

Elevated costs and high one-year mortality in patients with diabetic foot ulcers after surgery

Lise Nørregaard Søndergaard¹, Anette Bundgaard Christensen², Anker Lund Vinding³, Inge Lunding Kjær⁴ & Peter Larsen²

ABSTRACT

INTRODUCTION: In Denmark, approximately 300,000 patients have a diabetes mellitus diagnosis. Recently published guidelines emphasise that health-care professionals who are in direct contact with citizens should be aware of the importance of prevention and early detection of diabetic foot ulcers. The objective of this study was to evaluate the mortality, length of hospital stay and economic impact on health care in patients with acute diabetic foot ulcers who were hospitalised in the Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark.

METHODS: This was a prospective cohort study including all patients admitted with a diagnosis of acute foot ulcer to the Department of Orthopaedic Surgery, Aalborg, Denmark from September 2011 to February 2012.

RESULTS: A total of 48 patients were referred for surgical treatment of a diabetic foot ulcer. The average age on admission was 64 years (35-87 years). The median length of hospital stay was 17 days (3-150 days), and 14 patients were readmitted within the first year. Within the first year of enrolment, 13 patients died, corresponding to a 36% mortality rate. Based on the Danish Diagnosis-Related Groups rates, the median cost associated with a case in the study population was 133,867 DKK.

CONCLUSION: Patients referred for surgical revision of diabetic foot ulcers are often severely ill, and the condition is associated with a high one-year mortality rate. Furthermore, the cost of these cases is considerable. Preventive interventions, early diagnosis and treatment and multidisciplinary interventions – before and during hospitalisation – should be implemented.

FUNDING: not relevant.

TRIAL REGISTRATION: The Danish Data Protection Agency (J. No. 2008-58-0028) approved the study.

In Denmark, approximately 300,000 patients have a diabetes mellitus diagnosis. It is estimated that 22,000 Danish patients have a diabetic foot ulcer, and each year approximately 3,000 new patients with diabetic foot ulcers are added to the population [1]. From a Danish population, Bruun et al [2] report that 5% of 1,400 patients who were diagnosed with type II diabetes mellitus and followed prospectively for up to 19 years had undergone an amputation. A recent Danish health technology assessment (HTA) [3] estimates that new patients who de-

velop a diabetic foot ulcer represent a cost of 793 DKK (107 euro) million annually.

The health-related costs due to patients diagnosed with diabetic foot ulcers are significant. This group of patients is often severely ill, and lengthy hospitalisations are common. In 2012, the treatment of patients with diabetic foot ulcers accounted for 1,600 hospital days, corresponding to 8.6% of all hospital days in the Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark [4].

Recommendations relating to the diagnosis and treatment of patients with diabetic foot ulcers are described in two recently published Danish clinical guidelines [1, 5]. The guidelines recommend better coordination between the many health professionals involved in the diagnosis and treatment of diabetic foot ulcers. In particular, it emphasises that health-care professionals who come into direct contact with citizens should be aware of the importance of prevention and early detection of diabetic foot ulcers and should have the knowledge to undertake diagnosis and treatment. Moreover, the guidelines recommend establishing multidisciplinary foot ulcer centres at all hospitals involved in the treatment of patients with a diabetic foot ulcer. Another recently published review of diabetic foot ulcers highlights the growing need for orthopaedic surgical efforts in treatment and stresses the importance of multidisciplinary treatment [6]. Since 2004, referral of patients with diabetic foot ulcers to a multidisciplinary foot ulcer centre has been standard treatment at Aalborg University Hospital, Denmark.

The objective of this study was to evaluate the mortality, length of hospital stay and health-care costs associated with patients with acute diabetic foot ulcers who are hospitalised at the Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark.

METHODS

This was a prospective cohort study including all patients with a diagnosis of acute foot ulcer admitted to the Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark, from September 2011 to February 2012.

All patients with acute foot ulcers and a diagnosis of diabetes mellitus type I or II were included. Patients hos-

ORIGINAL ARTICLE

- 1) Department of Health Promotion, Aalborg University Hospital
- 2) Department of Occupational Therapy and Physiotherapy, Aalborg University
- 3) Health Planning, Patient Dialogue and Quality, The North Denmark Region
- 4) Department of Orthopaedic Surgery, Aalborg University Hospital, Denmark

Dan Med J
2015;62(4):A5050

 TABLE 1

Baseline characteristics.

Patients, n	36
Age at inclusion, yrs, mean (range)	64.0 (35-87)
Age at first time of diagnosis, yrs, mean (range)	59.0 (32-87)
Female/men, n	10/26
Weight, kg, median (range)	93 (55-176)
Height, m, median	1.79
Body mass index, kg/m ² , median	28.1
Smoker, daily, n	9
<i>Diabetes, n</i>	
Type I	6
Type II insulin	10
Type II oral antidiabetica (metformin or gliclazid)	8
Type II combination therapy (insulin and metformin)	5
Type II no medication	7
Heart disease ^a , n	20
Cancer ^b , n	4
Apoplexia cerebri, n	3
Arteriosclerosis, n	17
Collum femoris fracture, n	2
Chronic obstructive pulmonary disease, n	5
Rheumatoid arthritis, n	4

a) Ischaemic heart disease, atrial fibrillation and flutter, acute myocardial infarction.

b) Colon cancer, cervical cancer, prostate cancer.

 TABLE 2

Results.

Patients, n	36
Length of hospital stay, days, median (range)	17 (3-150)
Days for readmissions, n, median (range)	18.5 (0-243)
<i>Readmissions, n</i>	
In 0-14 days	6
In 15-30 days	2
In 31-360 days	6
No readmissions	22
Mortality within 1 year, n (%)	13 (36)

pitalised with a foot ulcer, but without a diagnosis of diabetes mellitus were excluded. Patients previously treated for foot ulcers were excluded.

Procedure

The baseline characteristics in terms of age, gender, weight, height, body mass index (BMI), and alcohol and smoking behaviours were recorded for all patients. Through a systematic review of the patient records, information concerning ischaemic heart disease, atrial fibrillation, cancer, stroke, arteriosclerosis, chronic obstructive pulmonary disease and fracture was registered for all patients.

The health-care cost was calculated in accordance with the Danish version of the Diagnosis-Related Groups (DRG) system [7]. The cost was calculated by linking the actual activity and procedures recorded for all patients after admission to the DRG costs.

Statistics

The statistical analysis was performed using SPSS (PAW-Statistic 21.0). The assumption of normal distribution of variables was checked visually through Q-Q plots. Continuous data were expressed as medians and ranges. Categorical data were expressed as frequencies.

Trial registration: The Danish Data Protection Agency (J. No. 2008-58-0028) approved the study.

RESULTS

During the study period, 36 patients were referred for surgical care due to a diabetic foot ulcer. The surgical treatment consisted of: debridement (n = 4), digital or metatarsal amputation (n = 13), fore- or midfoot amputation (n = 7), crus amputation (n = 5), knee exarticulation (n = 4), femur amputation (n = 2) and hip exarticulation (n = 1).

The average age at admission was 64 years (35-87 years). Among the cases 28% were women and 72% were men. Six patients were diagnosed with diabetes mellitus type I, and 30 patients were diagnosed with diabetes mellitus type II. The baseline characteristics of all patients are presented in **Table 1**.

The median length of hospital stay was 17 days (3-150 days), and 14 patients (39%) were readmitted within the first year (see **Table 2**).

The median period from a patient was first treated at the hospital with a diagnosis of diabetes mellitus to referral for surgical treatment due to a diabetic foot ulcer was 3.1 years (0-22 years). Six of the 36 patients presented with diabetic foot ulcers at the time they were diagnosed with diabetes mellitus.

Within the first year of enrolment, 13 patients died, corresponding to a 36% mortality rate.

The patients who died (n = 13) were significantly older than those who remained alive one year after referral for surgery. The median length of hospital stay for a patient who died was more than twice the duration (36 days) of patients who survived (14 days) (see **Table 3**).

Based on the DRG rates, the median cost of a case in the study population was 133,867 DKK (20,542-370,176 DKK) 17,970 euro). For the group of patients who died, the median DRG rate was 170,223 DKK (20,542-370,176 DKK) (22,850 euro), whereas the median for the group of surviving patients was 113,643 DKK (21,736-361,866 DKK) (15,260 euro).

DISCUSSION

This study shows that patients with diabetic foot ulcers who need surgical revision had a high one-year mortality rate and a high frequency of co-morbidity. Old age was associated with a higher one-year mortality risk than young age.

Patients with diabetic foot ulcers who need surgical revision are often severely ill. They usually presented with an impaired general condition, several chronic conditions and gangrene or abscess in the affected limb and osteitis in the underlying bone. These findings are supported by other studies which have reported that most adults with diabetes mellitus have at least one chronic condition in addition to their diabetes, and that multi-morbidities, including foot ulcers, are generally associated with older populations and with the duration of diabetes [8]. Romon et al [9] studied the burden of diabetes-related mortality and cause of death and reported that diabetic foot ulcers and coronary and kidney diseases were the most frequent causes of death in patients diagnosed with diabetes mellitus.

The length of hospital stay in the present study was high compared with that of other patient groups at the hospital. In this study, the patient group who died had a considerably longer length of hospital stay than the group of patients who survived. This might have a negative impact on the perceived quality of life and the patient's likelihood of being discharged. A recent Danish study [10] investigated if health-related quality of life (HRQoL) could predict amputation and/or death in diabetic patients with foot ulcers. The study found a correlation between HRQoL scores and prognosis and illustrated that a low HRQoL score was a predictor of major amputation and death; however, a high HRQoL score showed no better wound healing. More research is needed to examine whether the HRQoL score is a predictor that can be used to identify specific vulnerabilities in the population.

The HTA "Diabetic Foot Ulcers" [3] estimated that new patients diagnosed with diabetic foot ulcers represented a cost of 793 million DKK annually. For patients with diabetic foot ulcers in the present study, the economic impact supports the contention that there is a substantial financial cost. The average DRG rate for a patient in this study was 165,177 DKK (22,175 euro), compared with an average DRG rate of 36,533 DKK (4,905 euro) for a medical patient admitted to Aalborg University Hospital in 2013. Hence, the 4.5 times higher costs were incurred for hospital treatment of patients with diabetic foot ulcers than for hospital treatment of medical patients. Moreover, the HTA [3] estimates that 44% of the socio-economic costs incurred in the treatment of patients with diabetic foot ulcers may be related to home care, 36% to hospitalisation and 20% to out-patient care.

Two recently published clinical guidelines on the diagnosis and treatment of diabetic foot ulcers [1, 5] highlight prevention and early detection as significant elements in effective prevention of both diabetic foot ulcers and amputation.

The guidelines recommend annual foot examinations for patients with diabetes mellitus and referral to a multi-disciplinary team with specific skills in the treatment of diabetic foot ulcers. In addition, the guidelines provide concrete recommendations on close cooperation between GPs and both primary and secondary health-care providers, collaboration with patient groups, potentially comprising patient self-care. Despite specialist surgical treatment, a daily endocrinology ward round function and attention to daily physical activity in the study population, this study reports a high one-year mortality rate. According to our study, attention needs to be paid to health prevention initiatives in the patient group with diabetic foot ulcers before the need for surgical revision arises. These findings support the National Clinical Guideline [1] recommendations on early diagnosis and treatment in general and early referral to a multidisciplinary foot ulcer centre in particular in order to avoid surgical treatment of diabetic foot ulcers. Surgical revision of foot ulcers is often the final stage in treatment and has important implications for both patients



TABLE 3

Results by events one year after referral for surgery.

	Alive	Dead
Patients, n	23	13
Women/men, n	5/18	5/8
Age at inclusion, yrs, mean (range)	60.7 (35-87)	79.7 (49-87)
Age at first time of diagnosis, yrs, mean (range)	54.9 (32-87)	70.0 (57-86)
Weight, kg, median (range)	100.0 (55-176)	77.0 (60-120)
Height, m, median	1.81	1.74
Body mass index, kg/m ² , median (range)	32.6 (17-46)	26.3 (24-38)
<i>Surgical treatment, n</i>		
Debridement	3	1
Digital or metatarsal amputation	10	3
Forefoot or midfoot amputation	4	3
Crus amputation	3	2
Knee exarticulation	1	3
Femur amputation	2	0
Hip exarticulation	0	1
<i>Diabetes, n</i>		
Type I	4	2
Type II	19	11
Length of hospital stay, days, median (range)	14 (3-37)	36 (5-150)
Economy, DRG ^a , DKK, median (range)	113.643 (21.736-361.866)	170.233 (20.542-370.175)

DRG = Diagnosis-Related Groups.

a) The DRG rates are average cost charges for consumption of resources in the treatment of patients in each DRG group.

Patients diagnosed with diabetes mellitus must have early treatment and multidisciplinary intervention to improve their overall health.



and society. There should be preventive interventions, early diagnosis and treatment, including team functions and close collaboration with primary health care – although, as yet, the evidence of their efficacy is not strong.

CONCLUSION

Patients referred for surgical revision of diabetic foot ulcers are often severely ill and have a high one-year mortality rate (36%) and a high frequency of co-morbidity. The economic impact is considerable as treatment of patients with diabetic foot ulcers costs 4.5 times more than treatment of medical patients during hospitalisation. Early diagnosis, treatment and multidisciplinary intervention – before, during and after hospitalisation – should be implemented to improve the treatment and overall health of the patient group.

CORRESPONDENCE: Lise Nørregaard Søndergaard, Sund Info, Aalborg Universitetshospital, Hobrovej 18-22, 9000 Aalborg, Denmark.
E-mail: lise.soendergaard@rn.dk

ACCEPTED: 3 February 2015

CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk

LITERATURE

1. National klinisk retningslinje for udredning og behandling af diabetisk fodsår [National clinical guideline for diagnosis and treatment of diabetic foot ulcers]. Copenhagen: The Danish Health and Medicines Authority, 2013.
2. Bruun C, Siersma V, Guassora AD et al. Amputations and foot ulcers in patients newly diagnosed with Type 2 diabetes mellitus and observed for 19 years. The role of age, gender and co-morbidity. *Diabet Med* 2013; 30:964-72.
3. Diabetiske fodsår – en medicinsk teknologivurdering [Diabetic foot ulcer – Health Technology Assessment]. Copenhagen: The Danish Health and Medicines Authority, 2011.
4. Data from the hospitals' Patient Administrative System (PAS). Koncern IT, North Denmark Region, 2013. Unpublished.
5. National Behandlingsvejledning: den diabetiske fod.[National Treatment Guideline. The diabetic foot.] Copenhagen: Danish Endocrine Society, 2014.
6. Uhl RL, Rosenbaum AJ, DiPrea JA et al. Diabetes mellitus: musculoskeletal manifestations and perioperative considerations for the orthopaedic surgeon. *J Am Adad Orthop Surg* 2013;22:183-92.
7. Danish version of the DRG-system (Diagnosis-Related Groups). www.norddrg.net/casemixconf/poster_til%20print.pdf (1 Dec 2014).
8. Piette JD, Kerr EA. The impact of comorbid chronic conditions on diabetes care. *Diabetes Care* 2006;29:725-31.
9. Romon, I, Jouglu E, Blakau B et al. The burden of diabetes-related mortality in France in 2002: an analysis using both underlying and multiple causes of death. *Eur J Epidemiol* 2008;23:327-34.
10. Siersma V, Thorsen H, Holstein PE et al. Health-related quality of life predicts major amputation and death, but not time to healing in people with diabetes mellitus presenting with foot ulcers: the Eurodiale study. *Diab Care* 2014;37:694-700.