Lower limb amputation in diabetic foot disease: experience in a tertiary hospital in southern Nigeria

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Abstract

The diabetic foot is characterised by the triad of neuropathy, infection, and ischaemia, which may ultimately lead to limb amputation. It is important to understand the factors that place diabetic patients at increased risk of amputation in our society, hence the need for this study. The medical records of all patients admitted and treated for diabetic foot complications over a 3-year period (January 2007 to December 2009) were retrieved. Relevant information was obtained from the case notes. Thirty-six (36) patients entered the study, 25 males and 11 females (M:F ratio 2.3:1.0). Mean age was 54 years (range 24–74). Patients presented with foot gangrene (58%), ulceration (31%) and infection (11%) with trauma being the most common precipitating factor (53%). Nineteen patients (53%) had lower limb amputation, the commonest of which was below knee. Of the patients that had amputation, 18 (95%) had type 2 diabetics. Adequate diabetic foot disease preventive strategies need to be designed and implemented to reduce the incidence of lower limb amputations.

Introduction

Diabetes is a metabolic disorder in which there is abnormality in the metabolism of glucose due to qualitative and/or quantitative deficiency of insulin. It is a disease with worldwide occurrence. The total number of people with diabetes mellitus is projected to rise from 171 million in 2000 to 366 million in 2030.[1] The disease has long-term consequences on many organs systems including the foot. The diabetic foot, characterised by the triad of neuropathy, infection, and ischaemia,[2] is a common and serious complication of diabetes with associated long periods of hospitalisation of the affected patient and the risk of limb amputation. It is considered as one of the most expensive complications of diabetes to treat.[3]

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Diabetic foot disease presents in various ways such as ulcer, infection/abscess, and gangrene. Diabetic foot ulcers are common and estimated to affect 15% of all diabetic individuals during their lifetime.[2] It is now appreciated that 15–20% of patients with such foot ulcers go on to need an amputation. Almost 85% of the amputations are preceded by diabetic foot ulcers.[4–6] The risk of lower extremity amputation increases by a factor of 8 once an ulcer develops.[7]

In a Nigerian study, diabetic foot gangrene accounted for 58% of all major limb amputations.[8] In India, it is estimated that approximately 40 000 legs are being amputated every year, of which 75% are neuropathic with secondary infection, which is potentially preventable.[2] Certain factors, such as barefoot walking, illiteracy, low socioeconomic status, late presentation by patients, ignorance about diabetic foot care among primary care physicians, and belief in the alternative systems of medicine contribute to this high prevalence.[9]

It is, therefore, important to understand the factors that place diabetic patients at increased risk of amputation in our society, hence the need for this study.

Patients and methods

The medical records of all patients admitted and treated for diabetic foot complications over a 3-year period (January 2007 to December 2009) at a major tertiary hospital were retrieved. Information extracted from the case notes included socio-demographic characteristics, occupation, level of education, type of diabetes and duration of disease, type of foot lesion, side affected, duration of symptoms, precipitating factors, presence of neuropathy, dorsalis and posterior tibial artery pulsations, organisms cultured and type of treatment given, awareness of the diabetic foot care protocol (standard education concerning foot inspection, use of correct shoes, moisturising of feet, and rapid reporting of problems to hospital), and application by the patient. The data so obtained were analysed by a statistician using EPI INFO 2002 computer software.

Results

Thirty-six (36) patients entered the study, 25 males and 11 females with a male to female ratio of 2.3:1.0. Age ranged from 24 to 74 years, with a mean of 54 years. Most

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Table 1 Socio-demographic characteristics of the patients (n=36)

	Number of patients (%)
Age group (years)	
20–39	4 (11%)
40–59	19 (53%)
60–79	13 (36)
Sex	
Male	25 (69%)
Female	11 (31%)
Educational status	
Non-formal	21 (58%)
Primary	3 (8%)
Secondary	6 (17%)
Tertiary	6 (17%)

patients (53%) were middle aged and 86% had no formal education (See Table 1 above). The duration of diabetes ranged from 1 week to 23 years before the development of foot lesions, with a mean of 7 years. In one patient, diabetes was diagnosed during investigation for the foot lesion. The interval between the occurrence of foot lesions and presentation to hospital ranged from 5 days to 5 months (mean of 6 weeks). The patients presented with foot gangrene (58%), ulceration (31%), and infection (11%), with trauma being the most common precipitating factor (53%) (see Table 2).

Table 2 Clinical presentation of patients (n=36)

	Number of patients (%)
Mode of presentation	
Gangrene	21 (58%)
Ulcer	11 (31%)
Infection/abscess	4 (11%)
Precipitating factor	
Trauma	19 (53%)
Burns	6 (17%)
Blistering	6 (17%)
Boil	3 (8%)
Unknown	2 (5%)

A significant number of the patients (67%) had peripheral neuropathy at presentation. Posterior tibial pulsation was palpable in 25 diabetic feet, while dorsalis pedis pulsation was palpable in 15. The common bacterial isolates were coliforms (31%) and *Staphylococcus aureus* (22%). Nineteen patients (53%) had a lower limb amputation, the

Table 3 Types of amputation (n=19)

Type of amputation	Number (%)
Below knee	10 (53%)
Ray	7 (37%)
Above knee	2 (10%)

commonest of which was below knee (53%) (see Table 3). Of the patients that had amputation, 18 (95%) had type 2 diabetes. Four of the patients left the hospital against medical advice at different stages of treatment (two before amputation), and overall mortality was 11%. Twelve patients (33%) were aware of the diabetic foot care protocol but only nine (25%) patients actually practised it.

Discussion

The diabetic foot syndrome is a severe complication of diabetes as it often leads to limb amputation with consequent negative effects on the quality of life[10] and productivity of the affected patient. In this study, more males presented with diabetic foot lesions, which is consistent with findings of other studies.[11,12] This may be due to engagement of more males in manual labour often without wearing protective shoes. The high incidence of patients without any formal education in this study is a reflection of the general level of literacy in the country and has a direct bearing on the ability of the patient to understand and practice diabetic foot care education programmes. Only 33% of the patients were aware of the diabetic foot care protocol with only 25% practising it.

Most of our patients (58%) presented with foot gangrene. Even though a few studies have given similar results,[13] most other studies have identified foot ulcer as the most common presentation of diabetic foot syndrome.[2,8] The high incidence of foot gangrene may be due to a number of factors including seeking alternative medical care where irritant topical agents were applied to the affected foot, self medication, ignorance, and poverty, with consequent delay in presentation to hospital for appropriate medical care.[9] The average interval between the occurrence of foot lesions and presentation in hospital was about 6 weeks, the longest being 5 months. Trauma was found to be an important precipitating factor in the occurrence of diabetic foot lesions. In a similar study in Trinidad and Tobago, trauma accounted for 51% of precipitating factors,[14] comparable with the figure of 53% in this study.

Lower limb amputation was carried out in 53% of the patients, with type 2 diabetic patients constituting 95% of these. This is comparable to findings of another study[14] in which 80% of the major amputations were performed on type 2 diabetic patients. This tends to suggest a higher tendency for lower limb amputations in type 2 diabetes. However, a study in Taiwan does not support this.[15] Further prospective studies to fully evaluate this relationship are therefore needed.

The most common lower limb amputation carried out in this study was below knee amputation (53%) probably due to late presentation of our patients. In other studies in developed countries, most of the amputations were minor amputations around the foot.[11,12,16] The high rate of major amputations in this study places even greater burden, economic and social, on the affected patients as many of them are unable to acquire limb prosthesis to ensure full rehabilitation.

Peripheral neuropathy, as found in 67% of the patients, and peripheral vascular disease, as determined by the absence of palpable peripheral arterial pulsations, were closely associated with a higher risk of lower limb amputations. This is in keeping with the findings of other studies.[16-19] This underscores the need for intensive diabetic foot care in patients with these lesions as a means of preventing the occurrence of foot lesions and consequent lower limb amputation.

Conclusion

The identified risk factors for lower limb amputations in this study are male sex, type 2 diabetes, delayed presentation to hospital, illiteracy, peripheral neuropathy, peripheral vascular disease, and lack of awareness and practice of diabetes foot care protocols. In view of this, adequate diabetic foot disease preventive strategies (with the particular challenges of our society in mind) need to be designed and implemented to reduce the incidence of lower limb amputations.

References

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes. *Diabetes Care* 2004; 27: 1047–53.
2. Pendsey SP. Understanding diabetic foot. *Int J Diabetes Dev Ctries* 2010; 30: 75–9.
3. Al-Maskari F, El-Sadig M. Prevalence of risk factors for diabetic foot complications. *BMC Fam Pract* 2007; 8: 59.
4. Palumbo PJ, Melton LJ. Peripheral vascular disease and diabetes. In *Diabetes in America*. Eds Harris MI, Hamman RF. Washington: US Government Printing Office, 1985; pp. 16–21.
5. Pendsey S. *Diabetic Foot: A Clinical Atlas*. Jaypee Brothers Medical Publishers, 2003.
6. Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation: basis for prevention. *Diabetes Care* 1990; 13: 513–21.
7. Adler AI, Boyko EJ, Ahroni JH, Smith DG. Lower-extremity amputation in diabetes. The independent effects of peripheral vascular disease, sensory neuropathy, and foot ulcers. *Diabetes Care* 1999; 22: 1029–35.
8. Udosen AM, Ikpeme IA, Etiuma A, Egor S. Major amputations at the University of Calabar Teaching Hospital, Calabar, Nigeria. *Nig J Surg Sciences* 2004; 14: 60–3.
9. Pendsey S, Abbas ZG. The Step-by-step program for reducing diabetic foot problems: A model for the developing world. *Curr Diab Res* 2007; 7: 425–8.
10. Teichmann J, Sabo D. Epidemiology and classification of diabetic foot syndrome. *Orthopäde* 2009; 38: 1139–48.
11. van Houtum WH, Lavery LA, Harkless LB. The impact of diabetes-related lower-extremity amputations in The Netherlands. *J Diab Complic* 1996; 10: 325–30.
12. Resnick HE, Carter EA, Sosenko JM, et al. Strong Heart Study. Incidence of lower-extremity amputation in American Indians: the Strong Heart Study. *Diabetes Care* 2004; 27: 1885-91.
13. Nather A, Bee CS, Huak CY et al. Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diabetes Complications* 2008; 22: 77–82.
14. Solomon S, Affan AM, Gopie P, et al. Taking the next step in 2005, the year of the diabetic foot. *Prim Care Diabetes* 2008; 2: 175–80.
15. Tseng CH. Prevalence of lower-extremity amputation among patients with diabetes mellitus: is height a factor? *Can Med Ass J* 2006; 174: 319–23.
16. Aksoy DY, Gürlek A, Cetinkaya Y, et al. Change in the amputation profile in diabetic foot in a tertiary reference centre: efficacy of team working. *Exp Clin Endocrinol Diabetes* 2004; 112: 526–30.
17. Mayfield JA, Reiber GE, Nelson RG, Greene T. (1996); A foot risk classification system to predict diabetic amputation in Pima Indians. *Diabetes Care* 1996; 19: 704–9.
18. Del Aguila MA, Reiber GE, Koepsell TD. How does provider and patient awareness of high-risk status for lower-extremity amputation influence foot-care practice? *Diabetes Care* 1994; 17: 1050–4.
19. Nather A, Bee CS, Huak CY, et al. Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diab Complic* 2008; 22: 77–82.

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Introduction

Among the killer diseases that are waging war against the survival, growth, and development of human beings globally, mention must be made of diabetes. It is an epidemic disease which can lead to severe chronic complications. Governments, NGOs, and information providers worldwide are now showing wide concern and giving much attention to the disease. Awareness campaigns are being utilised in order to educate people on how to guard themselves against the disease; and for the already inflicted victims of the disease. Those who already have diabetes are advised on how to manage the disease and adopt lifestyles that will not aggravate the disease.

Diabetes in African is rapidly on the increase, especially among urban communities. The reason can be attributed principally to the nature of food consumed and lifestyles adopted. Sobnigwe and colleagues[2] have said that, 'the prevalence of diabetes mellitus and other non-communicable diseases is on the rise in African communities due to the ageing of the population and drastic lifestyle changes and accompanying urbanization and westernization.' Due to a lack of proper awareness and education, diabetes suffereres are particularly prone to complications and increased mortality.[3] According to a report from the International Diabetes Federation (IDF), 'even though diabetes is as lethal as HIV/AIDS and cases in Africa have nearly doubled to more than 7 million within the past 15 years, the illness receives scant attention from donors or governments in Africa.'[4] This is true also of the Nigerian situation. Kolawole and colleagues have commented that, 'food exchanges, home blood sugar monitoring, continuous ambulatory insulin infusion by pump, and other modern therapies that are routinely employed in the care of diabetics in the developed world are only for a privileged few in a developing nation like Nigeria.'[5] Gray and colleagues are of the view that, 'like politics, all health and disease is local. Sound information on levels of health and illness in a specific geographic location is essential for an acceptable quality of patient care, primary care research and recruitment of health professionals to that location.'[6] According to Adefemi,[7] it has been estimated that the number of people with diabetes in Nigeria is presently over 1.5 million. This is an indication that, the disease is spreading widely and silently in the country.

Bibiometrics

Bibliometrics refers to the study of information materials using relevant statistical and mathematical approaches. Egghe and Rousseau[8] said that 'bibliometrics is the study of documents and their bibliographic reference and citation structures.' Haiqi[9] expressed a similar view that 'bibliometrics is concerned with mathematics and statistical methods to media of communication and has become a well-established part of information research to the quantitative description of documents.' This goes in line with the comment of, Marshakova-Shaikevich[10] that, 'bibliometrics was born in the 1960s and is aimed at the quantitative analysis of documentary output in science as a whole or in its fields.' Moed[11] comments that, 'during the past decades, there has been an increasing interest in the use of bibliometric indicators for assessing or monitoring scientific or technological activities. Bibliometrics involves the quantitative analysis of bibliographic data derived from scientific documents.' The flexibility and applicability of the method provides it with an opportunity to penetrate the domain of science and technology, arts and social sciences disciplines.' Janeving[12] says that 'bibliometrics methods may be applied for the mapping of different aspects of science and technology systems and contribute to information research, political decisions, and the management of research.'

Bibliometrics offers a range of methods for evaluating research productivity,[13] for individuals and institutes.[14] Evaluative bibliometrics gives quantitative information on publications, citations, and other performance indicators.[15] Somogyi and Schubert[16] undertook bibliometric studies on diabetes in the USA, and felt that the main impact of medical research on health was related to the activity of experts 'willing to participate in the information mainstream of their profession.'[16] Falogas and colleagues[17] found that, at least with regard to parasitology, the research output from Africa was disappointingly low. Others have also emphasised the major research output by Western Europe and the USA.[18]

Bibliometrics has been applied to epidemiological research,[19] diabetes, and other non-communicable diseases,[20] acupuncture,[21] nutrition,[22] HIV/AIDS,[23] and neglected tropical diseases.[24] A wide variety of countries have also been involved,[25] and the technique is now widely accepted as a method of measuring literary output[26] which is logical and accessible.[27]

Study methods

The study considered periodical literature on diabetes in Nigeria. The literature was drawn out from the National Library of Medicine PubMed using Nigeria and Diabetes as MeSH terms. PubMed was selected because it is found to be comprehensive and representative in its coverage. Somogyi and Schubert[16] described it as, 'the most comprehensive medical literature database.' In this study the number of articles on diabetes about or on Nigeria produced by each journal was written down

and the data presented in tabular form as shown in Table 1. In order to determine the core of productive journals Bradford`s Law was applied to the data in Table 1. Bradford[28] said, 'if the journals containing articles on a given subject are arranged in decreasing order of productivity of articles they carried on the subject, then successive zones of periodicals containing the same number of articles on the subject form the simple geometric series $1:n:n^2:n^3$.' The first zone is considered the core zone and contains the most productive journals. The succeeding zones are considered to have journals that decrease in their productivity of carrying articles on the subject. The Bradford–Zipf distribution refers to determining the extent to which articles on a subject are distributed or scattered into journals. The journals may not necessarily be in the same subject area. The terms submissions and cumulative submissions refers to the number of titles on diabetes produced by each journal and the cumulative number of titles by each journal. In Table, 1 cumulative number of articles and cumulative percentage of articles can be seen clearly.

Results

1. Growth of the literature

Table 1 shows the spread of the periodical articles produced at a four year interval. It clearly indicates that about 90% (461 articles) of diabetes literature were published during 1986–2009. Figure 1 shows the growth of diabetes literature of Nigeria. As one can see, from the initial stage, the growth was very slow but gradually picked up. From the year 1986 the growth of the literature became exponential in speed. These changes in the spread and growth of the literature clearly shows that researches in diabetes is gaining attention and interest from Nigerian scientists, medical practitioners, researchers, scholars, and information providers. This may be related to the general Nigerian population increase, as well as specific increases in diabetes prevalence.[29] There has also been a great increase in teaching and research institutes in the country.

2. Bradford–Zipf distribution

The pattern of publication in the journals dealing with diabetes clearly indicates that there is a tremendous scattering of diabetes literature of Nigeria. Table 2 shows the list of 57 journals that published 512 articles relating to diabetes in Nigeria from 1966 to 2009. The journals are ranked according to their decreasing order of productivity in the literature. This means that, the ranking start with the journal that published the highest number of articles on diabetes, followed by other journals in this manner up to the lowest journal that published articles on diabetes. From the data, nine journals were located within the core zone. These nine journals altogether contributed 184 articles or (36%) of the total (see Table 2).

In order to determine the existence of a Bradford–Zipf distribution pattern, the journal rank numbers were plot-

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ted logarithmically on the X axis, while the cumulative submissions were plotted along the Y axis. In Figure 2 (on the following page), after the initial rise, the relationship is linear, which clearly shows that the literature is growing and vastly scattered and that a Bradford–Zipf relationship exists in the diabetes literature. Interestingly, this has also been shown in the nutrition literature of Bangladesh.[30]

Discussion

Diabetes literature in Nigeria is expanding very rapidly. The growth of the literature has implications for the healthy living of Nigerians. This is because the more cases and reports received about the disease in the country, the more the literature grows and expands. The growth of the literature also relates to an increase in the population and the expansion of higher institutions.

A collaborative effort needs to be exercised by medical doctors, health, and allied workers to combat the spread of diabetes. Issa and colleagues [32] hold the view that 'a close collaboration and adequate liaison is essential to ensure better quality of life of patients with this chronic medical illness.'

Control and prevention of diabetes also requires a 'multidisciplinary and multisectorial entegrated approach,'[32] concentrating on a community and primary care approach. Education, lifestyle, and behaviour change are also vital elements of control and prevention,[33] as is a firm scientific research research base.[34]

Library and information services are also a vital part of combatting diabetes.[35,36] The bibliometric approach we have described in this paper will help to fight diaabetes, and improve the treatment and life quality of those with the disease. Healthy nations rely on useful, relevant, and accessible information to survive and prospe