Challenges for management of the diabetic foot in Africa: doing more with less

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ABSTRACT

Diabetes mellitus reached epidemic proportions in much of the less-developed world over a decade ago. In Africa, incidence and prevalence rates of diabetes are increasing and foot complications are rising in parallel. The predominant risk factor for foot complications is underlying peripheral neuropathy, although there is a body of evidence that confirm the increasing role of peripheral vascular disease. Gangrene and infections are two of the more serious sequelae of diabetic foot ulcer disease that cause long-standing disability, loss of income, amputation or death. Unfortunately, diabetes imposes a heavy burden on the health services in many African countries, where resources are already scarce or cut back. Reasons for poor outcomes of foot complications in various less-developed countries include the following: 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; delays 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 training programs for health care professionals; and finally lack of surveillance activities. There are ways of improving diabetic foot disease outcomes that do not require an exorbitant outlay of financial resources. These include 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. Allied with the golden rules of prevention (i.e. maintenance of glycaemic 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.

Key words: Africa • Amputation • Diabetes • Diabetic foot • Diabetic ulcers and infection • Peripheral neuropathy • Peripheral vascular disease

INTRODUCTION

Diabetes mellitus, now one of the most common non communicable diseases globally, reached epidemic proportions in much of the less-developed world over a decade ago (1). Since then, incidence and prevalence rates have been increasing in many African countries and have largely been attributed to the attendant sedentary and dietary habits associated with the increased adoption of urban lifestyles and behaviour in many of these countries (1,2). Closely underlying these increases in diabetes rates, and in parallel with the urban lifestyle, is the escalating incidence

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Key Points

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Key Points

- in the past 20 years, the rates of obesity have tripled in less-developed countries that have been adopting a Western lifestyle involving reduced physical activity and over-consumption of cheap energy-dense food
- by current estimates that suggest sub-Saharan Africa will experience the greatest rise in prevalence rates of diabetes over the next 20 years
- for less-developed countries, high costs and lack of trained medical personnel and facilities absolutely preclude the institution of the diabetic foot management paradigm that is standard in Europe or North America
- in Africa, foot complications are the main cause of prolonged hospital stays for patients with diabetes and are associated with substantial mortality, constituting a major public health problem

of overweight and obesity in less-developed countries (3). In a recent review, Hossain *et al.* pointed out that in the past 20 years, the rates of obesity have tripled in less-developed countries that have been adopting a Western lifestyle involving reduced physical activity and over-consumption of cheap energy-dense food (4).

The number of people with diabetes in less-developed countries worldwide is projected to increase from 84 million in 2000 to 228 million by 2030 (5). Underscoring this projection is the fact that approximately 197 million people worldwide have impaired glucose tolerance and this number is expected to increase to 420 million by 2025 (5). Currently, there are 7–8 million patients with diabetes resident in Africa alone (1,5); in sub-Saharan Africa, diabetes remains a leading cause of morbidity and mortality and imposes a heavy burden on the health services in these countries (2,6–8). The potency of the crisis is made all the more urgent by current estimates that suggest sub-Saharan Africa will experience the greatest rise in prevalence rates of diabetes over the next 20 years (5).

For Europe and North America, the economic consequences of diabetic foot complications are enormous and have been well documented. In a recent review, Boulton pointed out that the cost of diabetic foot lesions encompasses interventions to prevent foot ulcers, management strategies to heal ulcers, and the management and care necessary for disability after amputations (9,10). Of course, these costs, although high and worrisome for patients in the industrialised world, are still largely affordable by most people with medical insurance coverage (North America) or access to care in a national health service (United Kingdom, Sweden). The same is not true for less-developed countries, where high costs and lack of trained medical personnel and facilities absolutely preclude the institution of the diabetic foot management paradigm that is standard in Europe or North America. These limitations are compounded by the reality that diabetes already imposes a heavy burden on the health services in some African countries, where resources are already scarce or cut back. For example, nearly 4% of the annual health care budget in the Gambia is spent exclusively on the treatment of diabetes patients (11); in Tanzania, the total government expenditure on health as a percentage of total expenditure declined during the 1980s and 1990s and, in US dollar terms, per capita health expenditure declined in parallel (12).

THE REALITY

The diabetic foot (defined as one or more of infection, ulceration or destruction of deep tissue in the lower limbs) is invariably associated with neurological abnormalities and varying degrees of peripheral vascular disease (PVD), especially affecting the lower limb (13). However, while most reports from Africa suggest that diabetic foot lesions are more likely to be associated with neuropathy rather than PVD, concomitant infections in the foot seem to be playing an increasing role in the pathogenesis of foot ulcer disease, which can progress to systemic infection, necrosis, gangrene, loss of the limb or death (6–8). More recent data suggest that PVD is now increasing in diabetes populations in various African countries (6). For example, rates of PVD in Tanzania have increased from 2·9% in 1980 to 12·5% in 1997 and 21% in 2002; similar rates in Nigeria have increased from 1·7% in 1968 to 4·4% in 1971 and 54% in 1990 (6).

Diabetic foot infection is a limb-threatening complication and several studies have shown it to be the immediate cause of amputation in 25–50% of diabetic patients (13–16). Although it would seem reasonable to conclude that the increasing occurrence of PVD among African patients with diabetes is the natural progression of the condition and a manifestation of the increasing incidence of diabetes in the general population, changes in diet trends, increasing tobacco usage and artherosclerotic vascular disease are almost certainly important contributory risk factors, although the relative contribution of each of these factors to PVD occurrence remains uncharacterised.

In Africa, foot complications are the main cause of prolonged hospital stays for patients with diabetes and are associated with substantial mortality, constituting a major public health problem (2,6–8). In Tanzania, the highest mortality rates are observed in patients with severe ulcers that have progressed to gangrene but not treated with aggressive surgery (8).

THE CHALLENGES

Over the past two decades, diabetes research in the areas of genetics and molecular epidemiology has escalated significantly in

industrialised nations. However, this increase in research at the molecular level has not been translated to patient care and improvement in patient outcomes in many of these same countries that provide routine, diabetic follow-up care. For limb complications, ready availability of technology, drugs and antimicrobials in North America and Europe is offset by the increasing burden of diabetes competing for allocated resources in these nations. In North America, the high cost of health care and insurance premiums often precludes optimal provision of diabetic foot care. In less-developed nations, including many in the African continent, the only research that has had any significant impact on patient outcomes has been in the area of epidemiological characterisation of diabetic complications, especially of the lower limb, and implementation of the findings to evidence-based practice. Ironically, there are reasons to be more pragmatic about improving diabetic foot care in Africa than in developed nations, the simple reason being that the incidence and prevalence rates of diabetes mellitus, although rising in Africa, are still at levels that render the diabetic foot burden manageable. Moreover, for the time being, foot complications rather than large vessel disease are probably the most common adverse events associated with diabetes in African patients and are potentially preventable. In contrast, the sharp upward movement of secular trends in diabetes prevalence rates in North America, some European countries, the Indian subcontinent and Asia threaten to overburden the retrospective health care systems (9). In less-developed countries where diabetes populations have relatively large rates of large and small vessel disease complications, the additional financial burden on health care providers often results in inadequate allocation of resources for addressing foot complications in these patients. The major challenge for less-developed countries, like Tanzania, is how to take advantage of the current epidemiological realities and implement programmes that could truly improve the outcomes of diabetic foot complications, using relatively small proportions of available resources. The question, then, remains: how do we actually achieve successful management of the diabetic foot in a less-developed country, without the technology and resources available in developed nations?

Commitment by individual physicians and nurses

In less-developed countries with limited resources, there is generally little or no incentive for individuals to commit themselves to training, especially when satisfactory remuneration or recognition might not be forthcoming or guaranteed. A recent commentary in the *Lancet* pointed out that even when general health care is accessible, there might be no professionals with an interest in the diabetic foot (17,18). To broach this limitation, Abbas and colleagues in Tanzania actively involved the nurses and ancillary personnel in their diabetic foot centre in all aspects in patient care and follow up. In addition to on-the-job practical experience in foot care and outpatient surgery, nurses in the foot centre are given opportunities to participate in seminars and to travel to conferences and workshops pertaining to foot care. Even administrative and clerical personnel with a minimum of clinical experience are given the opportunity to obtain training if they so wish. In fact, several of the key personnel in the Dar es Salaam foot clinic started off with little or no experience and were moulded into competent practitioners of diabetic foot care and management skills, including minor surgery skills. In turn, Abbas and colleagues have received 100% commitment from their staff and an extremely low rate of personnel turnover.

Treatment of infected feet and optimal use of microbiology facilities

Most published reports suggest that foot lesions in African diabetes patients have an infectious aetiology (2,19–21). Patients often present to hospital only after gangrene and infection have developed, or after localised infection has progressed to systemic sepsis that might not be amenable to conventional supportive therapy with antimicrobials (8). In many less-developed countries, foot infections are especially common where there are no available chiropody services, or lesions are ignored or detected relatively late in the course of the infection after unsuccessful home therapy, such as soaking in hot water or application of unproven home remedies or after seeking medical assistance from traditional healers. It is obvious, therefore, that much of the sequelae of foot complications (infection, ulceration and amputation) are potentially

Key Points

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- Abbas and colleagues in Tanzania actively involved the nurses and ancillary personnel in their diabetic foot centre in all aspects in patient care and follow up. In addition to on-the-job practical experience in foot care and outpatient surgery, nurses in the foot centre are given opportunities to participate in seminars and to travel to conferences and workshops pertaining to foot care
- in many less-developed countries, foot infections are especially common where there are no available chiropody services, or lesions are ignored or detected relatively late in the course of the infection after unsuccessful home therapy

Key Points

- the *sine qua non* for successful management of the diabetic foot in a less-developed country is an approach that fully integrates available medical (treatment of infection and diabetes control) management of the patient and surgical therapy (debridement and amputation where appropriate)
- the success in this endeavour, measured through outcome surveillance data, is largely attributable to this integration of services in which variation in clinical decision making is minimised by abolishing different layers of care
- the perennial problem of antimicrobial availability and ability of patients with limited resources to afford various courses of antimicrobials for foot infections plays a significant factor in the outcome of these infections
- Abbas and colleagues have been using sources of cheap antimicrobials in India and China and, in fact, have shown positive outcomes in foot ulcer healing, using adjunct therapy with cheap broadspectrum antimicrobials from India and China, that were similar or better than more expensive antimicrobials obtained from the West

preventable and may be reduced substantially through foot care initiatives that are practical, pragmatic to both patient and caregiver alike, and doable.

Foot infections encompass cellulitis (the least invasive), deep soft tissue infection (involvement of fascia, muscles and deep tissue) to osteomyelitis (8,13). Osteomyelitis generally underlies chronic foot ulcers, developing through contiguous spread of soft tissue infection in an ulcer to the underlying bone (22). The presence or absence of osteomyelitis underlying an infected foot ulcer is crucial to long-term cure. Osteomyelitis may be ascertained through bone radiographs, isotope bone scans, histology, or by simply probing the bone beneath an ulcer with a sterile blunt instrument. Given that radiological or nuclear medicine services are not routinely available, Abbas and colleagues usually probe the bone beneath an ulcer to physically ascertain the presence or absence of osteomyelitis. Should there be osteomyelitis, the dead bone is debrided as needed or until it is felt that viable tissue has been reached, although this is difficult to ascertain accurately. Next, the patient is commenced on long courses of empirical antimicrobial therapy. If the limb looks poorly (e.g., purulent or gangrenous), then the patient is referred for surgical assessment with a view to removal of necrotic bone, or amputation, if necessary. It follows that the *sine qua non* for successful management of the diabetic foot in a less-developed country is an approach that fully integrates available medical management (treatment of infection and diabetes control) of the patient and surgical therapy (debridement and amputation where appropriate). Success in this endeavour, measured through outcome surveillance data, is largely attributable to this integration of services in which variation in clinical decision making is minimised by abolishing different layers of care. Rather, as suggested in a recent commentary, adherence to a defined management working protocol enables strict delineation of the roles and responsibility of each member of the foot care team (17). Allied with the acquired skills and experience among committed nursing and medical personnel, and the trust and pragmatism of patients, the foot clinic in Dar es Salaam has achieved remarkable outcomes with limited financial and human resources.

Foot ulcers are commonly colonised with normal flora that may later cause deep infections (23). Cultures of superficial swab specimens are not very useful because they generally tend to yield polymicrobial growth, which are largely uninterpretable. Procurement of a deep tissue biopsy is likely to yield more useful data. However, many microbiology services in sub-Saharan Africa do not have the resources to provide or maintain routine culture services. Abbas and colleagues conducted epidemiological and microbiology studies that showed unequivocally that for patients with infected foot ulcers, empirical broad-spectrum antimicrobials (without microbiology cultures), used in conjunction with surgical debridement yielded similar or better outcomes than antimicrobials chosen by antimicrobial susceptibility testing of pathogens isolated from deep tissue cultures (24).

The perennial problem of antimicrobial availability and ability of patients with limited resources to afford various courses of antimicrobials for foot infections plays a significant factor in the outcome of these infections. Although altruism on the part of the physician plays an important role in countries like Tanzania, it is not sustainable for a long term. Thus, the foot clinic at Abbas Medical Centre has been actively seeking alternative antimicrobial donors in the West, including Christian and Muslim organisations. In addition, Abbas and colleagues have been using sources of cheap antimicrobials manufactured in India and China. More recently they demonstrated outcomes in foot ulcer healing, using adjunct therapy with cheap broad-spectrum antimicrobials from India and China, that were similar or better than more expensive antimicrobials obtained from the West (24).

Surveillance and prevention

Perhaps one of the most important challenges in the management of the diabetic foot is the institution and maintenance of a surveillance system. Most surveillance systems require substantial amounts of funding, personnel trained in data collection, statistics, epidemiology and data analysis, and elaborate computer network and information technology systems and software. For countries with limited resources, establishment of surveillance for diabetic limb complications are necessary, notwithstanding the cost, for a number of

reasons: (i) to identify risk factors through analytic study of the surveillance data; (ii) to characterise unique diabetes populations thereby enabling appropriate active and preventive responses and (iii) to assess the effectiveness and outcomes of therapy and interventions. In Tanzania, Abbas and colleagues have instituted perhaps the largest surveillance system for limb complications in Africa (6–8,25,26). Using strict case definitions for upper and lower limb complications, a comprehensive standardised questionnaire, and staff who are trained in data collection and intimately involved with the care and follow-up of patients, their surveillance system has been sustained through the commitment of the staff and careful attention to the type and quality of the data collected for evidence-based practice. Through the conduct of analytic case–control and cohort epidemiological studies, independent risk factors associated with various types of limb complications have been identified and characterised. For example, differentiating whether there is underlying PVD or peripheral neuropathy in a diabetic patient with foot infection is essential because these underlying complications require different therapeutic and prevention strategies.

Regarding the identification of new or unique populations, Abbas *et al.* were able to identify a relatively unstudied population of diabetic patients with infected ulcers but who have neither significant neuropathy nor vascular disease (7,8). One third of patients with an infected foot who attend the diabetes clinic in Dar es Salaam have this pattern of acute foot ulcers, and are typically young adults with type 1 diabetes, who were identified as diabetic at their initial presentation to the outpatient clinic with the infected foot (27). The pathogenesis of these acute ulcers usually starts with a non specific injury followed by breakdown of the skin. Although the complete epidemiology and microbiology of foot infections in this unique population needs to be better defined, Abbas and colleagues have recorded positive outcomes among these patients by using the principles delineated above.

Through their surveillance system, Abbas and colleagues have been able to monitor diabetic limb complications in East Africa. Using a minimum of human and financial resources, some of their other achievements include the following: (i) evaluation of outcomes of therapies and interventions, education and preventive programmes; (ii) characterisation of the role of ethnicity and type of diabetic complications encountered in patients; (iii) characterisation of the outcomes of diabetic foot ulcers in Dar es Salaam and (iv) characterisation of risk factors and outcome correlates for upper limb infections. But one of the most important consequences of maintaining a surveillance system in Tanzania is the positive effect it has had on patients' perception of their medical condition and their ability to deal with the untoward complications. This is reflected in the appreciation among attendees of the foot clinic of the quality of care provided, that is, one that is centred on the patient rather than the disease. In consequence, patients are generally pragmatic in their assessment of the care provided, are knowledgeable about diabetes and its complications, and, importantly, tend to keep their appointments, regardless of the distances they might have to travel. The end result is almost 100% participation by patients and the opportunity to validate therapeutic interventions and preventive programmes.

The importance of sentinel centres

In developing countries, where limited resources and infrastructure may preclude comprehensive medical, surgical and laboratory services for every region or province, centralisation of available resources in a few selected centres (sentinel hospitals) is one way of optimising resources. This paradigm is evident in many countries in Africa, Southeast Asia, Latin America and the Caribbean. Sentinel institutions tend to be large (usually >500 beds) teaching centres for medicine, surgery, nursing and laboratory science; they commonly house specialised medical and surgical units and are associated with microbiology laboratories that are often reference centres with the ability and capacity to conduct various microbiological tests using scrupulous, quality-controlled methods. However, sentinel centres could be independent, specialised institutions devoted to the study and management of various medical conditions. For diabetic foot complications in Tanzania, much of the published surveillance activities and epidemiological data have been made possible through the maintenance of a large diabetes clinic at the sentinel teaching hospital in Dar es Salaam working in conjunction with a smaller, private medical centre devoted

Key Points

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- through the conduct of analytic case-control and cohort epidemiological studies, independent risk factors associated with various types of limb complications have been identified and characterised
- one of the most important consequences of maintaining a surveillance system in Tanzania is the positive effect it has had on patients' perception of their medical condition and their ability to deal with the untoward complications
- the end result is almost 100% participation by patients and the opportunity to validate therapeutic interventions and preventive programmes

Key Points

- the importance of behaviour and customs as obstacles to improving patient outcomes is exemplified by the finding that although symptomatic peripheral neuropathy is very common among diabetes patients in the large diabetes outpatient clinic in Dar es Salaam, higher literacy among patients does not necessarily prevent complications and is not associated with better outcomes compared to patients with relatively lower literacy

to the study of the diabetic foot in the East African setting. This approach underscores the advantage of alliances in studying and characterising the epidemiology of the diabetic foot in a resource-poor setting, and the role of sentinel institutions as natural aggregating centres for surveillance, follow-up, interventions and outcomes ascertainment for patients with diabetes.

Sequential time-line in patients' decision to seek medical assistance

Time and again, delay in seeking medical assistance has factored as an independent risk factor for poor outcomes among diabetes patients with upper and lower limb complications in Dar es Salaam. On further investigation into why patients consistently delay presentation, Abbas and colleagues found that the reasons are almost always associated with customary behaviour and cultural tradition. For example, diabetic patients with severe upper or lower limb sepsis commonly give a history of attempting to treat small lesions (e.g. callus, corns and boils) at home, using herbal baths, razor blades or various poultices. Often, the patient or a relative carry out the procedure themselves. If there is failure following self-therapy, the patient's next likely step is a visit to a faith healer or herbal doctor. Faith healers practice their arts in the villages, and generally demand and receive much undeserved credibility and loyalty from patients. Many of these healers prescribe herbal medications that actually compete with those prescribed by physicians. Herbal remedies are available at almost every street corner with various advertisements claiming effective remedies for diabetes, callus, corns and various other diabetic complications or diseases. And when this approach too fails, patients might then visit a local health centre, where there is a relative paucity of foot care expertise. This is likely to be followed by a visit to a primary healthcare centre or a regional health centre, where there are no health workers who are trained for the severe complications that have now set in. Thus, by the time the patient is finally referred to hospital, it is often too late to save a foot or even prevent death from septicaemia (8,26).

Other cultural beliefs can form intractable barriers that prevent appropriate referral for management of limb complications; the outcome for these patients includes amputation or death (8). Thus, patients with diabetes might avoid or delay seeking medical attention, when they develop a new ulcer that becomes progressively worse, for fear of losing a limb (in many parts of Africa, loss of a limb is considered worse than death). Lack of awareness or knowledge among health care personnel regarding current effective regimens for complicated diabetic foot problems can also lead to poor outcomes. For example, soaking the foot in antiseptic liquid or washing powder water for half an hour is a common practice among nurses in some parts of Africa. Aqueous soapy water is a great growth medium for pseudomonas infection and can worsen the condition of the foot. For very serious complications, referral to an inadequately equipped centre or lack of training among personnel might result in a patient being treated inadequately for long periods (17).

Delays in seeking medical attention for diabetic foot complications can be inadvertent. For example, patients with diabetes who sustain rodent bites to an anaesthetic foot often do not recognise the injury immediately for various reasons, including the most obvious – lack of sensation in the foot, failure to examine their feet on mornings or concomitant presence of retinopathy that prevents them from actually recognising that they have sustained a gnawing injury or lost one or more toes as a result of rodent bites (28). The importance of behaviour and customs as obstacles to improving patient outcomes is exemplified by the finding that although symptomatic peripheral neuropathy is very common among diabetes patients in the large diabetes outpatient clinic in Dar es Salaam, higher literacy among patients does not necessarily prevent complications and is not associated with better outcomes compared to patients with relatively lower literacy (25).

Sustainable infrastructure—a "Step by Step" approach

Data from Tanzania indicate that 70% of all lower limb amputations in the country are related to underlying diabetes foot disease; 33% of patients with diabetes, who are hospitalised for foot ulcer complications, undergo amputation during their hospital stay and that there is a 54% mortality rate among patients with progressive foot ulcer complications, who delay presentation to hospital (8). Until

recently, however, there had been no sustainable infrastructure for diabetic foot management in Tanzania. Compounding the problem is the lack of trained personnel and formal podiatry services in the country, and limited financial resources to underwrite comprehensive preventive programmes. For all these reasons, the 'Step by Step' Foot Project was initiated as an applied approach to improve educational skills and the management of diabetic foot problems (29). The objectives of the 'Step by Step' Project were as follows: (i) to implement sustainable training programmes for health care professionals (physicians and nurses, and community health care workers) in the management of the diabetic foot; (ii) initiate educational programmes that focused on the transfer of information and expertise from health care professionals, who have undergone training, to other health care professionals with little or no training in foot care; (iii) to reduce rates of lower limb complications in persons with diabetes through identification of attributable risk factors that are potentially modifiable and (iv) to use education as a means of engendering greater motivation among persons with diabetes to take greater responsibility for the care of their feet, to detect problems earlier on and act upon them and to appreciate the importance of seeking help in a timely manner when problems do arise.

The Project essentially consisted of two components: an educational training programme in which a basic 3-day course was given to medical doctors and nurses followed 1 year later by a 3-day advanced course, held at the same venue, for the same participants; and an applied project conducted during the interim year between courses in which course participants would carry out a screening project related to the diabetic foot. Project-related activities during the interim year were evaluated after the second course. In the basic course, medical doctors and nurses were taught how to obtain a relevant history, perform physical examinations, screen for peripheral neuropathy and ischaemia, classify and stage foot ulcers, and having identified at-risk patients, how to organise and implement appropriate and timely foot care and education for patients. In addition, participants were provided diagnostic kits that included equipment necessary for foot care. The expectation was that following the course, participants would educate their patients and disseminate the acquired knowledge and skills to other healthcare professionals in their respective regions. A total of 15 pairs of medical doctors and nurses from 14 regions across the country participated in the 'Step by Step' Project: the first and second courses were held in 2004 and 2005, respectively. During the interim, 11 583 patients were screened in the 14 regions; 4322 (37%) were identified with various foot complications, including 465 (11%) with foot ulcers. Among patients with foot ulcers, 42 (9%) underwent amputation and 17 (4%) subsequently died. Moreover, there was marked dissemination by course participants of acquired knowledge and information to other personnel in the respective regions.

Institution of the 'Step by Step'Foot Project resulted in improved foot ulcer management for diabetic patients in 14 regions in Tanzania and a reduction in the number of documented lower limb amputations (Table 1). The project also showed that for diabetic patients with high-risk feet, it is feasible to circumvent amputation or death through a programme of education of both health care providers and patients allied with dissemination of informa-

Table 1 Outcome data after 1 year of the basic course in December 2005 and after 1 year of advanced course in December 2006

Self-reporting data by delegates of December 2005 and December 2006			
No	Variables	December 2005	December 2006
1	Registered patients at diabetic clinics	11 583	14 716
2	Patients with high-risk foot, *n* (%)	4322 (37)	5540 (38)
3	Patients with foot ulcers, *n* (%)	465 (11)	794 (14)
4	Reported patients ended up with amputation , *n* (%)	42 (9)	52 (6·5)
5	Reported patients died, *n* (%)	17 (4)	38 (4·7)
6	Clinical officers trained by trainees	69	125
7	Nurses trained by trainees	147	176
8	Education sessions with patients in 14 centres in 2005 and 2006	163	563

Key Points

- the 'Step by Step' Foot Project was initiated as an applied approach to improve educational skills and the management of diabetic foot problems
- the expectation was that following the course, participants would educate their patients and disseminate the acquired knowledge and skills to other healthcare professionals in their respective regions
- institution of the 'Step by Step' Foot Project resulted in improved foot ulcer management for diabetic patients in 14 regions in Tanzania and a reduction in the number of documented lower limb amputations

Key Points

- the key underlying risk factors for diabetic foot ulcer disease and complications in less-developed countries are poverty, social deprivation and limited or complete lack of access to health care
- relatively little outcomes research have been carried out to study the effectiveness of various primary and secondary interventions for the prevention of diabetic foot complications or death in less-developed settings
- in the long run, motivation and action by diabetes patients themselves will be the key, essential elements for protecting the feet from complications
- education remains the most important preventive tool in Africa and other less developed countries, and should be an integral part of all preventive programmes: simple and repetitive, and targeted at both health care workers and patients alike

tion to other health care professionals involved in patient care. In addition, early detection and treatment of diabetic foot complications through targeted screening programmes, such as the one carried out in this Project, showed vast potential in reducing morbidity and mortality and in improving patient outcomes.

WHERE DO WE GO FROM HERE

In summary, the reasons for suboptimal foot care in Africa and other 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 treatment for anything other than simple problems of the foot (17); non existent podiatry services; long distances to travel making regular visits to the clinic impossible; delays among patients in seeking timely medical care or among professionals in referring patients with serious complications to a centre that is more capable of dealing with the problem; lack of the concept of a team approach; blind referrals of patients to surgeons for amputation; absence of training programmes for health care professionals and finally lack of surveillance activities. In addition, in countries with a paucity of trained personnel, many of the services are run by nurses rather than a foot specialist.

It is almost certain that the most important advance that will change the practice of diabetic foot care throughout the developing world in the next 25 years will not be increased availability of high technology, molecular genetics or development of new drugs, but rather the ability to aggregate and disseminate evidence-based epidemiological data, through educational programmes, especially to health care workers (training the trainers), who in turn disseminate information to patients with diabetes, their relatives and friends. This approach is certain to have enormous impact in two ways: (i) it is powerful tool for prevention of diabetic foot complications, as evidenced by work carried out in Tanzania, where the feasibility of prevention and control of diabetic foot complications in a resource-poor setting has been shown (6,7,29); and (ii) it will enable and empower health care givers to manage foot complications more comprehensively resulting in better outcomes, improved quality of life for patients, and significant reductions in amputations and mortality rates.

But by far, the key underlying risk factors for diabetic foot ulcer disease and complications in less-developed countries are poverty, social deprivation and limited or complete lack of access to health care. The unfortunate implication is that patients with severe peripheral neuropathy might not be able to afford appropriate footwear even if they recognised the inherent risks of walking barefoot on hot asphalt under the midday sun (6,7). In industrialised countries, numerous clinical studies have shown that special diabetic foot clinics reduce the incidence of serious foot problems and that patient education results in unequivocal reduction in the occurrence of ulcers and amputations. In contrast, relatively little outcomes research have been carried out to study the effectiveness of various primary and secondary interventions for the prevention of diabetic foot complications or death in less-developed settings.

CONCLUSION

While it may be impossible to totally prevent foot ulceration, it is certainly feasible to prevent the progression of small ulcers to infection, sepsis, osteomyelitis or gangrene. In the long run, motivation and action by diabetes patients themselves will be the key, essential elements for protecting the feet from complications. Such action, however, depends on education, which remains the most important preventive tool in Africa and other less-developed countries, and should be an integral part of all preventive programmes: simple and repetitive, and targeted at both health care workers and patients alike. Diabetes patients must be educated on the importance of foot care, use of appropriate, affordable footwear, and of consulting a doctor during the early stages of foot-related symptoms. Ultimately, success will depend on the ability of health care providers to inculcate the motivation and self-help that is essential for the well-being of patients with diabetes.

In truth, lack of financial or human resources do not preclude the implementation of the golden rules of prevention – i.e., maintenance of glycaemic control to prevent or delay the onset of peripheral neuropathy, regular inspection of feet by self or relatives at home, podiatric care that includes regular feet inspec-

tion, 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 when a foot lesion, however minor, has developed. These simple rules, if followed, will go a long way in reducing adverse events associated with the diabetic foot in less-developed settings.

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