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Chapter 3

Trends in Amputation

F. Santosa and K. Kröger

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http://dx.doi.org/10.5772/52175

1. Introduction

Representatives of government health departments and patients' organisations from all European countries met with diabetes experts under the aegis of WHO Regional Offices for Europe and the International Diabetes Federation (IDF), European region, in St Vincent, Italy on 10–12 October 1989. Within this declaration of the five-year targets was to reduce by one half the rates of limb amputations for diabetic gangrene.

There is an ongoing discussion whether this target could be achieved. In the recent years some data were published presenting promising numbers of decreasing amputation rates.

2. United States

Rowe et al. analysed data from a Nationwide Inpatient Sample (NIS) from 1996-2005 in the United States (Rowe et al. 2009). The NIS included 74 millions discharge records and was used as source data regarding treatment patterns for patients with PAD. Since 1988, the NIS has constructed a dataset comprising approximately 20% of the hospital discharges within the United States. In order to develop a sample that most accurately represents the total universe of domestic hospitalizations, hospitals are sampled according to specific characteristics (strata), including geographic region, hospital ownership, urban/rural location, and teaching status. Each discharge in the NIS dataset, therefore represents approximately five domestic discharges. This 5:1 ratio is not constant across the NIS sample, however. Certain combinations of strata may be under-sampled or over-sampled due to pragmatic considerations of sampling design. When this occurs, the importance (weight) assigned to a specific hospitalization may be greater or less than five. Unless specifically stated, all data and analyses in this study are reported using the weighting scheme included with the NIS.

Average annual admissions receiving major amputation in the years 1996 to 2005 were 41,275. 53.2% were females. Individuals undergoing major amputation were older (72.2 years) than those that had open or endovascular procedures performed. The number of major amputations fell significantly between 1996 and 2005, by an estimated 6.4% per year (P <0.05) (Fig 1). Rates of decrease were more dramatic in the above 75 age group than in the younger age groups.

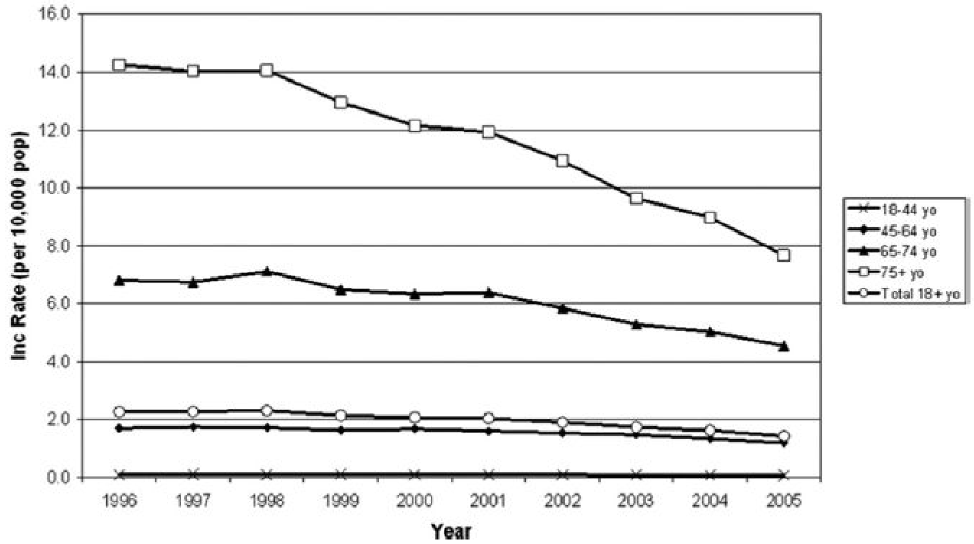

Figure 1. Rates of major amputation for peripheral arterial disease by age in the United States from 1996 to 2005. Overall incidence rate reflects population-adjusted incidence rate among individuals aged 18years and older in the United States (adjusted to 1996 population). (Rowe et al., 2009)

The authors also analyzed population-based rates of major amputation by diagnosis (PAD, non-atheroslerotic PVD, infection, malignancy, trauma, and other/unspecified). The vast majority of the reduction in population-based rates of major lower extremity amputations is due to decreases in amputation rates for PAD (Fig. 2).

A more recent publication from Li et al. based on the same population analysed the period from 1988 to 2008. The age-adjusted nontraumatic lower-extremity amputation per 1,000 persons among those diagnosed with diabetes and aged ≥40 years decreased from 11.2 in 1996 to 3.9 in 2008 (absolute percent -8.6%; P < 0.01), while rates among persons without diagnosed diabetes changed little. (Li et al., 2012)

In 2009 Goodney et al. published data based on the Medicare population (Goodney et al., 2009). The Medicare population included all people 65 years and older and regardless of age, every citizen with a recognized disability and each citizen with acute renal failure, which makes long-term dialysis or a kidney transplant needed. All Medicare claims from the Centers for Medicare and Medicaid Services between 1996 and 2006, using the Medicare Physician/ Supplier Procedure Summary Master File were included. This is a 100% sample of all Part B claims from all insurance carriers. Codes including a 250 modifier represented a procedure done on both sides of the body; therefore, any code with this modifier was multiplied by two in order to account for each limb. The absolute size of the Medicare population remained was rather stable over the study period, (31.7 million beneficiaries in 1996, 31.9 million beneficiaries in 2006). Presented were only unadjusted data reported per 100,000 beneficiaries. Rates of major amputations, defined as above-knee or below-knee amputation, coded according to current procedural terminology were examined over the study period. Given that lesser amputations at the metatarsal or single toe level are not generally considered failures of limb salvage, amputations at lesser levels were not included in this analysis. To allow for comparison over time, annual rates were again normalized to reflect incidence rates per 100,000 Medicare beneficiaries, and RRs were calculated similarly as above. The author assumed that the proportion of major lower extremity amputation due to peripheral vascular disease remained constant over the study period, as prior analyses have demonstrated that fewer than 15% of major lower extremity amputations are traumatic in nature, and little change has occurred in the incidence of traumatic amputation in recent years.

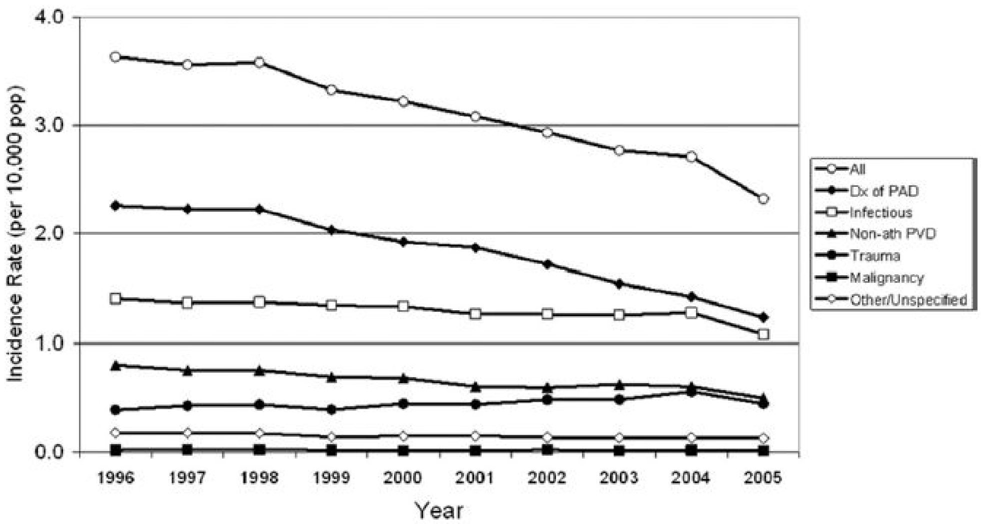

Figure 2. Rates of major amputation by indication in the United States from 1996 to 2005. Incidence rates are population-adjusted to 1996. (Rowe et al., 2009)

A distinct decline in the population based rates of major lower extremity amputation occurred between 1996 and 2006 (Fig. 3)). Overall, the rate of below and above-knee amputation decreased from 263 to 188 amputations per 100,000 Medicare beneficiaries, a 29% decline (RR 0.71, 95% CI 0.6-0.8). This decline began in 2000, and remains progressive throughout the next 6 years. Results were not different if above-knee amputations were studied distinctly from below-knee amputations as both decreased in similar magnitude.

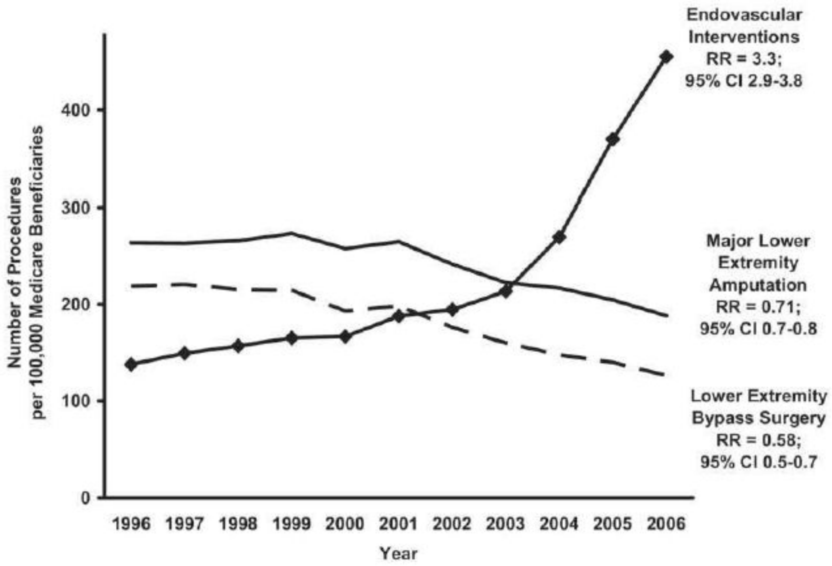

Figure 3. Trends in endovascular interventions, major amputation, and lower extremity bypass surgery, 1996-2006. *RR,*Risk ratio; *CI,* confidence interval. (Goodney et al., 2009)

3. Australia

In contrast to the data from the United States the number of diabetes-related hospitalisations for major lower limb amputation did not show a significant trend in Far North Queensland, Australia. (O'Rouke et al. 2012). There was a discrepancy of 6 (3.7%) in 161 cases over 10 years from 1998-99 to 2007-08. The number of diabetes-related hospitalisations for major lower limb amputation did not show a significant trend during this period, with an annual percentage change of -0.32% (P=0.915). Thus, there was a modest reduction in the hospitalisation rate for major lower limb amputation over the 10-year period only, demonstrating the need for improvements in the organisation of care.

4. United Kingdom

Recent data from the United Kingdom are in line with the findings from Australia. Vamos et al identified all patients aged >16 years who underwent any nontraumatic amputation in England between 2004 and 2008 using national hospital activity data from all National Health Service hospitals. During the study period the incidence of diabetes-related amputations decreased by 9.1%, from 27.5 to 25.0 per 10,000 people with diabetes (p>0.2) (Fig. 4). The incidence of minor and major amputations did not significantly change (15.7-14.9 and 11.8-10.2 per 10,000 people with diabetes; p=0.66 and p=0.29, respectively). Poisson regression analysis showed no statistically significant change in diabetes-related amputation incidence over time (0.98 decrease per year [95% CI 0.93-1.02]; p=0.12) (Vamos et a. 2010).

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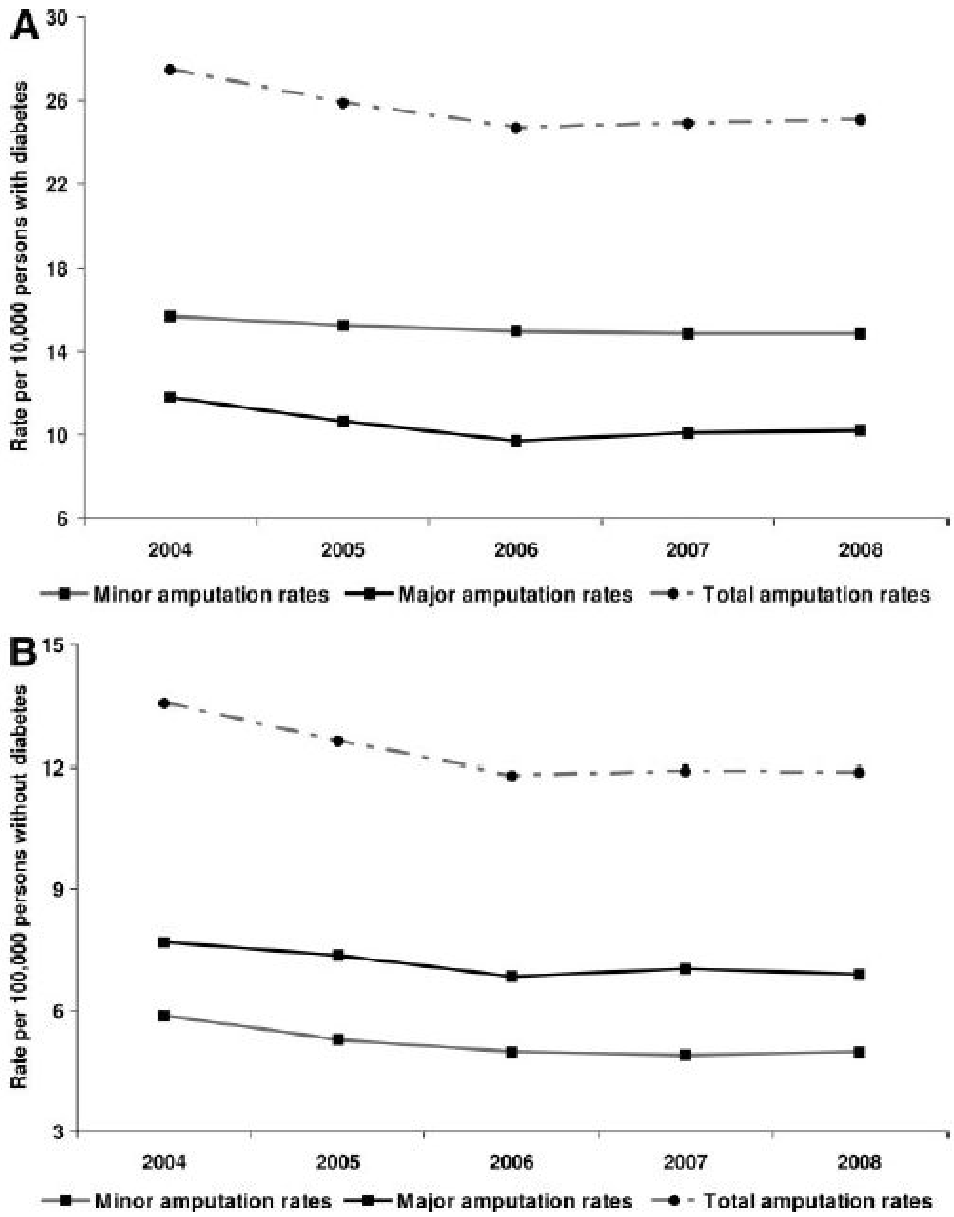

Figure 4. Changes in minor and major amputation incidence rates in (A) individuals with diabetes expressed per 10,000 people with diabetes and (B) individuals without diabetes expressed per 100,000 people without diabetes. (Vamos et al. 2010)

Incidence of lower extremity amputations was significantly higher among men than among women with diabetes ($P < 0.001$). However, changes in overall lower extremity amputations rates did not significantly differ between men and women (19.9 to 18.3 vs. 7.6 to 6.7 per 10,000 people with diabetes; $P = 0.81$). When stratified by age, the incidence was the highest among individuals aged ≥65 years in both men and women. Poisson regression analysis showed no significant decrease in incidence of amputations after adjustment for age, sex, year, and level of amputation (0.98 decrease per year [95% CI 0.93–1.02]; $P = 0.12$).

The number of people without diabetes who underwent a lower extremity amputations decreased during the study period. Although the percentage of men undergoing minor amputations increased significantly, male predominance was not evident among minor amputees. Amputation incidence (minor and major combined) decreased from 13.6 per 100,000 people without diabetes in 2004 to 11.9 per 100,000 people without diabetes in 2008.

Incidence of minor lower extremity amputations decreased significantly from 5.9 to 5.0 per 100,000 people without diabetes ($P < 0.01$). There was a nonsignificant reduction in the incidence of major lower extremity amputations among individuals without diabetes, from 7.7 to 6.9 per 100,000 people ($P = 0.39$) (Fig. 1).

The fall in lower extremity amputations rates was achieved between 2004 and 2006, and incidence rates remained constant afterward for both minor and major procedures. Incidence of lower extremity amputations declined among both men and women.

Poisson regression analysis showed that the decline in nondiabetes-related lower extremity amputations was marginally significant after adjustment for age, sex, level of amputation, and year (0.97 decrease by year [95% CI 0.93–1.00], $P= 0.059$).

5. Spain

A Spanish analysis did not report a decrease in the incidence of lower limb amputation in Andalusia from 1998 to 2006 in the population with and without diabetes (Almaraz et al., 2012). Andalusia, one of the 17th Spanish Autonomous Communities in Spain, had a total population of 7,975,672 inhabitants in 2006. The Andalusian Health Service, guarantees health care to almost 100% of the population (free, universal care). The information system is the same for the whole of Andalusia and all main diagnosis from people admitted to hospital are recorded in the CMBD (Conjunto Mı´nimo Ba´ sico de Datos, a basic set of data), at patient discharge. This data collection (CMBD) is mandatory and this collection of data with a standardized methodology was introduced in Spain in 1982. These data are registered in accordance with the ICD-9-CM, and then send them to the Andalusian Health Service Central Services.

During the study period 1998–2006 a total of 16,210 lower limb amputations were performed in people aged ≥30 years old in Andalusia. Of these, 11,770 (72.6%) were in patients with diabetes mellitus and 4440 (27.4%) in individuals without diabetes mellitus. The average age of patients who underwent lower limb amputations was (mean ± SD): 70.6 ± 11.6 years; patients with diabetes mellitus were aged 70.3 ± 10.7 years and patients without diabetes mellitus were 71.3 ± 13.7 years old ($p <0.05$). In the population with diabetes the standardized incidence of all lower limb amputation was found to be 34.0 per 10,000 (95% CI, 31.5-37.2) in 2004-2006. There was an estimated incidence increase for all lower limb amputation by 14% and for minor lower limb amputation by 13.6% in 2004-2006. In people with diabetes the RR increased by 31.6% as compared to the first period (Fig. 5).

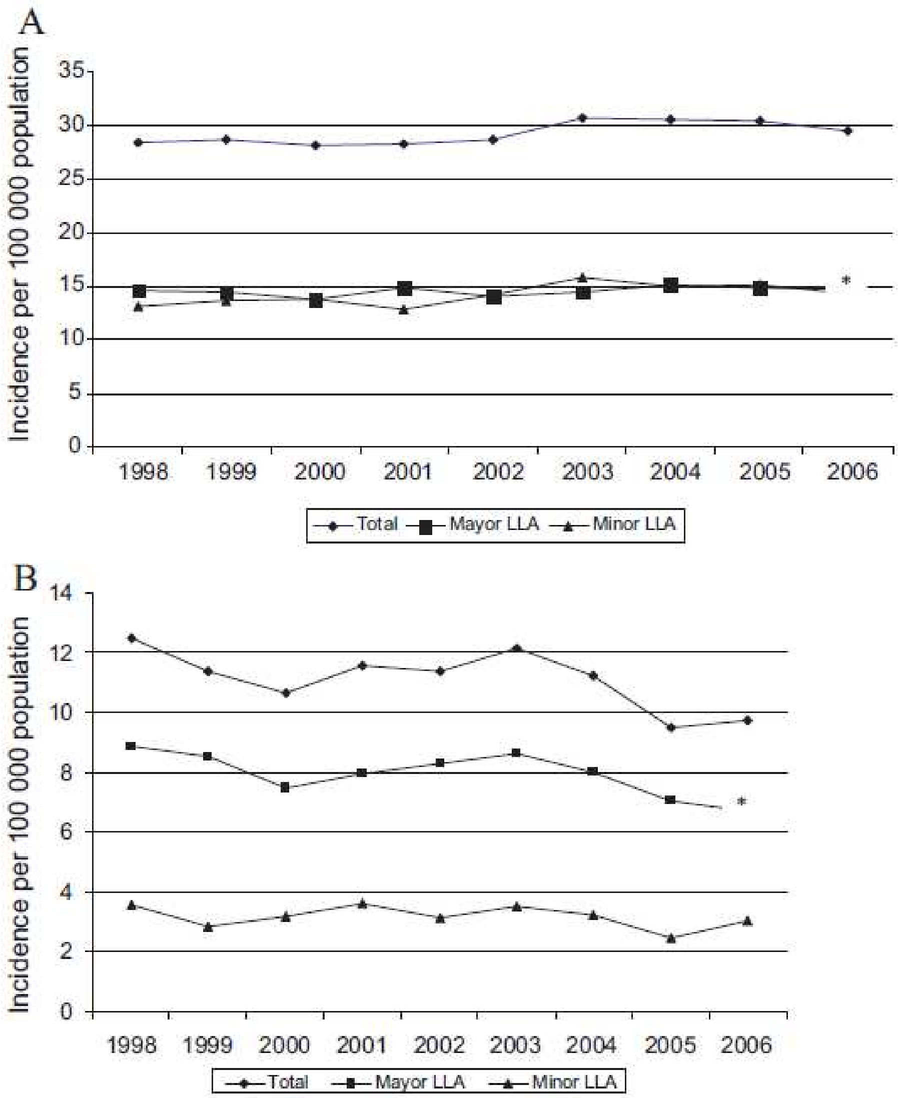

Figure 5. Changes in total, major and minor LLA incidence rates in patients with diabetes mellitus (A) and without diabetes mellitus (B) expressed per 100,000 inhabitants. *$p < 0.05$ (Poisson regression analysis).(Almaraz et al. 2012)

6. Germany

In 2011 Moysidis et al published data from Germany based on the national statistics (DRG statistics) provided from the Federal Statistical Office. The DRG-statistics include data from all hospitals in Germany that use the DRG system, which are more than 99 %. These hospitals are legally obliged to deliver extensive data on hospital treatment, including demographic data, diagnoses, co-morbidities, complications, and procedures to the "Institute for the Hospital Remuneration System" which uses the data for a yearly adaptation of the German DRG system and transmits them to the Federal Statistical Office.

Major amputation							
		total	< 50	50-60	60-70	70-80	"/>80
all							
	2005	23.3	1	14	43	94	181
	2006	22.6	1	14	41	87	173
	2007	21.8	1	14	37	85	161
	2008	21.0	1	13	36	79	153
Males							
	2005	27.0	1	22	67	135	216
	2006	26.6	1	23	65	125	208
	2007	25.6	2	22	59	124	180
	2008	25.1	1	21	58	116	178
Females							
	2005	19.7	1	5	20	63	168
	2006	18.7	1	6	18	57	158
	2007	18.2	1	6	16	54	152
	2008	17.1	1	5	16	49	142
Minor amputation							
		total	< 50	50-60	60-70	70-80	"/>80
all							
	2005	35.0	3	31	79	144	183
	2006	36.1	3	33	81	147	180
	2007	36.6	3	33	78	148	180
	2008	38.1	3	33	80	148	192
Males							
	2005	47.4	4	51	129	224	266
	2006	49.5	4	54	133	230	259
	2007	50.6	4	54	129	234	261
	2008	53.7	4	55	134	240	285
Females							
	2005	23.1	2	12	31	83	150
	2006	23.1	1	11	32	82	148
	2007	23.1	2	12	29	80	146
	2008	23.2	2	11	29	76	151

Table 1. Age-adjusted incidence of major (OPS 5 – 864) and minor (OPS 5 – 865) amputations per 100.000 inhabitants in Germany from 2005 to 2008 excluding those patients amputated for injury and toxicity, musculoskeletal disorder, diseases of skin and subcutaneous tissue and malignant neoplasm. (Moysidis et al. 2011)

The total number of patients hospitalised with the principal diagnosis peripheral arterial disease and neurovascular disease increased from 163,520 in 2005 to 178,086 in 2008. Within

http://dx.doi.org/10.5772/52175

the same time period the total number of major amputations decreased from 25,315 in 2005 to 23,009 in 2008 whilst the number of minor amputations increased form 37,690 in 2005 to 40,276 in 2008. After age adjustment major amputation rates still decreased for both genders (Tab. 1) Overall minor amputation rates do not show such a decrease but increased in males and remained unchanged in females.

7. Discussion

All in all there is a great variation in the incidence of lower extremity amputations, even within one country. In England the incidences of amputations in adults determined from hospital episode statistics over 3 years to 31 March 2010 showed large variation between 151 Primary Care Trusts. Incidence varied eightfold across Primary Care Trusts in people both with diabetes (range 0.64-5.25 per 1,000 person-years) and without (0.03-0.24 per 1,000 person-years). Amputations in people with diabetes varied tenfold-both major (range 0.22-2.20 per 1,000 person-years) and minor (range 0.30-3.25 per 1,000 person-years). (Holman et al. 2012).

Moxey et al. performed an electronic search using the EMBASE and MEDLINE databases from 1989 until 2010 for incidence of lower extremity amputation. There reviewed showed significant global variation exists in the incidence of lower extremity amputation. Incidence of all forms of lower extremity amputation ranges from 46.1 to 9600 per 100.000 in the population with diabetes compared with 5.8-31 per 100.000 in the total population. Major amputation ranges from 5.6 to 600 per 100.000 in the population with diabetes and from 3.6 to 68.4 per 100.000 in the total population (Moxey et al., 2011). The authors mad the following conclusions:

- Significant reductions in incidence of lower extremity amputation have been shown in specific at-risk populations after the introduction of specialist diabetic foot clinics.
- Ethnicity and social deprivation play a significant role but it is the role of diabetes and its complications that is most profound.
- Lower extremity amputation reporting methods demonstrate significant variation with no single standard upon which to benchmark care.

Thus, all data and the specific conclusion drawn from these data, respectively, have to be handled with care as there are no lower extremity amputation reporting standards used that would allow benchmark (Moxey et al., 2011). Especially data regarding minor amputation rates can be assumed to underestimate the truth. An unknown but probably high number of patients suffering from foot lesion is effectively treated in outdoor settings and do not appear in the analysed data basis. In light of the rising prevalence of diabetes mellitus minor amputations might mirror the burden of the problem more accurately, whereas major amputation rates might give an insight in effectiveness of treatment strategies. Minor amputation rates that do not decrease or even increase show that prevention of foot lesions is not effectively achieved. Decreasing major amputations rates show, that if patients will get optimal treatment this treatment is able to prevent deterioration of the lesion in some patients.

Author details

F. Santosa[1] and K. Kröger[2]
1 Klinik Angiologi & Kardiologi "Waringin Medika", Jakarta, Indonesia
2 Department of Angiology, HELIOS Klinikum Krefeld, Germany

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