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Possible Diabetic-Foot Complications in Sub-Saharan Africa

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1. Introduction

In Sub-Saharan Africa, fast uncontrolled urbanization and changes in standard of living are responsible for the rising epidemic of diabetes mellitus and the observed increase presents a substantial public health and socioeconomic burden in the face of scarce resources (Mbanya *et al.*, 2010). Ten to fifteen percent of diabetic patients develop foot ulcers at some stage of their lives and nearly fifty percent of all diabetes-related admissions are due to diabetic foot problems (Kumar and Clark, 2009). The epidemiology of Ketosis-prone atypical diabetes in Africans is not well understood because of scarce data for pathogenesis and subtypes of diabetes. The prevalence of undiagnosed diabetes mellitus is high in most countries of sub-Saharan Africa, and individuals who are unaware they have the disorder are at very high risk of chronic complications. Therefore, the prevalence of diabetes-related morbidity and mortality could grow substantially

Causes of amputation in sub-Saharan Africa vary between and within countries (Ephraim *et al.*, 2003, Thanni and Tade 2007) depending on ethnic background and socio-economic status (Leggetter *et al.*, 2002, Rucker-Whitaker *et al.*, 2003). In sub-Saharan Africa, tumours and trauma are the leading causes of lower extremities amputation (Abbas and Musa, 2007, Thanni and Tade 2007), with increasing incidence of cardiovascular risk factors (Akinboboye *et al.*, 2003).

In Kenya, rates of vascular amputations vary between 25% and 56% with Muyembe and Muhinga (1999) reporting that the leading indications of lower extremities amputation were trauma, tumours and complications of diabetes mellitus, each accounting for 26.5% of the amputations done. Another Kenya study recorded seven years later by Awori and Atinga, (2007) reported that 17.5% of patients who underwent amputation were due to diabetes-related gangrene. Two years later in 2009, diabetic vasculopathy accounted for 11.4% of the amputations and 69.6% of the non vascular cases while other causes of amputation included: 35.7% trauma, 20% congenital defects, 14% infection and 12.8% tumours respectively (Ogeng'o *et al.*, 2009).

Kidmas et al., (2004) in Nigeria reported 26.4% diabetic foot sepsis as one of the main indications for lower limb amputations while Sié Esoh *et al.*, (2009) from Ivory Coast (Cote D'Ivoire) reported 46.9% below knee diabetes related amputation and 11.2% below elbow diabetes-related amputations as common procedures performed. However, in Zimbabwe, Sibanda et al., (2009) reported 9% diabetes related lower limb amputation rate among 100 patients evaluated. Thus, different regions of Africa reported decreasing trend in diabetes related amputations.

Non-diabetes related lower extremities amputation have also been well documented. Obalum and Okeke, (2009) in Nigeria reported 61.8% trauma as the most common indication of lower limb amputation with motorcycle related accidents accounting for 61.9% of the trauma related cases. This was followed by 19.0% lower limb amputations due to pedestrians involved in road traffic accidents. Again, Abbas and Musa (2007) reported 42.8% trauma related lower extremities amputation and 18.4% lower extremities amputations due to other malignancies. Below knee amputation was the commonest amputation carried out constituting 62.8% of the 35 lower limb amputations. A Nigerian study by Kidmas *et al.*, (2004) also found that trauma and malignant conditions of the limb were the main indications for lower limb amputations in 29.9% and 23% patients respectively. According to Awori and Atinga, (2007) in a study done in Kenya, 24.3% had tumours, 16.2% of which were mainly osteogenic sarcoma while trauma accounted for 18.9%. Fifty five per cent of the amputations were above-the-knee, 24 (31%) below-the-knee, four (5%) hip disarticulations and seven (9%) were foot amputations.

The prominence of diabetic foot among debilitating tropical diseases which influences the duration of patients hospital admission is noteworthy. Diabetic foot is a important health issue in sub-Saharan Africa, where it must compete for resources with other prevalent non-communicable diseases. One of the reasons for the poor outcome of diabetic foot complications in developing countries is the lack of patient education and inadequate medical supervision. Thus, health education tailored to the individual's risk status, which promotes self-care and addresses misconceptions and medical supervision are needed to effectively contain the multi-factorial pathology of diabetic foot ulcerations.

Though the risk factors for developing diabetic foot ulcers are manageable, poor outcomes of foot complications may be due to: poor awareness among patients and some cadre of health care providers, poor and delayed access to health care, poor referrals for specialist treatment, lack of team approach for the treatment of the complicated diabetic foot, absence of refresher training programmes for health care providers and lack of quality assurance programmes.

Diabetic foot infection is the most common soft tissue infection associated with diabetes mellitus, with disease-related peripheral neuropathy and peripheral vascular disease playing major roles in this complication of diabetes. More serious complications include failure of ulcers to heal and gangrene which may lead to osteomyelitis, amputation, and death. Diabetic foot ulcers may begin after minor trauma, become infected and may progress to cellulitis, soft tissue necrosis, and extension into bone. Exploration of the ulcer is crucial to determine its depth (the palpable bone strongly suggests osteomyelitis). It is also important to determine the presence of sinus tracts and to obtain a culture. Involved organisms include group A *Streptococcus* and *S aureus*, as well as aerobic gram-positive

cocci, gram-negative rods, and anaerobes. It is highly promising to know that organism's involved in delayed healing diabetic foot complications in Nigeria including *Staphylococcus* and *Pseudomonas* species were susceptible to Quinolones (Agwu et al., 2010). If this information is confirmed in other parts of Africa, it will offer health care workers the scenario to design an intervention that will help reduce the incidences of diabetic foot complications and chances of lower limb amputations to barest minimum.

To reduce the incidence of Diabetes mellitus related amputation, medical supervision and patient education on prevention of diabetic foot complication are recommended. The predominant risk factors for foot complications are underlying peripheral neuropathy, peripheral vascular disease (Abbas and Archibald., 2007) and infection. Gangrene is a more serious complication of **diabetic foot disease** that causes long-standing disability, loss of income, amputation or death. Reasons for poor outcomes of **foot complications** in various less-developed countries include: lack of awareness of **foot** care issues among patients and health care providers alike; very few professionals with an interest in the **diabetic foot** or trained to provide specialist treatment; non-existent podiatry services; long distances for patients to travel to the clinic; delay among patients in seeking timely medical care, or among untrained health care providers in referring patients with serious **complications** for specialist opinion; lack of the concept of a team approach; absence of refresher training programs for health care professionals; and finally lack of surveillance activities (Abbas and Archibald., 2007). Other important factors include use of ill-fitting foot-wears and complete absence of foot wears (Krasner et al., 2007).

Abbas and Archibald., (2007) suggested the following ways of improving **diabetic foot** disease outcomes that do not require exorbitant outlay of financial resources: implementation of sustainable training programmes for health care professionals, focusing on the management of the complicated **diabetic foot** and educational programmes that include dissemination of information to other health care professionals and patients; sustenance of working environments that inculcate commitment by individual physicians and nurses through self growth; rational optimal use of existing microbiology facilities and prescribing through epidemiologically directed empiricism, where appropriate; and using sentinel hospitals for surveillance activities.

In Uganda and indeed many other African countries, little has been documented about diabetes care and far fewer data exist for diabetic foot among the diabetics. The worst scenario is the high prevalence of unknown cases in where people only discover they are diabetic when they can no longer contain the associated complications. Lack of diabetes clinic in major hospitals and at the grass root could explain the poor education of diabetic foot patients on what to do and how to manage the situation. Evaluation of diabetic foot complications in this region is a study designed to fill the knowledge gap, sensitize the appropriate authorities to intervene and remind the diabetics on the need to participate in an integrated community directed efforts to reduce the impact of diabetic foot to the barest minimum. The situational analysis of diabetic foot epidemic, prevention and control in South Western Uganda is very necessary. The objective of this manuscript is therefore to outline the current prevalence and impact of diabetic foot and its associated complications among the diabetics in South Western Uganda

2. Methods

This was a biphasic study made up of a prospective stake-holders descriptive survey and a retrospective cross sectional health-point survey of diabetic foot and its associated complications among diabetic patients attending randomly selected hospitals in Bushenyi, Sheema, Rubirizi and Mbarara districts of South Western Uganda. Hospital records of diabetic patients attending clinics at Mbarara metropolis made available for this assessment are those which fulfilled our data inclusion criteria which states that clinical data must be confirmed by laboratory investigation and laboratory data must be confirmed by clinical observation.

For reasons not explained by participating hospitals but which may include difficulty in information storage and retrieval, occasioned by changing hospital policies which allow patients to go home with their case files, the only data made available for this study were data generated in the year 2005. For retrospective data, Mbarara Regional Referral Hospital was selected based on: 1) presence of diabetes clinic, 2) possession of a side laboratory for rapid tests for diabetes, 3) being a referral hospital which covers referral cases from district hospitals and 4) having medical and surgical records which might include data on diabetic foot.

Pre-tested data collection tool was used to obtain socio-demographic information from the case-files of diabetic patients in Mbarara region of Uganda and also diabetes and diabetic foot associated disease complications as contained in patient's case-files.

To get a glimpse of the current diabetic management situation in an environment with few diabetic clinics, structured questionnaires were self-administered to randomly selected diabetes stakeholders such as Clinicians, Medical Laboratory Scientists, diabetic patients and nursing officers working in hospitals located in South-Western Uganda and its environs. Criteria for diabetes stakeholders' selection include: having worked in- or being in-charge of clinical chemistry laboratories, Medical and Surgical wards of hospitals located in Mbarara and its environs. Mbarara and environs were defined as hospitals located in a nearby Bushenyi district such as Kampala International University Teaching Hospital (KIUTH), Comboni Hospital, Kitagata Hospital and Lugazi Health Center IV. Information obtained from the officers included comments on the overall routine approaches in diabetic care including existence of diabetic clinic, inspection of the feet of diabetics (during ward round and out-patients consultations), diabetes education, surveillance, and complications of diabetic foot.

At random, five clinicians and two senior nursing officers at KIUTH; two diabetic patients two clinicians and one nursing officer at Lugazi Health Center IV; one nursing officer at Kitagata hospital and one clinician at Comboni hospital were interviewed. The retrospective data included in this study were from patients clinically diagnosed with diabetes mellitus and subsequently confirmed with standard clinical chemistry methods in the side laboratories of the participating hospitals. Clinical data not confirmed in the laboratory and laboratory data not confirmed by the clinical records were excluded from the study. The Research and Ethics Board of Kampala International University Uganda approved this study.

3. Results

The 233 data reviewed were from 104 (44.6%) males and 129 (55.4%) females aged from 10 years old to 60 years and above with a mean age of 40 years (Table 1). According to our data

source, there were no routine diabetic clinics in most hospitals in the year 2005 when the retrospective data of the study population were reviewed. Known diabetic patients were cared for at the Medical and Surgical departments of the hospital. The hospital records evaluated did not distinguish between insulin dependent and non-insulin dependent diabetes making it difficult to determine the impact of diabetes types on disease establishment and progression (Table 1). The complications and co-morbidities reported in this study (Table 2) were obtained from the records of medical out- and in- patient departments of the clinic.

Consequently 233 diabetic patients presented 32 different diabetes associated co-morbidities and complications with peripheral nephropathy (22.8%) being the most prevalent complications followed by infection (9.5%) (vaginal candidiasis, Urinary tract infection, skin infection; and 1.7% obesity. Others listed in the table are co-morbidities found among the diabetic patients seen during the period. Other unclassified disease conditions accounted for 4% of the total complications/co-morbidities recorded (Table 2).

Interestingly there were no clear records of diabetic foot among the reported 32 complications and co-morbidities outlined above (Table 2). This unique and conspicuous absence of diabetic foot in the record of 233 diabetic patients prompted a prospective descriptive study involving stakeholders of diabetes disease and its management in Mbarara district and its environs.

Age (years)	No (%) prevalence	
	Male	Female
<10	0 (0.0)	0 (0.0)
11-20	6 (2.6)	2 (2.6)
21-30	20 (8.6)	14 (6.0)
31-40	25 (10.7)	23 (10.0)
41-50	14 (6.0)	25 (10.7)
51-60	18 (7.7)	32 (13.7)
>60	21 (9.0)	29 (12.4)
Total	104 (44.6)	129 (55.4)

n=233

Table 1. Age and sex distribution of 233 dependent diabetic patients attending clinics in Mbarara district of Uganda

Stake-holders opinion clearly indicated that in Mbarara and environs with no diabetes clinics, foot inspection is not done routinely during ward-round even among known diabetics. Also there were inadequate diabetes education and surveillance. The main assistance rendered to the known diabetics include monitoring and control of blood glucose level and care for any major complaints they may have. Stakeholders also outlined the fact that most patients do not even know they have diabetic foot because of loss of sense of touch

due to peripheral neuropathy. The diabetic foot complications reported by stakeholders include: peripheral neuropathy (sensory, motor and/or autonomic), chronic leg ulcers and gangrene. The clinicians reported that many foot lesions treated among diabetic patients were not documented as part of the final diagnosis for these patients. That may account for the absence of diabetic foot in previous hospital records retrieved for the retrospective study

complication/co-morbidity	No (%) positive	
Peripheral Neuropathy*	53	(22.8)
Esophagitis	20	(8.6)
HIV/ AIDS	18	(7.7)
Cataract*	16	(6.9)
Renal disease	14	(6.0)
Peptic ulcer disease	9	(3.9)
Malaria	9	(3.9)
Oral thrush	9	(3.9)
Vaginal candidiasis*	7	(3.0)
Diarrhea	6	(2.6)
Urinary tract infection*	10	(4.3)
Tuberculosis	6	(2.6)
Herpes zoster	5	(2.2)
Psychosis	5	(2.1)
Hypertension	4	(1.7)
Obesity*	4	(1.7)
Pancreatitis	4	(1.7)
Skin infections*	3	(1.3)
Asthma 1	3	(1.3)
Arthritis	3	(1.3)
Pneumonia	2	(0.9)
Parkinsonism	2	(0.9)
Dental carries	2	(0.9)
Anemia	2	(0.9)
Sepses*	2	(0.9)
Testicular swelling	1	(0.4)
Spontaneous Abortion	1	(0.4)
Road traffic accidents	1	(0.4)
Phimosis	1	(0.4)
Epilepsy	1	(0.4)
Others	10	(4.0)

n= 233
NOTE: The items with * are absolute or relative complications of diabetes mellitus

Table 2. Complications and co-morbidities found among diabetic patients attending clinic at Mbarara Regional Referral Hospitals in 2005.

4. Discussion

Damage to the nervous system, is one of the serious complications of diabetes. A person with diabetes may not be able to feel his or her feet properly. Normal sweat secretion and oil

production that lubricates the skin of the foot is impaired. These factors together can lead to abnormal pressure on the skin, bones, and joints of the foot during walking and can lead to breakdown of the skin of the foot. Sores may develop. Damage to blood vessels and impairment of the immune system from diabetes make it difficult for wounds to heal. Bacterial infection of the skin, connective tissues, muscles, and bones can then occur. These infections can develop into gangrene, because of the poor blood flow. If the infection spreads to the bloodstream, this process can become life-threatening.

The relative absence of diabetes clinics in the participating hospitals at the time of this investigation may highlight the observed apparent absence of diabetic foot in the data obtained in retrospect from the hospital records of the 233 diabetic patients. We could not confirm zero prevalence of diabetic foot among the records of the diabetic patients reviewed because information obtained from the prospective survey suggests that the foot findings may not have been documented as part of the diagnoses (since it has never been part of the routine practice during ward rounds and at the Out-patient department clinics). Stakeholders report of patients not knowing about foot infection points to lack of diabetes education in the society. The non-inclusion of foot inspection in the non-diabetic clinics has made it difficult to determine the prevalence of diabetic foot among the diabetics in the studied area. In this study, we could not confirm the prevalence of diabetic foot among the studied population and we also have no result to compare with the reported percentage prevalence of diabetic foot all over Africa.

Such reports include but not limited to: 15% by Boulton, (2000); 63.9% reported by Monabeka and Nsakala-Kibangou (2001); 24% reported by Nouedoui *et al.*, (2003); 13% reported by (Ndip *et al.*, 2006, Tchakonté *et al.*, 2005, Kengne *et al.*, 2009); 16.7% by Amoussou-Guenou *et al.*, (2006); 53% by Ogbera *et al.*, (2006); 13.4 by Ahmed *et al.*, (2009); 33% reported by Mugambi-Nturibi *et al.*, (2009);

The majority of the reported complications were similar to reported diabetic foot complications elsewhere in Africa. Notable among the reported complications is 22.8% peripheral neuropathy reported in this study. This is lower than: 68% old Nigerian report by Akanji and Adetuyidi (1990) and slightly lower than 27.3% reported by Ndip *et al.*, (2006) in Cameroon. However, it is similar to 22.7% reported by Ahmed *et al.*, (2009) in Khartoum, Sudan.

Akanji and Adetuyidi (1990) reported a 68% prevalence of neuropathy, 54% foot ischaemia 42% hypertension, 38% chronic osteomyelitis 35% soft tissue changes. Sixty per cent were anaemic at presentation. Mixed bacterial organisms were cultured in 70% of the cases and 20% nephropathy in Nigerian diabetics with foot lesions. The initiating factors were observed to be predominantly trivial trauma and "spontaneous" blisters. Allied with the golden rules of prevention (i.e. maintenance of glycemic control to prevent peripheral neuropathy, regular feet inspection, making an effort not to walk barefooted or cut **foot** callosities with razors or knives at home and avoidance of delays in presenting to hospital at the earliest onset of a **foot** lesion), reductions in the occurrence of adverse events associated with the **diabetic foot** is feasible in less-developed settings.

Other possible complications associated with diabetic foot in Africa

There are few reports relating the level of research in Africa showing different possible disease complications which may be associated with diabetic foot. These reports are

impressive but definitely not enough to represent the true picture of the situation in Africa largely because many African countries either do not presently have any report on diabetic foot or the incidence are under-reported.

The prevalence of active **foot** ulceration was reported by Boulton, (2000) to vary from about 1% in Europe and North America to more than 11% in reports from some African countries. Monabeka and Nsakala-Kibangou (2001) reported 2.8% trophic disorders and 1.2% mal perforant with total of 22.6% mortality rate before surgical intervention was high (22.6%). The complications reported by Nouedoui *et al.*, (2003) in Yaunde, Cameroon, included: 4.39% gangrenous lesion while 89% have various un-identified infections in young patients with short history of diabetes and poor education about diabetes. Bouguerra *et al.*, 2004 reported a high prevalence of mycotic infection among **diabetic** patients compared to their non-**diabetic** colleagues. Tchakonté *et al.*, 2005 reported a strong correlation between an history of **foot** ulcer, a neuropathy and **foot** deformations and the evidence of a **diabetic foot**. Ndip *et al.*, (2006) reported high prevalence of diabetic foot lesions and associated complications. Specific observations include: 21.3% ischemia and 17.3% deformity, 12.3% had a previous history of foot lesions, 47% had a risky nail-trimming habit and 22% wore ill-fitting shoes.

According to Feleke *et al.*, (2007), infection is the most serious complication of diabetes and recognized as leading cause of morbidity while cardiovascular diseases were the leading cause of mortality. However, **Diabetic foot** ulcers were the major cause of infection followed by tuberculosis, skin infection, subcutaneous infections, Pneumonia. *S. aureus from wound infection and E. coli from urinary tract infection were the common pathogens*. Muthuuri (2007), found that post-amputation mortality was 28% and the mortality was found to be associated with high co-morbidity, mainly due to: 100% uncontrolled diabetes mellitus, 75% Sepsis, 42% ischaemic heart disease, 25% uncontrolled hypertension and renal insufficiency. The mortality associated with **diabetic foot** ulcer disease may be predicted by measurable characteristics such as high blood sugars, raised White blood cell count, high creatinine, high serum lipids, abnormal ECG and abnormal arterial Doppler scans (Muthuuri, 2007). These parameters point to conditions that are themselves **complications** of diabetes mellitus and whose management will reduce mortality. The management of **diabetic foot** is therefore, multidisciplinary.

Abbas *et al.*, (2009) characterised the role of ethnicity in the occurrence of diabetic **foot** ulcer disease in persons with diabetes in Tanzania and found that: ethnic Africans were more likely to: present with gangrene ($P < 0.01$) and have intrinsic **complications** such as neuro-ischaemia or macrovascular disease which delays ulcer healing while Indians were more likely to be obese ($P < 0.001$), have large vessel disease ($P < 0.001$) and mode of intervention such as sloughectomy or glycaemic control with insulin or oral agents seems to determine the same outcome like in African counterparts. Peripheral vascular disease and gangrene are playing a larger role in ulcer pathogenesis and outcomes for both ethnic groups than was previously thought (Abbas *et al.*, 2009). In a study by Obalum and Okeke 2009 in Nigeria, 61% trauma found was the most common followed by below knee amputation was done in 51 (75.0%) of cases, stump wound infection was found in 26.5% while three (4.7%) patients died. Ahmed *et al.*, 2009 could not identify the causative agents of 48.7% patients with hand sepsis while 42.9% prevalence was due to trauma; 36.1% cellulitis, 29.5% deep seated abscess, 14.3% digits amputation and 1.7% of patients were unavoidably hand-amputated.

Kengne *et al.*, 2009 in reviewing the changing pattern of diabetic foot with time found **foot** ulcer to be associated with 115% more bed use and a nonsignificantly lower risk of death or dropout.

Bahebeck *et al.*, (2010), in an effort to identify clinical patterns and outcomes related to the treatment of these diabetic foot infections reported that life-threatening hand and **foot** infections in **diabetic** patients account for a large proportion of amputations and a substantial number of deaths and concluded that 7 patterns of serious limb- or life-threatening infection were identified and, in the absence of vascular surgical intervention, mortality can be reduced at the expense of more amputations. The seven pattern of limb infections were as follows: 30.36% of the patients studied had necrotizing cellulitis, 21.43% had wet gangrene, 16.07% had acute extensive osteomyelitis, 8.93% had dry gangrene, 8.93% had gas gangrene, 7.14% had necrotizing fasciitis, and 7.14% had diffuse hand infections. Mani *et al.*, 2011 reported that since some 15% of the population with diabetes develop **foot complications**, the reported observations of venous incompetence in patients with diabetes but not **foot** disease offer hope of alleviating symptoms if not preventing ulcers.

Tsimerman *et al.* 2011 found that circulating micro-particle characteristics are related to the specific type of vascular **complications** and may serve as a bio-marker for the pro-coagulant state and vascular pathology in patients with Type 2 Diabetes Mellitus. Shapoval *et al.*, 2011 defined surgical tactics based on concrete **complications** of the diabetic foot syndrome, frames conditions for the unification and uniform registration of the form and severity of the disease and volume of the surgical treatment. Ragunatha *et al.*, 2011. Suggested that well-controlled diabetes decreases the prevalence of diabetic mellitus specific cutaneous disorders associated with chronic hyperglycemia. Oguejiofor *et al.*, 2010. Long duration of diabetes mellitus and peripheral neuropathy are risk factors for **foot** complication in Nigerians with diabetes mellitus. Asumanu *et al.*, 2010, in Ghana reported surgical complications which included foot infections, cellulitis, and abscesses.

There is an adage that says “prevention is better than cure” Therefore, this discussion will be incomplete without noting the principles of diabetic foot care which include: daily feet inspection; early reporting of any foot injury among diabetic patients; checking shoes inside and outside for sharp bodies/areas before wearing; use of lace-up shoes with adequate room for the toes; keeping feet away from sources of heat; and checking bath temperature before stepping in (Kumar & Clark). According to the stakeholders, the use of advocacy and health education by health care providers in prevention and control of diabetic foot complications is yielding good results as it is now common to see diabetic patients talking about how to avoid risky behaviour such as avoiding certain food as a way of prevention and control of diabetes.

5. Conclusion

Africa and South Western Uganda have contributed to the knowledge about possible foot complications as outlined above. Relative absence of diabetic foot in the retrospective data of South Western Uganda was confirmed prospectively as due to lack of specialized diabetic foot clinic in the studied population, absence of specialised diabetes clinics, poor education and various complications influenced diabetic foot in South Western Uganda region of Africa.

Examination of the diabetic foot and appropriate documentation of findings among the diagnosis should be encouraged among healthcare workers, especially clinicians. Also refresher courses on care of diabetics should be encouraged among all healthcare workers. Diabetes clinics should be included in all health centres IVs and above OR major health centres in African countries. Another important thing is adequate and relevant health education for patients with diabetes mellitus in health care institutions, the media and diabetes associations. These measures will help reduce the morbidity and mortality associated with the diabetic foot among diabetic patients.

Finally, it is recommended that further local studies should be done in order to be able to document the true prevalence of diabetic foot ulcers among diabetics in the community. These shall lead to deeper studies that will help identify the causes of those ulcers and determination of ways of preventing or minimizing those causes, thereby giving the diabetics a better overall quality of life.

6. Acknowledgment

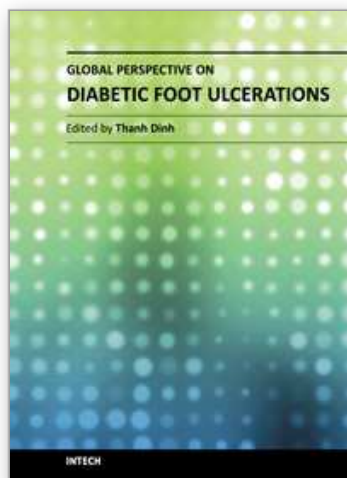
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Over the last decade, it is becoming increasingly clear that diabetes mellitus is a global epidemic. The influence of diabetes is most readily apparent in its manifestation in foot complications across cultures and continents. In this unique collaboration of global specialists, we examine the explosion of foot disease in locations that must quickly grapple with both mobilizing medical expertise and shaping public policy to best prevent and treat these serious complications. In other areas of the world where diabetic foot complications have unfortunately been all too common, diagnostic testing and advanced treatments have been developed in response. The bulk of this book is devoted to examining the newest developments in basic and clinical research on the diabetic foot. It is hoped that as our understanding of the pathophysiologic process expands, the devastating impact of diabetic foot complications can be minimized on a global scale.

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