Original Research Article

Efficacy of diabetic ulcer severity score in patients with diabetic foot ulcer in predicting prognosis

Robinson George*, Joe Mathew, Vishnu M. L., Jacob P. Thomas

Department of General Surgery, Pushpagiri Institute of Medical Sciences and Research Centre, Tiruvalla, Kerala, India

*Correspondence:
Dr. Robinson George,
E-mail: docrg7@hotmail.com

ABSTRACT

Background: Diabetic foot ulcer (DFU) is a full-thickness wound, skin necrosis or gangrene below the ankle induced by peripheral neuropathy or peripheral arterial disease in patients with diabetes. There are well-accepted classification systems for DFUs, namely Wagner's scoring system, university of Texas scoring system etc. However, only few are scientifically validated. Diabetic ulcer severity score (DUSS) introduced by Beckert et al consists of easily accessible clinical parameters which categorizes wounds into specific subgroups for comparison of outcomes.
Methods: A prospective study was conducted on 250 diabetic ulcer patients, attending the out-patient department (OPD) of surgery, Pushpagiri institute of medical sciences, Tiruvalla.
Results: Most common age group affected with diabetic foot was between 51-60 years (mean 58.9±10.2 years). Males accounted for 54% of patients. Most common ulcers were of score of 2 followed by score 3. Overall, 105 (42%) of 250 people had amputations in our study with majority undergoing minor amputation (30%) than the major amputation (12%). None of the patients with scores 0, 1 and 2 had major amputation. Probability of healing among the various scores were-100% for score 0, 97.9% for score 1, 83.4% for score 2, 17.7% for score 3 and 4.8% for score 4. Lower score is strongly associated with primary healing and higher score with amputations.
Conclusions: DUSS system is an easy wound based diagnostic tool for anticipating probability of healing or amputation and need for surgery by assessing the four clinical parameters and combining them which is safe and easily reproducible.

Keywords: DUSS, DFU, Amputation, OPD, SSG, Diabetes mellitus

INTRODUCTION

The prevalence of diabetes mellitus (DM) is exploding worldwide and is expected to involve more than 500 million people in the next 10 to 15 years. By 2030, this figure predicted to rise to 366 million due to longer life expectancy and changing dietary habits. In fact, the prevalence is soaring in southern India and may reach an astronomical figure of 13% to 18%.[1,2]

Diabetic foot disease is a growing global public health challenge and a major financial burden on healthcare systems worldwide. DFUs are one of the most-costly aspects of care, and ulcer-related complications are the leading cause of hospitalization for diabetic patients. The major risk factors for foot ulceration are a loss of protective sensation due to neuropathy, Peripheral arterial disease and trauma, and the major adverse outcome of foot ulceration is amputation. Appropriate classification of the foot wound based on a thorough assessment is essential to categorize the wound and compare the treatment modalities. Any valid classification system of foot ulcers should facilitate appropriate treatment, simplify monitoring of healing progress and serve as a communication code across specialties in standardized terms. A number of wound classification systems are present, and those which are validated includes the Meggitt and Wagner system, university of Texas San

Antonio (UTSA) system.[3-7] The diabetic ulcer severity score (DUSS) designed by Beckert et al defines four clinical parameters, namely palpable pedal pulses, probing to bone, ulcer location and presence of multiple ulcerations, and, is the latest wound-based classification which needs to be validated.[17]

METHODS

Sample size

Assuming that the prevalence of DUSS 4 is 28.5% with absolute error as 80% and 95% confidence interval, the required minimum sample size is 250 using the formula:

$$N = Z^2 \left(1 - \frac{\alpha}{2}\right) P \times (1 - P) \div d^2$$

Sampling procedure

Total of 250 diabetic patients with foot ulcers irrespective of their duration, attending surgical outpatient clinic or admitted in Pushpagiri medical college hospital were recruited into the study, from December 2018 to April 2020 based on the inclusion and exclusion criteria mentioned below. The baseline demographic data which included age, sex, occupation, education status, habits, socioeconomic status and treatment history were taken. The subjects will be clinically examined and will be assessed for the following parameters: palpable pedal pulsation, probing to bone, ulcer site-toe or heel and ulcer number-single or multiple.

Inclusion criteria

Inclusion criteria for the study included patients with age of 30-80 years from both genders, all patients suffering from DM as per world health organization (WHO) criteria with foot ulcers and willingness for study.

Exclusion criteria

Exclusion criteria for the study excluded patients with venous ulcers, all patients with less than 2 follow up visits, ulcers above the ankle and patients not willing for the study.

Study procedure

Necessary data were collected. DUSS was calculated for each patient by clinical examination and assessing following parameters: palpable pedal pulsation, probing to bone, ulcer site- toe or heel, ulcer number- single or multiple. Standard wound therapy for each category is given according to the protocol including cleaning and dressing, debridement, limited bone resection, adequate offloading, skin grafting and amputation besides adequate glycemic control and infection control. Patient is kept on follow up and prospective documentation was made once

in a fortnight for 1st month, then once in a month till ulcer is healed or minimum period of up to 6 months.

Analysis

Qualitative variables are expressed as frequency and percentages and quantitative variables as mean and standard deviation. Association of categorical variables were assessed using chi-square test and risk assessment of healing status was analysed by Kaplan Meier survival analysis, with $p < 0.05$ is considered as statistically significant.

DUSS

Ulcers were scored by the below mentioned variables. DUSS was calculated by adding these separate scored variables to a theoretical maximum of 4.

Table 1: DUSS.

Variables	Score 0	Score 1
Palpable pedal pulses	Presence	Absence
Probing to bone	No	Yes
Ulcer site	Toes	Foot
Ulcer number	Single	Multiple

Table 2: Ulcer grading.

Ulcer grades	Wound depth as measured by sterile blunt probe
Grade 1	Dermis
Grade 2	Subcutaneous tissue
Grade 3	Fascia
Grade 4	Muscle
Grade 5	Bone

Ulcers were labelled infected if a purulent discharge was present with two of the local signs mentioned below. Wound depth was evaluated using a sterile blunt probe. The ability to probe to bone with the presence of local inflammation (warmth, erythema, lymphangitis, lymphadenopathy, oedema, pain) or signs of systemic infection and suggestive radiological features provided a clinical diagnosis of osteomyelitis. Peripheral vascular disease was clinically detected by the absence of both pedal pulses, patients were categorized into groups having either single or multiple ulcerations on the same foot. In patients with multiple ulcers, the wound with the highest grading was selected for analysis. For wounds with identical grading, the larger wound was chosen. Standard wound therapy is given according to the protocol which includes local sharp debridement, advanced local surgical procedures such as limited bone resections, moist wound therapy, and adequate pressure offloading besides adequate glycemic control and infection control. Patient is kept on follow up and

prospective documentation made, once in a fortnight for 1st month, then once in a month till ulcer is healed or minimum period of up to 6 months.

RESULTS

Most common age group affected with diabetic foot was between 51-60 years (39.6%), second group being between 61-70 years (25.6%). Median age was 59. Mean age group was 58.9±10.2.
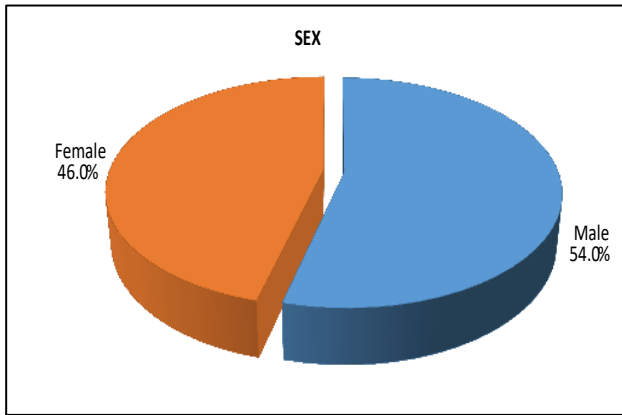

Figure 1: Gender distribution of study population.

Males were commonly affected by DFUs accounting to 54.0% in our study.
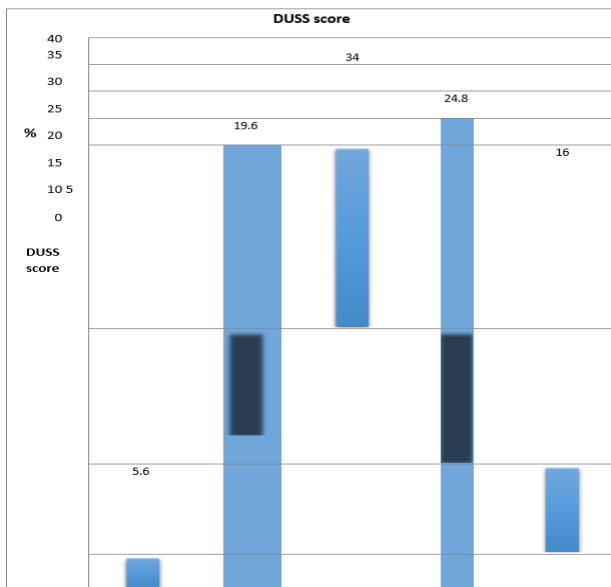

Figure 2: Distribution of DUSS score among study population.

Most commonly ulcers were of DUSS 2 (34%) followed by DUSS 3 (24.8%).

Total of 42% of patients underwent amputation in our study. Major amputation was done for 12 % of patients and Minor amputation was done in 30 % of patients in

our study. Toe amputation accounts for 17.2%, followed by forefoot amputation-12.8% taking in to account of minor amputation. Above knee amputation accounts for 6.4%, followed by below knee amputation-5.6%, when considering major amputations. 124 patients (49.6%) had primary healing and 126 patients (50.4) had to undergo amputation as treatment. Split skin graft was done for 21 patient (8.4%). No amputation was required for patient with DUSS 0.
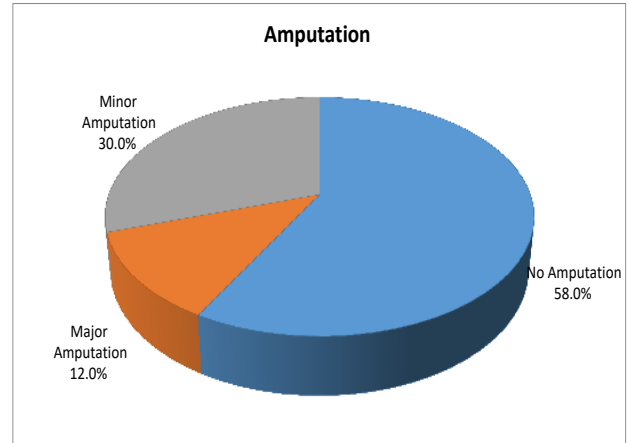

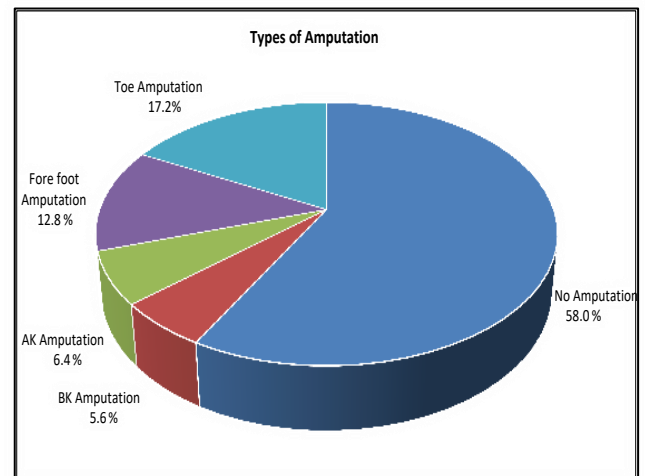**Figure 3: Amputation distribution of study population.**

Figure 4: Types of amputation.

One patient with DUSS 1 required minor amputation (1.3%) and 14 patients with DUSS 2 had minor amputation (18.7%). 51 patients out of 62 patients with DUSS 3 had to undergo amputation with 40 patients had minor amputation (53.3%), whereas 11 patients ended up with major amputations (36.7%). 39 out of 40 patients with DUSS 4 had to undergo amputation with 19 patients' major amputation (63.3%) and 20 minor amputation (26.7%). None of the patients with score 0, 1 and 2 had major amputation. Toe amputation was done in total of 43(17.2%) of patients. No patients with DUSS 0 and 1 had toe amputations. 11 (25.6%) patients with

DUSS 2, 28 (65.1%) patients with DUSS 3, and 4 (9.3%) patients with DUSS 4 had toe amputations. Fore foot amputation was done in total of 32 (12.8%) of patients. None of the patients with DUSS 0 had forefoot amputation. 1 patient (3.1%) with DUSS 1, 3(9.4%) patients with DUSS 2, 12 (37.5%) patients with DUSS 3 and 16 (50%) patients with DUSS 4 had forefoot amputation. Below knee amputation was done in total of 14 (5.6%) of patients. None of the patients with DUSS 0, 1 and 2 had below knee amputation. 8 (57.1%) patients with DUSS 3 and 6 (42.9%) patients with DUSS 4 had below knee amputations. Above knee amputation was done in total of 16 (6.4%) of patients. None of the patients with DUSS 0, 1 and 2 had above knee amputations. 3 (18.8%) patients with DUSS 3 and 13 (81.3%) patients with DUSS 4 had above knee amputation. There were no revision amputations in our study.
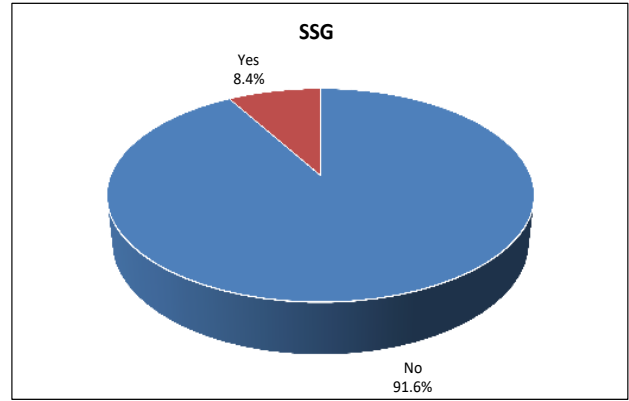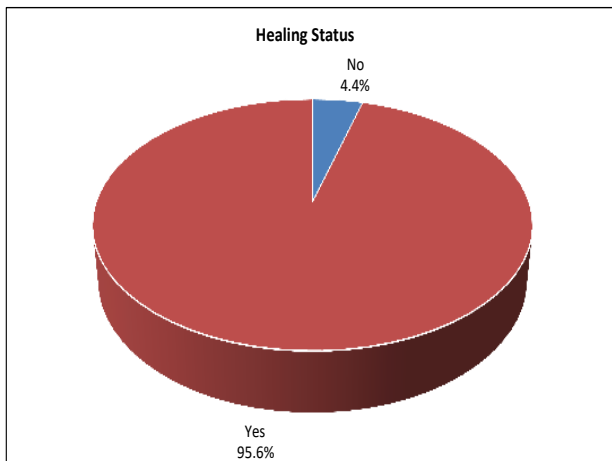

Figure 5: Healing status.

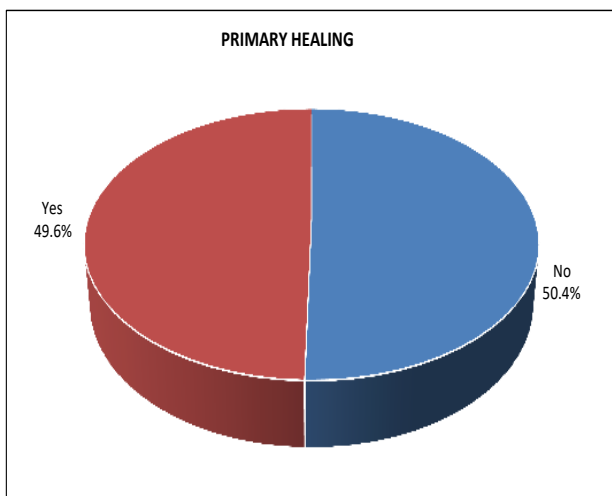Distribution of ulcers (DUSS 0-4) with study endpoints was followed up and endpoint, that is healing was assessed.

Figure 6: Primary healing among the study population.

Figure 7: Incidence of split skin graft among study population.

Wounds healed by primary healing or with help of skin graft or resulted in amputation, either major or minor. Distribution of DUSS among the outcome was studied. Majority of foot ulcers among study population with DUSS 0, 1 and 2 healed by primary intention, that is, 14 (11.3%), 47 (37.9%) and 60 (48.4%) respectively. The incidence of primary healing among different DUSS (0-4) was found to be statistically significant ($p<0.001$). Among study population with 1 patient (4.8%) with DUSS 1, 11 patients (52.4%) with DUSS 2, 8 patients (38.1%) with DUSS 3 and 1 patient (4.8%) with DUSS 4 healed by skin grafting.

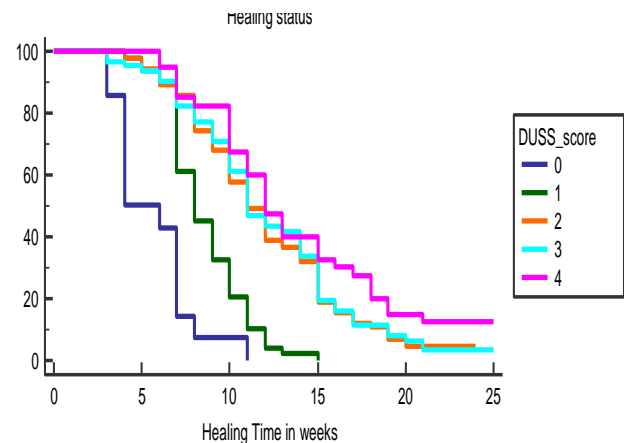So DUSS 2, 3 are associated with healing by skin grafting and association was found significant ($p<0.05$).

Figure 8: Healing status-Kaplan-Meier survival curve of healing status in terms of healing time according to DUSS score.

Association of no healing among the DUSS was studied and found that patients with DUSS 0, took an average of 4 weeks to heal. Those patients with DUSS 1 took an average of 8 weeks to heal. Patients with DUSS 2, 3 and 4 took an average of 11, 11 and 12 weeks to heal respectively. Low DUSS was associated with early healing and higher DUSS was associated with a longer

healing time. Probability of healing (primary healing + split skin graft) among the various DUSS were-100% are DUSS 0, 97.9% for DUSS 1, 83.4% for DUSS 2, 17.7% for DUSS 3 and 4.8% for DUSS 4.

DISCUSSION

Total of 250 diabetic patients with foot ulcers irrespective of duration of ulcers attending surgical outpatient clinic or admitted in Pushpagiri medical college were recruited into the study based on the inclusion and exclusion criteria mentioned earlier. Most common age group affected with diabetic foot was between 51-60years (39.6%), Second group being between 61-70 years (25.6%). Median age was 59. Mean age group was 58.9±10.2. Similar results in various studies conducted by Viswanathan et al were mean age was 60.6 years, Prompers et al a mean age of 64.7 years, Deribe et al a mean age of 50.7 years, Paul et al a mean age of 66.7 years. Lee et al in a Scottish study reported a mean age of 67.4 years.[35,36] A study undertaken in the USA in 2004 through the 2002 national hospital discharge survey, evaluated 275,000 in patient records from 500 hospitals from 1996 onwards.

This study revealed that elderly diabetics had twice the risk of developing a foot ulcer, three times the risk of developing a foot abscess and four times the risk of developing osteomyelitis.[37] Males were commonly affected by DFUs accounting to 54.0%in our study. In the original study of Beckert et al 1,000 diabetic patients were included in this study, with 675 (67.5%) being male and 325 (32.5%) being female.[17] In our study, most commonly ulcers were of score 2 (34%) followed by score 3(24.8%), followed by score 1 (19.6%), 4 (16%) and 0 (5.6%). Overall, 105 (42%) of 250 people had amputations in our study. Major amputation (below or above knee amputations) was done for 12% of patients in our study. Minor amputation (toe or forefoot amputations) was 30%. In our study, toe amputation accounts for 17.2%, followed by forefoot amputation-12.8%, above knee amputation accounts for 6.4% and below knee amputation for 5.6%. Lee et al in a Scottish study found 12% of patients required major or minor amputation. Maria Persis in a Brazilian study reported that 12% of patients underwentamputation.[38] A study by Margolis et al found that total of 1653 (6.7%) individuals had an amputation and 46.3% of these amputations were of a toe or ray (minor amputation). The percentage of those who had an amputation varied from 5.6% to 618.4%. Of those who had an amputation, the percentage that had a minor amputation increased over time from 4.0% in the earlier years to more than 60% in the later years of observation. In our study, none of the patients with score 0, 1 and 2 had major amputation. 11 patients (36.7%) with score 3 and 19 patients (63.3%) with score 4 had major amputation. Regarding minor amputation, no amputation was required for patient with score 0. One patient with score 1 required minor amputation (1.3%) and 14 patients with score 2 had minor amputation

(18.7%), 40 patients with score 3 had minor amputation (53.3%) and 20 patients with score 4 had to have minor amputation (26.7%). In our study, ulcers with low DUSS had low risk of amputation, and showed a trend of increasing incidence of amputation with increase in score. Majority of them being minor amputations and need for major amputations were seen in high DUSS ulcers. We could identify that, those ulcers with high DUSS are having high risk of amputation. So, DUSS helps in the selection of appropriate treatment for each group.

In the original study by Beckert et al, wounds demonstrated a trend of increasing probability for major amputation along with increasing DUSS.[17] Patients with a score of 0 had no risk of major amputation, while patients with a score of 1 had a 2.4%, patients with a score of 2 had a 7.7%, patients with a score of 3 had a 11.2%, and patients with a score of 4 had a 3.8% probability to lose their limb. In our study, probability of healing among the various DUSS were-100% for DUSS 0, 97.9% for DUSS 1, 83.4% for DUSS 2.

The 17.7% for DUSS 3 and 4.8% for DUSS 4 similar to as shown by the study conducted by Beckert et al.[17] In the study by Beckert et al there was a 93% probability of healing for uncomplicated ulcers (score 0), decreasing to 57% for ulcers with a severity score of 4. Beckert et al reported primarily healing of 74% (n=1,000), Promper et al 77% (n=1,229), Oyibo et al 65% (n=194).[17,39,40] Low DUSS patients healed well by primary healing and SSG than the high DUSS patients. In our study, it was found that patients with DUSS 0, took an average of 4 weeks to heal. Those patients with DUSS 1 took an average of 8 weeks to 62 weeks to heal. Patients with DUSS 2, 3 and 4 took an average of 11, 11 and 12 weeks to heal respectively. Low DUSS was associated with early healing and higher DUSS with a longer healing time. However, in our study, the probability of healing was assessed as those ulcers which healed by primary healing or grafting. Those ulcers with high DUSS underwent amputation and that wound healed by this time period. Among 14 ulcers with DUSS 0, all healed by primary intention. Among ulcers with DUSS 1, 47 (95.9%) of 49 ulcers healed by primary intention, 1 of them healed by SSG and 1 had minor amputation. Among ulcers of DUSS 2, 60 of 85 ulcers (70.5%) healed by primary intention, 11 had SSG and 14 had minor amputation that is, 3 forefoot (9.4%) and 11 toe amputation (25.6%). Among ulcers with DUSS 3, only 3 out of 62 (4.8%) healed by primary intention, 8 (12.9%) had SSG and 51 had amputations, mainly 40 minor amputations and 14 major amputations. Among ulcers with DUSS 4, 39 out of 40 (97.5%) ulcers had amputations mainly 19 major and 20 minor amputations, 1 healed with help of SSG (4.8%). So, based on DUSS system, probability of hospitalization and surgical procedures could be anticipated. Patients with a high DUSS were more likely to undergo surgery and hospitalization. Original study by Beckert et al also showed patients with a high DUSS

were more likely to undergo surgery and hospitalization.[17]

CONCLUSION

DUSS system is an easy wound based clinical diagnostic tool for anticipating probability of healing or amputation and need for surgery by assessing the four clinical parameters and combining them. This scoring system does not investigate disease-based parameters such as duration of diabetes, type of diabetes, and comorbid illness and other parameters the previous scoring systems has. Even with this limitation, DUSS system helps in discriminating patients with ulcerations of different outcomes.

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