DOI: https://doi.org/10.30795/scijfootankle.2019.v13.913

ORIGINAL ARTICLE

Scientific Journal of the Foot & Ankle

Multidisciplinary care of diabetic feet: 578 patients assessed for 12 years

Cuidados dos pés diabéticos por equipe multidisciplinar: 578 pacientes avaliados por 12 anos

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ABSTRACT

Objective: This study evaluated the foot and ankle disorders developed among patients treated by a multidisciplinary team of the diabetic foot group outpatient clinic at our institution using a specific protocol. The natural disease progression of these patients was examined after a 12-year follow-up period.

Methods: The data collected included gender, age, body mass index, disease duration, insulin use, duration of insulin use, tobacco use, peripheral pulse palpation, history of previous partial foot amputations, foot deformities secondary to peripheral neuropathy, degree of foot sensation assessed using the Semmes-Weinstein monofilament test, association with ulcers as evaluated by the Wagner classification, and the presence of Charcot foot as evaluated by the Brodsky anatomical classification and the Eichenholtz radiographic classification.

Results: We prospectively evaluated 578 patients with type 2 diabetes and found that they had a mean disease progression of 14 years; 53% were insulin-dependent, with an average insulin use duration of 9.7 years; 9.8% of patients had previous amputations performed by a vascular surgeon due to acute arterial insufficiency; 72.6% lost protective sensation according to the sensation assessment associated with deformities secondary to peripheral neuropathy; and 21.5% presented with hallux valgus and claw toes, 12.6% presented with ulcers, and 9.5% presented with Charcot neuroarthropathy.

Conclusion: A treatment protocol overseen by a multidisciplinary team and the use of therapeutic footwear to protect insensitive feet were associated with low rates of plantar foot ulcers and Charcot neuroarthropathy.

Level of Evidence II; Therapeutic Studies; Comparative Prospective

Keywords: Diabetes mellitus; Diabetic foot; Arthropathy, neurogenic; Pressure ulcer; Amputation.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar as afecções do pé e tornozelo desenvolvidas em pacientes que são atendidos dentro de um protocolo específico no ambulatório do grupo do pé diabético da nossa instituição, com equipe multidisciplinar e a evolução natural da doença encontrada nesses pacientes após 12 anos de seguimento.

Métodos: Os dados coletados foram: gênero, idade, índice de massa corpórea, tempo de doença, uso ou não de insulina e por quanto tempo, presença ou não de tabagismo, palpação de pulsos periféricos e amputações parciais prévias nos pés, deformidades nos pés secundárias à neuropatia periférica, grau de sensibilidade dos pés avaliada pelo teste do monofilamento de Semmes – Weisntein e a associação com úlceras avaliadas pela classificação de Wagner, neuroartopatia de Charcot, avaliada pela classificação anatômica de Brodsky e radiográfica de Eichenholtz.

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Conflicts of interest: none. **Source of funding:** none.
Date received: December 22, 2018. **Date accepted:** March 18, 2019. **Online:** March 31, 2019.

Resultados: Ao avaliarmos prospectivamente 578 pacientes com diabetes tipo 2 observamos que eles possuem um tempo médio de evolução da doença de 14 anos, 53% eram insulino-dependentes, com tempo médio de uso de insulina de 9,7 anos, 9,8% dos pacientes com amputações prévias realizadas pela cirurgia vascular por insuficiência arterial aguda, 72,6% apresentaram comprometimento vulnerável a lesões na avaliação da sensibilidade que foram associadas às deformidades secundárias à neuropatia periférica: 21,5% com hálux valgo e dedos em garra, 12,6% com úlceras, 9,5% com neuroartropatia de Charcot.
Conclusão: O protocolo de tratamento com equipe multidisciplinar, bem como o uso de calçados terapêuticos para proteger os pés insensíveis apresentou uma baixa incidência de úlceras plantares e neuroartropatia de Charcot.
Nível de Evidência II; Estudos Terapêuticos; Prospectivo Comparativo.

Descritores: Diabetes mellitus; Pé diabético; Articulação de Charcot; Úlcera de pressão; Amputação.

How to cite this article: Rodrigues AB, Borges VQ, Ferraz GF, Sacilotto R, Portes ES, Stéfani KC. Multidisciplinary care of diabetic feet: 578 patients assessed for 12 years. Sci J Foot Ankle. 2019;13(1):70-6.

INTRODUCTION

Diabetes mellitus has become a global public health problem. Its incidence has shown an alarming increase in both developed countries (e.g., Japan and the United States) and developing countries (e.g., Brazil). The increase in the prevalence of diabetes and its associated medical costs is greatest among people over 65 years old; therefore, the "diabetes epidemic" will continue, even if obesity levels remain constant. However, with the increasing prevalence of obesity, it is likely that these numbers underestimate the future incidence of diabetes[1].

A study conducted in Latin American and Caribbean countries estimated that in 2015, the total annual (direct and indirect) costs in Brazil were US $43.6 billion. The direct costs included drugs, hospitalizations, consultations, and the treatment of complications, totaling US $24.6 billion, whereas the indirect costs included the loss of income due to permanent or temporary disability and premature death, totaling US $19 billion. Of the 25 countries included in this analysis, Brazil had the highest costs related to this disease[2].

Importantly, diabetes imposes a substantial financial burden on society as well as costs that cannot be measured such as pain and suffering, the care provided by unpaid caregivers, and the costs associated with undiagnosed diabetes[3].

Foot injuries are frequent causes of the hospitalization of diabetic patients and account for two-thirds of non-traumatic lower limb amputations. Diabetic neuropathy plays a key role in the genesis of such injuries. Although the pathophysiology of diabetic sensorimotor polyneuropathy (DSP) is complex and controversial, the polyol pathway is an intrinsic element in the progression of this disorder. In response to high blood glucose levels, the aldose reductase enzyme activity increases, thereby increasing the conversion of glucose into sorbitol, a sugar alcohol. In turn, this action leads to an accumulation of sorbitol in the erythrocytes and nerves. Laboratory studies with diabetic animals have shown that an increase in nerve sorbitol is associated with nerve damage. The abnormal activity of the polyol pathway is associated with multiple pathophysiological changes in the peripheral nerves. This symmetrical distal peripheral polyneuropathy leads to the loss of protective sensation that predisposes patients to the appearance of ulcers and development of Charcot neuroarthropathy. Patients can develop severe deformities as well as soft tissue and bone infections that put the limb at risk[4,5].

The evidence supporting the use of specific self-management interventions and adequate footwear to prevent recurrent ulcers is strong. Regarding the prevention of foot injuries, recent studies have shown the benefit of preventive actions, patient education, and therapeutic footwear, which relieve plantar pressure and protect insensitive feet from injury[6].

The objective of this study was to evaluate the effects of foot and ankle disorders developed among patients treated with a specific protocol at the outpatient clinic of the diabetic foot group of our institution by a multidisciplinary team composed of an orthopedist, endocrinologist, vascular surgeon, physiotherapist, nurse, plaster technician, and prosthetic technician. This study also evaluated the natural progression of this disease among these patients after a 12-year follow-up period.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 46121815.0.0000.5463.

The patients included in the study were treated by the diabetic foot group of our institution between February 2005 and February 2017. All patients were recruited consecutively after signing an informed consent document.

Patients with diabetes as well as ulcers or Charcot neuroarthropathy were excluded from this study.

An endocrinologist referred patients to the diabetic foot group to prevent foot injuries. The care protocol consisted of an initial visit to perform a medical interview and physical examination by the physicians (orthopedist and endocrinologist), daily foot care guidelines provided by the nurse, and guidelines regarding the activities of daily living and walking provided by the physiotherapist. The physicians scheduled return visits every 6 months. All patients were instructed at the outpatient clinic to use footwear and insoles for insensitive feet made by the prosthetic technician (Figure 1), and the hospital provided two pairs per year at no cost to the patient. Any care visits provided by the emergency department, when necessary, were performed by the vascular surgeon.

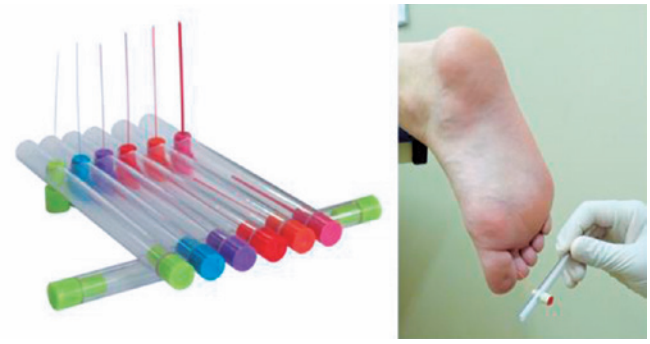
The data collected at the initial visit included gender, age, body mass index (BMI) evaluated based on the classification of the World Health Organization (WHO)[7], disease duration, insulin use, duration of insulin use, tobacco use, degree of foot sensation as assessed by the Semmes-Weinstein monofilament test[8] (Figure 2), peripheral pulse palpation, and history of previous partial foot amputations performed by a vascular surgeon.

The data collected during disease evolution were foot deformities secondary to peripheral neuropathy, including ulcers as evaluated by the Wagner classification[9] as well as Charcot neuroarthropathy as assessed by the Brodsky anatomical classification[10] and the Eichenholtz radiographic classification[11].

Patients with foot deformities progressed with pressure ulcers and Charcot neuroarthropathy; their data correlated over time, beginning with the initial visit.

The studied variables are presented in tables with absolute and relative frequency distributions. The associations were tested using Pearson's chi-square test, and the quantitative variables were tested using Student's t-test, both at

Figure 1. Footwear for insensitive feet.
Source: Author's personal archive.



Functional level represented by color scale

1. **Green 0.05 g** - Normal foot sensitivity
2. **Blue 0.2 g** - Normal foot sensitivity
   - Difficulty discriminating texture (light touch)
3. **Purple 2.0 g** - Diminished protective sensation of the foot
   - Difficulty discriminating shape and temperature
4. **Red (closed) 4.0 g** - Loss of protective sensation
   - Loss of texture discrimination
   - Impaired shape and temperature discrimination
5. **Red 10 g** - Loss of protective sensation
   - Loss of texture discrimination
   - Impaired shape and temperature discrimination
6. **Orange 300 g** - Loss of surface pressure sensation
   - Deep pressure sensation only on the foot
7. **Pink** - No response
   - Loss of deep pressure sensation on the foot

Figure 2. Semmes-Weinstein monofilament test.
Source: Author's personal archive.

a significance level of 5%; therefore, those with p-values lower than 0.05 were considered as significant.

RESULTS

A total of 578 patients were evaluated, of whom 69% (399) were female. The mean age of patients was 67 years, and their mean duration of diabetes was 14 years, with a standard deviation (SD) of 7.4 years. Of these patients, 53% were insulin-dependent, with an average insulin use duration of 9.7 years.

BMI was classified as follows: 13.2% (76 patients) had a normal weight (BMI up to 24.9); 44.3% (254 patients) were overweight (BMI between 25 and 29.9) and 42.5% (244 patients) were obese (BMI above 30). The mean BMI was 29.6±4.8, ranging from 19 to 54.3. Tobacco use was reported by 38 patients (6.6%).

We found 45 patients (7.8%) without palpation of the tibial and fibular artery pulses. A total of 57 patients (9.8%) presented with an amputation on the first visit that was performed by the vascular surgery team of the emergency department. These amputations were distributed as follows: toe amputation (41 patients), transmetatarsal amputation (13 patients), and transtibial amputation (three patients). All patients used insulin and had increased rates of deformities, ulcers, and amputations.

The assessment of sensation performed using the Semmes-Weinstein monofilament test revealed that 414 patients (72.6%) presented with a loss of protective sensation (sensation present only after 4.0 g; see table 1).

The injuries secondary to peripheral neuropathy that appeared during treatment were distributed as follows: 124 patients (21.5%) had hallux valgus and claw toes, 73 patients (12.6%) had ulcers, 55 patients (9.5%) had Charcot neuroarthropathy, and 57 patients (9.9%) had previous amputations.

Of the 73 patients with ulcers, all were unilateral and distributed as follows according to the Wagner classification: 41 patients (56.16%) presented with grade 1, 26 patients (35.62%) presented with grade 2, and six patients (8.22%) presented with grade 3. In most cases, ulcers were located in the forefoot (54.8%), followed by the midfoot (31.5%; Figure 3); fewer were located in the hindfoot (13.7%). The presence of ulcers was significantly associated with diminished sensation, Charcot neuroarthropathy, the presence of deformities, insulin use duration ($p<0.001$), and the absence of palpable pulses ($p=0.03$).

Of the 55 patients with Charcot neuroarthropathy, all injuries were unilateral. According to the Eichenholtz radiographic classification, 17 patients (30.9%) presented with grade 1, 11 patients (20%) presented with grade 2, and 27 patients (49%) presented with grade 3. Regarding the Brodsky anatomical classification, 35 patients (63.6%) presented with 1-Lisfranc, 10 patients (18.2%) presented with 2-midfoot, and 10 patients (18.2%) presented with 3A-ankle (Figure 4). The presence of Charcot neuroarthropathy was significantly associated with diminished sensation, the presence of ulcers, the presence of deformities, a history of previous amputations, and the absence of palpable pulses ($p<0.001$). The present study did not find correlations between cases of Charcot neuroarthropathy and the use of insulin, vascular insufficiency, or tobacco use (Table 2).

DISCUSSION

The studied population had a predominance of women (69%), with a mean age of 67 years. Approximately 86.8% of patients had excess weight as evaluated by their BMIs (overweight, 44.3%; obese, 42.55%). Obesity is a chronic metabolic disease that affects adults and children worldwide. It has become one of the major causes of death because

Table 1. Semmes-Weinstein monofilament test results.

Filament	Interpretation	Patients
Green (0.05 g)	Normal sensation	9 (1.6%)
Blue (0.20 g)	Normal sensation	38 (6.6%)
Purple (2.00 g)	Difficulty discriminating shape and temperature	111 (19.2%)
Dark red (4.00 g)	Diminished protective sensation due to loss of hot/cold discrimination	123 (21.3%)
Orange (10.000 g)	Loss of protective sensation but still able to feel deep pressure and pain	117 (20.2%)
Red (10.000 g)	Loss of deep pressure sensation but still able to feel pain	122 (21.1%)
No response	Complete loss of sensation and inability to feel pain	58 (10%)
Total		578 (100%)

Source: Prepared by the author based on the results of the research.

Figure 3. Wagner grade 2 plantar ulcer in the midfoot and its progression until fully healed.
Source: Author's personal archive.

it is the main risk factor for type 2 diabetes. This close relationship led to the portmanteau "diabesity", which highlights the fact that most individuals with diabetes are overweight or obese. To date, BMI has been used to classify overweight and obesity. Because reduced muscle mass is highly prevalent throughout the BMI range, a measurement of body composition is strongly recommended[12,13].

Patients had a mean disease duration of 14 years. Moreover, we observed that 307 patients (53%) were insulin-dependent, with an average insulin use duration of 9.7 years. The disease duration analysis revealed a greater need for insulin over time as well as a greater number of Charcot neuroarthropathy cases and amputations. Therefore, longer courses of diabetes increase the use of insulin, which increases the chances of developing complications inherent to peripheral neuropathy. This condition leads to loss of proprioception and protective sensation; it also exposes the distal joints of the lower limbs to repetitive trauma and, consequently, to progressive joint destruction, i.e., Charcot joint. Trauma predisposes patients to the development of osteoarticular deformities of the foot and ankle as well as to the formation of plantar ulcers that result from the abnormal distribution of weight-bearing pressure while walking. These ulcers can become contaminated and cause secondary infections to the soft tissues or the adjacent bone[5].

A total of 57 patients (9.8%) presented with amputation (the vast majority of which were toes; 41 patients) at the

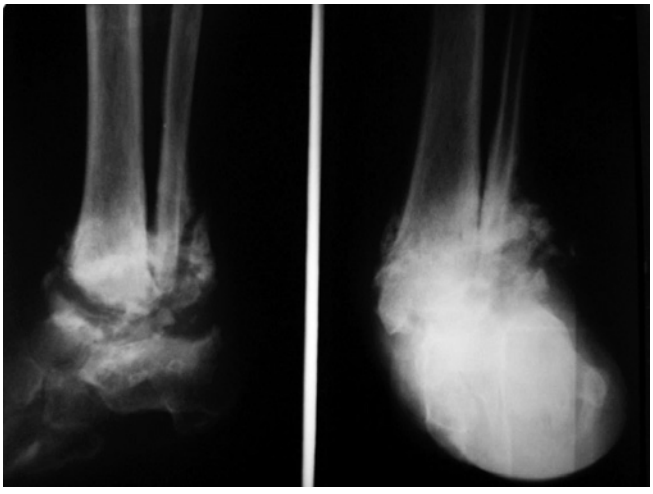


Figure 4. Charcot neuroarthropathy at anatomical site 3A; ankle at grade 3 stage of evolution and Eichenholtz radiographic classification.
Source: Author's personal archive.

Table 2. Secondary lesions to peripheral neuropathy that appeared during treatment

Variables	With ulcer (n=73) n (%)	Without ulcer (n=505) n (%)	p
Gender			<0.001
Male	35 (47.9)	364 (72.1)	
Female	38 (52.1)	141 (27.9)	
Insulin use			0.014
Yes	48 (65.8)	364 (72.1)	
No	25 (34.3)	259 (51.3)	
Tobacco use			0.266
Yes	07 (09.6)	31 (06.1)	
No	66 (90.4)	474 (93.9)	
Deformity			<0.001
Yes	29 (39.8)	95 (18.8)	
No	44 (60.3)	410 (81.2)	
Charcot			<0.001
Yes	18 (32.7)	37 (10.5)	
No	55 (67.3)	468 (89.5)	

Source: prepared by the author based on the results of the research.

first visit, which was performed by the vascular surgery team in the emergency room. Like ulcers are most frequent in the forefoot, amputations are more frequent in this region. We found 45 patients (7.8%) did not have palpation of the tibial and fibular artery pulses. All patients used insulin and had increased rates of deformities, ulcers, and amputations, which were associated with tobacco use (38 - 6.6%)[14,15]. Despite the association between chronic arterial insufficiency and tobacco use, the rate found in our series (6.6%) was low compared with that in the literature. This result is most likely because of the success that anti-smoking policies have recently achieved in Brazil[16].

All of the ulcers among the 73 patients (12.6%) were unilateral, and most of the affected were men (52%). In a review article from 2017, the lifetime incidence of foot ulcers was estimated at 15 to 25% among people with diabetes[17]. Furthermore, the relationship between the appearance of ulcers and disease duration was significant, with a higher prevalence of insulin use in 56% of the sample. This result is explained by the evolution of peripheral neuropathy, which leads to diminished sensation and the presence of secondary deformities and/or Charcot neuroarthropathy that generate areas of hyperpressure. In most cases (54.8%), the ulcers were located in the forefoot; moreover, ulcers were correlated with deformities resulting from peripheral neuropathy in 124 patients (21.5%). After the ulcers were treated with total contact casting and the use of footwear for insensitive feet, they did not reoccur after subsequent healing[18].

The prevalence of Charcot neuroarthropathy in the literature ranges from 0.08 to 7.5%. However, some studies have suggested a higher prevalence, reaching 13% among all patients with diabetes and 29% among those with neuropathy[19]. In our series, 55 patients (9.5%) presented with Charcot neuroarthropathy, and all cases were unilateral; the midfoot was affected in 63% of all cases. In another Brazilian study, the prevalence of Charcot neuroarthropathy was 34%[20], which differs greatly from ours (9.5%) because of the epidemiological differences of the studied populations. In our series, the presence of Charcot neuroarthropathy was significantly associated with diminished sensation, the presence of ulcers, the presence of deformities, the presence of previous amputations, and the absence of palpable pulses ($p<0.001$).

When we prospectively evaluated 578 patients with type 2 diabetes, we observed the following results.

- The patients had a mean disease duration of 14 years.
- A total of 307 (53%) patients were insulin-dependent, with a mean insulin use duration of 9.7 years.
- Approximately 6.6% were smokers, and 9.8% of patients had previous amputations performed by vascular surgeons due to acute arterial insufficiency.
- A total of 414 patients (72.6%) presented with the loss of protective sensation (sensation present only after 4.0 g) based on a sensation evaluation using the Semmes-Weinstein monofilament test. However, the lesions secondary to peripheral neuropathy were distributed as follows: 124 patients (21.5%) presented with hallux valgus and claw toes, 73 patients (12.6%) presented with ulcers, and 55 patients (9.5%) presented with Charcot neuroarthropathy.

The disease duration analysis revealed a greater need for insulin use with age; age also positively predicted the number of cases of Charcot neuroarthropathy and amputation.

However, lower rates of ulcers and Charcot neuroarthropathy were observed in association with the multidisciplinary protocol and the use of footwear for insensitive feet compared with the rates in the literature.

CONCLUSION

The treatment protocol of a multidisciplinary team and the use of therapeutic footwear to protect insensitive feet from injuries decreased the incidence of plantar foot ulcers and Charcot neuroarthropathy.

Authors' contributions: Each author contributed individually and significantly to the development of this article: ABR *(https://orcid.org/000-0002-2503-8860) data collection and wrote the article; VQB *(https://orcid.org/0000-0001-7889-8090) data collection and wrote the article; GFF *(https://orcid.org/0000-0001-8032-3077) statistical analysis and participated in the review process; RS *(https://orcid.org/0000-0001-9847-3751) bibliographic review and participated in the review process; ESP *(https://orcid.org/0000-0003-1050-5371) bibliographic review and participated in the review process; KCS *(https://orcid.org/0000-0003-1534-9654) conceived and planned the activities that led to the study, participated in the review process and approved the final version. *ORCID (Open Researcher and Contributor ID).

REFERENCES

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27(5):1047-53.
2. Barcelo A, Arredondo A, Gordillo-Tobar A, Segovia J, Qiang A. The cost of diabetes in Latin America and the Caribbean in 2015: Evidence for decision and policy makers. J Glob Health. 2017;7(2):020410.
3. Economic Costs of Diabetes in the U.S. in 2017. Diabetes Care. 2018; 41(5):917-28.
4. Canavan RJ, Unwin NC, Kelly WF, Connolly VM. Diabetes - and nondiabetes -related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care: continuous longitudinal monitoring using a standard method. Diabetes Care. 2008;31(3):459-63.
5. Stéfani KC, Mercadante M. Treatment principles of foot and ankle Charcot neuroarthropathy. Rev Bras Ortop. 2003;38(9):497-506.
6. van Netten JJ, Price PE, Lavery LA, Monteiro-Soares M, Rasmussen A, Jubiz Y, et al. Prevention of foot ulcers in the at-risk patient with diabetes: a systematic review. Diabetes Metab Res Rev. 2016;32(Suppl 1):84-98.
7. Group WW. Use and interpretation of anthropometric indicators of nutritional status. WHO Working Group. Bull World Health Organ. 1986;64(6):929-41.
8. Birke JA, Sims DS. Plantar sensory threshold in the ulcerative foot. Lepr Rev. 1986;57(3):261-7.
9. Calhoun JH, Cantrell J, Cobos J, Lacy J, Valdez RR, Hokanson J, et al. Treatment of diabetic foot infections: Wagner classification, therapy, and outcome. Foot Ankle. 1988;9(3):101-6.
10. Brodsky JW. Evaluation of the diabetic foot. Instr Course Lect. 1999; 48:289-303.
11. Eichenholtz S. Charcot Joints. Springfield, IL, USA: Charles C. Thomas; 1996.
12. Leitner DR, Fruhbeck G, Yumuk V, Schindler K, Micic D, Woodward E, et al. Obesity and type 2 diabetes: Two diseases with a need for combined treatment strategies - EASO can lead the way. Obes Facts. 2017;10(5):483-92.
13. Bahia L, Coutinho ES, Barufaldi LA, Abreu Gde A, Malhao TA, de Souza CP, et al. The costs of overweight and obesity-related diseases in the brazilian public health system: cross-sectional study. BMC Public Health. 2012;12:440.
14. Anderson JJ, Boone J, Hansen M, Spencer L, Fowler Z. A comparison of diabetic smokers and non-smokers who undergo lower extremity amputation: a retrospective review of 112 patients. Diabet Foot Ankle. 2012;3.
15. Sohn MW, Stuck RM, Pinzur M, Lee TA, Budiman-Mak E. Lower-extremity amputation risk after Charcot arthropathy and diabetic foot ulcer. Diabetes Care. 2010;33(1):98-100.
16. Silva ST, Martins MC, Faria FR, Cotta RM. Combate ao tabagismo no brasil: a importância estratégica das ações governamentais. Ciênc Saúde Colet.2014;19(2):539-52.
17. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot ulcers and their recurrence. N Engl J Med. 2017;376(24):2367-75.
18. Dorresteijn JA, Kriegsman DM, Assendelft WJ, Valk GD. Patient education for preventing diabetic foot ulceration. Cochrane Database Syst Rev. 2010(5):CD001488.
19. Schmidt BM, Holmes CM. Updates on diabetic foot and Charcot osteopathic arthropathy. Curr Diab Rep. 2018;18(10):74.
20. Ferreira RC, Silva APS, Costa MT, Frizzo GG, Santin RAL, Fucs PMMB. Aspectos epidemiológicos das lesões no pé e tornozelo do paciente diabético. Acta Ortop Bras. 2010;18(3):135-41.