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(Research Article)

Utilizing the SINBAD score to assess amputation risk in diabetic foot ulcers

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Abstract

Background: Diabetic foot ulcers (DFUs) represent a serious complication of diabetes, often resulting in significant morbidity and limb loss. This study aimed to assess the predictive value of the SINBAD scoring system—which includes Site, Ischemia, Neuropathy, Bacterial infection, Area, and Depth—in identifying the risk of major foot events, particularly amputations, in patients with DFUs.

Material and Methods: A prospective observational study was carried out at Sree Mookambika Institute of Medical Sciences from November 2023 to November 2024. A total of 150 patients diagnosed with diabetic foot ulcers and meeting the eligibility criteria were enrolled. The SINBAD scoring system was applied to evaluate ulcer severity and its correlation with clinical outcomes.

Results: The study population consisted mainly of male patients (63%), with mean ages of 62 years for males and 50 years for females. Ulcers exceeding 1 cm^2 were found in 97% of cases, with 68% being superficial and 93% located on the forefoot. A SINBAD score of 2 was the most frequently observed (58%). All patients scoring 2 achieved wound healing without amputation, while a SINBAD score of 6 was associated with a 100% amputation rate. The data revealed a progressive rise in amputation risk with increasing SINBAD scores.

Conclusion: The SINBAD scoring system is a practical and reliable method for predicting the likelihood of amputation in patients with diabetic foot ulcers. It offers a structured approach for assessing ulcer severity and guiding treatment decisions. Further research is necessary to confirm these results across broader populations and to develop focused strategies for reducing amputation rates in high-risk individuals.

Keywords: Diabetic Foot Ulcer; SINBAD Score; Amputation Risk; Ulcer Severity; Predictive Tool

1. Introduction

Diabetic foot ulcers (DFUs) are open wounds or sores that commonly occur on the feet of individuals with diabetes. These ulcers often develop due to a combination of factors such as impaired blood circulation, peripheral neuropathy, and infection, making them one of the most serious complications associated with diabetes. Early detection and effective management are essential to avoid further complications and to enhance patient outcomes.

DFUs pose a significant health concern and contribute substantially to the overall burden of diabetes-related complications. They are associated with considerable morbidity and require timely evaluation and treatment to prevent serious consequences, including limb amputation. A thorough understanding of the risk factors involved in ulcer formation and the application of standardized scoring systems like the SINBAD classification can improve clinical decisions and patient care [1].

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It is estimated that the lifetime risk of developing a foot ulcer in diabetic individuals is around 15%, and approximately 3% may undergo lower limb amputation during their lives [2–5]. Preventive efforts, including routine foot checks and patient education on foot hygiene, play a critical role in lowering these risks. Additionally, multidisciplinary care involving podiatrists, endocrinologists, and wound specialists is crucial for providing comprehensive treatment. Emerging therapies such as Platelet-Rich Plasma (PRP), Epidermal Growth Factor (EGF), and various off-loading techniques have also been explored for managing DFUs [6–10].

Ulceration is known to contribute to over two-thirds of lower limb amputations in diabetic patients. Many of these individuals also suffer from underlying atherosclerotic vascular disease, particularly in older age groups. Diabetic foot ulcers requiring major amputation are associated with high mortality rates, reaching up to 15% [2].

Clinical outcomes of DFUs are influenced by factors such as vascular supply, the extent of infection, and the depth of tissue involvement at the time of presentation. Recording these variables systematically is vital for guiding treatment plans, evaluating therapeutic responses, forecasting outcomes, and facilitating communication among healthcare professionals [4].

The SINBAD scoring system evaluates six clinical parameters—Site, Ischemia, Neuropathy, Bacterial infection, Area, and Depth—each graded 0 or 1. For Site, a score of 0 is given for forefoot ulcers (distal to the tarsometatarsal joint), and 1 for ulcers on the midfoot or hindfoot. Ischemia is scored as 0 when at least one palpable pulse is present, indicating adequate perfusion, and 1 when no pulse is felt along with signs of poor blood flow such as cold limbs, discoloration, or gangrene. Neuropathy is assessed using a 10-g monofilament; a score of 0 denotes absence, and 1 indicates the presence of sensory loss.

According to the Infectious Disease Society of America (IDSA) and the International Working Group on the Diabetic Foot (IWGDF), bacterial infection is identified through clinical signs of soft tissue or bone infection and is scored as 0 if absent or 1 if present [3]. The Area is calculated by multiplying the ulcer's length and width, with a score of 0 for ulcers ≤1 cm^2 and 1 for those >1 cm^2. Depth is scored as 0 if the ulcer is superficial and 1 if it extends to muscle, tendon, joint capsule, or bone. The total SINBAD score ranges from 0 to 6, providing a concise yet comprehensive assessment of ulcer severity [3].

2. Methodology

This prospective study was conducted between November 2023 and November 2024 at Sree Mook Ambika Institute of Medical Sciences, involving 150 inpatients and outpatients who met specific inclusion and exclusion criteria. Eligible participants were aged 18 years or older and had diabetic foot ulcers (DFUs) attributed to diabetes mellitus, with ulcer duration of less than 12 months. Patients with ulcers on the leg or malleolar region, ulcers of non-diabetic origin, incomplete data on age, gender, BMI, or SINBAD score, those lost to follow-up, or with significant comorbid conditions were excluded.

Detailed clinical information was systematically collected for each participant, and ulcer severity was assessed using the SINBAD scoring system (Site, Ischemia, Neuropathy, Bacterial Infection, Area, Depth). Throughout the study, all patients received daily wound care and maintained strict glycemic control. Ethical approval was granted by the institutional ethics committee, and statistical analysis was conducted using appropriate software to evaluate clinical outcomes and determine the predictive value of SINBAD scores in guiding treatment strategies.

3. Results

In [Table 1], the demographic characteristics of the study participants are presented. The mean age of participants was 55.3 ± 7 years, with a male predominance (63%) compared to females (37%). The majority of ulcers were located on the forefoot (93%), followed by the hindfoot (5%) and midfoot (3%). Ischemia was present in 35% of participants, while 65% showed no signs of ischemia. Neuropathy was prevalent in 60% of participants, whereas 40% did not exhibit neuropathy. Bacterial infection was observed in 90% of ulcers, indicating its high prevalence in diabetic foot ulcers, with only 10% being infection-free. Most ulcers were larger than 1 cm^2 (97%), and the majority were superficial (68%), with 32% classified as deep ulcers.

Table 1 Demographic distribution of study participants

Characteristics	**Frequency**	**Percentage**
Mean Age	55.3±7 years	
Gender		
Male	95	63%
Female	55	27%
Site of Ulcer		
Forefoot	140	93%
Hind Foot	7	5%
Mid Foot	3	3%
Presence of Ischemia		
Present	52	35%
Absent	98	65%
Presence of Neuropathy		
Present	90	60%
Absent	60	40%
Presence of Bacterial Infection		
Yes	135	90%
No	15	10%
Size of the Ulcer		
<1cm2	5	3%
>1cm2	145	97%
Depth of the Ulcer		
Deep	48	32%
Superficial	102	68%

Table 2 SINBAD Score for the Ulcer

Score	**Number of Patients**	**Percentage**
1	8	5.3
2	87	58
3	17	11.3
4	32	21.3
5	4	2.6
6	2	1.3
Total	150	100%

[Table 2] presents the distribution of SINBAD scores among the study participants. The majority of patients (58%) had a SINBAD score of 2, indicating relatively mild ulcer severity. Scores of 3 and 4 were observed in 11.3% and 21.3% of participants, respectively, reflecting moderate severity. Higher severity scores of 5 and 6 were less common, observed in only 2.6% and 1.3% of patients, respectively. A small proportion of patients (5.3%) had a SINBAD score of 1, representing the least severe ulcers.

Table 3 Clinical Outcomes Based on SINBAD Score

Sinbad Score (N)	Hospitalisation N (%)	Secondary Infection N (%)	Recurrence N (%)	Amputation N (%)
1 (8)	2 (25)	1(12.5)	1(12.5)	0(0)
2(87)	15(17.24)	7(8.04)	5(5.7)	0(0)
3(17)	8(47)	5(29.4)	7(41.1)	5(29.4)
4(32)	25(78)	16(50)	5(15.6)	12(37.5)
5(4)	3(75)	1(25)	1(25)	2(50)
6(2)	1(50)	1(50)	1(50)	2(100)

[Table 3] highlights the clinical outcomes of diabetic foot ulcers stratified by SINBAD scores. Patients with lower SINBAD scores (1 and 2) experienced lower rates of hospitalization, secondary infection, recurrence, and amputation. Specifically, hospitalization occurred in 25% of patients with a SINBAD score of 1 and 17.24% of those with a score of 2, with no amputations in either group. However, as the SINBAD score increased, worse outcomes were observed. Among patients with a score of 3, hospitalization occurred in 47%, secondary infection in 29.4%, recurrence in 41.1%, and amputation in 29.4%. For scores of 4, 5, and 6, the rates of adverse outcomes rose sharply, with the highest rates of hospitalization (78%), secondary infection (50%), recurrence (50%), and amputation (100%) occurring in patients with a SINBAD score of 6. These findings demonstrate a clear correlation between higher SINBAD scores and poorer clinical outcomes, emphasizing the importance of early intervention and aggressive management in patients with severe diabetic foot ulcers.

4. Discussion

The SINBAD classification system serves as a practical and thorough method for assessing and diagnosing diabetic foot ulcers (DFUs). These ulcers present complex clinical challenges that demand tailored treatment strategies. By organizing ulcer characteristics into defined criteria, SINBAD allows healthcare providers to evaluate ulcers systematically, improving communication and informing appropriate management approaches.

As a numerically based tool, the SINBAD score quantifies ulcer severity, which aids in identifying complex wounds and tracking healing progression over time. This scoring system supports clinicians in making evidence-based decisions and in modifying treatment plans to achieve the best possible outcomes for patients.

Our study supports previous literature by establishing a strong link between elevated SINBAD scores and poorer prognoses. For example, a 2021 study reported a 100% healing rate in ulcers with a SINBAD score of 0, while healing dropped to 49% in those with a score of 6. The study also highlighted a clear downward trend in healing rates as SINBAD scores increased, with ulcers scored as 4 comprising 28% of cases, while scores of 0 and 1 represented only 0.7% and 4.5%, respectively [11]. Likewise, research by Alas beck et al. [12] found that ulcers with SINBAD scores of 3 or above had a median healing time of 14 weeks, compared to just 4 weeks for those scoring 2 or lower.

In our findings, most patients had a SINBAD score of 2 (58%), followed by scores of 4 (21.3%), 3 (11.3%), 1 (5.3%), 5 (2.6%), and 6 (1.3%). Similar to earlier studies, ulcers with scores of 1 and 2 demonstrated complete healing, while those with higher scores exhibited a gradual reduction in healing rates. This trend emphasizes the score's predictive value and the importance of early intervention in patients with lower scores to prevent complications and improve outcomes.

We also found a significant correlation between SINBAD scores and adverse foot outcomes, including amputation, secondary infections, hospitalization, and recurrence. These findings highlight the score's utility even in low-resource settings, where its simplicity and predictive ability make it a valuable clinical tool. The system has been validated for predicting both ulcer healing and risk of amputation, and our results reinforce its relevance in forecasting adverse outcomes.

Our study also explored the causes of DFUs, noting that repetitive mechanical stress on neuropathic plantar surfaces remains the leading factor. While neuropathic ulcers are commonly found on the plantar surface of the hallux and metatarsophalangeal joints, our results suggest the hind

foot is especially vulnerable, justifying the SINBAD classification of 1 for midfoot and hindfoot lesions and 0 for those on the forefoot.

While several classification systems for DFUs exist, the Wagner scale remains one of the most widely used. However, it mainly evaluates ulcer depth and the presence of gangrene or osteomyelitis, without accounting for essential elements such as neuropathy and ischemia. The SINBAD system addresses these gaps, offering a more balanced and inclusive assessment.

A limitation of our study was its relatively short follow-up period, which may explain the absence of observed mortality associations. Although diabetic foot ulcers are associated with increased long-term mortality, this is more often due to underlying comorbidities than the ulcer itself. A longer follow-up would help clarify the long-term implications of DFUs more comprehensively.

5. Conclusion

The SINBAD scoring system is a straightforward and clinically practical tool that relies solely on physical examination, making it easy to implement in routine settings. It provides essential information for effective triage by specialist teams. Notably, each incremental increase in the SINBAD score is associated with a higher risk of adverse outcomes in diabetic foot ulcers, with rising scores significantly correlating with an increased likelihood of amputation.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflicts of interest.

Statement of ethical approval

The study was conducted in accordance with ethical standards. Approval was obtained from the appropriate ethics committee.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study

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