widespread variation (1–6). Most of these reports are based on data derived from hospital practice, although van Houtum et al. (7) previously reported nationwide amputation rates for the Netherlands in 1991 and 1992, and these were comparable to those documented in other publications.

Amputations are considered a very debilitating complication of diabetes. Both the social impact of such amputations for the patient and the financial implications for health care systems are grave (8–10). The occurrence of an amputation may reflect the severity of the disease or may be a marker of disease management. In the literature, lower-extremity amputations are mainly used as a parameter to stress the impact of diabetic foot disease.

A high percentage of all lower-extremity amputations are preceded by a nonhealing ulcer with underlying neuropathy and peripheral vascular disease, often complicated by an infection. Incidence may be reduced using a multidisciplinary approach, with a team that preferably consists of an internist, podiatrist, orthopedic and vascular surgeon, rehabilitation physician, orthopedic shoemaker, and diabetes specialist nurse. Using such an approach, a 50–85% reduction in amputations has been described (11–13). In addition, other reports showed a decrease in major amputations (14,15). As was set forth in the St. Vincent Declaration, a 50% reduction in lower-extremity amputation should be the target for improved foot care (16).

The prevalence of known diabetes will increase over the years, more than can be expected on demographic changes of the general population alone (17). It follows that more people will be defined as being at risk for devastating long-term diabetes-related complications, such as neuropathy and peripheral vascular disease. Therefore, the number of diabetes-related amputations could be expected to increase.

There has been increased interest in the diabetic foot in the Netherlands. There was a significant increase in the number of podiatrists from 1995 to 2000, along with a similar trend in the number of multidisciplinary foot teams (18). This has been linked to the effort being invested in attempts to decrease the incidence of lower-extremity amputations, with the associated impact of such procedures on patient's lives and the Dutch health care system.

However, the possible benefit of this

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Table 1—*Crude numbers of amputees, hospitalizations, and lower-extremity amputations among individuals with diabetes in the Netherlands from 1991 to 2000*

	Men			Women		
Year	Amputees	Hospitalizations	Amputations	Amputees	Hospitalizations	Amputations
1991	818	915 (112%)	1,182 (144%)	869	950 (109%)	1,227 (141%)
1992	814	927 (114%)	1,228 (151%)	826	907 (110%)	1,139 (138%)
1993	842	960 (114%)	1,265 (150%)	851	934 (110%)	1,176 (138%)
1994	883	1,027 (116%)	1,363 (154%)	805	909 (113%)	1,128 (140%)
1995	914	1,037 (113%)	1,371 (150%)	799	893 (112%)	1,101 (138%)
1996	933	1,075 (115%)	1,375 (147%)	801	893 (111%)	1,095 (137%)
1997	943	1,107 (117%)	1,381 (146%)	776	861 (111%)	1,084 (140%)
1998	926	1,062 (115%)	1,348 (146%)	777	883 (114%)	1,087 (140%)
1999	932	1,082 (116%)	1,406 (151%)	726	810 (112%)	1,011 (139%)
2000	971	1,149 (118%)	1,470 (151%)	702	783 (112%)	978 (139%)

observed increase in diabetic foot care has not been documented. Therefore, the aim of this study was to compare the incidence of diabetes-related lower-extremity amputations in the Netherlands between 1991 and 2000.

RESEARCH DESIGN AND METHODS

— A secondary database was obtained from Prismant including all hospitalizations for a lower-extremity amputation from 1991 to 2000 (19). Prismant is a corporation that obtains medical information from the National Medical Register, including data on hospital admissions, procedures, and diagnoses. The database used for this study included information on sex, age, type of amputation, and diagnosis codes including diabetes. Furthermore, a patient-unique identifier was available, allowing identification of patients being admitted for lower-extremity amputation more than once in a year or several times in consecutive years. This enabled the calculation of the actual number of amputees as well as the number of hospitalizations and specific procedures on a year-to-year basis.

Lower-extremity amputations were identified by level: toe level (toe and ray amputation), foot level, leg level (ankle disarticulation to knee disarticulation), and thigh level (above-knee amputation to hip disarticulation). An entry in the database was determined to be related to diabetes when an International Classification of Diseases, 10th revision (ICD-10) code of 250 was encountered (20). Four age categories were considered: <45, 45–64, 65–74, and >75 years.

Because it is impossible to have exact national diabetes prevalence rates for every year observed in our study, diabetes prevalence rates were based on a continuous morbidity registration of four family practices. This project is an ongoing prospective study of chronic diseases, including diabetes, in a population of ~12,000 people in Nijmegen (21). The diabetes prevalence rates derived from this population, which is similar demographically to the Netherlands in total, are in concordance with the diabetes prevalence rates for the Netherlands, calculated using weighted results from different population studies. Age- and sex-specific rates were calculated using a 3-year average for every year (e.g., rates for 1991 were based on diabetes prevalence figures for 1990–1992). The population at risk for diabetes in the Netherlands was determined by applying age- and sex-specific diabetes prevalence rates to the general population of the Netherlands for each year. Census information for the Netherlands was obtained from the Statistics Bureau in the Netherlands (22).

Statistics

Incidence rates were expressed as the number of amputees per 10,000 patients with diabetes. Age- and sex-specific rates were calculated. The software package used for statistical analysis was SPSS for Windows 10.0.5 (SPSS, Chicago, IL) (23). Trend analyses over the 10 years observed were made using the Pearson χ^2 test. The results of statistical tests were considered significant at a level of $P < 0.05$.

RESULTS

— In the period of 10 years observed in this study, the total number of diabetic and nondiabetic patients who underwent lower-extremity amputation remained stable. The mean annual number of lower-extremity amputations performed for diabetic and nondiabetic individuals combined was 5,379 procedures. For these procedures, 4,499 hospitalizations were required and 4,029 individuals were involved. In patients with diabetes, 2,442 lower-extremity amputations were performed during 1,916 hospitalizations in a total of 1,691 patients. Therefore, the diabetic population accounted for 45.4% of all lower-extremity amputations, 43.6% of all hospitalizations for a lower-extremity amputation, and 42.0% of all individual amputees. In general, the absolute number of amputees, hospitalizations, and lower-extremity amputations performed among the diabetic population did not change in the 10-year period. The same trend could be observed for the nondiabetic population.

The mean age of patients undergoing a lower-extremity amputation was 71.5 years (SD 11.9). There was no significant change in age over the years observed. Men who underwent amputation were significantly younger than their female counterparts (69.0 [11.8] vs. 74.3 [11.4] years, $P < 0.001$).

The total number of amputees with diabetes remained stable over the years observed. Therefore, the actual health care burden was not diminished. However, significant changes could be observed in the crude numbers when sex was considered. In men, the number of amputees increased over the period of 10 years, from 818 amputees in 1991 to 971 amputees in 2000 ($P < 0.001$). In women, a significant decrease was observed, from 869 in 1991 to 702 in 2000 ($P < 0.001$). These trends continued to be true when

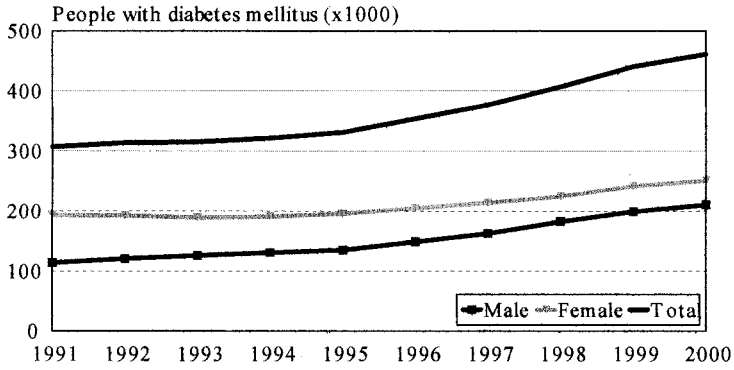

Figure 1—*Total number of individuals with diabetes in the Netherlands.*

the number of hospitalizations and actual lower-extremity amputations were considered (Table 1). No such trends were observed in the nondiabetic population.

The level of amputation did not change over the years. The mean proportional distribution of the level of diabetes-related amputations for toe, foot, leg, and thigh was 42.0, 9.3, 33.9, and 14.8%, respectively, and did not change significantly over time. A similar trend could be observed among nondiabetic amputees.

Based on the prospective population study in Nijmegen, age- and sex-specific prevalence rates of known diabetes were calculated for the general population of the Netherlands. As expected, from 1991 to 2000, a significant increase in prevalence of diabetes was found (Fig. 1). The total number of individuals with diabetes in the Netherlands increased from 307,000 in 1991 to 462,000 in 2000. This increase in prevalence was more pronounced in men (from 114,000 to 211,000; 84.9%) than in women (from 193,000 to 251,000; 29.9%).

If the incidence rate for amputees is expressed per 10,000 individuals with diabetes, a significant decrease was observed (Fig. 2). The incidence rate for all amputees was 55.0 per 10,000 patients with diabetes in 1991, whereas the incidence rate in 2000 was 36.3 per 10,000 ($P < 0.05$), a 34% reduction in the incidence of diabetes-related lower extremity amputees. The incidence rate decreased from 71.8 to 46.1 per 10,000 in men with diabetes ($P < 0.05$) and from 45.0 to 28.0 per 10,000 in women with diabetes ($P < 0.05$).

The duration of hospitalization decreased over time. In 1991, patients were admitted to the hospital for a mean duration of 45.0 days (SD 44.4). In 2000, the number of days spent in the hospital for a lower-extremity amputation decreased to 36.2 (SD 38.4) ($P < 0.01$). These trends could be observed for both men and women and for every level of amputation, although for the latter subcategories of level, no significance could be reached. People without diabetes were found to have a similar reduction in the length of hospital stay, from 36.1 days (SD 36.0) in 1991 to 29.4 days (SD 33.5) in 2000.

CONCLUSIONS — To our knowledge, this is the first nationwide analysis of incidence of diabetes-related lower-extremity amputations, and it shows a decrease in the incidence of lower extremity amputees over time. All diabetes-related lower-extremity amputations performed in a consecutive 10-year period have been included. Previous reports mostly documented hospital-oriented or regional information (2,14,15,24–26). These studies may be biased, because the centers observed are mainly highly specialized in diabetic foot care or tertiary referral centers, and the results cannot necessarily be extrapolated to the total population. Previously, Ebskov and Ebskov (24) published data on lower-extremity amputations over a 12-year period but were unable to calculate diabetes-specific incidence rates because there was no information available on diabetes prevalence.

For this study, a secondary database was used in which all admissions for lower-extremity amputation were gathered by Prismant. In general, secondary databases do not have full completeness and entries may be misdiagnosed or missed (27). However, the validity of this database was shown to be high. Misclassification of procedures in databases from Prismant has been reported only in 4% of patients (28). The number reported may therefore be (slightly) underreported. Furthermore, the database provided a patient-unique identifier, enabling identification of multiple hospitalization and repeat amputations in any one patient. Also, multiple amputations within a single hospitalization could be identified. For the incidence calculation, the numerator was defined as the number of patients with diabetes who had undergone lower-extremity amputation. Therefore, the numbers reported represent the actual social impact, because individuals are counted instead of hospitalizations or procedures.

To calculate incidence rates, the total population at risk must be identified. The denominator in this study consists of the calculated total number of patients with diabetes in the Netherlands. Due to the impossibility of screening all inhabitants of the Netherlands for diabetes, concessions had to be made. Age- and sex-specific prevalence rates were used, based

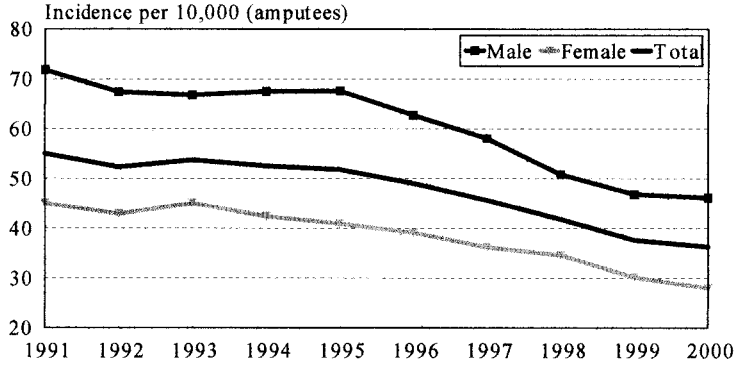

Figure 2—*Incidence rates for the number of amputees per 10,000 people with diabetes in the Netherlands*

on a continuous morbidity registration in a middle-sized city and its vicinity in the Netherlands. Separate data were available for each year observed, and therefore, the actual population at risk for lower-extremity amputation could be calculated. The limitation inherent in use of a small sample size is outweighed by the unique possibility of having a dynamic population at risk. This has never been documented before in any study on diabetes-related amputation epidemiology. The number of individuals with diabetes using the prevalence rates obtained from the continuous morbidity registration from Nijmegen did not differ from estimates made by the National Institute for Public Health and the Environment for the year 2000, using all available prevalence data on diabetes in the Netherlands (29).

The first striking observation was the decrease in the number of diabetes-related lower extremity amputees in the Netherlands over a period of 10 years. The incidence decreased by 36% in men and 38% in women with diabetes. The reduction in the number of amputees was more pronounced in women, in whom a decrease in the crude number of amputees (numerator) was shown, as well as an increase in the number of individuals at risk with diabetes (denominator). In men, the lower incidence rate was mainly related to an increase in the denominator, while the numerator also showed an increase. A clear explanation for the difference in growth in the number of individuals with diabetes between men and women is lacking. The prevalence of diabetes diagnoses in the U.S. also showed a greater increase in men than women (30). However, when incidence rates are reviewed, the decrease in incidence observed is comparable for both men and women. Previous studies found higher incidence rates for men with diabetes compared with their female counterparts, but this does not explain the changes observed (3,7,31,32).

The increase in the prevalence of diabetes in the Netherlands was marked and in agreement with previous reports that predicted an increase in the prevalence of diabetes, resulting partly from demographic changes (17). Comparison of incidences reported in this study with earlier reports on lower-extremity amputations is difficult because there is no uniform method in presenting amputation data and studies differ considerably in the methods used. Case finding and selection often vary, and dissimilar definitions are used in both the numerator and denominator.

In contrast to previous publications demonstrating a reduction in the number of lower-extremity amputations, the level of amputation in this report continued to be unchanged over time. Although the total number of lower-extremity amputations performed in the Netherlands decreased, the proportional distribution of the level of amputation remained the same. The duration of hospitalization, which may be regarded as a major determinant of the financial burden of diabetes-related lower-extremity amputations to society, was found to decrease, but this may reflect general changes in hospital practices and may not necessarily be a consequence of effort directed at the management of foot problems in diabetes.

Possible explanations for the decrease in the incidence of amputations in diabetes may reflect increased attention toward the diabetic foot in the Netherlands. During the period studied, more hospitals were employing podiatrists and an increasing number of multidisciplinary foot clinics had been established (18). The number of Dutch hospitals with a podiatrist increased from 32% in 1995 to 72% in 2000. The number of hospitals with multidisciplinary foot clinics increased from 16 to 40%. Furthermore, in 1998, a national consensus on the diabetic foot was conceived in the Netherlands, later followed by the International Consensus on the Diabetic Foot, developed by the International Working Group on the Diabetic Foot, in which several Dutch physicians were involved (33,34). A possible consequence of the increased attention toward the diabetic foot may have resulted in more preventive surgery, including a more aggressive approach to peripheral arterial obstructive disease. In 1994, the preoperative vascular workup for amputees in the Netherlands was found to be insufficient in nearly half the cases (35). Despite this, there is evidence that the number of surgical interventions for peripheral vascular disease did not increase in the total (diabetic and nondiabetic) population between 1994 and 2000 (19).

Although the above-mentioned observations are impressive and could be interpreted as positive developments, these results need cautious interpretation. It may be misleading to focus only on the number of amputations. Amputations may not give an accurate indication of the overall quality of diabetic foot care. Many factors need to be taken into consideration when using lower-extremity amputations as a marker for diabetic foot care. Low incidence rates may actually reflect either a conservative approach by surgeons or a relatively mild disease progression. High incidence rates may reflect either worse disease prevalence or a more aggressive attitude by surgeons who quickly decide that amputation is the only solution. However, when reviewing amputation data in consecutive years within a well-defined geographical area, those factors will not affect the outcome to a significant extent.

In conclusion, we have shown that the incidence of individuals with diabetes who are hospitalized for lower-extremity amputations is decreasing in the Netherlands, but despite this, there is still room for improvement. It is possible that increased use of minor amputations may result in a lower incidence of major amputations, with their impact on patients' quality of life. Therefore, more must be done regarding selection of amputation level, possibly enabling a decrease in high-level amputations.

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