

SINBAD SCORING SYSTEM FOR PREDICTING AMPUTATION RISK IN DIABETIC FOOT ULCERS

J.A. Jayalal¹, P.R. Baghavath², N.Joshua Joy Samuel², Parvathy Vijayakumar³

¹Professor and Head, Department of Surgery, Kanyakumari Govt Medical College, Asaripallam, Tamil Nadu, India

²Assistant Professor, Department of Surgery, Kanyakumari Govt Medical College, Asaripallam, Tamil Nadu, India

³Postgraduate Scholar, Department of Surgery, Kanyakumari Govt Medical College, Asaripallam, Tamil Nadu, India

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Corresponding Author:
Dr. N. Joshua Joy Samuel,
Email: wtjjs@gmail.com

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Abstract

Background: Diabetic foot ulcers are a major complication of diabetes, leading to significant morbidity and amputation. This study aimed to evaluate the impact of the SINBAD score—comprising Site, Ischemia, Neuropathy, Bacterial Infection, Area, and Depth—on predicting serious foot events, such as amputation, in patients with DFUs. **Materials and Methods:** A prospective study was conducted at Kanyakumari Government Medical College between November 2023 and November 2024. A total of 150 patients diagnosed with DFUs and meeting the inclusion criteria were analyzed. The SINBAD scoring system was applied to assess ulcer severity and its association with adverse outcomes. **Result:** The study included predominantly male patients (63%), with a mean age of 62 years for males and 50 years for females. Ulcers larger than 1 cm² were observed in 97% of patients, with the majority being superficial (68%) and located on the forefoot (93%). The most common SINBAD score was 2 (58%). All patients with a SINBAD score of 2 healed without requiring amputation, whereas patients with a SINBAD score of 6 had a 100% risk of amputation. The findings demonstrated a stepwise increase in the risk of adverse outcomes, including amputation, with higher SINBAD scores. **Conclusion:** The SINBAD score is an effective and straightforward tool for predicting amputation risk in patients with DFUs. It enables healthcare providers to systematically assess ulcer severity and guide clinical decision-making. Further studies are recommended to validate these findings in diverse populations and to explore targeted interventions to reduce amputation rates in high-risk patients.

INTRODUCTION

Diabetic foot ulcers are open sores or wounds on the feet of people with diabetes. These ulcers can result from various factors, including poor circulation, neuropathy, and infection, making them a significant complication of diabetes. Early identification and appropriate management are crucial to prevent further complications and improve patient outcomes. Foot ulcers are a common and important complication of diabetes, representing a major healthcare burden with significant morbidity. The timely assessment and management of these ulcers are crucial to prevent severe outcomes, including amputation. Understanding the factors that contribute to ulcer development and utilizing scoring systems like SINBAD can enhance clinical decision-making and improve patient outcomes.^[1]

The lifetime risk of foot ulceration in patients with diabetes may be as high as 15%, and up to 3% of patients will have a lower limb amputation during their lifetime.^[2-5] Preventive strategies, such as regular foot examinations and patient education on proper foot care, can significantly reduce this risk. Additionally, interdisciplinary approaches involving podiatrists, endocrinologists, and wound care specialists are essential for optimizing management and ensuring comprehensive care for at-risk individuals. Various novel treatments like Platelet rich Plasma, Epidermal growth factor and umpteen off-loading measures were used in the treatment.^[6-10] Diabetic patients have identified ulceration as a major contributor to more than two-thirds of lower limb amputations. Underlying atherosclerotic vascular disease is common in this elderly group of patients; a high mortality of up to 15% is associated

with diabetic foot ulcers requiring major amputation.^[2]

Blood supply, the presence of infection, and the depth of involvement at presentation all influence the outcome of diabetic foot ulcers. Systematically recording these confounding factors is critical to planning treatment strategies, monitoring treatment effectiveness, predicting clinical outcomes, and improving communication among healthcare providers.^[4]

The SINBAD score was calculated with six factors graded from 0 to 1: Site, Ischemia, Neuropathy, Bacterial infection, Area, and Depth [Table 1].

The ulcer site was scored as 0 for forefoot (distal tarsometatarsal joint) or 1 for midfoot or hindfoot. Ischemia was scored as 0: at least one pulse palpable (blood flow relatively intact on the affected foot) or 1: no pulse palpable with signs of poor perfusion (cold feet, skin discoloration, slower hair growth, swelling, cramping) with or without gangrene. Neuropathy, or loss of protective sensation on the basis of examination using 10-g nylon monofilaments, was scored as 0: absent or 1: present. The Infectious Disease Society of America (IDSA) and IWGDF defined bacterial infection as clinical signs of either soft tissues or bone and assigned a score of either 0: absent or 1: present.³ The area, which is the result of multiplying the two maximum dimensions at right angles, received a score of 0: 1 cm. Last, depth was scored as 0: superficial or 1: deep-reaching muscle, tendon, joint capsule, or bone. The SINBAD score was obtained by summing the components of the classification, creating a SINBAD score range of 0–6.³

MATERIALS AND METHODS

This prospective study was conducted from November 2023 to November 2024 at Kanyakumari

Government Medical College, including 150 inpatients and outpatients who met predefined inclusion and exclusion criteria. Patients aged 18 years or older with diabetic foot ulcers (DFUs) caused by diabetes mellitus, present for less than 12 months, were included, while those with leg or malleolar ulcers, ulcers due to non-diabetic causes, missing data on age, gender, BMI, or SINBAD score, those lost to follow-up, or with major comorbidities were excluded. Patient details were systematically collected and analyzed, and the SINBAD (Site, Ischemia, Neuropathy, Bacterial Infection, Area, Depth) scoring system was applied to assess ulcer severity. All patients received daily wound dressings and strict glycemic control during the study period. Ethical clearance was obtained from the institutional ethical committee, and statistical analyses were performed using software to evaluate outcomes and assess the effectiveness of treatment protocols based on SINBAD scores.

RESULTS

In [Table 2], 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 cm² (97%), and the majority were superficial (68%), with 32% classified as deep ulcers.

Table 1: SINBAD Score.

| Category | Definition | SINBAD Score |
|----------------------|--|--------------|
| Site | Forefoot | 0 |
| | Midfoot and Hindfoot | 1 |
| Ischemia | Pedal blood flow intact, one pulse palpable | 0 |
| | Clinical evidence reduced pedal blood flow | 1 |
| Neuropathy | Protective sensation intact | 0 |
| | Protective sensation lost | 1 |
| Bacterial Infection | None | 0 |
| | Present | 1 |
| Area | Ulcer <1 cm ² | 0 |
| | Ulcer >1 cm ² | 1 |
| Depth | Ulcer confined to skin and subcutaneous tissue | 0 |
| | Ulcer reaching muscle, tendon, or deeper | 1 |
| Total Possible Score | | 0-6 |

Table 2: Demographic Characteristics of the 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 | | |
| <1cm ² | 5 | 3% |
| >1cm ² | 145 | 97% |
| Depth of the Ulcer | | |
| Deep | 48 | 32% |
| Superficial | 102 | 68% |

Table 3: 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 4: 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] 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 4] 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.

DISCUSSION

The SINBAD classification system provides a practical and comprehensive framework for the evaluation and diagnosis of diabetic foot ulcers (DFUs). DFUs present considerable challenges in patient care due to their complexity and the necessity for individualized treatment plans. By categorizing ulcers based on specific criteria, the SINBAD system enables healthcare professionals to systematically assess these wounds, enhancing communication and guiding effective management strategies.

The numerical basis of the SINBAD scoring system offers a quantitative measure of DFU severity, facilitating both the identification of ulcer complexity and the monitoring of progress over time. This allows clinicians to make informed decisions about interventions and adjust treatment plans as needed to optimize patient outcomes.

Our study findings align with previous research, demonstrating a strong correlation between higher SINBAD scores and poorer clinical outcomes. A 2021 study reported a 100% healing rate in patients with a SINBAD score of 0, compared to a significantly lower healing rate of 49% in patients with a SINBAD score of 6. The study also noted a

stepwise decline in ulcer healing rates with increasing SINBAD scores, with ulcers categorized as SINBAD 4 accounting for 28% of cases, while SINBAD 0 and 1 represented 0.7% and 4.5% of cases, respectively.^[11] Similarly, Alasabeck et al,^[12] found that patients with SINBAD scores of 3 or higher had a median healing time of 14 weeks, compared to 4 weeks for those with scores of 2 or lower.

In our study, the majority of 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%). Consistent with prior findings, ulcers with SINBAD scores of 1 and 2 showed a 100% healing rate, with a progressive decline in healing rates as the SINBAD score increased. This stepwise reduction underscores the utility of the SINBAD scoring system in predicting healing outcomes and highlights the importance of early intervention in patients with lower SINBAD scores to achieve optimal results and prevent complications associated with more severe ulcers.

Our study also demonstrated a significant relationship between SINBAD scores and adverse foot events such as amputation, secondary infection, hospitalization, and recurrence. This emphasizes the relevance of SINBAD scoring, even in resource-limited settings, as a simple yet effective tool for predicting outcomes. The classification has been validated for both ulcer healing and amputation prediction, and our findings confirm its utility in predicting relevant adverse events.

The study also sheds light on the etiology of foot ulceration, with repetitive mechanical pressure on neuropathic plantar tissue being the most common cause. While neuropathic ulcers predominantly occur on the plantar metatarsophalangeal joints and the plantar aspect of the hallux, our findings suggest that the hindfoot is particularly at high risk, justifying the SINBAD score of 1 for midfoot and hindfoot areas and a score of 0 for the forefoot.

There are several scoring systems for DFUs, with the Wagner classification being widely accepted. However, the Wagner system focuses primarily on ulcer depth, osteomyelitis, abscess, and gangrene, without incorporating critical factors like neuropathy and ischemia. The SINBAD system addresses these limitations, offering a more comprehensive assessment of DFUs.

One limitation of our study is the short duration of follow-up, which likely explains the absence of an association with mortality. While diabetic ulcers are linked to increased mortality, this is typically observed over long-term follow-up due to associated comorbidities rather than the ulcer itself being a direct cause. Extending the follow-up duration would provide further insights into the long-term outcomes of patients with DFUs.

In conclusion, the SINBAD scoring system is a valuable tool for the evaluation, management, and prediction of outcomes in DFUs. It provides a

standardized approach for assessing ulcer severity and tracking progress, making it particularly useful in resource-limited settings for guiding clinical decisions and improving patient outcomes.

CONCLUSION

The SINBAD scoring system is simple and easy technique requiring clinical examination alone and containing the necessary information to allow for triage by a specialist team. Each unit of SINBAD score correlates with adverse outcomes in diabetic foot ulcers and increase in score increases the risk of amputation.

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