Foot Ulceration and Lower Limb Amputation in Type 2 Diabetic Patients in Dutch Primary Health Care

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OBJECTIVE — To determine the incidence of foot ulceration and lower limb amputation in type 2 diabetic patients in primary health care.

RESEARCH DESIGN AND METHODS — Data on type 2 diabetes were collected by the Nijmegen Monitoring Project between 1993 and 1998 as part of a study of chronic diseases. The records of all patients recorded as having diabetic foot problems and those who died, moved to a nursing home, or were under specialist care were included. The annual incidence of foot ulceration was defined as the number of type 2 diabetic patients per patient-year who developed a new foot ulcer. Incidence of lower limb amputation was similarly defined. Additional information was collected on treatment of foot ulcers.

RESULTS — The study population of type 2 diabetic patients increased from 511 patient-years in 1993 to 665 in 1998. The annual incidence of foot ulceration varied between 1.2 and 3.0% (mean 2.1) per year; 25% of the patients had recurrent episodes. The annual incidence of lower limb amputation varied between 0.5 and 0.8% (mean 0.6). Ten of the 15 amputees died, and 12 of 52 (23%) patients with ulceration had a subsequent amputation or a previous history of amputation. In 35 of the 73 (48%) episodes of ulceration, only the family physician provided treatment. Patients with foot problems were older and had more cardiovascular disease, retinopathy, and absent peripheral pulses.

CONCLUSIONS — The incidence of foot ulceration and lower limb amputation in type 2 diabetes is low; nevertheless, recurrence rates of ulceration and risk of amputation are high, with high mortality.

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In the Netherlands, the care for patients with type 2 diabetes has shifted from outpatient clinics to primary health care. Approximately three-quarters of all type 2 diabetic patients are treated by family physicians. The family physician acts as the gatekeeper for hospital-based care. The frequency of diagnosis of type 2 diabetes is rising (1). It is estimated that by the year 2010, there will be 400,000– 500,000 diabetic patients in the Netherlands (2). The family physician plays a central role in the treatment of the diabetes-related complications, such as the diabetic foot, and decides on referrals to hospital clinics (3).

Studies outside the Netherlands report varying prevalences in type 2 diabetic patients of foot ulceration (2–7%) and of lower limb amputation (0.2–4%)

in primary health care (4–9). A 14-year incidence of lower limb amputation of 9.9% is reported in primary care (10). Dutch studies report that the prevalence of ulceration is 1.8% (11,12). Nothing is known about its incidence. The age-adjusted incidence of amputation in the Netherlands is estimated to be 35.1 per 10,000 diabetic males and 17.4 per 10,000 diabetic females (13). In primary health care in the Netherlands, it is estimated that 13% of diabetic patients are at risk for developing foot problems (11). The most important intervention to prevent foot ulceration and its consequences is early recognition of high-risk patients and referral to appropriate multidisciplinary teams (14–17). High risk can be detected from the history of a previous ulcer/amputation and clinical examination; for example, impaired monofilament sensation and vibration perception, absent Achilles tendon reflex, callus foot deformities, inappropriate footwear, and absent pedal pulse (3,14,18). The International Working Group on the Diabetic Foot advises an annual foot examination for all diabetic patients and more frequent examinations for those at high risk (3). Since 1989, the Dutch College of General Practitioners has recommended an annual foot inspection (19), but review of patients' records showed that this recommendation has been the least honored by family physicians, who feel they have no time to comply with it (20). The revised recommendation advises education on foot care and inspection annually for all diabetic patients and every 3 months for those who have had previous ulceration or have foot deformities or neuropathy. Referral is recommended when a foot ulceration has not healed within 2 weeks or the ulcer is deep. A classification of foot ulceration is not obliged (21).

Despite these recommendations, little is known about the extent of the diabetic foot problem and its management in Dutch family practice. We therefore studied the diabetic cohort of the Academic Research Network of the Department of Family Medicine, University Nijmegen,

the Nijmegen Monitoring Project (NMP). The NMP is an ongoing prospective longitudinal study of the course of a number of chronic diseases in 10 family practices, run by 26 family physicians, with a total population of ~45,500 patients (22–24).

Primarily, we sought to determine the incidence of foot ulceration and lower limb amputation in type 2 diabetic patients and, secondarily, to study the referral rate of patients with foot ulceration.

RESEARCH DESIGN AND METHODS

The NMP
In the NMP, the family physician's register includes, among others, all their diabetic patients, including those under specialist care. Patients are included under a standard protocol if the diagnostic evidence agrees with the World Health Organization criteria (1985) on diabetes (22,23,25). Patients who were treated with insulin within 1 year after diagnosis and remained on it were considered to have type 1 diabetes and were excluded.

In the NMP, a limited monitoring is carried out every 3 months, and a full evaluation is made annually. As part of this annual review, foot examination was performed. This implies that the condition of the feet was recorded annually and graded as follows: *1*) no abnormalities; *2*) abnormalities and/or mycosis of the nails; *3*) pressure marks and/or ulceration; *4*) combination of 2 and 3; *5*) amputation below the ankle; and *6*) amputation at higher level. No distinction was made between pressure mark and foot ulceration, no prior grading of foot ulceration was determined, and no parameters were defined to distinguish between the different types of ulcers. Defining neuropathy was restricted to monitoring the presence or absence of the Achilles tendon reflex. No data on sensory neuropathy was collected. As a parameter for peripheral vascular disease, absence or presence of peripheral foot pulses was determined. Prevention of foot ulceration consisted of annual investigation of the feet and education. The family physicians did not use a treatment protocol for foot problems. Foot ulceration was treated with wound debridement, antibiotics, and ordinary wound care products. No off-loading devices were used.

All data are collected and analyzed by the Department of Family Medicine, University of Nijmegen. The participating family physicians received feedback on their data and held monthly meetings. Currently, there has been no feedback on registration and treatment of foot problems.

Subjects
All patients with type 2 diabetes who were registered in the NMP between 1993 and 1998 were included. The study population, in any year, was defined as the total number of patients with type 2 diabetes seen in that year: *1*) patients who were treated by the family physician (regardless of whether an annual review was performed); *2*) patients newly diagnosed in that year (the new intakes); and *3*) patients who were treated by shared care between a family physician and medical specialist. Shared-care patients make hospital visits for regular monitoring of their diabetes, but they consult their family physician for intercurrent medical problems. Patients were excluded from the NMP and from our study the year after they moved out of practice, after being admitted to a nursing home, or after death. The composition of the study population, therefore, varied from year to year.

Data collection
To differentiate between pressure marks and ulceration, the records of all patients who had been graded category 3 or 4 (see above) at least once were retrospectively studied by one researcher (I.S.M.). Pressure mark was defined as callus and/or pretrophic ulcer, and foot ulceration was defined as full-thickness skin loss and any recording on the chart of an ulceration that needed dressing or referral. The record study checked whether foot problems had occurred at any time in the complete period of 1993–1998. In patients with multiple episodes, an ulceration was defined as new if any previous ulceration had healed at least 1 year before. All chronic ulcerations were recorded only once. When there was no actual mention of ulceration in the patients' records, a grading of 3 or 4 was defined as a pressure mark. Additional information was collected on all recorded treatments of foot ulceration, whether dressed in the family practice or referred to a chiropodist or medical specialist.

To limit the amount of missing data from absence of annual reviews, death, or clinical deterioration, all the records of deceased patients, those who had moved to a nursing home, those who had been referred to a medical specialist for treatment of diabetes, and those whose annual reviews had been irregular were scrutinized. Furthermore, the records of all amputees were examined to establish whether ulceration had preceded the amputation. All additional information was added to the NMP database.

Statistical analysis
The annual incidence of foot ulceration was defined as the number of type 2 diabetic patients in the study population who developed a new foot ulceration during the year. The annual incidence of lower limb amputation was similarly defined. We calculated the incidence for patient-years. Because patients entered and left the study population every year, we calculated the true patient-years. The calculation rule is shown in Table 1.

The database of the NMP was analyzed using SPSS version 8.0. Frequencies and means with SD were calculated with the SAS package. Of the patients with an annual evaluation, we compared diabetic patients with and without foot problems annually from 1993 to 1998 in respect to the following characteristics: age, sex, duration of diabetes, HbA_{1c}, fasting blood glucose levels, systolic and diastolic blood pressure, cardiovascular morbidity, absent Achilles tendon reflex, absent peripheral foot pulse (one or more), serum cholesterol levels, retinopathy, and smoking habits.

Morbidity and causes of death were defined according to the definitions of the International Classification of Health Problems in Primary Care (26). To analyze the differences between the patients with and without diabetes-related foot problems, we used χ^2, Mantel Haenszel χ^2, and likelihood ratio χ^2 tests. $P < 0.05$ was considered statistically significant.

RESULTS

Study population
The study population increased slightly due to a growing number of new intakes each year. The male-to-female ratio and mean age of the study population remained constant over the years. The mean ($\pm$ SD) duration of diabetes increased from 5.7 ± 3.8 years in 1993 to 6.5 ± 5.0 years in 1997. On average, 7.4% (range

Table 1—Study population in the NMP

Year	N	NI	Male (%)	MA (years)	MDD (years)	Died (%)	NH (%)	M (%)	SC (%)	NDA (%)	Patient-years
1993	552	42	38	67.4	5.7 (0–28)	3.6	0.9	2.7	3.6	2.2	511
1994	579	56	40	67.5	6.0 (0–18)	5.0	1.0	2.8	3.3	1.9	526
1995	614	80	41	67.7	6.0 (0–22)	3.6	0.5	1.8	1.8	3.7	556
1996	655	71	42	67.6	6.3 (0–24)	5.2	0.9	1.8	2.3	3.2	594
1997	682	71	42	67.2	6.5 (0–21)	5.1	0.9	1.9	1.2	2.6	621
1998	745	111	43	67.1	6.4 (0–34)	5.0	0.8	0.8	2.3	1.2	665

M, moved; MA, mean age; MDD, mean diabetes duration (range); NDA, no data available; NH, nursing home; NI, new intakes; SC, specialist care. Patient-years = $n - (0.5 \times NI) - (0.5 \times died) - (0.5 \times NH) - (0.5 \times M)$.

5.9–8.8) of the study population left the NMP because of death, admission in a nursing home, or moving to another area. A varying number of patients were under specialist care (Table 1).

Diabetes treatment changed minimally over the years, with means of 18.6% (range 17–22) of the patients being treated with diet only, 62% (60–65) with oral blood glucose–lowering agents, and 12.6% (11–14) with insulin; in an average of 6.6% (4–8), treatment was unknown.

Incidence of diabetic foot ulcers and lower limb amputation

During the study period, there were 73 episodes of ulceration in 52 patients; 56 episodes were unilateral, and 17 were bilateral. The annual incidence of foot ulceration varied from 1.2 to 3.0% (mean 2.1, 95% CI 1.52–2.28) (Table 2). Table 3 shows the characteristics of the patients. When reviewed year to year, a mean of 32% of the patients with ulceration were men, and 12–40% of the ulcerations were bilateral. Of the 52 patients with foot ulceration, 26 died during the study period.

Table 2—Incidence of foot ulceration and lower limb amputations in type 2 diabetic patients

Year	Patient-years	U	IU (%)	A	IA (%)
1993	511	10	2.0	3	0.6
1994	526	10	1.9	3	0.6
1995	556	11	2.0	3*	0.5
1996	594	18	3.0	5†	0.8
1997	621	16	2.6	3*	0.5
1998	665	8	1.2	3	0.5

*Two patients with previous amputation; †one patient with previous amputation. A, patients with lower limb amputation; IA, incidence of patients with lower limb amputation per patient-year; IU, incidence of patients with foot ulceration per patient-year; U, patients with foot ulceration.

Twelve of the 52 (23%) patients with ulceration had a subsequent amputation (10 patients) or a previous history of amputation (2 patients).

During the study period, 15 patients had 28 amputations: 11 had an amputation of a toe, 1 had a partial foot amputation, 7 had an amputation below the knee, and 9 had an amputation above the knee. In 1994, one patient had three amputations; in 1995, two patients had two amputations; and in each of the following years, only one patient had two amputations. The annual incidence of amputation varied from 0.5 to 0.8% (mean 0.6, 95% CI 0.37–0.56) (Table 2). In 12 of the 15 (80%) patients, ulceration preceded amputation and was characterized by infection and necrosis. Of the 15 patients with amputation, 13 patients had peripheral vascular disease, and from studying patient records, 5 were known to have sensory polyneuropathy. Four patients had bypass surgery before the amputation. Ten patients were referred to a surgeon or vascular surgeon within 4 months of existing ulceration, four were referred later, and one patient's data were unknown.

Table 3—Clinical characteristics of patients with foot ulceration and lower limb amputations

	Patients with foot ulceration	Patients with lower limb amputation
n	52	15
M/F (%)	38/62	67/33
Mean age (years)	75.0 (54.0–94.0)	72.3 (59.0–90.0)
Mean diabetes duration (years)	8.9 (1.0–19.0)	10.3 (1.0–25.0)
With one- or two-sided foot ulceration	37/15	10/5
With recurrences	13	
Two episodes	5	
Three episodes	7	
Four episodes	1	
With multiple amputations		8
Two amputations		4
Three amputations		3
Four amputations		1
Second/third amputation at higher level		6
With a chronic non-healing ulcer	2	
With an amputation or a history of amputation	12	
With a foot ulceration preceding (first) amputation		12

Data are n and mean (range).

Two-thirds of the amputees were men. The mortality rate was high: 10 of the 15 patients died, 4 of whom died at the hospital during their stay for amputation. The other six patients survived on average 1.8 years (range 1–3) after their first amputation. The causes of death in these 10 patients were complications of infection and necrosis in the amputated leg in four patients, cerebrovascular accident in two, myocardial infarction in two, and heart failure in one (data unknown for one patient). For further characteristics of the amputees, see Table 3.

In each of the 6 study years, patients with foot problems were older than those without (mean 75 vs. 67 years of age), more patients had cardiovascular disease (mean 70 vs. 30%), more had at least one absent peripheral pulse (mean 67 vs. 38%), and more had retinopathy (significant only during the last 3 years). There were no differences between patients with and without foot problems that year in regard to sex distribution, HbA$_{1c}$, fasting blood glucose levels, duration of diabetes, systolic and diastolic blood pressures, serum cholesterol levels, and smoking habits. Significance of absence of Achilles tendon reflex could not be determined due to incomplete registration (data not shown).

In 35 of the 73 (48%) episodes of ulceration, the only treatment was provided by the family physician. In the other 38 episodes, patients were mostly referred to a surgeon (23 of 38 [60%]), followed by a chiropodist (10 of 38 [26%]), and a dermatologist (9 of 38 [24%]). In nine cases, more than one specialist was consulted.

CONCLUSIONS — The incidence of new episodes of foot ulceration in type 2 diabetic patients in a primary care setting was 2.1% per year, and amputations were 0.6% per year. To our knowledge, this is the first study to report on the incidence of diabetic foot ulceration in an unselected population of type 2 diabetic patients during 6 successive years. It is the first study to report on the incidence of lower limb amputations in the Netherlands in an unselected population. Of the patients with an ulcer, 62% were women, although other studies have reported a preponderance of men or equality between the sexes (4,27). In 25% of all patients with foot ulceration, there were one or more recurrent episodes, showing the high risk of relapse. A high percentage of

patients with ulceration (23%) had a lower limb amputation or a previous history of amputation. This is in accordance with the findings of others (28). More than one-half of the patients had more than one amputation, and in 75% of the cases, the subsequent amputation was at a higher level than the last. The high mortality (67%) in our study is comparable with that quoted in other reports (27), as is the occurrence of ulceration preceding the first amputation (28).

Overall, patients with foot problems were older than those without and were more likely to have cardiovascular disease, at least one absent peripheral pulse, and retinopathy. This is in accordance with other studies that defined these and other risk factors (4,6,11,18,26). The physicians in the NMP referred about one-half of their patients with ulcers, most frequently to a surgeon or chiropodist. There was no multidisciplinary foot care team in the NMP practice area, although previous studies have shown that treatment by a specialized multidisciplinary foot care team can reduce the need for hospitalization and amputation (14–17). As referral of all patients to a multidisciplinary foot care team is not yet feasible in the Netherlands, more research is needed to determine whether all type 2 diabetic patients should be referred to a medical specialist or chiropodist.

In the Dutch health care system, all known diabetic patients are on the list of a family physician. The population described in this study consists of all known type 2 diabetic patients in primary health care in the NMP. Therefore, we believe our study population can be assumed to be representative for all known type 2 diabetic patients in the general population. Review of the patients' records covered the whole study period and was not confined to the information provided by the annual evaluation. The records of all deceased patients, those who moved to a nursing home, those under specialist care, and those with irregular annual reviews were scrutinized, along with those patients with at least one registration of pressure mark, ulceration, or amputation. For this reason, we believe our data on incidence of foot ulceration and amputation are accurate. Only a few foot ulcers could have been missed because the records of patients with abnormalities and/or mycosis of the nails or with no foot abnormalities registered on the annual re-

view were not examined. Studies outside the Netherlands only report the prevalence of diabetes-related foot ulceration or only include those patients treated by specialist or include type 1 and type 2 diabetic patients (4–7).

Our incidence rate for foot ulceration is low, and the incidence of lower limb amputations is slightly higher compared with two previous studies from Germany and Finland (8,9). Although no feedback has been given on diabetic foot problems in the NMP, it can be guessed that participating in the monitoring system has made family physicians more dedicated to the care of their diabetic patients. Those aspects of diabetes care that have not explicitly been put under attention in the monthly feedback sessions of the family physician, such as foot care, could also be improved. Nevertheless, the diabetic foot is an underestimated problem by family physicians in the Netherlands. Study of the patient records showed that doctors significantly differ in treatment and means for secondary prevention; possibly, late referral to a surgeon for vascular bypass surgery did not prevent a number of lower limb amputations. The family physicians did not use any kind of classification of foot ulceration in their diabetic patients. Although the incidence of foot ulceration and lower limb amputation is relatively low, foot care in diabetic patients in primary care can be improved.

In conclusion, the incidence of foot ulceration and lower limb amputation is low in type 2 diabetic patients in primary health care. However, the recurrence rate and risk for subsequent need for amputation are high, with high subsequent mortality. This emphasizes the need and challenge for all those who provide diabetes care in type 2 diabetic patients to recognize and refer high-risk patients as early as possible.

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