

Research Article

Amputations by Diabetic Foot and Factors Associated with People and Morbidity

Isabel Cristina Ramos Vieira Santos^{1*}, Eduardo Freese de Carvalho², Wayner Vieira de Souza², and Emídio Cavalcanti de Albuquerque³

¹Nursing College, University of Pernambuco, Brazil

²Public Health and Epidemiology Division, Oswaldo Cruz Foundation, Brazil

³The Professor Fernando Figueira Integral Medicine Institute, Brazil

***Corresponding author**

Isabel Cristina Ramos Vieira Santos, Nursing College, University of Pernambuco, 310 Arnóbio Marques Street, Recife, Pernambuco, Brazil, Tel: 55-81-31833621; Email: tutornad@yahoo.com.br

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Abstract

Objectives: To estimate the prevalence of diabetic foot amputations and check for association with factors related to people and morbidity.

Methods: Descriptive study using 5,055 records concerning all hospitalizations in the vascular clinic of one of the three hospitals of the public health system of the state of Pernambuco - Brazil. Data was collected through a form based on the definitions of the International Consensus on the Diabetic Foot.

Results: The prevalence of amputation was 69%. The logistic model showed a significant association between them and glycemia at admission above 126 mg / dl ($P = .004$), smoking ($P < .001$), non-realization of conservative procedures ($P < .001$) and gangrene at admission ($P < .001$).

Conclusion: The prevalence was higher than that found in similar studies and point to the need to intensify educational activities, early diagnosis, and better control of the disease, considering the factors associated, for that amputations will be indeed preventable.

INTRODUCTION

Foot ulcers still represent frequent and costly complications of diabetes mellitus (DM), especially in developing countries, and they represent the most common risk factor of lower limb amputations in these patients. Peripheral neuropathy (PN) and peripheral vascular disease (PVD) contribute to the formation of these ulcers and, together with immunodeficiency lead to the development of extensive and severe infections, which, if not treated, can lead to amputation and even death [1-4].

In most cases, the foot ulcers can be avoided and 50% of amputations can be prevented by implementing simple actions such as education to patients and families, as well as the systematic implementation by doctors and nurses of regular evaluation of patient's feet, risk classification, and referral to more complex care units in a suitable time [2,5,6].

Available treatments for diabetic foot ulcers vary from conservative procedures aimed at preserving the limb, such as dressings, debridement, skin grafting and revascularization, even amputations, which are the last treatment option [7-9].

The lower limb amputation (LLA) is indicated when it is

impossible to save the limb or when there is threat to patient's life and represent the failure of the method for the preservation of the limb [10,11].

Although debated, LLA rate has been considered an important indicator of quality of care for patients with diabetic foot. The incidence of LLA in people with diabetes varies widely in different communities, ranging from 46.1 to 9600 per 100,000 [12]. In the US, diabetic patients account for about 3% of the total population and over 50% of them are subjected to amputation. Studies in UK record rates of 250 per 100,000 in this population [1,13].

Brazil has a continental dimension which makes difficult the achievement of a national prevalence study. The regions have different socioeconomic realities, so that, while the Southeast collaborates with 55.5% of national GDP, the Northeast accounts for only 13.3% of the national production of wealth. This slow economic development of this region has repercussions on the quality of life and illness of the population. Pernambuco is one of 09 states that add the Northeast and has a slightly smaller land area than South Korea. In this state the prevalence of diabetic foot is 9%.

The hospital care is important subject of research in health services due to its central role in health care and its high cost [14]. Understanding the factors associated with the assessment of hospital services here exemplified by amputations for diabetic foot is very important to the discussion of policies to increase equity in the Brazilian health system as well as to the reorganization of health activities and services.

This article aims to: estimate the prevalence of amputations due to diabetic foot and check the association with factors related to people and morbidity conditions.

MATERIALS AND METHODS

This is an epidemiological study conducted in one of the three hospitals with vascular clinic of the public health system of the state of Pernambuco - Brazil.

Epidemiological data of all patients admitted to the vascular clinic from 2001 to 2010 (N= 5,055 admissions) were collected from their medical records. Taking into account the valid records (complete filling of the variables being studied) were analyzed 4,633 records. For data collection was used a form built from the definitions of the International Consensus on the Diabetic Foot [15].

The variables analyzed were: amputations in the last hospitalization for diabetic foot; variables related to people (age and gender) and variables related to morbidity (blood glucose levels on admission, existence of gangrene on admission, injury or amputation in the other limb, other admissions, number of hospitalizations, length of stay in the last hospitalization, previous amputation, conservative procedures, hypertension, heart disease, stroke, nephropathy and smoking).

Data were analyzed using frequency distributions, measure of central tendency and dispersion, and to assess the independence between explanatory variables and amputation was performed Chi-square test with Yates correction.

Both bivariate and multivariate analysis used the odds ratio (OR) as an estimator of relative risk, with an interval confidence of 95% (CI-95%) and the modeling process adopted was the logistic regression model. All variables associated with amputations ($p \leq 0,20$) in the bivariate analysis were included in the logistic model, except those with very low frequency and high odds, suggesting confounding factor. From there, the variables were excluded one by one by the method of Backward Stepwise (Likelihood Ratio).

The development of the study followed the national and international standards of ethics in research involving human subjects.

RESULTS AND DISCUSSION

Of the 4,633 records of patients analyzed in this study, there were a total of 1,267 admissions for diabetic foot in the period considered, with a prevalence of 27.3%. Of these admissions, a total of 874 patients underwent some amputation, corresponding to a prevalence of amputations for diabetic foot of 69%.

Prevalence studies of amputations due to diabetic foot show a marked variation in their rates in the world, and since most of them date of ten years or more, require an updating [14]. In Brazil, there are few studies that assess the occurrence of diabetic foot, and specifically amputations related to this disease.

According to the author's knowledge there are only two studies on the prevalence of diabetic foot amputations performed in recent years in Brazil that however used small samples ($n = 214$ and 137 respectively) are not suitable for comparison with the results discussed here. On the other hand, studies in other countries have different methodological approaches, making it difficult to compare with these results.

The prevalence found in this study of amputations for diabetic foot was high, even considering the population of the hospital based here evaluated, accounting for more than half of the admissions of these patients and overcome the study findings with the same type of population in Tanzania (46.3%) [10].

The variables related to people and morbidity were chosen from those often presented in the literature and specifically the variables of people because of the importance it has for the occurrence of diabetic foot, mainly in developing countries.

Given the magnitude of prevalence found in previous studies with small samples carried out in Brazil, was elaborated the hypothesis on the correlation between amputations with morbidity status, variable directly or indirectly related to primary care.

Knowing that complications of the diabetic foot can be prevented by low complexity measures, the results of this study reflect the importance of this complication to the Brazilian health system, because in addition to these, patients compete for surgical treatment that requires hospitalization often prolonged, creating obstacles to other demands also important.

The variables related to people are shown in Table (1). With regard to age, it is observed predominance of those patients aged 60 years or more. The mean and median found for this variable was 67 years and standard deviation (SD) of 10 years.

Included in aging diseases, hospitalizations for diabetic foot reached a corresponding prevalence to more than a quarter of admissions in vascular clinic, although the association between age and amputations was not statistically significant ($P = .052$).

As shown in Table (1) below it was observed bigger frequency of female and when evaluated by chi-square test with Yates correction the variable gender was not statistically significant ($P = .651$).

The glycemic level at admission (Table 2) shows a predominance of values above 126 mg / dl for both those undergoing amputation as for the other group of patients (mean = 241,5mg / dL; median = 200,0mg / dl, SD = 113,3mg / dl). The prevalence for patients with blood glucose levels above the cutoff point among those who underwent amputation was 95.2%.

Blood glucose levels on admission, which expresses the metabolic control before the current admission, has shown that effective blood glucose control is still a challenge for professionals working in primary care especially in some regions of the country where the assessment of glucose through glycated hemoglobin is not yet a reality.

The two analyses (bivariate and multivariate) showed that the group with hyperglycemia admission has a two-fold increased risk of suffering an amputation in the current hospitalization (Tables 2 and 3). Results consistence with those found in

Table 1: Amputations and variables related to people.

Variables	Amputations		OR	CI (95%)	P Value*
	Yes (%)	No (%)			
Age					
≥60 years old	608 (69,6)	295 (75,1)	0,76	0,57 – 1,00	0.052
<60 years old	266 (30,4)	98 (24,9)	1		
Gender					
Female	469 (53,7)	217 (55,2)	0,93	0,74 – 1,19	0.651
Male	405 (46,3)	176 (44,8)	1		

*Chi-Square test with Yates correction

Abbreviations: OR: Odds Ratio; CI (95%): Interval Confidence of 95%

Table 2: Amputations and variables related to morbidity.

Variables	Amputations				OR	IC (95%)	P Value*
	Yes (%)		No (%)				
Blood glucose levels on admission							
≥126mg/dl	832 (95,2)	357 (90,8)	2,00	1,23-3,25	0.004		
<126mg/dl	42 (4,8)	36 (9,2)	1				
Existence of gangrene on admission							
Yes	459 (52,5)	98 (24,9)	3,33	2,53 - 4,38	<0.001		
No	415 (47,5)	295 (75,1)	1				
Injury or amputation in the other limb							
Yes	181 (20,7)	80 (20,4)	1,02	0,75 – 1,39	0.945		
No	693 (79,3)	313 (79,6)	1				
Other admissions							
Yes	218 (24,9)	119 (30,3)	0,77	0,58 – 1,01	0.055		
No	656 (75,1)	274 (69,7)	1				
Number of hospitalizations							
≥2	217 (24,8)	117 (29,8)	0,78	0,59 – 1,02	0.075		
Single	657 (75,2)	276 (70,2)	1				
Length of stay in the last hospitalization							
1-3 months	371 (42,4)	154 (39,2)	1,14	0,89 - 1,47	0.304		
< 1 month	503 (57,6)	239 (60,8)	1				
Previous amputation							
Yes	538 (61,6)	279 (71,0)	0,65	0,50 - 0,85	0.001		
No	336 (38,4)	114 (29,0)	1				
Conservative procedures							
No	603 (69,0)	199 (50,6)	2,17	1,69 – 2,79	<0.001		
Yes	271 (31,0)	194 (49,4)	1				
Hypertension							
Yes	533 (61,0)	262 (66,7)	0,78	0,60 – 1,01	0.061		

No	341	(39,0)	131	(33,3)	1		
Heart disease							
Yes	192	(22,0)	80	(20,4)	1,10	0,81 - 1,49	0.567
No	682	(78,0)	313	(79,6)	1		
Stroke							
Yes	74	(8,5)	23	(5,9)	1,49	0,90 - 2,49	.132
No	800	(91,5)	370	(94,1)	1		
Nephropathy							
Yes	49	(5,6)	27	(6,9)	0,81	0,48 - 1,35	0.454
No	825	(94,4)	366	(93,1)	1		
Smoking							
Yes	447	(51,1)	127	(32,3)	2,19	1,70 - 2,84	<0.001
No	427	(48,9)	266	(67,7)	1		

*Chi-Square test with Yates correction

Abbreviations: OR: Odds Ratio; CI (95%): Interval Confidence of 95%

other studies [4,16]. And they need to be considered by health professionals from primary care to plan new approaches for the blood glucose control in population.

The finding of the gangrene at admission showed a prevalence of 52.5% (Table 2), with a significant difference to less than 1% level between the two groups in terms of amputation ($P < .001$).

Gangrene occurs more frequently in diabetics than in non-diabetics and is one of the most common indications for amputation [3,11]. Thus, it indicates the seriousness of the case when it is admitted to the hospital. In this study, the existence of gangrene on admission was associated with the occurrence of amputation, with a risk three times that those who had gangrene on admission undergo an amputation when compared to those without this condition (Tables 2 and 3).

Access to health services include: knowledge, usage and satisfaction with the service provided and the consequent adhesion. The presence of gangrene highlights problems in patient access to primary health care and in addition to that, we should also consider problems to refer these patients from primary care to the hospital.

Although there are standards of preventive measures for diabetic foot established by the Health Ministry of Brazil and also the vast literature that draw attention to the regular examination of the feet of diabetic patients is noted by the prevalence of amputations and odds found for this variable, that there is a major problem in achieving these care and referral of patients at risk for specialized care.

An association was observed between previous amputation and amputation in the last hospitalization, with statistically significant difference ($P = .001$) in the bivariate analysis (Table 2), but this association was not confirmed by multivariate analysis. This finding agrees with another hospital based study on risk factors for amputation for diabetic foot [17].

The bivariate analysis showed a statistically significant association for the variables not carrying out conservative procedures ($P < .001$) and smoking ($P < .001$) (Table 2) and these associations also remained in a stepwise logistic regression

model, which confirmed the failure to carry out conservative procedures and smoking are independent risk factors for amputation (Table 3).

The DM, added to other factors such as age and smoking influences the progression of peripheral vascular disease. The results showed that smokers have a risk 2 times larger to undergo an amputation and are consistent with the literature [1,18].

Whereas peripheral vascular disease manifests itself early among people with diabetes, and that smoking is an aggravating factor for the obliteration of the arteries and arterioles, it is important to raise awareness in this population abandonment of this practice as a measure of prevention and healthy lifestyle.

Brazil has developed a program against smoking that has shown good results by following a model in which the educational, communication, health care, associated with the legislative and economic measures, are enhanced to prevent smoking initiation,

Table 3: Significant results of the multivariate analysis of variables associated with the occurrence of amputations.

Variables	OR (IC95%)*
Blood glucose levels on admission	
≥ 126 mg/dl	1.00
< 126 mg/dl	2.130 (1.294 - 3.507)
Existence of gangrene on admission	
No	1.00
Yes	3.302 (2.502 - 4.358)
Conservative procedures	
Yes	1.00
No	2.010 (1.546 - 2.614)
Smoking	
No	1.00
Yes	2.496 (1.911 - 3.261)

*OR (95% CI): Odds ratio and 95% confidence interval of logistic regression for all the variables listed in the table.

Abbreviations: OR: Odds Ratio; CI (95%): Interval Confidence of 95%

promote smoking cessation and protect the public from exposure to environmental tobacco smoke.

Peripheral arterial disease can be considered as an important risk factor for amputation. In fact, when there are alterations of the dorsalis pedis and posterior tibial pulses, the patient may progress to amputation if not undergo a revascularization [4,9].

Palpation of the distal arterial pulses has been considered a valuable tool in screening for peripheral vascular disease in diabetic patients, especially in places with few resources [4,9]. And thus nurses can effectively help identify patients at risk, collaborating to referencing them in perfect time for hospitals to perform conservative procedures.

Nursing associations related to tissue viability in Brazil have been struggling for the proper preparation of nurses for this. It is expected that the incorporation of these professionals in primary care teams can modify the present results in the coming years.

With regard to amputations association with the lack of performing conservative procedures there is consensus that the revascularization procedure is technically possible in most patients suffering from critical limb ischemia, therefore, a more effective approach to revascularization procedures must be performed.

The chi-square test did not detect statistical significance for the variables: injury or amputation in the other limb ($P = .945$), other hospitalizations ($P = .055$), length of stay in the last hospitalization ($P = .304$), hypertension ($P = .061$), heart disease ($P = .567$), stroke ($P = .132$) and nephropathy ($P = .454$).

Finally, although this study is unprecedented in the country, the reflections on the results should consider that although the study design may be used to investigate the association between the putative risk factor and a health outcome. However this type of study is limited in its ability to draw possible causality because the presence of risk factors and outcomes are measured simultaneously. Also because the study was conducted through hospital records other variables related to socioeconomic status and lifestyle habits could not be assessed.

Another limitation relates to the fact that this study was conducted in a northeastern state in Brazil where the population treated by the public health system presents an underprivileged socioeconomic status. Since Brazil is a country of continental dimensions, with different realities in different regions is suggested that further studies be conducted with the same methodology so that comparisons can be made.

CONCLUSION

Prevalence study is important to understand the burden of an event in a population. The prevalence study at the hospital population is indicated, especially for this theme, in view of the reliability of the data serving as a reference for managers and health professional committed to the control of diabetes and prevention of its complications.

Despite the limitations related to hospital-based studies, the prevalence found here and the associated factors point to the need to intensify educational activities, early diagnosis and better disease control.

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Prevalence of Amputations Due to Diabetic Foot - Data Collect Form		
Form N° _____		
Patient record N°: _____		
N°	VARIABLES	CODE (write only the number of response)
01	ADMISSION YEAR: _____	
02	AGE: _____ years old	
03	GENDER:	
	1 Male	
	2 Female	
04	DIABETIC FOOT DIAGNOSIS:	
	1 Yes	
	2 No	
05	REGISTRATION OF OTHER ADMISSIONS:	
	1Yes	
	2No	
06	NUMBER OF HOSPITALIZATIONS: _____	
07	DATE OF LAST HOSPITAL ADMISSION: _____	
08	DATE OF LAST HOSPITAL EXIT: _____	
09	BLOOD GLUCOSE PLASMA VALUE IN ADMISSION (1st registration after admission): _____ mg/dl	
10	GANGRENE DIAGNOSIS AT THE ADMISSION:	
	1Yes	
	2No	
11	PREVIOUS AMPUTATION RECORD:	
	1Yes	
	2No	
12	RECORD OF INJURY AND / OR PRIOR AMPUTATION IN OTHER LOWER LIMB:	
	1 Yes	
	2 No	
13	RECORD OF CONSERVATIVE PROCEDURES PERFORMED (revascularizations):	
	1 Yes	
	2 No	
14	RECORD OF HYPERTENSION:	
	1 Yes	
	2 No	
15	RECORD OF HEART DISEASE:	
	1 Yes	
	2 No	
16	RECORD OF STROKE: 1 Yes, 2 No	
17	RECORD OF NEPHROPATHY:	
	1 Yes	
	2 No	
18	RECORD OF SMOKING 1 Yes	
	1 Yes	
	2 No	

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