



## Original Article

## Diabetic foot ulcer carries high amputation and mortality rates, particularly in the presence of advanced age, peripheral artery disease and anemia



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## ABSTRACT

**Introduction:** Foot ulcer is also a clinical marker for limb amputation and for death in diabetic patients. The purpose of this study was to determine amputation and mortality rates and its associated factors in patients with diabetic foot ulcerations in a tertiary hospital in Brazil.

**Methods:** Retrospective medical records from 654 diabetic foot patients were reviewed. The risk factors were determined using the conditional logistic regression model analysis.

**Results:** The mean patient age was 63.1 years (SD 12.20). Peripheral arterial disease was present in 160 patients (24.5%). Major amputations were performed in 135 (21%). The in-hospital mortality rate was 12% and the mortality rate of the amputees was 22.2%. The lowest hemoglobin level, the median value was 9.50 g/dL, (4.0–17.0). Anemia was detected in 89.6% of patients submitted to amputation and in 82.1% of those who died. Hemoglobin <11 g/dL was the most significant risk factor for major amputation (odds ratio 5.57,  $p < 0.0001$ ). The presence of peripheral arterial disease and old age were also a risk for major amputation (odds ratio 1.84,  $p = 0.007$  and 1.02,  $p = 0.028$ , respectively). Factors associated with increased risk for death were hemoglobin <11 g/dL (odds ratio 4.04,  $p < 0.001$ ), major amputation (1.79,  $p = 0.03$ ) and old age (1.05,  $p < 0.001$ ).

**Conclusions:** Diabetic foot ulcer is associated with high amputation and mortality rates. Old age, peripheral arterial disease and low hemoglobin level are risk factor for major amputation. Old age, major amputation and low hemoglobin level are risk factors for death.

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### 1. Introduction

The impact of the global diabetes burden is evidenced by the growing morbidity and mortality rates, and by permanent disabilities such as blindness, diabetic retinopathy, end-stage renal failure and lower extremity amputations [1]. The diabetic foot is one of the major complications of this disease, with an estimated 10% to 25% of diabetic patients developing a diabetic foot ulcer in their lifetimes [2]. Foot ulcers, the leading cause of

hospitalization in diabetic patients, are among the most common, serious and costly complications of diabetes mellitus, resulting in major medical, financial, and social consequences for patients, their families and society in general [3,4]. Foot ulcer is also a clinical marker for limb amputation and for death in these patients [5,6].

The etiology of diabetic foot ulcers is complex and risk factors include peripheral vascular disease, peripheral neuropathy, foot deformities and local foot trauma [7]. The coexistence of neuropathy, ischemia and immunosuppression in diabetic patients, favors development of severe ascending infections emanating from the ulcer and is associated with a poor prognosis as these infections frequently lead to amputation and even death [8]. In the literature, the amputation rates associated with diabetic

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foot disease range from 4.7 in Germany [9] to 47.7% in a study carried out in Brazil [10]. The in-hospital mortality rate from diabetic foot ulcer can reach 40.5% in a prospective study conducted in Nigeria<sup>11</sup>.

Therefore, the early recognition and management of risk factors for foot complications may prevent amputations and deaths [12]. The present study was undertaken to determine amputation and mortality rates and its associated factors in patients with diabetic foot ulcerations in a tertiary hospital in Brazil.

## 2. Methods

This retrospective study was conducted in the Vascular Surgery Unit of Hospital Risoleta Toletino Neves, a tertiary university hospital in Belo Horizonte, Brazil. The records of 654 consecutive patients admitted to the vascular surgery service with diabetic foot lesions between January 2007 and December 2012 were reviewed. All patients presented with deep ulceration, gangrene, infection and/or deep tissue injury in the foot below the ankle, e.g. Wagner wound classification equal or greater than 3. All patients had diabetes and neuropathy, independent of the presence or absence of peripheral arterial disease (PAD), and were classified according to the International Consensus on the Diabetic Foot and Practical Guidelines [13].

Data recorded included age, sex, smoking status and comorbidities such as hypertension and PAD. An admission ankle-brachial index (ABI)  $\leq 0.9$  was considered as presence of PAD [14]. Serum lower hemoglobin and higher creatinine levels during the admission, number of previous surgical procedures, level of lower limb amputation, intra-hospital mortality and number of readmissions were also collected. Lower limb amputation above the ankle was considered as major amputation. Digit, ray and transmetatarsal were considered as minor amputations.

Analyses were carried out using the Statistical Package for the Social Science (SPSS) 17.0 Windows version (SPSS Inc., Chicago, IL, USA). Descriptive analysis was done for demographic characteristics. Categorical data were analyzed using the chi-squared ( $\chi^2$ ) test. Continuous data were expressed as means and standard deviation, and were analyzed using Student's *t*-test. Predictors of lower limb amputation and death were determined using conditional logistic regression. Multivariable analysis was performed by including variables selected through univariable analysis ( $p < 0.10$ ) that were eliminated with backward selection.

This study was approved by the Federal University of Minas Gerais Ethics Committee (ETIC number 15638113.5.0000.5149).

## 3. Results

Demographic and clinical characteristics of 654 consecutive patients with diabetic foot ulcers are summarized in Table 1. The mean patient age was 63.1 years (SD 12.20), 441 (67%) were male. The most common co-morbidities were hypertension (60.55%) and active smoking (32.72%). Peripheral arterial disease was present in 160 patients (24.5%). The mean ABI was 0.41, with the majority of ischemic patients having an ABI lower than 0.4. On the other hand, only eleven subjects had incompressible ABIs, as shown in Table 1. In the amputees subgroup the mean ABI was 0.33, and within the patients that eventually died the median was 0.42; there was no statistically difference between these groups. The median serum level of the highest creatinine during any admission was 1.29 mg/dL (range 0.47–11.73). For the lowest hemoglobin level, the median value was 9.50 g/dL, ranging from 4.0 to 17.0.

From the total sample, 487 participants (74%) required only a single surgical procedure. Eighty patients (12%) required two procedures, while 24 patients (4%) required three procedures and less than 2% required four or more procedures (Fig. 1). Fifty-five patients (8%) were treated with conservative management of antibiotics and wound care without any intervention.

Revascularization via conventional bypass and/or endovascular therapy were performed in 150 patients (23%).

Amputations were performed in 449 patients (69%). 314 (48%) were minor amputations (214 toe amputation and 100 transmetatarsal) and 135 (21%) were major amputation (56 below the knee, 75 above the knee and 4 hip disarticulation). The overall limb salvage rate was 79%. The mortality rate of the amputees was 22.2%.

Sixty-one percent of the patients were admitted only once, while 134 patients (20%) had to be readmitted only once, and 124 patients (19%) were readmitted twice or more times. The total rate of readmissions at the same hospital was 39% through the period of the study.

The in-hospital mortality rate was 12%. Analysis of mortality rate by age (Table 3), showed an increase of mortality as the groups got older. For patients younger than 30 years, there was no death. The mortality rate for patients with 31 to 60 years was 6.1%, with 61 to 80 years was 13.4%, and older than 80 years was 38.1%.

**Table 1**  
Demographics, comorbidities, creatinine serum level, hemoglobin serum level and number of surgical procedures.

	General (%) (n = 654)	Amputees (n = 135) <sup>a</sup>	Deceased (n = 78)
Age, mean (SD)	63.08 (12.19)	65.97 (12.17)	70.04 (10.77)
Sex (male) n (%)	441 (67.4)	91 (67.4)	48 (61.5)
Hypertension n (%)	258 (39.4)	73 (54.7)	42 (53.8)
Active Smoking n (%)	214 (32.7)	43 (31.8)	24 (30.7)
PAD n (%)	160 (24.5)	50 (37.0)	23 (29.4)
ABI <sup>b</sup>			
<0.4	63 (43)	26 (52)	10 (43.5)
0.4–0.59	53 (33)	12 (24)	8 (34.8)
0.6–0.9	28 (17)	6 (12)	4 (17.4)
Incompressible	11 (7)	6 (12)	1 (4.3)
Highest serum creatinine, median (min-max) <sup>c</sup>	1.29 (0.47–11.73)	1.34 (0.47–9.39)	1.40 (0.54–11.73)
Lowest serum hemoglobin, median (min-max) <sup>c</sup>	9.50 (4.0–17.0)	7.50 (4.1–14.0)	7.05 (4.1–16.2)
Number of surgical procedures per patient, mean (SD)	1.15 (0.69)	1.32 (0.76)	1.04 (0.74)
Amputation n (%)	135 (20.6)	135 (100)	30 (38.4)
Mortality n (%)	78 (11.9)	30 (22.2)	78 (100)

SD = Standard deviation – PAD = Peripheral arterial disease – ABI = Ankle-brachial index.

<sup>a</sup> Amputees: patients who underwent major amputation.

<sup>b</sup> n = 155.

<sup>c</sup> n = 629

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