ORIGINAL RESEARCH

Assessing usefulness of PEDIS scoring in identifying the severity of diabetic foot ulcer and its management: An observational study

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Abstract
Aim: To evaluate the usefulness of PEDIS scoring in identifying the severity of diabetic foot ulcer and its management.
Methods: After receiving permission, individuals with diabetic foot ulcers below the malleolus level who presented to the hospital as either outpatients or inpatients were included in this prospective observational research. One hundred patients were enrolled and monitored for a duration of six months.
Results: There were 66 males and 34 women out of 100. High white blood cell counts were found in 35% of people. WBC above 11,000/mm3 was considered high. The high random blood sugar cut-off was 140 mg/dl. In 68% of patients, random blood sugar was unusually high. 10 patients (10%) had osteomyelitis and positive probe-to-bone tests. Debridement improved outcomes for patients with scores under 7. Patients with scores over 4 and high random blood sugar and white cell count recovered slowly. We predicted diabetic foot complications using PEDIS scoring and factors like uncontrolled blood glucose, grossly increased white blood cell count, co-morbidities, and previous foot surgery. All factors including diabetic foot ulcer therapy had p values below 0.05 except conservative care.
Conclusion: Based on the findings of our research, we have arrived at the conclusion that PEDIS scoring is beneficial in predicting complications in diabetic foot ulcers and the treatment of these ulcers.
Keywords: Diabetic foot ulcer, PEDIS scoring, osteomyelitis, non-healing, amputation

Introduction

The tremendous increase in the global incidence of diabetes mellitus (DM) has led in an inevitable rise in diabetes-related complications. In 2011, there were an estimated 366 million persons with diabetes globally and forecasts show this number would climb to 552 million by 2030.[1] Amputation is a generally avoidable consequence of diabetes and >85% of major amputations in people with diabetes are preceded by foot ulceration.[2] Targeted therapies from multidisciplinary care may prevent limb loss, but progress has been modest.[3] Whilst the number and incidence of amputations have fallen in an ageing population without diabetes, those in patients with type 2 diabetes have risen in some countries.[4] Twenty years on from the St Vincent's Declaration,5 attempts to achieve 5-year targets to halve the number of lower limb amputations in patients with diabetes have failed. Diabetic foot and lower limb problems are a prominent source of morbidity and death among patients with diabetes mellitus (DM).[6,7] People with diabetic foot ulcers (DFU) need more hospital visits and hospitalizations than those without this condition.[3] Disease-related complications such as DFU can negatively impact the patient's quality of life, as well as increase healthcare costs.[6,7] Primary healthcare centers are the patient's first contact with the health system in many countries, and its role in the prevention and treatment of chronic conditions such as DM and its complications is fundamental. Therefore, the task of primary health professionals is crucial for the prevention, early detection, and treatment of diabetic foot complications. Increasing the knowledge and awareness of the risk factors that worsen the prognosis of people with DFU at this level of the healthcare system (i.e. primary care) is

necessary to act in a more focused, resourceful and decisive way. So far, various research on the prognosis of the diabetic foot and its related contributing variables have been carried out in hospital settings, in specialist diabetes clinics and multidisciplinary foot centers.[8-12]

Perhaps the most unpleasant potential consequence of DFU besides death is lower extremity amputation (LEA). An initially minor amount of trauma may frequently progress in chronic ulcers and become the basis for hospital admission hence imposes substantial expense to the patients.[13] The co-existence of neuropathy, peripheral arterial disease (PAD), and poor glycemic management may encourage the development of serious infections and/or foot gangrene, which if not treated effectively, may lead to lower extremity amputation (LEA) or even death.[14] Therefore, the DFU have a severe medical, social, and economic effects, particularly when hospitalization is essential.[15]

The purpose of the current research was to examine the effectiveness of PEDIS score in diagnosing the severity of diabetic foot ulcer and its therapy.

Materials and Methods

Hospital-based prospective observational research was undertaken on patients with diabetic foot ulcers below the level of malleolus, including both outpatients and inpatients, who provided consent. 100 patients were involved in the trial and monitored for 6 months.

Inclusion criteria

Patients over 18 years old with a history of diabetes mellitus, foot ulcers below the malleolus, previous amputation of part of the foot/toes, numerous diabetic ulcers in the same foot, and recurring diabetic foot ulcers were part of the research.

Exclusion criteria

Patients with diabetes who simply had soft tissue infections in the foot without ulcers, diabetic patients who developed foot ulcers after a trauma, and diabetic patients with foot ulcers and acute limb ischemia were not included in the study.

PEDIS scoring

Perfusion: 0-no evidence of peripheral artery disease, 1-signs of peripheral arterial disease, but no critical limb ischemia and 2-critical limb ischemia. Extent: 0-skin intact, 1-<1 cm^2, 2-1-3 cm^2, 3-> 3 cm^2. Depth: 0-skin intact, 1-superficial, 2-fascia, muscle, tendon, 3-bone or joint. Infection: 0-none, 1-surface, 2-abscess, fascitis, and/ or septic arthritis, 3-Systemic inflammatory response syndrome (SIRS). Sensation: 0-sensation intact, 1-loss of feeling. PEDIS score interpretation: low:0-7, high:8-12.

All the patients were briefly told about the research and were enrolled in the trial only after assuring that they were satisfying the inclusion and exclusion criteria. All the patients presenting with foot ulcers with diabetes mellitus were taken up for survey and categorized according to the PEDIS score after a thorough examination. Perfusion i.e. blood flow to the foot was clinically assessed by palpating the peripheral pulses of the foot, most especially the dorsalis paedis pulsation. Hand held doppler investigation was carried out in individuals with faint pulse in the foot. In suspected instances of peripheral vascular disease, ultrasonography doppler examination was done additionally.

CT peripheral angiography has been carried out for patients solely with the characteristics of limb ischemia. The extent of ulcer was assessed with the use of measuring tape. Examining the wound or palpating its base allowed us to determine the ulcer's depth. We may classify the depth according to tissue that is situated above the base such muscle, ligaments, tendon, underlying bone. Along with these aspects and general hemodynamics of the patient being taken into account, severity of the infection such sepsis, systemic inflammatory response syndrome, multiorgan dysfunction syndrome may be diagnosed and graded which helps to react swiftly. We tested the foot ulcer's sensation by applying pain stimuli and touching the sore spot with cotton and fingertip. Along with these scores, we also sought to confirm the accuracy of the probe-to-bone test in identifying diabetic foot osteomyelitis. Patients underwent X-rays of the foot if the test came back positive, to substantiate its reliability. The patients were effectively treated using a combination of conservative and surgical procedures according to the results. After the procedure, patients were monitored for 6 months to determine how well the wound was healing and how long it typically took. In order to proceed with the procedures, we made sure to get the patient's verbal and written informed consent.

Statistical analysis

Data entry was done in Microsoft Excel 2007. Statistical analysis was done by IBM SPSS statistics for windows version 25. All p values <0.05 were considered as statistically significant.

Results

Table 1: Gender distribution

Gender	N	%
Female	34	34
Male	66	66
Total	100	100

Out of 100, 66 (66%) were males and 34 (34%) were females.

Table 2: White blood cell counts, blood glucose level, Positive probe to bone test and presence of osteomyelitis in DFU patients

WBC >11,000/mm^3	**N**	**%**
No	65	65
Yes	35	35
Total	100	100
RBS >140 mg/dl		
No	32	32
Yes	68	68
Total	100	100
PTB test		
No	90	90
Yes	10	10
Total	100	100
Osteomyelitis		
No	90	90
Yes	10	10
Total	100	100

White blood cell counts were found to be elevated in 35 (35%) patients. The cut-off value for high WBC was considered to be more than 11,000/mm^3. Cut-off value taken for high random blood sugar was 140 mg/dl. About 68 (68%) patients were having abnormally elevated random blood sugar. 10 (10%) patients were found to have osteomyelitis and they were tested positive for probe to bone test.

Table 3: The classification of patients based on PEDIS score and their management

Parameters	**PEDIS score 0-7**	**PEDIS score 8-12**	**Total**	**P value**
Male	40	26	66	-
Female	20	14	34	-
RBS	40	28	68	0.001
WBC	15	20	35	0.000
Past surgery	25	12	37	0.007
PTB	2	10	12	0.000
Osteomyelitis	2	10	12	0.000
Conservative	2	0	2	0.190
Debridement	52	17	69	0.000
Healed	49	2	51	0.000
Non healed	4	10	14	0.052
Amputation	8	20	28	0.055

In the end, debridement was effective for patients with a score below 7. Delays in healing were seen in patients with a score more than 4, high random blood sugar, and an increased white cell count.

Table 4: The various outcomes of DFU like healed, non-healing ulcers, amputation of involved parts

Outcome of diabetic foot	**Healed**	**Non healed**	**Amputation**	**Total**
High RBS	28	9	24	61
High WBC	8	7	17	32
Past surgery	23	8	6	37
Osteomyelitis	2	4	6	12
Conservative	1	1	0	2
Debridement	48	13	9	70

Using PEDIS grading, we identified potential diabetic foot problems caused by variables such as uncontrolled blood glucose levels, significantly elevated white blood cell counts, other co-morbidities, and a history of surgery on the same foot. With the exception of conservative treatment, all of the variables and methods for diabetic foot ulcer therapy had p-values lower than 0.05.

Discussion

Diabetes mellitus is a chronic condition characterized by abnormally increased blood glucose level with raised level of insulin and presence of resistance to the secreted insulin. Foot ulcers can occur in between fifteen and twenty-five percent of people with diabetes mellitus over the course of their lives.[17] Diabetic foot ulcer is defined as full thickness wound that occurs in the foot just below the level of malleolus.[18] Most commonly affected sites are the pressure points such as plantar aspect of toes, metatarsal heads and heel. It will often progress to non-healing ulcer, infection, dry and wet gangrene, ultimately leading to amputation of the involved parts. These complications can be avoided with prompt diagnosis and treatment. Foot ulcers are very likely to recur in the future with an incidence of 50% after 3 years of occurrence of foot ulcer.[19]

Increased glucose can cause hypercoagulability by altering the endothelial function and impairment of fibrinolysis, platelet aggregation.[20] An infection can be triggered by a rise in glucose levels in the surrounding tissue. Additionally, it changes the way wounds heal by making neovascularization less effective.[21] Damage to the foot that results in foot deformity. Loss of flexibility of tendons and ligaments promotes flattening of foot by modifying the arches of foot leading to formation of ulcer. Complications of diabetic foot are non-healing ulcer which is defined as any ulcer which is not showing any signs of healing for more than 3 months of duration, ischemia of foot indicates decreased blood supply to the foot, gangrene of foot which is described as macroscopic death of the tissue with blackish discoloration, Charcots neuroarthropathy a destructive syndrome affecting bones and joints in patients who already have neuropathy. Osteomyelitis infection of bone and bone marrow.[22,23]

Out of 100, 66 (66%) were men and 34 (34%) were girls. White blood cell counts were reported to be high in 35 (35%) individuals. The cut-off value for elevated WBC was deemed to be more than 11,000/mm3. Cut-off value measured for high random blood sugar was 140 mg/dl. About 68 (68%) individuals were experiencing unusually increased random blood sugar. 10 (10%) individuals were discovered to have osteomyelitis and they were tested positive for probe to bone test. In the end, debridement was effective for patients with a score below 7. Delays in healing were seen in patients with a score more than 4, high random blood sugar, and an increased white cell count. Ahmad *et al*., Bijan Iraj *et al*. revealed that uncontrolled blood glucose level, abnormally high white blood cell counts might alter the result of foot ulcer and also has an effect over the wound healing.[24,25]

Using PEDIS grading, we identified potential diabetic foot problems caused by variables such as uncontrolled blood glucose levels, significantly elevated white blood cell counts, other co-morbidities, and a history of surgery on the same foot. With the exception of conservative treatment, all of the variables and methods for diabetic foot ulcer therapy had p-values lower than 0.05. Khalid Al-Rubeaan *et al*. reported that diabetic foot ulcer patients with poorly regulated blood glucose level and the presence of infection impacts the prognosis of the diabetic foot.26 Amputation was also performed on individuals in our research who had poor scores, high glucose levels, and raised white blood cell counts. Armstrong *et al*. noticed recurrence of ulcer in DFU patients and they advocated thorough counselling of the patient and self-care to limit the recurrence rate.[27] Our results corroborate previous research linking high scores to an increased risk of diabetic foot ulcer complications.

Conclusion

We found that the PEDIS score was useful for determining the diabetic foot ulcer severity in our research. Patients requiring amputation had higher scores. Debridement alone was sufficient to handle most patients with poor scores, and the results were positive. Those patients with DFU who had osteomyelitis in its early stages were able to escape amputation with the use of debridement, bone curettage, and long-term antibiotic treatment. Our research shows that PEDIS score is useful for both the prevention and treatment of diabetic foot ulcer complications.

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