The Pattern and Surgical Management of Diabetic Foot at Muhimbili National Hospital, Dar-es-salaam, Tanzania

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Background: Diabetic foot is one of the chronic consequences of diabetes mellitus and is responsible for about 50% of non-traumatic lower limb amputations. It is thus associated with social devastation to the patients and their families, both emotionally and economically. This study aimed at determining the pattern and the surgical management of patients with Diabetic Foot at Muhimbili National Hospital, from March to December 2008.
Methods: All in-patients with diabetic foot who were admitted in the hospital during the study period were included into the study.
Results: A total of 67 patients presented with diabetic foot during the study period of 10 months. 4.5% had Type 1 Diabetes Mellitus and 95.5% had Type 2. The mean age of the patients was 52.4 years with a range of 21-75 years. The mean hospital stay was 35.5 days. Most patients had a positive family history of Diabetes Mellitus (59.7%). Majority of them lacked the known risk factors for foot ulceration such as hypertension, elevated cholesterol levels, trauma and duration of Diabetes Mellitus for longer than 10 years. Wagner Grade 4 and 5 were the most common ulcers encountered and major amputation was done in 44.8% of the patients. The mortality rate was relatively high (25.4%). Mortality was significantly higher in those with Wagner's Grade ulcers ≥ 3 (p-value = 0.0322).
Conclusion: Diabetic foot ulceration was found to be a significant cause of morbidity and mortality in our setting. These patients stay in the surgical ward for a prolonged period of time. This causes a significant strain to the provision health services in the hospital. Designing a diabetic foot management protocol and initiating a diabetic foot unit for admission of these patients could reduce the associated morbidity and mortality and improve outcome.

Introduction

Diabetic foot is one of the chronic consequences of diabetes and responsible for about 50% of non-traumatic lower lim amputations. It is thus associated with devastation to the patients and their families, both emotionally and economically. It is estimated that approximately 15% of the diabetic population develop a diabetic foot lesion sometime in their life[1]**.** Diabetes Mellitus is one of the most common chronic diseases, prevalent in both the western world and the developing countries. It is characterized by an absolute or relative lack of insulin, leading to hyperglycemia and associated disturbed carbohydrate, protein and fat metabolism[2].

The incidence of Diabetes mellitus has been increasing over the past decade. In Africa, incidence and prevalence rates of diabetes are on the rise, together with the foot complications[3]. It has been projected that, by 2010, the global diabetic population will double, compared to that of 1994 (from 110 million to 221 million) [2]. Diabetic foot problems are very common. They have a significant impact on the quality of life for the patients since they contribute to disability and often lead to premature deaths. Frequently, these are patients who have been under poor glycaemic control for a long time either inadvertently or out of sheer ignorance of the consequences.

The incidence of diabetic foot complications requiring amputation reflects the level of effectiveness of early detection of diabetes mellitus as well as detection of occurrence of the foot complications, education on foot care, compliance to treatment and overall control of diabetes mellitus in a community. These patients usually stay in the hospital for a long time in view of the surgical

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treatment needed, reduction of the associated complications, ensuring appropriate glucose level control and rehabilitation.

Pathophysiology

Diabetic foot is a consequence of two of the most frequent chronic complications of Diabetes Mellitus: - Peripheral neuropathy and vascular insufficiency. The combination of these factors in association with mechanical factors such as bone deformities triggers the ulcer formation. This polyfactorial aetiopathology explains the multidisciplinary approach required for this disease. The early detection of risk factors for diabetic ulcers may prevent their appearance. The major aetiopathological events in the development of diabetic foot lesions are peripheral neuropathy and peripheral vascular disease, with unrecognized repetitive trauma[4]. Peripheral arterial occlusive disease is four times more prevalent in diabetics than in non-diabetics. The arterial occlusion preferentially involves the posterior tibial and peroneal arteries and spares the dorsalis pedis artery. Smoking, hypertension and hyperlipidemia add to the risk of developing peripheral vascular disease among patients with diabetes[5]. The presence of lower extremity ischaemia is suggested by a combination of clinical signs and symptoms plus abnormal results on non-invasive vascular tests.

Signs and symptoms may include claudication, pain occurring in the arch or forefoot at rest or during the night, absent popliteal or posterior tibial pulses, thinned or dry shiny skin, absence of hair on the leg and foot, or thickened nails.

Peripheral neuropathy is another complication affecting the lower extremities of patients with diabetes mellitus, contributing to the development of foot lesions. This complication occurs in up to 58% of patients with longstanding disease[5]. Motor neuropathy leads to foot deformities. This is due to weakness and atrophy of the intrinsic muscles of the foot. Stability of the foot arch during walking is impaired and the action of the unopposed extrinsic muscles causes equines deformity of the foot or varus deformity of the hindfoot. Motor neuropathy is therefore implicated in the development of the joint deformities, the so called Charcot's osteoarthropathy[5].

Eventually, these events lead to lack of protective sensation, and combined with foot deformities, exposes patients to undue sudden or repetitive stress that leads to ulceration. In the diabetic foot, autonomic neuropathy has several common manifestations. For example, denervation of dermal structures leads to decreased sweating. This causes dry skin and fissure formation, which predispose the skin to infection[5].

Successful treatment of diabetic foot ulcers relies on reducing or eliminating pressure, resolving infection, correcting ischemia, and maintaining an environment that promotes wound healing. Relief of pressure on the ulcer along with rest and elevation of the limb should be started immediately. Foot ulcers do not heal in patients who continue to walk on the affected foot without taking some protective measures. Ideally, patients should keep weight totally off the limb with use of crutches, a walker, or a wheelchair with a foot extension. Complete bed rest may be necessary in some cases. Early surgical intervention especially in patients with bone deformities may relieve the pressure[9].
Most diabetic foot infections are polymicrobial, so aerobic and anaerobic cultures should be done and initial therapy started with a broad-spectrum antibiotic. Cultures should be from tissue deep in the ulcer so as to identify the true pathogens. Antibiotic coverage can then be tailored according to culture and sensitivity results and clinical response. In most cases of deep ulcer, radiographs should be ordered to evaluate the lesion for osteomyelitis. When osteomyelitis is found, aggressive debridement of devitalized bone is needed. All infected bone and any underlying osseous prominence, which may be the cause of the ulceration, should be removed[9].

Patients and Methods

This was a cross-sectional study in which 67 consecutive DM patients with foot ulceration were

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recruited for the study that was carried out for a period of 10 months at the Muhimbili National Hospital, Dar-es-salaam, Tanzania. The patients' history was obtained during admission and included variables such as biodata, educational status, family history of diabetes mellitus, duration of illness, onset of the ulcer, footwear habits and history of hypertension as well as smoking.

Physical examination was done to document the site and type of the foot lesion and other general examination findings. A blood sample was taken for random blood sugar measurement and also serum cholesterol levels. An X-ray of the affected limb was ordered. Ulcers were graded according to the Wagner Classification. Subsequent data on the surgical management offered and the outcome during discharge were obtained during the course of the admission.

Computer software, EPI Info 6 was used for data entry and analysis. Where appropriate, the Chi-square was used to test for significance of association between variables.

Results

A total of 67 patients presented with diabetic foot during the study period of 10 months, from March to December 2008. All of them were recruited to the study. Of these, 3 (4.5%) had Type 1 Diabetes Mellitus while 64 (95.5%) had Type 2. 15 patients (22.4%) were newly diagnosed to be diabetic with the onset of the diabetic ulcer.

The mean age of the patients admitted with diabetic foot ulcers was 52.4 years with a range of 21-75 years. The mean hospital stay was 35.5 days, with a range of 2-98days. Most patients were in the age group 40-49 years (32.8%). Majority were males (68.7%). The Male to Female ratio was 2.2:1
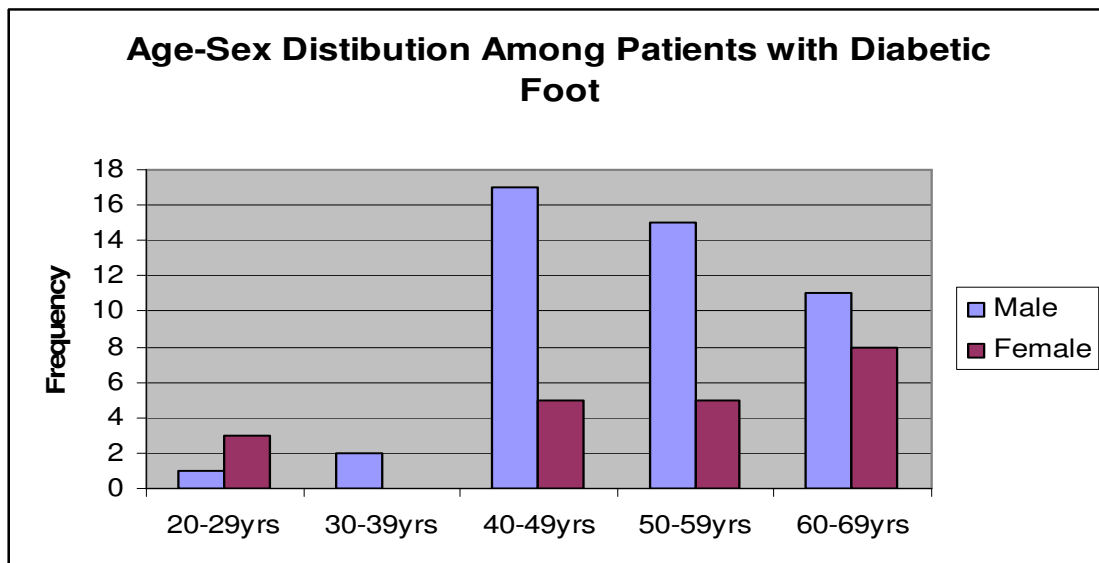

Figure 1. Age sex Distribution

Table 1. RBG values at admission among patients with diabetic foot at MNH:

RBG at Admission (mmol/L)	Frequency	Percent
Below 10.0	9	13.4%
10.0-19.9	30	44.8%
≥ 20.0	28	41.8%
Total	**67**	**100.0%**

Majority of the patients (44.8%) had RBG at admission between 10.0-19.9mmol/L

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Table 2. Risk Factors for Diabetic Foot among patients at MNH (n=67)

| Risk Factor	Positive		Negative	
Smoking	13	(19.4%)	54	(80.6%)
Hypertension	21	(31.3%)	46	(68.7%)
Elevated total cholesterol	5	(7.5%)	62	(92.5%)
Ill-fitting shoes	8	(11.9%)	59	(88.1%)
Lower limb trauma	19	(28.4%)	48	(71.6%)
Duration of DM > 10 years	10	(14.9%)	57	(85.1%)
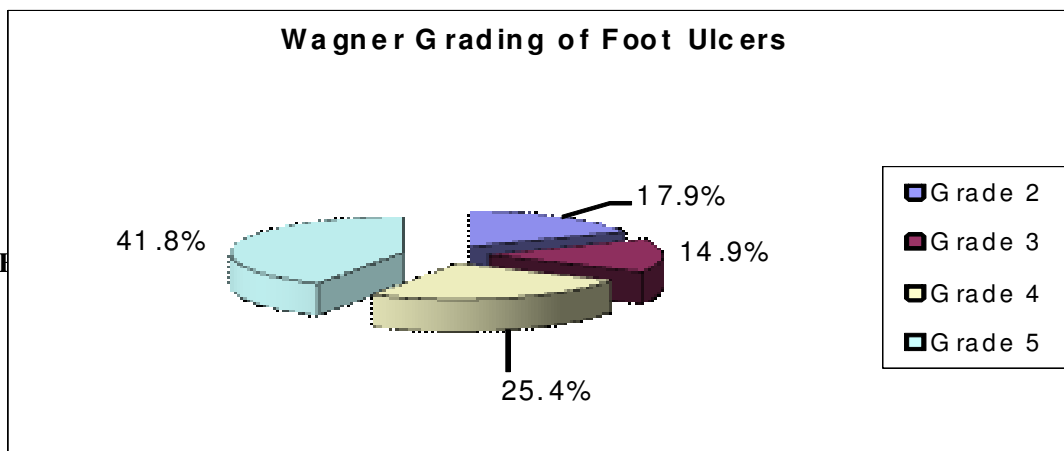
Figure 2. Wagner Grading of Foot Ulcers
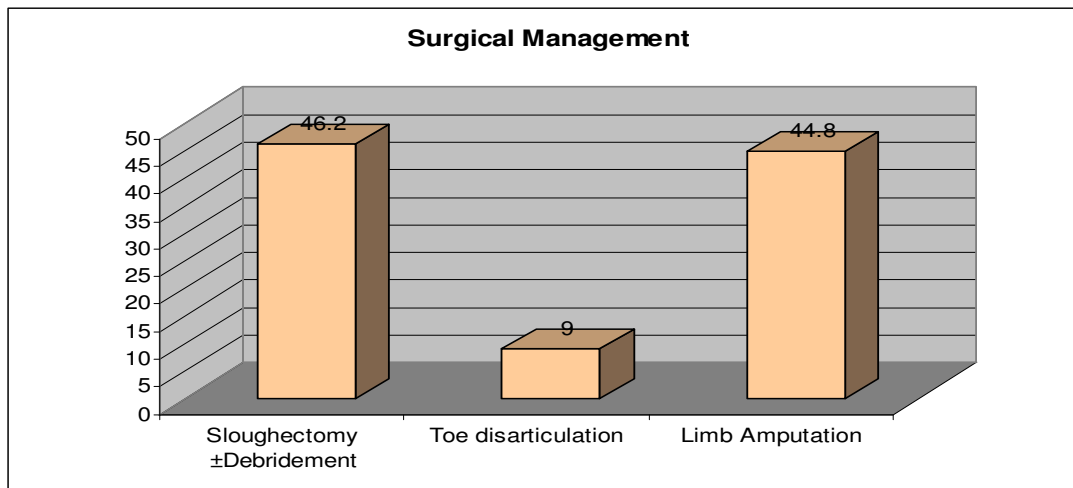
Figure 3. Surgical Management

Most patients were not smokers, did not have hypertension and had normal cholesterol levels. 28.4% had a history of trauma prior to progression of the ulcer. Majority (85.1%) had Diabetes Mellitus for less than 10 years. The mean duration of Diabetes Mellitus in this study was 5.46 years (Range 0-26

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years). Most patients had a positive family history of Diabetes Mellitus (59.7%). Most patients already had extensive gangrene of the foot (Wagner Grade 4 and 5 in 25.4% and 41.8% of patients respectively= 67.2%). No patient was admitted with a superficial ulcer.

Majority of the patients (44.8%), underwent a major amputation (BKA or AKA) while 9% underwent a minor (toe) amputation. The mortality rate among was 25.4%. Of those who died, 9 (53%) were documented to need amputation but died before the procedure was done.
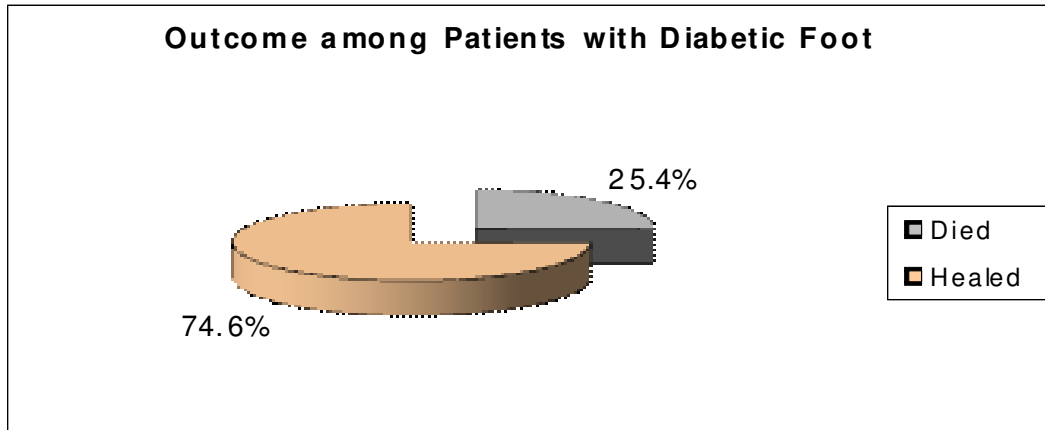
Figure 4. Outcome Among Patients with Diabetic Foot

Table 3. Association between the Wagner's Grade and Outcome among patients who were admitted with diabetic foot at MNH

Wagner Class	Outcome		TOTAL
	Died	**Healed**	
≤ 3	2 (9.1%)	20 (90.9%)	22 (32.8%)
> 3	15 (33.3%)	30 (66.7%)	45 (67.2%)
TOTAL	17 (25.4%)	50 (74.6%	67 (100.0%)

Chi square = 4.59, p-value = 0.0322

The mortality rate was higher in those with Wagner's Grade Ulcer >3 whilst the healing occurred mostly in those who had Wagner's Grade Ulcers ≤ 3. This difference was statistically significant (p-value < 0.05).

Discussion

Diabetic Mellitus is common health problem both globally and in Africa[15]. Diabetic foot ulceration is a common complication of Diabetes Mellitus causing significant social and economical devastation to the patients as well as a heavy burden to health services in developing countries [28, 32, 34, 37, 38]. Most patients had Type 2 Diabetes Mellitus (95.5%). This finding was consistent to other studies done elsewhere where most patients with Diabetic foot ulcers were Type 2. Nwadiaro et al in Nigeria found that 86.6% of the patients had Type 2 DM while 13.2% had Type 1, giving a Type 1: Type 2 ratio of 1:6.6[27]. Similarly, in the U.S, the Seattle Diabetic Foot Study reported the proportion of Type 2 DM to be 93.6%[31]. Nyamu et al in Kenya reported a similar observation[35].

Presentation

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Foot ulceration may be the presenting symptom in patients with Diabetes Mellitus, especially in those with Type 2. In this study, 22.4% of the patients were newly diagnosed to be diabetic, the foot ulceration being the initial symptom. Similar findings were reported in Nigeria by Ogbera et al[28] where 26% of patients had a foot ulcer as the presenting symptom. This finding supports the documented occurrence of Type 2 DM presenting at diagnosis already with complications. Ukere at al in Nigeria[30] and Nyamu et al in Kenya[35] documented much less proportion of newly diagnosed Diabetics (8% and 8.5% respectively).

The mean age of the patients admitted with diabetic foot ulcers was 52.4 years with a range of 21-75 years. Majority of the patients were aged 41-50 years. This is similar to most studies which have shown diabetic foot to be a problem of the middle aged and the elderly [27, 34, 37, 30, 32].

The mean duration of hospital stay was 35.5 days, with a range of 2-98 days. Nwadiaro et al reported a longer hospital stay in Nigeria where on average patients stayed for 2.4 months[27]. Also Ogbera reported a mean hospital stay of 60.3 days[28]. Many of the patients (44.8%) had RBG at admission between 10.0-19.9mmol/L (Table 1). This could signify poor glycaemic control amongst our patients. Ogbera et el reported mean RBG values of 10.8 mmol/L and 11.6mmol/L for Type 1 and Type 2 DM respectively[28]. However, the best measure to depict glycaemic control would have been Glycosylated Haemoglobin levels (HbA_{1c}). This could not be performed in our hospital. Other studies have reported poor glycaemic control among patients with diabetic foot when they checked HbA_{1c} levels [24, 35, 40].

Positive family history of DM was present in 59.7%. Most had a low level of education; majority were peasants. However, some studies have shown an absence of an association between diabetic foot ulceration and sociodemographic factors [19, 28, 31]

Risk Factors

The documented risk factors for Diabetes Mellitus such as smoking, hypertension and elevated cholesterol levels were not prevalent in these patients (Table 2). Boyko et al also reported that ulcer risk was not related to smoking (either past or current) [31]. Nyamu et al showed lack of association between hypertension and risk of foot ulceration[35]. Although dyslipidaemia is associated with a higher risk of vascular disease, hence microvascular disease, with subsequent foot ulceration, most patients (71.6%) had normal total cholesterol levels. This is contrary to the findings by Muthuuri et al who reported a high proportion of patients who had elevated cholesterol level, especially those who died[34]. Possibly, this could not be observed since our patients were not assessed according to the predominant pathogenesis (i.e. whether the ulcer was neuropathic, ischaemic or neuroischaemic). Ischaemic ulcers are associated with significantly higher total cholesterol [35]

History of Trauma was reported in 28.4% of the patients. Similarly, trauma was reported to be a causative factor for diabetic foot lesions in 17% of patients of patients in Nigeria [28]. Abbas et al also reported this to be the cause in 22% of patients, of whom 11% were due to pin prick[38]. Nyamu et al found a higher proportion of diabetics having trauma as a predisposing factor among 48.8% of patients[35]. Commonly however, these patients start with a spontaneous blister which progresses to a frank ulcer [27]. Microtrauma, caused by ill-fitting shoes was reported by 11.9% of the patients. This finding was comparable to that by Ndip et al in Cameroon[26] who reported that 22% of the patients in their study had worn tight shoes prior to the onset of the ulcer. It was difficult to assess whether shoes were inappropriate or not, since most of the patients after development of the ulcer, wore only sandals. However, Ndip et al reported that 21% of the patients with diabetic foot ulcers had hardened leather shoes which were described to be inappropriate[26].

The mean duration of Diabetes Mellitus in this study was 5.46 years (Range 0-26 years). Similarly, Ogbera Reported a mean duration of DM of 6 years in Nigeria[28]. Ukere et al reported a mean age of 13 ± 5 years[30]. In this study, 85.1% of the patients had diabetes for less than 10 years.

Ulcers severity and Management

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Most patients presented with Wagner Grade 3, 4 and 5 Ulcers (14.9%, 25.4% and 41.8% of patients respectively= 82.1%). These findings are not very different from those reported by Bushra et al in Sudan[32] who reported 74.1% having Wagner Grade >3. The results were also similar to those by Abbas et al in MNH[38]. In contrast, in the Seattle Diabetic Foot Study in the US [31], most patients had Grade 1 and 2 Ulcers (66.4%). This reflects most of our patients present late, with advanced disease. It could also indicate better foot care and greater awareness on diabetic complications among patients in the developed world. The majority of the patients in our hospital underwent a major amputation (BKA or AKA). The amputation rate was 44.8%. Abbas et al, reported that 33% of patients in their study (i.e. 15.2%) underwent a major amputation[38]. Similarly, Muthuuri et al[34] and Bushra et al[32] reported amputation rates of 28% and 24.7% respectively. In the UK and the Netherlands, the amputation rates were found to be 15.5% and 16.0% respectively [(16, 17).] Therefore the amputation rate in this study was high. This could be due to the late presentation to hospital among our patients. In their study at MNH, Abbas et al documented that the reported amputation rate was lower than it should be since most patient didn't give consent for amputation or requested discharge against medical advice[38].

Mortality

The mortality rate was relatively high in this study (25.4%). Of those who died, 9 (53%) were documented to need amputation but died before surgery. This delay was caused by various reasons including poor general condition at admission, limited theatre space, and reluctance to give consent by the patients. Reasons for death in both those who died preoperatively and those who died post operatively included sepsis, anaemia, DKA and CVA. Abbas et el reported a mortality rate of 29% at MNH in 2002[38]. Ghanassia et al in France[39] reported a higher mortality rate of 51.7% among patients with diabetic foot. However the authors also documented that, of these, 19.6% deaths were related directly to the foot disease, the other deaths being due to unrelated events. In general, the mortality rate in our hospital was found to be high, compared to other studies done elsewhere in Africa. Kengne et al[33] in Cameroon reported a mortality rate of 19% in a Central Hospital in Yaounde. Similarly, Muthuuri et al[34] in Kenya and Bushra et al[32] in Sudan reported mortality rates of 13% and 7.4% respectively. The mortality rate was increasing with the severity of the ulcer according to the Wagner's Grade. This association was found to be statistically significant.   Similar findings were reported by Abbas[38] who reported a high mortality rate (54%) among patients with Wagner Grade ≥ 4.

Conclusion and Recommendations

- Diabetes Foot Ulceration was found to be a significant cause of morbidity and mortality in our setting.
- Most of these patients probably presented to hospital late hence came with severe ulceration. This increased the risk of amputation as well as mortality.
- These patients stay in the ward for a prolonged period of time. The burden of this problem to service provision in our hospital cannot be overemphasized.
- With such a high mortality of diabetic foot patients in our hospital, a diabetic foot protocol for the management of these patients is recommended. This should clearly stipulate the standard of care among these patients. The designing of the protocol should be in a multidisciplinary approach, taking on board all those who take care of these patients: surgeons, physicians, anaesthesiologists, physiotherapists, nutritionists as well as nurses. Emphasis should be on proper assessment and grading of these patients to enable early and proper management of these patients.
- A diabetic foot unit, for admission of all diabetic patients would also help to reduce the mortality and suffering in these patients since currently, they are being admitted into the general surgical/medical ward and less attention may be given to then until when it is too late.
- Further studies involving larger samples with the possible inclusion of outpatients, are recommended.

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