



Root causes for the development of foot ulcers of people with diabetes mellitus*

Causas referidas para o desenvolvimento de úlceras em pés de pessoas com diabetes mellitus

Causas referidas al desarrollo de úlceras en piés de personas con diabetes mellitus

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ABSTRACT

Objective: To analyze the root causes referred to in the etiology of foot ulcers in people with diabetes mellitus (DM). **Methods:** A sectional study, quantitative, conducted at the Diabetes Clinic of a University Hospital in Ribeirão Preto – SP (Brazil). Data were collected using a structured instrument and physical examination of the feet of a sample of 30 diabetic patients. **Results:** The sample had a mean age of 57.5 years, was predominantly male with a low educational level; 90% had type 2 DM, long-term and poorly controlled; obesity / overweight in 77%; and, 93.3% had plantar insensitivity. The metatarsal region was the site of ulcer most frequently mentioned, and the cause was the callus. **Conclusion:** The root causes involved in the etiology of these ulcers correspond, directly or indirectly, to extrinsic factors that can be prevented with basic care and at low cost. The plantar insensitivity, a key factor triggering the ulcers, was not recognized by these people.

Keywords: Diabetes mellitus; Diabetic foot; Foot ulcer; Risk factors

RESUMO

Objetivo: Analisar as causas referidas na etiologia das úlceras em pés de pessoas com Diabetes mellitus (DM). **Métodos:** Estudo seccional, quantitativo, realizado no Ambulatório de Diabetes de um Hospital Universitário em Ribeirão Preto – SP. Os dados foram coletados com instrumento estruturado e exame físico dos pés de amostra de 30 pacientes diabéticos. **Resultados:** Amostra com idade média de 57,5 anos, predominância do sexo masculino e baixa escolaridade; 90% possuíam DM tipo 2, de longa duração e mal controlado; obesidade/sobrepeso em 77% e insensibilidade plantar em 93,3%. A região metatarsiana foi o local de úlcera referido com maior frequência, e a causa foi a calosidade. **Conclusão:** as causas referidas envolvidas na etiologia das úlceras correspondem, de forma direta ou indireta, a fatores extrínsecos que podem ser prevenidos com cuidados básicos e de baixo custo. A insensibilidade plantar, fator fundamental desencadeador das úlceras, no entanto não foi reconhecida pelas pessoas.

Descritores: Diabetes mellitus; Pé diabético; Úlcera do pé; Fatores de risco

RESUMEN

Objetivo: Analizar las causas referidas en la etiología de las úlceras en piés de personas con Diabetes mellitus (DM). **Métodos:** Estudio seccional, cuantitativo, realizado en el consultorio externo de Diabetes de un Hospital Universitario en Ribeirão Preto – SP. Los datos fueron recolectados con un instrumento estructurado y examen físico de los piés de una muestra de 30 pacientes diabéticos. **Resultados:** muestra conformada por personas con una edad promedio de 57,5 años, predominio del sexo masculino y baja escolaridad; el 90% poseían DM tipo 2, de larga duración y mal controlado; obesidad/sobre peso en el 77% e insensibilidad plantar en el 93,3%. La región metatarsiana fue referida, con mayor frecuencia, como el lugar de la úlcera y la causa fue la callosidad. **Conclusión:** Las causas que están involucradas en la etiología de las úlceras corresponden, de forma directa o indirecta, a factores extrínsecos que pueden ser prevenidos con cuidados básicos y de bajo costo. Entre tanto la insensibilidad plantar, factor fundamental desencadenante de las úlceras, no fue reconocida por las personas.

Descriptores: Diabetes mellitus; Pié diabético; Úlcera del pie; Factores de riesgo

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INTRODUCTION

Foot ulcers and amputations represent the main morbidity causes among Diabetes Mellitus (DM)⁽¹⁾ patients, and the estimated risk of their development corresponds to 15%. Research shows that annual population-based incidence levels can range between 1% and 4.1%, with prevalence rates between 4% and 10%⁽²⁾.

In DM patients, ulcers are characterized as cutaneous injuries with epithelial loss, which extend to or cross the dermis and reach the deepest tissues. They may even reach bones and muscles^(3,4), precede 85% of amputations⁽⁴⁾ and result from the combination of two or more risk conditions that act at the same time, among which peripheral neuropathy is the most important⁽⁵⁾.

Ulceration risks are proportional to the number of risk factors and, in people diagnosed with peripheral neuropathy, this risk level is twice as high, increasing to 12 times higher risk levels in patients with neuropathy and limited joint mobility or foot deformity, and to 36 times in people with neuropathy, deformity and previous ulcer or amputation when compared with people without risk factors⁽⁶⁾.

Early recognition of causes and readily-available ulcer care are fundamental for good functional results⁽³⁾. Knowledge of factors that direct or indirectly contribute to foot injury development, so as to support care planning for DM patients, can contribute to bring down the prevalence of lesions and, consequently, of amputations.

AIM

This study was developed to analyze referred causes in the etiology of foot ulcers in Diabetes mellitus patients.

METHOD

This cross-sectional research with a quantitative approach was developed at the Diabetes Outpatient Clinic of the University of São Paulo at Ribeirão Preto Medical School *Hospital das Clínicas* (HCFMRP – USP). The hospital is located in the West of the city and serves as a referral institution for tertiary care.

Participants signed the Informed Consent Term and approval for the research project was obtained from the Ethics in Research Committee at the University of São Paulo at Ribeirão Preto Medical School *Hospital das Clínicas*, according to Process HCRP 1087/2007.

In the study, male and female patients with foot ulcer were included, aged 21 years or older, between April and June 2007.

The data collection instrument was structured based on the variables of interest^(7,8) and previously

tested, including sociodemographic data, alcohol consumption, smoking, physical exercise, clinical variables, laboratory data, DM treatment, foot examination and ulcer evaluation.

Pedal and posterior tibial pulse were assessed through palpation and classified as palpable (full or thin) and non-palpable⁽⁹⁾. Local temperature was checked using a Raytek portable infrared thermometer, according to the manufacturer's instructions.

Plantar protective sensitivity was assessed with the help of Semmes-Weinstein 5.07 monofilament (Sorri-Bauru), at nine points in the plantar and one in the dorsal foot region. The patient's inability to feel the ten-gram monofilament at four or more of the ten points tested after three evaluations demonstrates the absence of protective sensitivity in the feet⁽¹⁰⁾. The plantar pressure points were evaluated through the presence of hyperemic points in the plantar region.

Four characteristics were considered to evaluate the heels: style (model), width, length and manufacturing material. The style was considered appropriate when it was closed, preferably protecting the entire foot; for width and length, shoes of adequate size were considered, i.e. neither large nor small, with a space of one centimeter additional to the foot anatomy; concerning the material, the shoes should be made from soft leather or canvas/cotton⁽¹¹⁾. Therefore, shoes were considered appropriate when these characteristics were present.

To evaluate the ulcer, the following were considered: causal factors, duration, contour, border characteristics, local callus, exudate, pain, odor, ulcer staging, according to the criteria established in the literature⁽¹²⁾.

Data were categorized and transcribed into a database structured in Excel software, and then processed in EPIINFO, using double data entry, and presented using descriptive statistics. For the discrete variables, numerical and percentage distributions were used and, for the continuous variables, minimum, maximum, means, medians, standard deviations and percentages.

RESULTS

Among the thirty participants, 27 (90%) had type 2 DM and three (10%) type 1. Among the sociodemographic and clinical characteristics, low education (90%), retired people (66.7%), originating in Ribeirão Preto (SP) (66.7%), mean DM treatment time 12.5 years, systolic (73.7%) and diastolic pressure alterations (50%), with 77% of the sample suffering from overweight and obesity (Table 1). Three participants' body weight could not be verified as they could not be moved.

The main laboratory test result data to assess metabolic control, foot examination and ulcer cause data are displayed in Tables 2 to 4.

Table 1 – Characteristics of sociodemographic and clinical variables in the study sample (n=30), Ribeirão Preto-SP, 2007.

Variables		N	%	M	SD
Sex	Male	16	53.3		
	Female	14	46.0		
Age	30-50	6	20.0	57.5	11.24
	50-70	20	66.7		
	70-	4	13.3		
Education	High (12 years or more)	-	-		
	Average (9 ≥ 12 years)	3	10.0		
	Low (less than 9 years)	27	90.0		
Marital Status	With partner	17	56.7		
	No partner	13	43.3		
Occupation	Retired	20	66.7		
	Housewife	6	20.0		
	General maintenance	4	13.3		
Origin	Ribeirão Preto (SP)	11	36.7		
	Other cities in São Paulo State	18	60.0		
	Other States	1	3.3		
DM Treatment Time	4 - 12	12	40.0	12.5	7.35
	12 - 20	8	26.7		
	20 -	10	33.3		
BMI⁽¹⁾	Normal	6	22.2	29.3	5.13
	Overweight	10	37.03		
	Obese	11	40.7		
SBP⁽²⁾	Normal	8	26.7	142	24.10
	Altered	22	73.3		
DBP⁽²⁾	Normal	15	50.0	84.5	17.27
	Altered	15	50.0		
Complications/ Comorbidities	Renal	14	46.6		
	Ophthalmic	12	40.0		
	Neurologic	24	80.0		
	Cardiovascular	7	23.3		
	Arterial Hypertension	20	66.7		
	Obesity	5	16.6		
	Dyslipidemias	10	33.3		
Other illnesses	21	70.0			

⁽¹⁾ calculated through the formula weight (kg)/height (meters)², normal=BMI < 25.0 kg/m² (including the category < 18.5 kg/m² – underweight); overweight= BMI between 25.0 and 29.9 kg/m² and obese= BMI ≥ 30.0 kg/m²(13); total N =27.

⁽²⁾ normal value < 130 mmHg SBP and < 85 mmHg DBP(14).

As for the laboratory test results, study sample participants displayed bad glucose control (Table 2).

Table 2. Laboratory test results in the study sample, Ribeirão Preto-SP, 2007.

Variables	(No)	M	SD
Fasting Glucose (mg/dl) ⁽¹⁾	28	143.0	104.39
Glycated Hemoglobin (%) ⁽²⁾	20	9.4	2.42
Total Cholesterol (mg/dl) ⁽³⁾	20	156.0	49.47
HDL Cholesterol (mg/dl) ⁽⁴⁾	21	42.0	12.64
LDL (mg/dl) ⁽⁵⁾	20	87.5	29.84
Triglycerides (mg/dl) ⁽⁶⁾	21	144.0	238.79

⁽¹⁾ normal <110 mg/dl⁽¹⁵⁾.

⁽²⁾ normal <7%⁽¹⁶⁾. (The previous parameters were considered according to the normality standards of the hospital's laboratory method, but changed in line with the bibliographic reference. This change will not entail any changes in the results)

⁽³⁾ normal < 200 mg/dl and altered ≥ 200 mg/dl⁽¹⁷⁾.

⁽⁴⁾ normal ≥ 40 mg/dl for men and ≥ 50 mg/dl for women⁽¹⁷⁾.

⁽⁵⁾ normal <130mg/dl and ≥130mg/dl altered⁽¹⁷⁾.

⁽⁶⁾ normal <150 mg/dl and altered ≥ 150 mg⁽¹⁷⁾.

As expected, 93.3% of the sample displayed absence of plantar tactile-pressure sensitivity and, in 60%, thick nails were observed (Table 3).

Callus was identified more frequently, in the physical examination (56.7%) and also as a referred ulcer cause in 23.3% of the sample (Tables 3 and 4).

Table 3. Main feet alterations identified in the study sample (n=30), presented with numerical and percentage distribution, Ribeirão Preto-SP – 2007.

Characteristics	No	%
Absence of plantar sensitivity	28	93.3
Thick Lines	18	60.0
Callus	17	56.7
History of Ulcers	16	53.3
Amputation	10	33.3
Non-palpable pedal pulse	16	53.3
Non-palpable tibial pulse	16	53.3
Regular hygiene	10	33.3
Flat Foot	10	33.3
Inappropriate Footwear	10	33.3
Lesions between Toes	7	23.3
Cracks	8	26.7
Claw Toes	7	23.3
Cross Toes	1	3.3
Anhidrosis	3	10.0
Bromhidrosis	6	20.0

Table 4. Characteristics of injuries identified in the feet of the Diabetes mellitus patients analyzed (n=30), with numerical and percentage distribution.

Variables	No	%	M	SD
Location	Anterior	13	43.3	
	Medial	11	36.7	
	Posterior	5	16.7	
	Dorsal	1	3.3	
Ulcer Cause	Callus	7	23.3	
	Crack	6	20.0	
	Blister	5	16.7	
	Inappropriate Footwear	4	13.3	
	Sharp glass fragment	2	6.7	
	Prego	1	3.3	
	Trauma	3	10.0	
	Due to amputation	1	3.3	
	Infection of earlier lesion	1	3.3	
Ulcer Time (months)	0 - 4	24	80.0	
	4 - 8	5	16.6	8 months
	8 -	1	3.3	

DISCUSSION

In the study sample, a slightly higher frequency was observed for the male sex (53.3%) (Table 1), similar to Brazilian descriptive study results for sociodemographic characteristics, which also address foot complications in DM patients⁽⁷⁾. A review showed that ulcers, amputations, neuropathy and peripheral vascular disease are more common in men, with a 1.6 times greater risk of amputations than women⁽¹⁷⁾, without explaining the reasons though.

In a way, some characteristics inherent to age and education level can comprise self-care abilities. In this study, higher frequencies were observed for the age range from 50 to 70 years (67%) and for low education level (90%) (Table 1).

The aging process entails a gradual and progressive decrease in functional capacity⁽¹⁸⁾ which, associated with other factors, like the disease itself and low education levels, can lead to foot complications, mainly due to self-care difficulties⁽¹¹⁾.

The development of foot care skills is a fundamental part of diabetic education, and low education level is appointed as a condition for foot injury risks⁽¹⁹⁾.

The occupation the participants most frequently referred was that of retired/housewife (86.7%) (Table 1) which, associated with low education, characterizes a population with probable treatment difficulties, such as the purchase of medication and care inputs, access to health services and food, among others. Literature highlights that, besides the ulcer or amputation history, low social levels contribute to amputation risks⁽²⁰⁾.

Marital status represents another variable in the set of social factors for amputation risk⁽¹⁹⁾. In this study, 43.3% of participants indicated they were single or widowed (Table 1). In the presence of some physical, cognitive or sensory limitation, this condition hampers self-care. Family support is highlighted in foot care to prevent complications⁽²¹⁾.

When asked about how long they had been diagnosed with DM, generally, the study participants referred to the start of treatment; therefore, this variable was estimated based on the referred duration of treatment, with a mean 12.5 years (Table 1).

Associated with bad glucose control, long DM duration enhances the establishment and development of chronic complications.

The Wisconsin Epidemiologic Study of Diabetic Retinopathy, a prospective cohort study that involved two groups of DM patients, distinguished by how long the disease had been diagnosed, investigated the incidence of lower limb amputations and ulcers and risk factors for these complications. In group 1 (G1), diagnosed with DM before they reached the age of 30 years, the incidence of amputations was significantly related with increased duration of DM, higher systolic and diastolic blood pressure, severe retinopathy, smoking time, male sex, presence of proteinuria and history of foot and heel ulcers. In group 2 (G2), diagnosed with DM as from the age of 30 years, amputations were associated with increased glycated hemoglobin and severe retinopathy, male sex, presence of proteinuria and ulcer history⁽²²⁾.

Staying with the previous study, ulcers were associated with the same variables, except for sex. In addition, increases in body mass, glycated hemoglobin and duration of smoking were also associated with the incidence of ulcers⁽²²⁾. In this study, overweight/obesity, retinopathy, nephropathy, bad glucose control, systemic blood pressure alterations, current and previous smoking and insulin use stood out. The latter is probably due to the diagnosis time and DM-associated complications.

Associated with the above factors, Brazilian descriptive studies underline that basic and low-cost care like hygiene, drying between the toes, foot and footwear care can enhance ulcer development, infection and gangrene, which can culminate in amputation⁽²³⁾.

In foot evaluation, the presence of callus, regular foot hygiene, lesions between the toes and bromhidrosis also stand out, which contribute to risk factors for further injuries. Mycoses and foot infections are aggravating conditions, mainly in case of plantar tactile-pressure insensitivity, ischemia or both, as they contribute to a lack of metabolic control or progression to generalized infection⁽²⁴⁾.

Plantar pressure leads to callus formation, which will enhance increased local pressure even more. This is an important cause of ulcer, and its debridement can reduce plantar pressure by up to 26%⁽²⁵⁾. Using adequate footwear can not only prevent, but also reduce callus development, as a result of the decreased local pressure⁽²⁶⁾.

Concerning circulatory conditions, 53% of the study sample did not have a palpable pulse (Table 3) and the files of 23.3% indicated cardiovascular diseases (Table 1). Some risk factors for vascular diseases were observed though, including: advanced age range, long time of DM diagnosis, bad glucose control and dyslipidemia, which significantly compromised prognoses for these lesions⁽²⁶⁾.

In temperature evaluation, a mean increase of approximately 1.55°C was verified in the ulcerated limb when compared with the contralateral one. Ulcer site temperature has been associated with the pathogenesis and symptoms of diabetic neuropathy. A clinical, randomized, blinded research in a North American population, aimed at assessing the effectiveness of temperature monitoring to reduce the incidence of foot ulcers in DM patients and high lower limb extremity complication risks showed that an increase by more than 2.2°C indicated risk for ulcers⁽²⁷⁾. Temperature monitoring can be a strategy for use at home to identify inflamed tissue and practice foot ulcer prevention actions⁽²⁷⁾.

Plantar tactile-pressure insensitivity, deriving from peripheral neuropathy, was found in 93.3% of participants (Table 3), and is appointed in the literature as the main cause of foot ulcers in DM patients. It is present in more than 50% of people with the disease who are over 60 years of age⁽²⁵⁾. The loss of protective sensitivity leads to increased vulnerability and traumas, increasing foot ulcer risks by seven times⁽¹⁹⁾.

The two participants that were not classified with plantar tactile-pressure insensitivity showed less than four insensitive points on the injured foot and, therefore, did not comply with the adopted criteria⁽²³⁾. In this respect, the importance of further discussions on the criteria to assess plantar insensitivity is highlighted, especially because this is the main ulceration factor⁽²⁵⁾ and the fundamental element to direct interventions aimed at preventing foot complications in DM patients.

In this study, the main referred ulcer causes were callus (23.3%), cracks (20%) and blisters (16.7%) (Table 4). It is highlighted that the study participants' non-recognition of plantar sensitivity and bad metabolic control, as precursor factors of ulcers, puts them at greater risk for recurring ulcers and amputations.

According to the literature, the second main cause of ulcer, following on plantar insensitivity, is high plantar pressure⁽²⁸⁾, observed in 56.7% of the present study sample and recognized by 23.3%. Despite recognizing that the callus contributed to ulcer development, 33.3% use inappropriate footwear (Table 3).

Concerning ulcer characteristics, most (73.3%) presented one ulcer, 70% of which started less than one year earlier (Table 4). The mean duration of ulcers was eight months. The slowness of the healing process predisposes to infectious complications. In a review in the United States, it is reported that the presence of an ulcer for more than one month without healing can evolve to an infection or ischemia, or even both⁽²⁹⁾.

This study also showed that, concerning location, the metatarsal (30%), external lateral plantar (10%), heel (10%) and hallux (10%) regions (Table 1) were the main observed ulcer sites. The foot areas with the greatest trend for lesions are the hallux, the plantar surface in the metatarsal region, external foot sides, heels and malleoli⁽³⁰⁾, similar to the present study.

The ulcers were mostly (83.3%) classified as grade 1, which may indicate lesser complexity. Nevertheless,

the ulcer itself represents an important risk factor for amputations, aggravated in case of bad DM control, mainly due to the compromised healing process, related to intrinsic (function of collagen and metalloproteinases) and immunological (deficient defense by polymorphonuclears) disorders for healing purposes that are related to the ulceration process⁽²⁶⁾.

The recognition of factors leading to ulcers in DM patients has enhanced preventive interventions and improvements in patients' prognosis and quality of life⁽³⁾.

Ulcers are chronic complications that, on average, occur after ten years of DM evolution. They are the most common cause of non-traumatic amputations and can be prevented through basic and low-cost care^(11,23,26).

CONCLUSIONS

These study results appoint a profile characteristic of DM patients with foot ulcers, similar to research on the theme, i.e. higher frequencies among male, older adults and elderly people, long duration of DM and bad control. The referred factors involved in the ulcer etiology direct or indirectly correspond to extrinsic factors, including inadequate footwear, trauma, walking barefoot, blisters, callus and cracks that can be prevented through basic and low-cost care. The study participants did not recognize plantar insensitivity though, a fundamental factor that triggers ulcers.

REFERENCES

- American Diabetes Association. Implications of the United Kingdom prospective diabetes study. *Diabetes Care*. 2004; 27 Suppl 1:28-32.
- Reiber GE, Vileikyte L, Boyko EJ, del Aguila M, Smith DG, Lavery LA, et al. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes Care*. 1999; 22(1):157-62.
- Sumpio BE. Foot ulcers. *N Engl J Med*. 2000; 343(11):787-93.
- Boulton AJ. The diabetic foot: from art to science. The 18th Camilo Golgi lecture. *Diabetologia*. 2004; 47(8):1343-53.
- Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care*. 1990; 13(5):513-21.
- Armstrong DG, Harkless LB. Outcomes of prospective care in a diabetic foot specialty clinic. *J Foot Ankle Surg*. 1998; 37(6):460-6.
- Scapim EP. Perfil dos pacientes com Diabetes mellitus que possuem úlcera no pé, atendidos em unidade ambulatorial da cidade de Marília-SP [dissertação]. São Paulo: Universidade de São Paulo, Escola de Enfermagem; 2004.
- Rocha RM, Zanetti, ML, dos Santos MA. Comportamento e conhecimento: fundamentos para prevenção do pé diabético. *Acta Paul Enferm*. 2009; 22(1):17-23.
- Porto CC. Exame clínico. 5a ed. Rio de Janeiro: Guanabara Koogan; 2004. p. 227-32.
- Wunderlich RP, Armstrong DG, Husain K, Lavery LA. Defining loss of protective sensations in the diabetic foot. *Adv Wound Care*. 1998; 11(3):123-8.
- Ochoa-Vigo K, Pace AE. Pé diabético: estratégias para prevenção. *Acta Paul Enferm*. 2005; 18(1):100-9.
- Wagner FW Jr. The dysvascular foot: a system of diagnosis and treatment. *Foot Ankle*. 1981; 2(2):64-122.
- World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee [Internet]. 1995 [cited 2007 Jun 12]. Geneva: WHO; 1995. (WHO Report Series; 854). Available from: http://whqlibdoc.who.int/trs/WHO_TRS_854.pdf
- Brasil. Ministério da Saúde. Secretaria de Políticas de Saúde. Plano de reorganização da atenção à hipertensão arterial e ao Diabetes mellitus. Manual de hipertensão arterial e Diabetes mellitus [Internet]. Brasília: Ministério da Saúde; 2002 [citado 2007 Set 5]. (Série C. Projetos, Programas e Relatórios; n. 59). Disponível em: <http://www.scribd.com/doc/2869658/Manual-de-Hipertensao-Arterial-e-Diabetes-Mellitus>
- Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* [Internet]. 2001 [cited

- 2007/10/20];285(19):2486-97. Available from: <http://jama.ama-assn.org/cgi/content/full/285/19/2486>
16. Sociedade Brasileira de Diabetes. Consenso Brasileiro sobre Diabetes 2002. Diagnóstico e classificação do diabetes melito e tratamento do diabetes melito do tipo 2 [Internet]. Rio de Janeiro: Diagraphic Editora; 2003 [citado 2007 Set 5]. Disponível em: http://www.diabetes.org.br/educacao/docs/Consenso_atual_2002.pdf
 17. Brito FC, Nunes MI, Yauso DR. Multidimensionalidade em gerontologia II: instrumentos de avaliação. In: Papaléo Netto M. Tratado de gerontologia. 2a ed. Rio de Janeiro: Atheneu. p.133-47.
 18. Reiber GE, Pecoraro RE, Koepsell TD. Risk factors for amputation in patients with diabetes mellitus. *Ann Intern Med.* 1992; 117(2):97-105.
 19. Hathur HM, Boulton AM. The diabetic foot. *Clin Dermatol.* 2007; 25(1):109-20.
 20. Cisneros LL, Goncalves LA. Educação terapêutica para diabéticos: os cuidados com os pés na realidade de pacientes e familiares. *Ciênc Saúde Coletiva* [Internet]. 2011 [citado 2012 Jan 10];16, suppl.1:1505-14. Disponível em: <http://www.scielo.br/pdf/csc/v16s1/a86v16s1.pdf>
 21. Moss SE, Klein R, Klein BE. The prevalence and incidence of lower extremity amputation in a diabetic population. *Arch Intern Med.* 1992; 152(3):610-6.
 22. Gamba MA, Gotlieb SL, Bergamaschi DP, Vianna LA. Amputações de extremidades inferiores por diabetes mellitus: estudo caso-controle. *Rev Saúde Pública.* 2004; 38(3):399-404.
 23. Calsolari MR, de Castro RF, Maia RM, Maia FC, Castro AV, Reis R, et al. Análise Retrospectiva dos Pés de Pacientes Diabéticos do Ambulatório de Diabetes da Santa Casa de Belo Horizonte, MG. *Arq Bras Endocrinol Metabol.* 2002; 46(2):173-6.
 24. Young MJ, Cavanagh PR, Thomas G, Johnson MM, Murray H, Boulton AJ. The effect of callus removal on dynamic plantar foot pressures in diabetic patients. *Diabet Med.* 1992; 9(1):55-7.
 25. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with Diabetes. *JAMA.* 2005; 293(2):217-28.
 26. Lavery LA, Higgins KR, Lanctot DR, Constantinides GP, Zamorano RG, Athanasiou KA, et al. Preventing diabetic foot ulcer recurrence in high-risk patients: use of temperature monitoring as a self-assessment tool. *Diabetes Care.* 2007; 30(1):14-20.
 27. Veves A, Murray HJ, Young MJ, Boulton AJ. The risk of foot ulceration in diabetic patients with high foot pressure: a prospective study. *Diabetologia.* 1992; 35(7):660-3.
 28. Steed DL. Foundations of good ulcer care. *Am J Surg.* 1998; 176(2A Suppl):20S-25S.
 29. Yetzer EA, Sullivan RL. The foot at risk: identification and prevention of skin breakdown. *Rehabil Nurs.* 1992; 17(5):247-51.