

Relative mortality in lower limb amputees with diabetes mellitus

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Abstract

A nationwide epidemiological study included 3516 primary major lower limb amputations in diabetic patients, during the period 1982 to 1992. On this well defined diabetic amputee population the relative mortality (Standard Mortality Ratio, SMR) has been analysed. The mortality rate was found to be 8 times the expected during the first year following amputation. The relative mortality is higher for females than males. An inverse relation between age and SMR was found, and the SMR was significantly related to the level of amputation. No significant difference could be detected when analysing SMR in relation to subdiagnosis (NIDDM vs IDDM) or SMR in relation to the period of treatment 1982-87 versus 1988-92.

Introduction

Diabetic lower limb amputation continues to represent a major socioeconomic and health problem. In Denmark the number of individuals with diabetes mellitus (DM) is estimated to increase by about 1-2 per cent per year. The number of individuals older than 75 years has increased significantly (i.e. 25 per cent during the eighties), as well as the percentage of individuals suffering from severe overweight. The percentage of heavy smokers (i.e. more than 25 cigarettes per day) is unchanged. In spite of these developments, which in fact should lead to an increasing number of amputations, the Danish Amputation Register (DAR) has noted a significant decrease in the

number of DM amputations in Denmark (Ebskov, 1991a). The reason for this decrease during the last decade is probably multifactorial, involving the effect of an increased activity of vascular surgery, better diabetic control and better medical treatment of complications, but also significantly improved podiatric care. These epidemiological considerations render it important to follow the development of diabetic amputations. Mortality is an important epidemiological factor. A large number of studies have described different types of mortality (i.e. the in-hospital, the postoperative mortality, the third month mortality, the relative mortality). However many of these epidemiological studies cover only a sub-area or a single department, and could be influenced by local demographic factors. The author suggests that the relative mortality is the most true type of mortality description because it relates the mortality in a specific group of patients with the expected mortality. Further, it is of major importance to include a substantial number of patients from a large geographic area. This study therefore is nationwide.

Material and methods

Since 1978 the Danish Amputation Register (DAR) has based its statistics on data from the National Patient Register (Ebskov, 1977; Ebskov, 1986), as also is the case in the present study. Further information is used from the Central Bureau of Personal Registration (CBPR), in which all Danish residents are recorded by means of a personal identification number. The CBPR also contains information concerning death. The DAR and the CBPR have been linked to identify the diabetic amputees

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who died during the observation period (January 1982 to December 1992).

The present study analyses the relative mortality (Standard Mortality Ratio, SMR). The reference population for computation of the SMR is the Danish population.

The material consists of 3516 primary lower limb amputations on 3516 patients performed during the period January 1982 to December 1992. None of the patients had suffered a major (defined as the transmetatarsal level or more proximal) amputation before entering the study in 1982. It was estimated that about 20 per cent of the diabetic patients entering this study had already suffered one or more toe amputations.

Data concerning age at diagnosis of diabetes and data on degree of control is not accessible.

Definitions

Primary amputation: the first admission of a person for amputation of the lower limb excluding toes.

Following amputations: any admission for amputation of the limb, ipsi- or contralateral, after the primary amputation.

Assumptions

Primary amputees suffering a following amputation during a re-admission were excluded. During the first admission when the primary amputation is executed about 18% of the patients are exposed for a revision, or a re-amputation on the ipsi- or contralateral limb.

The rationale for exclusion of the toe amputations in this study is primarily that NPR data only includes information concerning patients admitted to a hospital, whereas information from out-patient clinics, where some of the toe amputations are carried out, is not registered in the NPR.

Statistical methods

When analysing factors influencing the SMR a Cox-like analysis was used. Level of significance 5%. Confidence limits have been calculated for all relevant data. Cross-matching analysis, calculations and statistical analysis was conducted on a mainframe computer, as well as on personal computers.

Results

The male to female ratio is 1:0.86. The mean age is 71.3 yrs (min 25 yrs, max 97 yrs, median

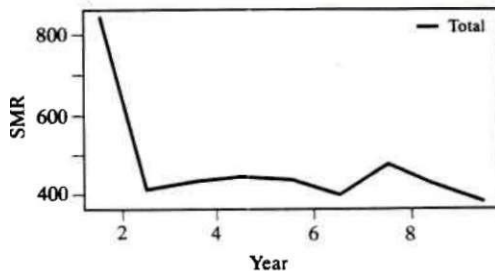


Fig. 1. The relative mortality (SMR) for the total material, with 11 years observation period.

73 yrs). At the time of amputation 14 per cent of the amputees were 59 yrs or younger; 24 per cent were between 60 and 69 yrs; 40 per cent were between 70 and 79 yrs and 22 per cent older than 80 yrs. Amputation at foot level (excluding toe amputations) accounts for 23 per cent; trans-tibial (TT) amputation for 52 per cent; knee disarticulation (KD) for 6 per cent and trans-femoral (TF) including hip disarticulation accounts for 19 per cent of the amputations. About 60 per cent of the amputees are classified as Non-insulin Dependent Diabetes Mellitus (NIDDM or Type 2 DM) and 40 per cent as Insulin Dependent Diabetes Mellitus (IDDM or Type 1 DM). Mean age for amputees with IDDM is 67 yrs, and mean age for NIDDM amputees is 73 yrs.

Figure 1 shows the SMR for the total material

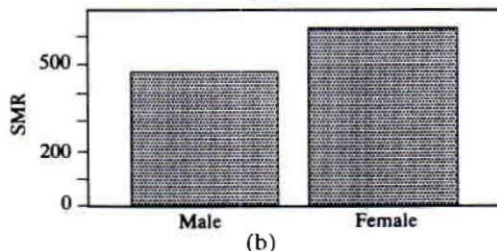
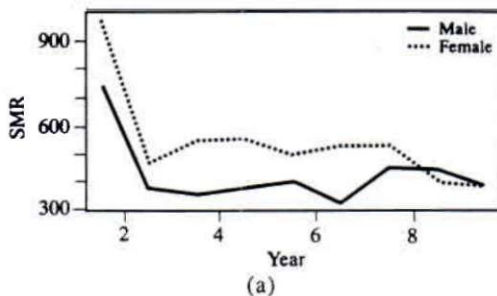


Fig. 2. (a) The relative mortality (SMR) for men and women respectively for each year in the observation period.

(b) SMR overall values for men and women.

(n=3516) as a function of year since amputation. The mortality is 8.4 times the expected mortality (95% confidence interval 7.95 - 8.9) in the first postoperative year. In the second year the mortality is 4.13 (95% confidence limits 3.8 - 4.5) times the expected mortality. During the rest of the period under study some non-significant variations are observed ranging from 4.1 to 3.8.

Figure 2a shows the SMR for men and women respectively. The tendency is obviously that the female group has the highest relative mortality in year 0 to 8. In the end of the observation period the curves tend to converge towards the same SMR.

Figure 2b show the overall values for the period, thus emphasising the higher SMR in the female group (510) versus the male group (490).

Figure 3a shows the SMR in the different age groups i.e. 0-59 yrs, 60-69 yrs, 70-79 yrs, 80 yrs and older. There seems to be an inverse relation between age and the SMR. In all but one year (i.e. year 5) the youngest amputees have the highest relative mortality and the oldest amputees have the lowest relative mortality.

Figure 3b shows the overall values for the period.

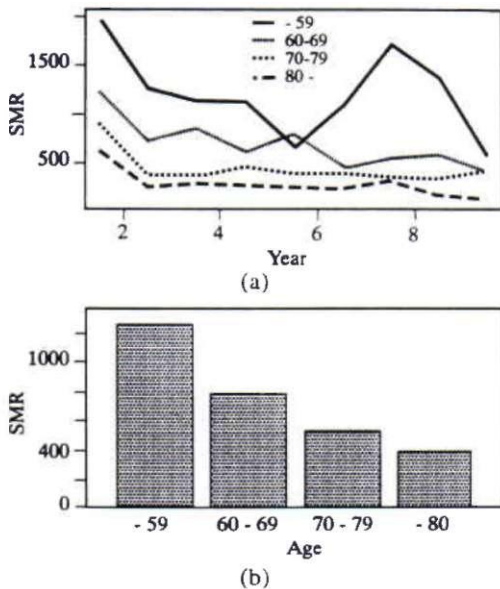


Fig. 3. (a) The relative mortality (SMR) for the age groups: \leq 59 yrs; 60-69 yrs; 70-79 yrs and \geq 80 yrs during the period. (b) SMR overall values for the different age groups.

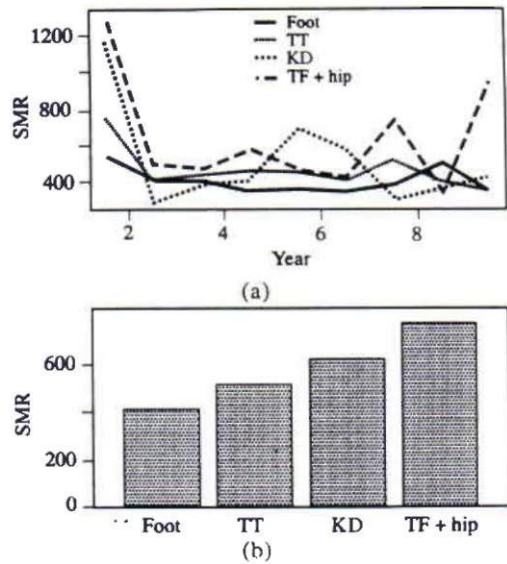


Fig. 4. (a) The relative mortality (SMR) for the level groups: foot (excl. toes); trans-tibial (TT); knee disarticulation (KD) and trans-femoral (TF) and hip. (b) SMR overall values for the level groups.

When the relation between the relative mortality and the level of amputation is analysed a somewhat surprising pattern is found (Fig. 4a). In year zero the relative mortality is significantly related to the level of amputation so that amputation at foot level implies the smallest SMR (5.39 times the expected mortality, 95% confidence limits 4.57 - 6.36), trans-tibial amputation has a significantly higher relative mortality (7.59 times the expected, 95% confidence limits 6.99 - 8.24), knee disarticulation and trans-femoral amputation again show a similar and significantly higher relative mortality (about 13 times the expected). This strong relation between level of amputation and SMR in year zero is found to be much less pronounced in the remaining period. The overall values (Fig. 4b) shows the differences for the period in total.

Analysis of NIDDM versus IDDM (Figs. 5a and 5b) shows that amputees with IDDM have a higher relative mortality.

It was not possible to detect any period-related (year 1982-87 versus year 1988-92) differences in the SMR.

A Cox-like multivariate analysis was performed regarding SMR and the confounders under study. It was found that sex, age and level of amputation significantly influence the SMR.

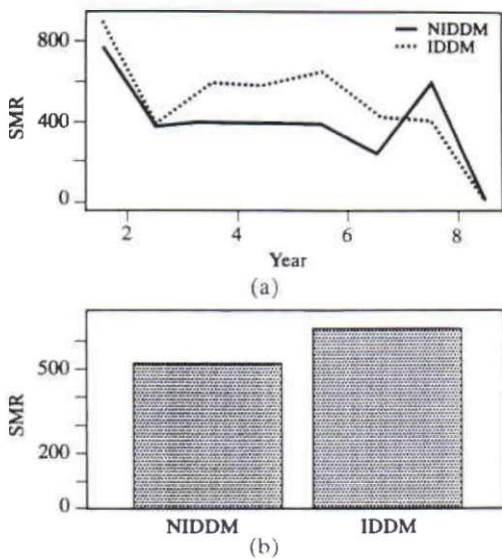


Fig. 5. (a) The relative mortality (SMR) for NIDDM respectively IDDM during the period.
(b) SMR overall values for NIDDM and IDDM.

Discussion

Denmark has a population of 5.1 million. In 1976 the Danish National Health Board established the NPR ordering all somatic hospitals to submit standardised registration on all in-patients admitted. In several studies the NPR has been found valid for epidemiological studies. The DAR was established in 1972 and from 1978 DAR has based its statistics on data from the NPR, as was the case in the present study. Data from the CBPR - especially the date of death - has been used in this study, in order to identify the diabetic amputees who died during the period of observation i.e. January 1982 to December 1992.

The present study represents the first published study analysing the SMR with a full national coverage, thus excluding local demographic factors. The overall epidemiologic characteristics i.e. age, sex, and amputation level distribution for the material is comparable to most other studies dealing with amputation on patients suffering from DM. The author has (Ebskov, 1991a) previously discussed the discrepancy at the national level, between the decrease in the number of DM amputations and the increasing number of diabetic patients, who have a 15-fold higher risk of amputation (Most and Sinnock, 1986) than non-diabetic individuals. Other authors have detected

significant local reductions in the number of lower limb amputations (Edmonds *et al.*, 1986; Falkenberg, 1990; Runyan, 1975; Lippman, 1979; Larsson, 1994).

A large number of authors (Lippman, 1979; Larsson, 1994; Hansson, 1964; Whitehouse *et al.*, 1968; Kolind-Sørensen, 1974; Ebskov and Josephson, 1980; Finch *et al.*, 1980; Mandrup-Poulsen and Jensen, 1982; Burgess and Romano, 1971; Persson and Suden, 1971; Ebskov, 1991b; Pohjolainen and Alaranta, 1988; Stewart *et al.*, 1992) have analysed the mortality (in-hospital, postoperative, SMR) or the long term survival for vascular insufficiency amputations (with or without diabetes). Fewer have examined exclusively diabetic cases (Larsson, 1994; Hansson, 1964; Pohjolainen and Alaranta, 1988; Stewart *et al.*, 1992; Silbert, 1952; Nelson *et al.*, 1988). As mentioned by some authors (Mandrup-Poulsen and Jensen, 1982; Stewart *et al.*, 1992) there are major differences in defining the materials as regards important determinants like post-operative period, hospitalisation time, age, amputation level (especially inclusion of toe-amputations) and etiology of amputation cause. Further the materials are of variable size and the degree of specialisation for the clinics involved is different. All these factors have a major influence on the results. It is evident that the variations between definitions as stated above lead to severe difficulties in comparison of the results from different studies. This study attempted to exclude or minimise some of these limitations by analysing the SMR on a national level.

It has only been possible to find two studies (Larsson, 1994; Stewart *et al.*, 1992) analysing the relative mortality exclusively for diabetic amputees, with a longer observation period, but no studies have had an observation period of 12 years as in the present study.

The main finding is that mortality is about 8 times more than normal during the first year after amputation. Thereafter the mortality is about 4 times the normal. The magnitude of the mortality during the first year is probably a consequence of the direct post-operative mortality or the in-hospital mortality, which in Denmark accounts for approximately 10 per cent during an average length of stay for an amputation admission of about 37 days. One year after amputation the mortality of the amputated diabetic patients is similar to the

mortality of the non-amputated diabetics, but still significantly higher than the background population. The mortality for non-amputated diabetics varies considerably. In Denmark Deckert *et al.*, (1979) found a relative mortality of 200-600 per cent (IDDM, Decrement analysis) Borch-Johnsen (1989) found that when 10 per cent of the background population are dead, more than 50 per cent of the diabetic (IDDM) population are dead. Concerning NIDDM patients the mortality is about 2-3 times the background population (Beck-Nielson *et al.*, 1990). Kessler (1971) found a relative mortality about 140-240 per cent (SMR, NIDDM and IDDM), and Garcia *et al.*, (1974) found a relative mortality from cardiovascular causes for males of 200 per cent and females 450 per cent (SMR, NIDDM and IDDM). This relation between background population, diabetic non-amputees and diabetic amputees as regards relative mortality can be explained by the presence, the degree and the severity of their diabetes. Nelson (1988) found significantly higher death rates in diabetic amputees than in diabetic non-amputees (death rate ratio from 1.4 to 3.9).

In this study sex was found to be significantly related to the relative mortality. The higher mortality among women corresponds to the findings of Nelson (1988) concerning death rates for female NIDDM patients (above 45 years).

The relation between age and SMR was expected, as well as the relation between level and SMR, but it was surprising to find the differences much less pronounced after the first year, even though the differences between the mean values from the period are significant. Most studies concerning diabetic amputations do not distinguish between NIDDM and IDDM. In the present study it was possible to differentiate between IDDM and NIDDM from 1987 onwards. With reservation for the limited observation period no significant difference was found in SMR for NIDDM in relation to IDDM. However the tendency was obviously a higher SMR in the IDDM group.

In Denmark the only major epidemiological factor which could have altered the mortality for the patients is the increase in vascular surgery (Seidelin and Eickhoff, 1995; Ebskov *et al.*, 1994) so that a larger proportion of patients (about 40%) before amputation has been operated on one or several times in vascular

surgical limb salvage procedures. It is important to emphasise that the mean age in the period under study is unchanged. No other studies have analysed SMR over time but Stewart *et al.* (1992) found that survival has improved significantly during the last 25 years. The author could not demonstrate any significant change in SMR, possibly because of the limited period under study.

REFERENCES

- BECK-NIELSON H, DAMSGAARD EM, FABER O, JØRGENSEN FS, SØRENSEN NS (1990). Non-insulin-dependent diabetes mellitus. Diagnosis and treatment: an explanatory report. *Ugeskr Læger* **152**, 2-10.
- BORCH-JOHNSEN K (1989). The prognosis of insulin-dependent diabetes mellitus. An epidemiological approach. Thesis, Lægeforeningens Forlag.
- BURGESS EM, ROMANO RL (1971). Amputation of leg for peripheral vascular insufficiency. *J Bone Joint Surg* **53A**, 874-890.
- DECKERT T, POULSEN JE, LARSEN M (1979). The prognosis of insulin-dependent diabetes mellitus and the importance of supervision. *Acta Med Scand Suppl* **624**, 48-53.
- EBSKOV B (1977). Fruhergebnisse des Dänischen amputationsregisters. *Orthopädiä Prak* **13**, 430-433.
- EBSKOV B (1986). The Danish amputation register 1972-1984. *Prosthet Orthot Int* **10**, 40-42.
- EBSKOV B, JOSEPHSEN P (1980). Incidence of reamputation and death after gangrene of the lower extremity. *Prosthet Orthot Int* **4**, 77-80.
- EBSKOV LB (1991a). Epidemiology of lower limb amputations in diabetics in Denmark (1980 to 1989). *Int Orthop* **15**, 285-288.
- EBSKOV LB (1991b). Lower limb amputations for vascular insufficiency. *Int J Rehabil Res* **14**, 59-64.
- EBSKOV LB, SCHROEDER TV, HOLSTEIN PE (1994). Epidemiology of leg amputations: the influence of vascular surgery. *Br J Surg* **81**, 1600-1603.
- EDMONDS ME, BLUDELL MP, MORRIS ME, . . . (*et al.*) (1986). Improved survival of the diabetic foot: the role of a specialised foot clinic. *Q J Med* **60**, 763-771.
- FALKENBERG M (1990). Metabolic control and amputations among diabetics in primary health care - a population based intensified program governed by patient education. *Scand J Primary Health Care* **8**, 25-29.
- FINCH DRA, MACDOUGAL M, TIBBS DJ, MORRIS J (1980). Amputation for vascular disease: the experience of a peripheral vascular unit. *Br J Surg* **67**, 233-237.
- GARCIA MJ, MCNAMARA PM, GORDON T, KANNELL WB (1974). Morbidity and mortality in diabetics in the Framingham population. *Diabetes* **23**, 105-111.

- HANSSON J (1964). The leg amputee. A clinical follow-up study. Thesis. *Acta Orthop Scand (Suppl) 35 (Suppl 69)*, 104pp.
- KESSELER I (1971). Mortality experience of diabetic patients. *Am J Med* **51**, 715-724.
- KOLIND-SØRENSEN V (1974). Follow-up of lower limb amputees. *Acta Orthop Scand* **45**, 97-104.
- LARSSON J (1994). Lower extremity amputation in diabetic patients. Thesis.- Lund, Sweden: KF-sigma.
- LIPPMAN HI (1979). Must loss of limb be a consequence of diabetes mellitus. *Diabetes Care* **2**, 432-436.
- MANDRUP-POULSEN T, JENSEN JS (1982). Mortality after major amputation following gangrene of the lower limb. *Acta Orthop Scand* **53**, 879-884.
- MOST RS, SINNOCK P (1983). The epidemiology lower extremity amputations in diabetic individuals. *Diabetes Care* **6**, 87-91.
- NELSON RG, GOHDES DM, EVERHART JE, HARTNER JA *et al* (1988). Lower-extremity amputations in NIDDM. 12-yr follow-up study in Pima Indians. *Diabetes Care* **11**, 8-16.
- PERSSON BM, SUNDEN G (1971). Amputation på underbenet vid åldersgangrän. *Nord Med* **86**, 1045-1049.
- POHJOLAINEN T, ALARANTA H (1988). Lower limb amputations in southern Finland 1984-85. *Prosthet Orthot Int* **12**, 9-18.
- RUNYAN JW (1975). The Memphis chronic disease program. *JAMA* **231**, 264-267.
- SEIDELIN CM, EICKHOFF JH (1995). Amputation and arterial reconstruction in peripheral occlusive arterial disease in Denmark. *Ugeskr Læger* **157**, 5985-5988.
- SILBERT S (1952). Amputation of the lower extremity in diabetes mellitus: a follow-up study of 294 cases. *Diabetes* **1**, 297-299.
- STEWART CPU, JAIN AS, OGSTON SA (1992). Lower limb amputee survival. *Prosthet Orthot Int* **16**, 11-18.
- WHITEHOUSE FN, JURGENSEN C, BLOCK MA (1968). The later life of the diabetic amputee: another look at the fate of the second leg. *Diabetes* **17**, 520-521.

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