RMMG
Revista Médica de Minas Gerais

ORIGINAL ARTICLE

Risk factors for mortality, amputation, and microbiological profile in infected diabetic foot in Belo Horizonte, Brazil (2014-2019): a retrospective analysis based on PEDIS score and Wagner classification

Fatores de risco para mortalidade, amputação e perfil microbiológico em pacientes com pé diabético infectado em Belo Horizonte, Brasil (2014-2019): uma análise retrospectiva baseada nos escores PEDIS e Wagner

Helena Duani[1,2], Mislene Pereira de Oliveira Persilva[2], Kaique Veloso Silva[3], Wallace Corbelli[3], Rebeca Rosetto Amaro da Silva[3], Emílio Valadares Gomes Neto[3], Frederico Moura Rodrigues[3], Unai Tupinambas[1,2], Tulio Pinho Navarro[4,5]

ABSTRACT

Introduction: Diabetic foot infections (DFIs) represent a major public health challenge, significantly impacting patient quality of life and survival. These infections often precede severe outcomes such as major lower limb amputation and increased mortality. Identifying clinical and microbiological risk factors is essential to guide early interventions and reduce complications. **Objectives:** To determine risk factors for mortality and lower limb amputation and to describe the microbiological profile of infected diabetic foot ulcers. **Methods:** This retrospective cohort study included 260 patients hospitalized with DFIs at a tertiary private hospital in Belo Horizonte, Brazil, between 2014 and 2019. Eligible patients were aged ≥18 years, underwent surgical procedures (eg, debridement or amputation), and had ulcer biopsies submitted for microbiological analysis. **Results:** The cohort had a mean age of 66.4 years (SD ±14.43), and 58.85% were male. At one year, mortality was 11.2%, minor amputation occurred in 40.8%, and major amputation in 9.2%. Peripheral arterial disease (PAD) was present in 11.2%. Among deceased patients, 14 (5.4%) had PAD, including 6 with critical ischemia (p<0.001). *Staphylococcus aureus* was the most frequent isolate (18.85%), with 25.64% methicillin-resistant, although not significantly associated with mortality or major amputation. According to PEDIS score and Wagner classification, scores >2 increased mortality risk by 2.98-fold (p=0.001) and 1.48-fold (p=0.0448), respectively. **Conclusions:** PEDIS score and Wagner classification are strong prognostic indicators for adverse outcomes in DFIs, underscoring their value in clinical risk stratification.

Keywords: Diabetic foot infection; Death; Microbiology.

[1] Serviço de Infectologia e Medicina Tropical, Departamento de Clínica Médica, Faculdade de Medicina da Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

[2] Programa de Pós-Graduação em Ciências da Saúde: Infectologia e Medicina Tropical, Faculdade de Medicina, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

[3] Faculdade de Medicina da Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

[4] Serviço de Cirurgia Vascular, Departamento de Cirurgia, Faculdade de Medicina da Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

[5] Programa de Pós-Graduação Ciências Aplicadas à Cirurgia e à Oftalmologia, Faculdade de Medicina, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

Associate Editor Responsible:

Alexandre Moura

Santa Casa de Misericórdia de Belo Horizonte

Belo Horizonte/MG, Brazil.

RESUMO

Introdução: As infecções do pé diabético representam um importante desafio de saúde pública, com impacto significativo na qualidade de vida e na sobrevida dos pacientes. Essas infecções, frequentemente, antecedem desfechos graves, como amputações maiores de membros inferiores e aumento da mortalidade. Dessa forma, a identificação de fatores de risco associados à infecção, que levam a maior mortalidade e amputação, é essencial para orientar intervenções precoces e reduzir complicações. **Objetivos:** Determinar os fatores de risco para mortalidade e amputação de membros inferiores, bem como descrever o perfil microbiológico das úlceras de pé diabético infectadas. **Métodos:** Este estudo de coorte retrospectivo incluiu 260 pacientes internados com infecção do pé diabético em um hospital privado terciário de Belo Horizonte, Brasil, entre 2014 e 2019. Foram incluídos pacientes ≥18 anos, submetidos a desbridamento ou amputação e cujas biópsias de úlcera foram encaminhadas para análise microbiológica. **Resultados:** A coorte apresentou idade média de 66,4 anos (Desvio Padrão ± 14,43), sendo 58,85% dos pacientes do sexo masculino. Em um ano, a mortalidade foi de 11,2%, a amputação menor ocorreu em 40,8% e a amputação maior em 9,2%. Doença arterial periférica esteve presente em 11,2% dos casos. Entre os pacientes que foram a óbito, 14 (5,4%) apresentavam doença arterial periférica, incluindo 6 com isquemia crítica (p<0,001). *Staphylococcus aureus* foi o microrganismo mais frequentemente isolado (18,85%), sendo 25,64% resistentes à meticilina, embora essa resistência não tenha se associado significativamente à mortalidade ou à amputação maior. PEDIS e Wagner >2 aumentaram o risco de mortalidade em 2,98 vezes (p=0,001) e 1,48 vezes (p=0,0448), respectivamente. **Conclusão:** Os escores PEDIS e Wagner são fortes indicadores prognósticos para desfechos adversos nas infecções do pé diabético, ressaltando seu valor na estratificação clínica de risco.

Palavras-chave: Infecção do pé diabético; Mortalidade; Microbiologia.

Corresponding author:
Helena Duani
Departamento de Clínica Médica, Faculdade de Medicina da Universidade Federal de Minas Gerais, Minas Gerais, Brazil.
E-mail: hduani@gmail.com

Supporting sources:
None.

Conflicts of interest:
None.

Ethic Committee:
Opinion number – 37231020500005149.

Received on: December 2, 2025.
Approved on: May 9, 2026.
Publication Date: October 23, 2026.

DOI: 10.5935/2238-3182.2026e36108-en

Background & Objectives

Globally, diabetic foot ulcers (DFUs) significantly impact patient morbidity and healthcare systems. Each year, approximately 18.6 million individuals are affected by DFUs. These ulcers often preceded severe outcomes, including lower limb major amputation and increased mortality rates[1]. Lower limb major amputations related to diabetic foot complications represent around 20% of DFU cases, primarily due to infection and the progression of gangrene[2]. Approximately half of DFUs develop infections requiring hospitalization, further increasing amputation risk[3]. Infections lead to around 15-20% of hospitalized patients undergoing lower limb major amputation, highlighting the substantial clinical burden of infected DFUs[4,5]. Polymicrobial infections are commonly observed in DFUs, involving aerobic and anaerobic bacteria, and vary by geographic region and healthcare setting. Among these, frequently isolated pathogens include *Staphylococcus aureus*, *Proteus* spp., *Escherichia coli*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*. Such microbial diversity complicates therapeutic management and often influences patient prognosis[6,7]. To classify the severity of DFUs, clinicians commonly employ validated systems, such as the Wagner-Meggitt classification and the PEDIS system (Perfusion, Extent, Depth, Infection, Sensation). The Wagner system primarily considers lesion depth and the presence of necrosis or gangrene[8], whereas the PEDIS classification includes detailed evaluations of arterial perfusion, ulcer area, depth, infection severity, and sensory neuropathy, providing comprehensive clinical insights[9]. Understanding the relationship between these classification systems, microbiological profiles, and clinical outcomes such as major amputation and mortality can significantly enhance patient care and clinical decision-making[10].

This study aims to evaluate associations between the Wagner and PEDIS classification scores, microbiological profiles, incidence of major amputations, and one-year mortality in patients with infected diabetic foot ulcers in Belo Horizonte, Brazil.

Methods

This retrospective study analyzed medical records of patients treated at a private tertiary hospital specializing in diabetic foot management in Belo Horizonte, Brazil, between 2014 and 2019. Inclusion criteria comprised diabetic patients aged ≥18 years who underwent surgical interventions, including wound debridement or limb amputation, and whose ulcer biopsies were submitted for microbiological analysis. Patients with incomplete records or missing data essential for the proposed analyses, such as unavailable microbiological results, were excluded. Also excluded were patients with ulcers of non-diabetic etiology, including venous, pure arterial, leprotic, or neoplastic ulcers, as well as those without a documented diagnosis of diabetes mellitus in their medical records. No prior sample size calculation was performed, as the study adopted a census-type sampling approach. All patients who met the inclusion criteria and were treated at the selected reference institution during the study period were consecutively enrolled in the analysis. Thus, the final sample corresponded to the totality of eligible cases identified during the study period, without random or convenience-based selection.

As this was a retrospective study, data collection was carried out exclusively from the medical records of patients who met the established inclusion criteria. Consequently, it was not possible to precisely quantify the number of patients who fell under the exclusion criteria, since the available institutional records did not allow for the systematic identification of all individuals seen during the period who could potentially have been eligible for the study. The final sample comprised all cases with sufficient and adequate documentation to meet the predefined inclusion criteria, which represents an inherent limitation of the retrospective design adopted.

The collected data included demographic information, comorbidities, clinical presentation, laboratory results, microbiological findings, and ulcer severity scores according to the Wagner and PEDIS classifications. Among the laboratory variables, blood urea nitrogen and casual blood glucose were used, as these were the tests consistently available in medical records for the majority of patients, given the retrospective nature of the study and the predominantly surgical profile of the service.

Statistical analysis involved ANOVA with Welch's correction, t-tests, and chi-square tests to compare continuous and categorical variables between groups, respectively. Logistic regression analysis assessed independent predictors of major amputation and mortality.

Declarations of ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee for Medical Research at the Federal University of Minas Gerais (UFMG) under CAAE no. 37231020500005149. Due to the retrospective design of the study, informed consent was not necessary and was waived by the local ethics committee.

Results

Table 1 summarizes the clinical characteristics of 260 patients, with a mean age of 66.4 years (SD 14.43), and a predominance of males (58.85%). The one-year mortality rate was 11.2%. Type 2 diabetes was present in 95.8% of cases, and 45.77% had a history of hypertension. The left lower limb was the most frequently affected site (49.6%). Amputations were performed in 30.8% of patients, predominantly minor (40.8%) and major in 9.2%, while 50% of patients did not undergo amputation. PEDIS and Wagner classifications both most scored 2 points, in 43.1% and 57.3% of patients, respectively. Table 2 shows that *Staphylococcus aureus* was the most common pathogen (49 cases), followed by *Enterococcus faecalis* (46) and *Pseudomonas aeruginosa* (23). Among the deceased patients, *E. faecalis* (4) was the most frequent, significantly associated with mortality (p=0.014).

The analysis of PEDIS and Wagner classification scores revealed statistically significant associations between more severe clinical features and the outcomes of amputation and mortality. Table 3 shows that the presence of peripheral arterial disease (PAD), particularly in critical ischemia, differed significantly across the amputation groups (p<0.001) and between deceased and surviving patients (p<0.001). Ulcers with an area greater than 3 cm² and depth reaching bone or joint were more common among patients who underwent amputation, with significant differences among groups (p<0.001). Similarly, deep and systemic infections, such as systemic inflammatory response syndrome (SIRS), were associated with both amputation (p<0.001) and mortality (p=0.0031). Loss of protective sensation was also significantly associated with both outcomes (p<0.001 for amputation; p<0.0001 for mortality). Although it is not possible to directly attribute each variable to major amputation specifically, it is notable that patients in this group exhibited the most severe clinical findings. These results emphasize the importance of structured severity assessment for early identification of patients at higher risk of complications in diabetic foot infections.

Table 4 shows that patients undergoing major amputation had higher mean PEDIS (2.58 vs. 1.64) and Wagner (2.50 vs. 1.50) scores compared to non-amputees (p<0.0001). C-reactive protein (CRP), urea, PEDIS score and Wagner classification were all significantly associated with mortality (p-values: 0.018, 0.018, 0.001, and 0.032, respectively).

Table 5 presents the results of the multivariate analysis using binary logistic regression, in which variables with statistical significance in the univariate analysis were included, expressing the associations through odds ratios with their respective 95% confidence intervals. Patients with higher PEDIS scores were 2.98 times more likely to die, while higher Wagner classifications increased mortality by 1.48 times.

Table 1. Demographic data, clinical history, comorbidities, laboratory tests, and infection scores at admission.

Baseline Features	N = 260		
	Minimum	Maximum	Mean (SD)
Age (years)	29	99	66.4 (14.43)
Height (m)	1.38	1.97	1.66 (0.09)
Platelets (/mm^3)	202,700	740,000	456,000 (659,000)
C-reactive protein (mg/dl)	45	625	83.77 (97.35)
Glucose (mg/dl)	75	441	189.51 (59.51)
Urea (mg/dl)	11	168	48.02 (26.86)
Categorical variables	**Frequency (N)**	**Percent (%)**	
Sex			
Female	107	41.15	
Male	153	58.85	
City			
Belo Horizonte	190	73.1	
Contagem	20	7.7	
Ribeirão das Neves	6	2.3	
Betim	3	1.2	
Others	41	15.8	
Smoking			
Current smoking	63	24.23	
Previous smoking	89	34.23	
Never smoked	108	41.54	
Alcohol consumption			
Current alcohol use	71	27.31	
Previous alcohol use	33	12.69	
Never consumed alcohol	156	60.0	
Death one year after culture			
No	231	88.8	
Yes	29	11.2	
Readmission in less than one year after the culture			
No	212	81.5	
Yes	48	18.5	
Comorbidities			
Diabetes mellitus			
Type 2	249	95.8	
Type 1	11	4.2	
Hypertension	119	45.77	
Cardiovascular disease	73	28.08	
Chronic kidney disease	21	8.1	
No medical conditions	12	4.6	
Others	35	13.5	
Previous dialysis or kidney transplantation			
No	245	94.2	
Yes	15	5.8	

continue...

... continuation Table 1

Baseline Features	N = 260		
	Minimum	Maximum	Mean (SD)
Lower limb venous disease			
Right lower limb	13	5.0	
Right and left lower limbs	23	8.8	
Left lower limb	10	3.8	
None	214	82.3	
Peripheral arterial disease			
Right lower limb	18	6.9	
Right and left lower limbs	39	15.0	
Left lower limb	25	9.6	
None	178	68.5	
Diabetic retinopathy			
No	247	95.0	
Yes	13	5.0	
Diabetic neuropathy			
No	219	84.2	
Yes	41	15.8	
Affected limb			
Right	117	45.0	
Right and left	14	5.4	
Left	129	49.6	
Affected part of the foot			
Hallux	86	33.1	
Calcaneus (heel)	55	21.1	
Plantar (sole)	44	15.7	
Second toe	34	13.6	
Third toe	17	7.2	
Fourth toe	6	2.3	
Fifth toe	4	1.3	
Others	14	5.4	
Foot deformity			
Plantar perforating ulcer	137	52.7	
Hallux valgus	11	3.9	
Charcot arthropathy	5	1.7	
None	107	41.7	
Surgical procedure			
Amputation	80	30.8	
Surgical debridement	58	22.3	
Surgical debridement with dressing	71	27.3	
Surgical debridement with amputation	50	18.8	
Mechanical debridement with dressing	1	0.8	

continue...

... continuation Table 1

Baseline Features	N = 260		
	Minimum	Maximum	Mean (SD)
Amputation type			
Major amputation	24	9.2	
Minor amputation	106	40.8	
Non-amputees	130	50.0	
PEDIS score			
0	6	5.1	
1	70	23.2	
2	112	43.1	
3	72	27.7	
Wagner's scale			
0	2	0.8	
1	83	31.9	
2	149	57.3	
3	7	2.7	
4	11	4.2	
5	8	3.1	

Caption: SD = Standard deviation.

Table 2. Microbiological profile.

	Amputation (p=0.117)								Deceased (p=0.014)		
Microorganism	**Major amputation**	**%**	**Minor amputation**	**%**	**Non-amputees**	**%**	**Total**	**%**	**Node**	**Yes**	**Total**
Staphylococcus aureus	2	0.77	13	5.00	34	13.08	49	18.85	48	1	49
Enterococcus faecalis	9	3.46	21	8.08	16	6.15	46	17.69	42	4	46
Pseudomonas aeruginosa	3	1.15	10	3.85	10	3.85	23	8.85	20	3	23
Escherichia coli	0	0	6	2.31	13	5.00	19	7.31	19	0	19
Proteus mirabilis	0	0	6	2.31	8	3.08	14	5.38	11	3	14
Staphylococcus epidermidis	2	0.77	5	1.92	4	1.54	11	4.23	11	0	11
Acinetobacter baumannii	0	0	5	1.92	4	1.54	9	3.46	7	2	9
Klebsiella pneumoniae	2	0.77	1	0.38	6	2.31	9	3.46	6	3	9
Morganella morganii	0	0	2	0.77	7	2.69	9	3.46	8	1	9
Enterobacter cloacae	0	0	2	0.77	5	1.92	7	2.69	6	1	7
Serratia marcescens	1	0.38	4	1.54	2	0.77	7	2.69	7	0	7
Klebsiella oxytoca	1	0.38	4	1.54	1	0.38	6	2.31	4	2	6

continue...

... continuation Table 2

Streptococcus agalactiae	0	0	3	1.15	2	0.77	5	1.92	5	0	5
Candida parapsilosis complex	0	0	3	1.15	1	0.38	4	1.54	3	1	4
Staphylococcus capitis	1	0.38	2	0.77	1	0.38	4	1.54	3	1	4
Staphylococcus haemolyticus	0	0	3	1.15	1	0.38	4	1.54	2	2	4
Stenotrophomonas maltophilia	0	0	3	1.15	1	0.38	4	1.54	4	0	4
Citrobacter freundii	1	0.38	2	0.77	0	0	3	1.15	3	0	3
Citrobacter koseri	0	0	1	0.38	2	0.77	3	1.15	3	0	3
Citrobacter spp.	0	0	1	0.38	1	0.38	2	0.77	2	0	2
Enterococcus faecium	0	0	0	0	2	0.77	2	0.77	2	0	2
Proteus vulgaris	0	0	1	0.38	1	0.38	2	0.77	2	0	2
Pseudomonas spp.	0	0	1	0.38	1	0.38	2	0.77	1	1	2
Coagulase-negative *Staphylococci* (CoNS)	0	0	0	0	2	0.77	2	0.77	1	1	2
Burkholderia cepacia	0	0	1	0.38	1	0.38	2	0.77	2	0	1
Candida albicans	0	0	0	0	1	0.38	1	0.38	0	1	1
Candida tropicalis	0	0	1	0.38	0	0	1	0.38	1	0	1
Chryseobacterium indologenes	0	0	1	0.38	0	0	1	0.38	1	0	1
Citrobacter braakii	0	0	1	0.38	0	0	1	0.38	0	1	1
Corynebacterium spp.	0	0	1	0.38	0	0	1	0.38	1	0	1
Klebsiella aerogenes	0	0	1	0.38	0	0	1	0.38	1	0	1
Providencia rettgeri	0	0	0	0	1	0.38	1	0.38	1	0	1
Providencia spp.	1	0.38	0	0	0	0	1	0.38	0	1	1
Providencia stuartii	1	0.38	0	0	0	0	1	0.38	1	0	1
Staphylococcus xylosus	0	0	0	0	1	0.38	1	0.38	1	0	1
Streptococcus pyogenes	0	0	1	0.38	0	0	1	0.38	1	0	1
Streptococcus viridans	0	0	1	0.38	0	0	1	0.38	1	0	1
Total	24	9.23	107	41.15	129	49.62	260	100	231	29	260

continue...

... continuation Table 2

Resistance profile	Amputation (p=0.717)								Deceased (p=0.600)		
	Major amputation	%	Minor amputation	%	Non-amputees	%	Total	%	Node	Yes	Total
GNB multiresistant (Colistin resistant)	0	0	1	0.39	0	0	1	0.38	1	0	1
GNB multi-sensitive	3	1.15	11	4.23	10	3.85	24	9.23	22	2	24
GNB Multidrug-resistant (MDR) non-fermenter	0	0	4	1.54	0	0	4	1.54	4	0	4
GNB multi sensitive non fermenter	5	1.92	10	3.85	11	4.23	26	10	23	3	26
GNB cefuroxime resistant	0	0	0	00	3	1.15	3	1.15	3	0	3
GNB cefuroxime & quinolone resistant	0	0	1	0.39	0	0	1	0.38	1	0	1
GNB amoxicillin clavulanate resistant	1	0.38	7	2.69	8	3.08	16	6.15	12	4	16
GNB Amoxicillin clavulanate & cefuroxime resistant	2	0.77	2	0.77	4	1.54	8	3.08	5	3	8
GNB Amoxicillin clavulanate & cefuroxime & quinolone resistant	0	0	1	0.39	1	0.38	2	0.77	2	0	2
GNB resistant to other drugs	0	0	1	0.39	0	0	1	0.38	1	0	1
GNB resistant quinolone	2	0.77	5	1.92	7	2.69	14	5.38	12	2	14
Ampicillin-sensitive *Enterococcus*	5	1.92	19	7.31	24	9.23	48	18.46	43	5	48
Extended spectrum beta-lactamase – ESBL	1	0.38	5	1.92	6	2.31	12	4.62	10	2	12
Coagulase-negative *Staphylococcus* not tested	0	0	2	0.77	0	0	2	0.77	1	1	2

continue...

... continuation Table 2

Oxacillin-resistant coagulase-negative *Staphylococcus*	1	0.38	6	2.31	7	2.69	14	5.38	11	3	14
Oxacillin-sensitive coagulase-negative *Staphylococcus*	1	0.38	3	1.15	2	0.77	6	2.31	5	1	6
clindamycin resistant *Streptococcus*	0	0	1	0.39	0	0	1	0.38	1	0	1
Quinolone resistant *Streptococcus*	0	0	1	0.39	0	0	1	0.38	1	0	1
MRSA (Methicillin resistant *Staphylococcus aureus*)	0	0	4	1.54	6	2.31	10	3.85	10	0	10
MSSA (Methicillin sensitive *Staphylococcus aureus*)	2	0.77	9	3.46	28	10.77	39	15:00	38	1	39
No resistance in other Gram positives	0	0	3	1.15	4	1.54	7	2.69	7	0	21
Other resistant gram positives	0	0	3	1.15	0	0	3	1.15	3	0	3
Pseudomonas cefepime Resistant	0	0	0	0	1	0.38	1	0.38	1	0	1
GNB Resistant to meropenem	1	0.38	6	2.31	4	1.54	11	4.23	9	2	11
Streptococcus sp. multi sensitive	0	0	2	0.77	3	1.15	5	1.92	5	0	5
Total	24	9.23	107	41.24	129	49.62	260	100	231	29	260

Caption: GNB = Gram-negative rods.

Table 3. Comparative data of the variable's perfusion, extent, depth, infection, and sensitivity used for the classification of PEDIS and Wagner.

Feature	Amputation				Deceased		
	Major amputation	Minor amputation	Non-amputees	*P*-value	N	Yes	*P*-value
Perfusion							
With peripheral arterial disease signs	10	29	25		51	14	
Critical ischemia	8	17	5		25	6	
Without PAD signs	7	60	99	**<0.001**	155	9	**<0.001**

continue...

... continuation Table 3

Feature	Amputation				Deceased		
	Major amputation	Minor amputation	Non-amputees	*P*-value	N	Yes	*P*-value
Extent							
<1 cm²	0	5	26		29	2	
>3 cm	19	71	25		98	17	
1–3 cm²	6	31	76		102	10	
Intact skin	0	0	1	**<0.001**	2	0	0.1378
Depth							
Fascia, muscle, tendon	4	20	36		52	9	
Bone or joint	18	76	17		98	13	
Intact skin	0	0	2		0	1	
Superficial	3	10	74	**<0.001**	81	6	0.140
Infection							
Abscess, fasciitis, septic arthritis	9	70	40		109	10	
None	0	0	3		1	1	
SIRS (Systemic Inflammatory Response Syndrome)	14	25	4		30	14	
Superficial	2	11	82	**<0.001**	91	4	**0.0031**
Loss of Sensitivity							
Present	15	37	14		49	16	
Absent	9	69	116	**<0.001**	182	13	**<0.0001**

Table 4. Clinical and laboratory variables, PEDIS and Wagner, by groups of amputation and death, in 260 patients with infected diabetic foot infections.

Feature	Major amputation		Minor amputation		Non-amputees		Deceased					*P*-value
							P-value	Yes		No		
	Mean	SD*	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Weight (kg)	81.75	26:45	75.81	15.03	74.99	16.57	0.368	70.9	14.6	76.6	17.4	0.095
Platelets (/mm3)	412,150	497,743	318,689	311,690	306,540	121,484	0.37	274,206.9	112,233	327,146.6	276,665.4	0.309
C-reactive protein (mg/dl)	112.36	106.71	95.79	111.4	69.28	81.45	0.059	139.9	161.8	77.8	86.5	0.018
Glucose (mg/dl)	223.27	59.65	192.4	54.52	181.71	62.03	0.124	180.6	59.1	191	59.7	0.485
Urea (mg/dl)	50.65	28.6	49.8	28.71	45.74	24.74	0.322	60	40.5	45.9	23.3	0.018
PEDIS	2.58	0.58	2.27	0.65	1.64	0.69	<0.001	2.5	0.7	1.9	0.7	<0.001
WAGNER	2.5	1.14	2.17	0.86	1.5	0.7	<0.001	2.2	1.2	1.8	0.9	0.032

Caption: SD = standard deviation.

Table 5. Multivariate logistic regression analysis of variables associated with in-hospital mortality in patients with infected diabetic foot.

Variable associated with mortality group	Odds Ratio	Lower limit of 95% confidence interval (CI)	Upper limit of 95% confidence interval (CI)	*P*-value
C-reactive protein	1.0047	1.0005	1,009	0.0383*
UREA	1.0158	1,002	1.0298	0.0295*
PEDIS	2.9838	1.6372	5.4382	0.001*
WAGNER	1.4761	1.0262	2.1232	0.0448*

Caption: *Statistically significant values (p<0.05). The analysis compared patients who died during hospitalization (mortality group) with those who were discharged from hospital (survival group). CI = confidence interval; PEDIS = Perfusion, Extent, Depth, Infection, Sensation.

Discussion

This single-center retrospective cohort analyzed the pathogen profile of diabetic foot infections (DFIs) and their association with PEDIS and Wagner classification scores, highlighting their correlation with amputation and mortality risk. Most affected patients were over 65, likely due to the higher prevalence of foot injuries in elderly individuals with diabetes and sensory neuropathy[11]. Patients commonly presented with comorbidities, notably hypertension and elevated blood glucose, with chronic hyperglycemia being the leading cause of diabetes-related complications[12]. Comparative analysis showed the left lower limb was most often affected (49.6%), aligning with findings by Brasileiro et al. (2005)[13], who reported higher amputation rates on the left side (51.8%) than on the right side (44.6%). The topographic distribution of lesions observed in this study was consistent with the literature, which identifies the hallux and plantar region as the most frequently affected sites in the infected diabetic foot, although Perim et al. (2015)[14] identified a higher predominance specifically in the right hallux. In terms of level of diabetes-related lower limb amputations, toe amputations comprise the majority of procedures[4].

The microbiological profile of infected DFUs varies across regions. This study assessed pathogen prevalence and antimicrobial susceptibility in ulcer bacteriological cultures, providing essential local epidemiological data to guide empirical therapy. Gram-positive and Gram-negative microorganisms were nearly equal in prevalence (48.85% and 48.08%, respectively). This contrasts with studies reporting Gram-positive predominance in DFIs[15], while others noted a higher prevalence of Gram-negative bacteria in specific regions[6]. A systematic review from Turkey analyzed 31 studies on DFIs over two decades, involving 2,097 patients and 1,974 bacteriological cultures. It found similar proportions of Gram-positive and Gram-negative aerobes across both time periods (1989–2007 vs. 2007–2011)[16]. DFUs often host multi-species microbial communities, with aerobic Gram-positive cocci, particularly *Staphylococcus aureus,* being the predominant pathogens in acute infections[17]. *S. aureus* is commonly the most frequently isolated and virulent pathogen in DFIs[14]. Our findings support this, as it was the most prevalent species across non-amputated limbs, and in patients who survived. In contrast, some Brazilian studies report a higher prevalence of *Enterobacterales* (51.5%), with *S. aureus* in 20% and *Enterococcus faecalis* in 17.9% of cases[18]. Another Brazilian study reported a predominance of Gram-positive bacteria, led by *S. aureus, followed* by *S. saprophyticus, S. epidermidis, S. agalactiae,* and *S. pneumoniae.* Among Gram-negatives, *Proteus* sp., *Enterobacter* sp., *E. coli, Pseudomonas* sp., and *Citrobacter* sp. were the most common genera[19]. While most Brazilian studies indicate a predominance of *S. aureus,* only one reported *Enterococci* as the main pathogen. These discrepancies emphasize the need for local epidemiological and resistance data to guide antibiotic therapy[20]. Among Gram-negative organisms, Enterobacterales were the predominant microorganisms, a pattern consistent with that described in both national and international literature. The prevalence of *Pseudomonas aeruginosa* observed was higher than that reported by Palomo et al. in São Paulo[7], corroborating the trend of increasing prevalence of this pathogen in diabetic foot infections in Brazil, as also evidenced by Turkish studies[16]. The presence of *Acinetobacter baumannii*, although in smaller proportions, warrants attention due to its antimicrobial resistance potential and association with infections that are clinically difficult to manage. Hawkins et al. (2022)[21] and a recent review also noted a rising incidence of *Pseudomonas aeruginosa* and multidrug-resistant Gram-negative bacilli. A Turkish study reported a higher *Pseudomonas* prevalence (13.7%)[16], while a 2015 Brazilian study showed a lower rate of 4.5%[14]. This suggests a possible upward trend in *Pseudomonas aeruginosa* prevalence in Brazil, mirroring the Turkish findings[16].

All *Enterococcus* isolates in this study were ampicillin-sensitive, while 25.64% of *S. aureus* showed oxacillin resistance. MRSA infections in DFUs have been reported in several studies. Chaudhry et al. (2016)[22] reported an 84% genotypic prevalence of MRSA in DFU isolates from Pakistan. This difference may reflect the greater sensitivity of genotypic detection methods. Non-genotypic studies report lower MRSA rates; for instance, Richard et al. (2011)[23] found 37.4% of *S. aureus* isolates were MRSA. Notably, MRSA infections are linked to higher mortality compared to methicillin-susceptible strains[24]. The high ampicillin susceptibility among

Enterococci likely reflects the predominance of *E. faecalis*, which is notably less resistant than *E. faecium*[25]. Brazilian studies show varied resistance profiles: Palomo et al. (2022)[7] reported 89% ampicillin sensitivity in *Enterococcus* sp. and 47% oxacillin sensitivity in *S. aureus*, while a study from Bahia (Brazil) found 29.4% oxacillin resistance[26]. Gram-negative isolates showed good susceptibility, with *Pseudomonas* largely sensitive to cefepime and meropenem. From 2007 to 2012, the same research team observed a shift in microbiological profiles at another but public tertiary hospital at the same city, Belo Horizonte (Brazil), where *Pseudomonas* spp. was the most frequently isolated genus in DFUs[27]. A study in Bahia (Brazil) found *Pseudomonas aeruginosa* to be the most common Gram-negative isolate (23 cases), and *Enterococcus faecalis* the most prevalent Gram-positive (26 cases)[18]. Such shifts in microbiological profiles reflect the dynamic nature of hospital and community microbiota, underscoring the need for ongoing surveillance by infection control teams.

A key limitation of this study is the absence of anaerobic cultures. While some studies suggest anaerobes play a minor role in DFIs, others report a high incidence of these pathogens[28,29]. Louie et al. (1976)[29] found anaerobes in 90% of samples from patients with chronic, malodorous ulcers that hadn't received antibiotics in the prior 30 days. They concluded that anaerobes are present significantly in deep infections and require proper transport and culture methods for detection[29]. Sasikumar et al. (2018)[30] found anaerobes in 23.8% of DFIs, mainly in patients with fever and deep ulcers. Anaerobic infections were linked to higher amputation risk but did not impact mortality.

Minor amputations predominated, consistent with findings by Hadadi et al. (2014)[31]. In contrast, a study in Sorocaba (Brazil) reported a 61% in-hospital major amputation rate[32], while a study in Goiânia (Brazil) found a similar rate of 61.9%[33]. Some hospitals in Rio de Janeiro (Brazil) reported rates exceeding 70%[34]. Major amputation rates in international referral centers range from 14.2%[35] to 20.2%[36], more similar to ours. In regions with structured, tiered healthcare systems, rates can drop to around 5% due to earlier intervention[37]. This study found no link between bacterial species or resistance profiles and the occurrence or type of amputation. In a Singapore study, Nather et al. (2008)[38] found that Staphylococcus aureus infections were associated with a higher rate of limb loss among 202 diabetic foot patients. Although *S. aureus* was the most common pathogen, it was not linked to increased amputation risk. Significant differences were observed in PEDIS scores across groups, with major amputations averaging 2.58 versus 2.27 for minor amputations. Wagner scores were also higher in major amputations (2.50 ± 1.14) than minor (2.17 ± 0.86). Quilici et al. (2016)[32] and another Brazilian study[39] similarly found that higher Wagner grades were directly associated with increased amputation risk.

CRP levels were significantly higher in deceased patients (p=0.018), reinforcing its potential role as a prognostic marker in diabetic patients. It should be evaluated alongside erythrocyte sedimentation rate (ESR) and procalcitonin (PCT) in diabetic patients with suspected foot infections, particularly when clinical assessment is unclear. The IWGDF Guidelines recommend CRP assessment as best clinical practice[4], although another study questioned its value as an infection marker in diabetic foot patients[40]. A pilot study with a limited sample found no significant elevation in PCT levels among DFI patients, including those who underwent amputation[41]. Two studies found that WBC count, CRP, and PCT levels significantly changed before and after infection, supporting their use as effective inflammatory markers for detecting DFIs[42,43].

The PEDIS and Wagner classifications demonstrated independent prognostic value for mortality in the multivariate analysis, reinforcing their utility as risk stratification tools in patients with infected diabetic foot. These findings are consistent with previous studies that have validated these classifications as predictors of adverse outcomes[44], and support the recommendations of the IWGDF/IDSA guidelines, which incorporate the infection component of the PEDIS system as the basis for grading lesion severity[9]. In resource-limited settings, both classifications provide clinically relevant information without the complexity of more sophisticated tools, such as the WIfI score[45], justifying their continued use in clinical practice. The 2023 IWGDF/IDSA guidelines include a four-grade infection classification, originally derived from the PEDIS system[9]. While not explicitly named, PEDIS is incorporated into current IWGDF/IDSA guidelines. Prior studies have validated this classification as part of broader diabetic foot assessment systems[44]. The WIfI[45] and SINBAD[46] classifications for DFUs incorporate the IWGDF/IDSA infection component and have been validated. The Wagner classification, originally proposed by Meggitt[8], is the oldest system. Current guidelines favor methods that integrate elements from both PEDIS and Wagner classifications. Wagner and PEDIS classifications remain practical in resource-limited settings, offering clinically valuable insights without the complexity of more resource-intensive tools like the WIfI score. Our findings support their continued use.

Study limitations

The present study has some limitations that should be considered when interpreting the results. As a single-center retrospective study, data were obtained exclusively from available medical records, which limited the standardization of certain variables. The absence of cultures for anaerobic microorganisms represents another relevant limitation, given that these pathogens may be present in a significant proportion of deep diabetic foot infections, with a possible impact on amputation risk. Finally, the single-center design, while ensuring homogeneity of care, limits the generalizability of the findings to other institutional and regional settings.

Conclusions

In conclusion, our findings highlight the clinical utility of PEDIS and Wagner classifications in predicting mortality among patients with infected diabetic foot. Elevated PEDIS

and Wagner scores, along with increased CRP and urea levels, were significantly associated with higher mortality risk. These results confirm that both scoring systems, despite differing complexity, effectively aid risk stratification in real-world settings where advanced tools like WIfI may not be available.

Our study supports routinely measuring inflammatory biomarkers, particularly CRP, in diabetic patients with suspected foot infections. As recommended by IWGDF guidelines, these tests aid in clarifying uncertain clinical presentations and guiding timely treatment decisions. A more holistic classification, including ulcer features, perfusion, infection status, neuropathy, and lab markers, may enhance outcomes in diabetic foot management. No specific pathogen or resistance pattern was significantly linked to amputation risk or type. These findings reinforce the importance of local epidemiological surveillance in guiding empirical antibiotic use. Despite a low MRSA prevalence, its clinical relevance remains due to its impact on outcomes. The use of PEDIS and Wagner classifications offered valuable insights into amputation risk, reinforcing evidence that higher scores indicate greater severity and poorer outcomes. Overall, these findings highlight the need for continuous microbiological monitoring, standardized ulcer classification, and comprehensive care strategies to improve outcomes in DFIs.

Authors' Contribution

We describe contributions to the papers using the taxanomy (CRediT) provide above:

Conceptualization, Material Preparation, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft, Writing – Review & Editing: H Duani. Investigation, Material Preparation, Data Curation, Writing – Review & Editing: MP de O Persilva. *Material Preparation, Data Curation, Formal Analysis, Validation, Visualization, Writing – Original Draft, Writing – Review & Editing*: KV Silva. *Material Preparation, Data Curation, Investigation, Validation, Visualization, Writing – Original Draft, Writing – Review & Editing*: W Corbelli. *Material Preparation, Data Curation, Formal Analysis, Investigation, Visualization, Writing – Original Draft, Writing – Review & Editing:* RRA da Silva. *Material Preparation, Investigation, Visualization, Writing – Original Draft, Writing – Review & Editing*: EV Gomes Neto. *Material Preparation, Formal Analysis, Investigation, Visualization, Writing – Original Draft, Writing – Review & Editing*: FM Rodrigues. *Supervision, Methodology, Writing – Review & Editing*: U Tupinambas. *Resources, Validation, Writing – Review & Editing*: TP Navarro.

Copyright

Copyright© 2021 Duani et al. This is na Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original article is properly cited.

References

1. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. N Engl J Med. 2017;376(24):2367.
2. McDermott K, Fang M, Boulton AJM, Selvin E, Hicks CW. Etiology, epidemiology, and disparities in the burden of diabetic foot ulcers. Diabetes Care. 2023;46(1):209–21.
3. Ndosi M, Wright-Hughes A, Brown S, Backhouse M, Bhogal M, Reynolds C, et al. Prognosis of the infected diabetic foot ulcer: a 12-month prospective observational study. Diabet Med 2018;35(1):78–88.
4. Senneville É, Albalawi Z, van Asten SA, Abbas ZG, Allison G, Aragón-Sánchez J, et al. Guidelines on the diagnosis and treatment of foot infection in persons with diabetes (IWGDF/IDSA 2023) [Internet]. The International Working Group on the Diabetic Foot; 2023; [cited 2023 Jun 12]. Available from: https://iwgdfguidelines.org/wp-content/uploads/2023/07/IWGDF-2023-04-Infection-Guideline.pdf.
5. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016. Diabetes Care. 2020;43(5):964–74.
6. Gadepalli R, Dhawan B, Sreenivas V, Kapil A, Ammini AC, Chaudhry R. A clinic-microbiological study of diabetic foot ulcers in an Indian tertiary care hospital. Diabetes Care. 2006;29(8):1727-32.
7. Palomo AT, Pires APM, Matielo MF, Soares R de A, Pecego C, Sacilotto R, et al. Microbiology of Diabetic Foot Infections in a Tertiary Care Hospital in São Paulo, Brazil. Antibiotics (Basel). 2022;11(8):1125.
8. Wagner FW. The dysvascular foot: a system for diagnosis and treatment. Foot Ankle. 1981;2(2):64–122.
9. Schaper NC. Diabetic foot ulcer classification system for research purposes: a progress report on criteria for including patients in research studies. Diabetes Metab Res Rev. 2004;20(Suppl 1):S90–5.
10. Saluja S, Anderson SG, Hambleton I, Shoo H, Livingston M, Jude EB, et al. Foot ulceration and its association with mortality in diabetes mellitus: a meta-analysis. Diabet Med. 2020;37(2):211–8.
11. Lipsky BA, Pecoraro RE, Ahroni JH. Foot ulceration and infections in elderly diabetics. Clin Geriatr Med. 1990;6(4):747-69.
12. Bortoletto MSS, de Andrade SM, Matsuo T, Haddad MDCL, González AD, Silva AMR. Risk factors for foot ulcers—a cross sectional survey from a primary care setting in Brazil. Prim Care Diabetes. 2014;8(1):71–6.
13. Brasileiro JL, Oliveira WTP, Monteiro LB, Chen J, Pinho ELP Jr, Molkenthin S, et al. Foot Diabetic: Aspects Clinicians. J Vasc Br. 2005;4(1):11-21.
14. Perim MC, Borges JDC, Celeste SRC, Orsolin EDF, Mendes RR, Mendes GO, et al. Aerobic bacterial profile and antibiotic resistance in patients with diabetic foot infections. Rev Soc Bras Med Trop. 2015;48(5):546–54.

15. Abdulrazak A, Bitar ZI, Al-Shamali AA, Mobasher LA. Bacteriological Study of Diabetic Foot Infections. J Diabetes Complications. 2005;19(3):138-41.

16. Hatipoglu M, Mutluoglu M, Uzun G, Karabacak E, Turhan V, Lipsky BA. The microbiological profile of diabetic foot infections in Turkey: A 20-year systematic review: Diabetic foot infections in Turkey. Eur J Clin Microbiol Infect Dis. 2014;33:871–8.

17. Machado C, Teixeira S, Fonseca L, Abreu M, Carvalho A, Pereira MT, et al. Evolutionary trends in bacteria isolated from moderate and severe diabetic foot infections in a Portuguese tertiary center. Diabetes Metab Syndr. 2020;14(3):205-9.

18. Santos VP dos, Andrade Barberino MGM de, Alves CAS. Microbiological Species and Antibiotic Resistance in Diabetic and Nondiabetic Lower Extremity Wounds: A Comparative Cross-Sectional Study. Int J Low Extreme Wounds. 2024 Jun;23(2):338-46.

19. Rastogi A, Sukumar S, Hajela A, Mukherjee S, Dutta P, Bhadada SK, et al. The microbiology of diabetic foot infections in patients recently treated with antibiotic therapy: A prospective study from India. J Diabetes Complications. 2017;31(2):407-12.

20. Li X, Qi X, Yuan G, Ju S, Yu Z, Deng W, et al. Microbiological profile and clinical characteristics of diabetic foot infection in northern China: a retrospective multicenter survey in the Beijing area. J Med Microbiol. 2018;67(2):160-8.

21. Hawkins BK, Barnard M, Barber KE, Stover KR, Cretella DA, Wingler MJB, et al. Diabetic foot infections: A microbiological review. Foot (Edinb). 2022;51:101877.

22. Chaudhry WN, Badar R, Jamal M, Jeong J, Zafar J, Andleeb S. Clinical -microbiological study and antibiotic resistance profile of mecA and ESBL gene prevalence in patients with diabetic foot infections. Exp Ther Med. 2016;11(3):1031-8.

23. Richard JL, Sotto A, Lavigne JP. New insights in diabetic foot infection. World J Diabetes. 2011;2(2):24–32.

24. Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y. Comparison of mortality associated with methicillin-resistant and methicillin-susceptible Staphylococcus aureus bacteremia: A meta-analysis. Clin Infect Dis. 2003;36(1):53–9.

25. Miller WR, Murray BE, Rice LB, Arias CA. Resistance in Vancomycin-Resistant Enterococci. Infect Dis Clin North Am. 2020;34(4):751-71.

26. Nascimento LD, Lopes ACP, Teixeira MM, da Silva JMA, Silva LO, de Almeida JB, et al. Clinical and Microbiological Profile of Diabetic Foot Ulcers Infected With Staphylococcus aureus in a Regional General Hospital in Bahia, Brazil. Int J Low Extrem Wounds. 2024;23(2):252-63.

27. Cardoso NA, Cisneiros LdL, Machado CJ, Cenedezi JM, Procópio RJ, Navarro TP. Bacterial genus is a risk factor for major amputation in patients with diabetic foot. Rev Col Bras Cir. 2017;44(2):147-53.

28. Candel González FJ, Alramadan M, Matesanz M, Diaz A, González-Romo F, Candel I, et al. Infections in diabetic foot ulcers. Eur J Intern Med. 2003;14:341-3.

29. Louie TJ, Bartlett JG, Tally FP, Gorbach SL. Aerobic and anaerobic bacteria in diabetic foot ulcers. Ann Intern Med. 1976;85(4):461-3.

30. Sasikumar K, Vijayakumar C, Jagdish S, Kadambari D, Raj Kumar N, Biswas R, et al. Clinical-microbiological Profile of Septic Diabetic Foot with Special Reference to Anaerobic Infection. Cureus. 2018;10(3):e2252.

31. Hadadi A, Ghiasi HO, Hajiabdolbaghi M, Zandekarimi M, Hamidian R. Diabetic Foot: Infections and Outcomes in Iranian Admitted Patients. Jundishapur J Microbiol. 2014;7(7):e11680.

32. Quilici V, Teresa M, Fiol D, de Sá F, Franzin Vieira AE, Toledo MI. Risk factors for foot amputation in patients hospitalized for diabetic foot infection. J Diabetes Res 2016;2016:8931508 .

33. Cássia Oliveira J, dos Santos Taquary SA, de Melo Barbosa A, Veronesi RJB. Foot diabetic and amputations in people hospitalized in a public hospital: a cross-sectional study. ABCS Health Sci. 2016;41(1):34-9.

34. Junqueira F. Rio é o estado do Sudeste que mais mutila pacientes diabéticos: uma amputação a cada 2 horas e 40 minutos. Extra [Internet]. 2019 nov 10; [cited 2026 Jun 28]; Saúde e Ciência. Available from: https://extra.globo.com/noticias/rio/rio-o-estado-do-sudeste-que-mais-mutila-pacientes-diabeticos-uma-amputacao-cada-2-horas-40-minutos-24072034.html .

35. Yusof NM, Ab Rahman J, Zulkifly AH, Che-Ahmad A, Khalid KA, Sulong AF, et al. Predictors of major lower limb amputation among type II diabetic patients admitted for diabetic foot problems. Singapore Med J. 2015;56(11):626-31.

36. Bruun C, Siersma V, Guassora A, Holstein P, de Fine Olivarius N. 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. Diabetic medicine. 2013;30(8):964-72.

37. Moon KC, Kim SB, Han SK, Jeong SH, Dhong ES. Risk Factors for Major Amputation in Hospitalized Diabetic Patients with Forefoot Ulcers. Diabetes Res Clin Pract. 2019:158:107905.

38. Nather A, Bee CS, Huak CY, Chew JL, Lin CB, Neo S, et al. Epidemiology of diabetic foot problems and predictive factors for limb loss. J Diabetes Complications. 2008;22(2):77-82.

39. dos Santos VP, da Silveira DR, Caffaro RA. Risk factors for primary major amputation in diabetic patients. Sao Paulo Med J. 2006;124(2):66–70.

40. Uzun G, Solmazgul E, Curuksulu H, Turhan V, Ardic N, Top C, et al. Procalcitonin as a diagnostic aid in diabetic foot infections. Tohoku J Exp Med. 2007;213(4):305–12.

41. Karakas A, Arslan E, Cakmak T, Aydin I, Akgul EO, Demirbas S. Predictive value of soluble CD14, interleukin-6 and procalcitonin for lower extremity amputation in people with diabetes with foot ulcers: a pilot study. Pak J Med Sci. 2014;30(3):578–82.

42. Park JH, Suh DH, Kim HJ, Lee YI, Kwak IH, Choi GW. Role of procalcitonin in infected diabetic foot ulcer. Diabetes Res Clin Pract. 2017;128:51–7.

43. Lauri C, Glaudemans A, Campagna G, Keidar Z, Kurash MM, Georga S, et al. Comparison of white blood cell scintigraphy, FDG PET/CT and MRI in suspected diabetic foot infection: results of a large retrospective multicenter study. J Clin Med. 2020;9(6):1645.

44. La very LA, Armstrong DG, Murdoch DP, Peters EJ, Lipsky BA. Validation of the Infectious Diseases Society of America's diabetic foot infection classification system. Clin Infect Dis. 2007;44(4):562–5.

45. Mills Sr JL, Conte MS, Armstrong DG, Pomposelli FB, Schanzer A, Sidawy AN, et al. The society for vascular surgery lower extremity threatened limb classification system: risk stratification based on wound, ischaemia, and foot infection (WIfI). J Vasc Surg. 2014;59(1):220-34.e2.

46. Ince P, Abbas ZG, Lutale JK, Basit A, Ali SM, Chohan F, et al. Use of the SINBAD classification system and score in comparing outcome of foot ulcer management on three continents. Diabetes Care. 2008;31(5):964-7.

This is an open access article distributed under the terms of the Creative Commons Attribution License.