Global Preventive Foot Care And A Decrease In Amputations: A Positive Step For Diabetes-related Foot Complications

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Abstract: Diabetes-related foot complications (DRFC) have the highest morbidity and mortality among all other complications. Every year, an estimated two million people with DRFC require amputation. It has long been established that education of people with diabetes and, importantly, health-care care professionals (HCPs) can lead to significant reductions in amputation rates. This article reports on the *Step-by-Step (SbS)* diabetic foot program and *Train the Foot Healthcare Professional (TtFHCP*) diabetic foot program, two successful international foot care education initiatives developed for HCPs.

Key words: *education program, step-by-step, health-care professional training, diabetes mellitus, diabetic foot, amputation prevention*

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The most recent 10th edition of the *International Diabetes Federation (IDF) Atlas* indicates that diabetes mellitus (DM) is one of the diseases with the most rapid global expansion of the twenty-first century. According to estimates, 537 million people were living with diabetes in 2021; by 2030, that number will rise to 643 million, and by 2045, it will reach 783 million. Every part of the world is at a different stage of the epidemiological shift due to the rise in DM.[1-5] Diabetes mellitus is becoming more common due to several reasons, including urbanisation, changes in lifestyle, the ageing of the population, and an increase in risk factors like obesity and physical inactivity. Sub-Saharan Africa, the Middle East and North Africa, South and Central America, the Western Pacific, and Southeast Asia are all experiencing rapid growth and rising prosperity.[1-6]

The IDF projects that over the next 20 years, low-middle-income countries (LMICs) will carry a heavy burden and have the largest potential rises in diabetes prevalence rates.[1-6] The majority of individuals (80%) with diabetes live in LMICs. In newly emerging nations, it is expected to become the most prevalent health concern.[1-6] Diabetes continues to be a prominent cause of morbidity and mortality in low, middle and high-income countries.[2-5]

Diabetes-related foot complications (DRFC) have the highest morbidity and mortality among all other complications.[2-5] Over 20 million people worldwide are believed to have DRFC, which is a prominent source of sickness and death. [2-4] Every year, an estimated two million people with DRFC require amputation, with less than half requiring hospitalisation due to infections or complications of peripheral artery disease.[3-5]

It is estimated that 40–60% of all lower limb non-traumatic amputations performed globally are due to diabetes.[2-5,7,8] Globally, the annual incidence of DRFC is between 2.5% and 5%, whereas the lifetime risk is estimated to be between 15% and 34%.[9,10]

The consequences of DRFC include substantial impairment, a lower quality of life, a shorter life expectancy, and high health-care costs.[1-8,11-13]

Every 20 seconds, a leg is amputated owing to diabetes, despite the fact that the majority of these, around 85%, could have been averted with relatively modest measures, backed by basic education on DRFC.[2-5, 7,14-22]

Five Pillars of Prevention of Diabetes Related Foot Complications

- Regular inspection and examination of feet
- Identification of the high risk foot
- Education of patients, family and health-care workers
- Appropriate footwear
- Treatment of non-ulcerative pathology

Education As A Preventative Strategy To Decrease Amputation Rates

It has long been established that preventive foot care, a multidisciplinary approach for foot ulcers, close monitoring of patients, and education of people with diabetes and health-care care professionals (HCPs) can lead to significant reductions in amputation rates, by up to 85%.[23,24] In particular, since the majority of diabetic foot ulcers in less developed settings seem to have neuropathy as an underlying risk factor, such ulcers are largely preventable or potentially curable.

Various studies have shown that simple education, care, motivation and action by patients with diabetes themselves are important in protecting the feet from complications.[17-28] The role of special diabetic foot clinics in reducing the incidence of foot problems has been shown by various clinical studies. It has been demonstrated in several studies globally that education given to patients with diabetes results in an unequivocal reduction of foot ulcers and amputations.[17-28]

This shows that the most important intervention for diabetic foot ulcers is preventive methods by educating individuals.[17-28] However, the primary obstacle still stands: which methods are most successful in lowering the prevalence of diabetic foot ulcers? Research in the prevention of diabetic foot disease is still sparse compared with the body of evidence for treatment. The most powerful preventive tool is education, and it should be a simple, repetitive and integral part of prevention programs.[20-22]

Foot education programs for people with diabetes usually include basic elements such as daily feet inspection for any changes (colour, temperature, swelling, discharge), avoidance of trauma (e.g., barefoot walking) and reporting immediately any new symptoms to their HCPs. It is important to educate patients regarding foot care, but educating the HCPs is as important. It is very important that HCPs should at least be able to perform a basic screening examination of feet that includes neurological examination, arterial, dermatological and musculoskeletal systems of the patient.[20-22,26]

Education, which is cost-effective, should be targeted at both patients and HCPs. A comprehensive foot care program should include education regarding DRFC, regular examination of feet, identification of high-risk feet, and educational programs for patients with diabetes and their HCPs. Several educational programs aimed at preventing DRFC have been carried out and executed successfully in both developed and less economically developed countries.[20-22,28]

One of these successful foot programs mentioned in this article and discussed as an illustrated example of foot care education among HCPs is the *Step-by-Step (SbS) Diabetic Foot Program,* which was piloted and carried out in Tanzania and India.[17-22] This program showed that infection, ulceration and limb amputation are potentially preventable through organised foot care programs and approaches that encompass comprehensive, preventive strategies, including patient and staff education, joint medical and surgical management of foot ulcers, appropriate use of microbiology resources, and regular follow-up. Importantly, the project was found to be associated with a more than 50% reduction in amputation rates.[17-20] Amputation rates of lower limbs in patients with diabetes can be reduced by 50% if the following recommendations are implemented: inspection of the feet and footwear regularly; high-risk feet (peripheral neuropathy and peripheral arterial disease) have to be diagnosed early; patients with

high-risk feet should be given preventive footwear and management of diabetic foot ulcers by implementation of a multidisciplinary approach; and patients with a high-risk foot, foot ulcer or past history of amputation must be followed up.

Key Message: Preventing Diabetic Foot Amputation

- Stratify people according to level of the risk, as not everybody with diabetes carries the same risk of ulceration / amputation in both feet
- Those at high risk need intensive education that involves practical demonstrations
- Patients at high risk require significant behavioural changes
- People need to learn to identify any problems that occur early
- Footwear is the most common cause of ulceration
- Problems should be identified early and treated promptly
- Health professionals need to be specially trained in caring for people with diabetic foot disease

Risk Stratification Education Aimed At Decreasing Amputation

To design interventions for the prevention of diabetic foot ulceration and amputation, and to ascertain patients' risks of developing foot ulcers, various epidemiologic studies have evaluated cohorts of patients with diabetes to identify and characterise risk factors associated with foot ulceration and lower limb amputation.

Educational programs may appear ineffective when applied in a standardised way to large, unselected populations. As yet, there is no hard scientific evidence that 'general education' of diabetes actually reduces the incidence of foot ulceration and lower limb amputation globally. By contrast, there is a growing body of evidence that structured, continuous education for individuals identified to be at risk of foot ulcerations reduces the incidence of foot ulcerations and lower limb amputation. Thus, it is more beneficial to patients when education is delivered according to the individual's risk classification for ulceration.

Generalised foot care education for all individuals with diabetes has questionable value: a person at relatively low risk may receive education that is irrelevant, while a person at high risk may receive education not intensive enough for preventing the condition. Identification of risk factors for foot ulceration is challenging and requires the conduct of epidemiologic studies that include all putative risk factors, including behaviour patterns associated with the pathogenesis of foot ulcers. Different people with diabetes require different levels of foot education.[17-20, 25] This is because there is a wide range of levels of foot risk (See Table 1). This needs to be taken into consideration when providing foot education programs.

No country in the world has the resources to provide comprehensive foot care to all people with diabetes. Therefore, a system has been developed for stratifying services based on levels of risk. This system is used widely around the world. We should stratify people with diabetes according to their level of risk – from low risk to very high risk.[17-20,25]

Category 0: *The people at low risk are those who have normal sensation in both feet and normal blood flow. These people need simple advice. They do not need to change their lifestyle, but it should be emphasised that they need an annual assessment of feet.*

Category 1: *Patients with a loss of sensation but good blood supply and no deformity in either foot or patients with no loss of sensation but peripheral arterial diseases and no deformity can be examined every six months and need intensive education to promote practical self-care skills and routine care.*

Category 2: *Those with diminished sensation, decreased blood flow and foot deformity should be examined at follow-up every three months, and they need intensive practical education that emphasises behaviour and lifestyle modification.*

Category 3: *Patients with previous history of ulcer or amputation should be examined at follow up every one to three months, and they need intensive education that emphasizes strategies to modify behaviour and lifestyle.*

Table 1: Diabetic foot risk categorization system for patients with diabetes

	No Ulcer ↓		General Information is enough ↓
Category	**Risk Profile**	**Follow up Frequency**	**Education Targeted**
0	No LPS / PAD (Loss of Protective Sensation / Peripheral Arterial Diseases)	Once a year	Basic care / no lifestyle changes
1	LPS OR PAD	Every six months	Intensive education to promote practical self-care skills, routine care
2	LPS + PAD + Deformity	Every three months	Intensive practical education that emphasizes strategies to modify behaviour and lifestyle
3	Previous Ulcer OR Amputation	Every one to three months	Intensive practical education that emphasizes strategies to modify behaviour and lifestyle
	Ulcer ↑		High risk foot needs Intensive foot education ↑

Risk stratification and screening of patients with diabetes should be carried out before a person with diabetes receives education on foot care. Individuals with diabetes should receive an education that corresponds to their individual level of risk.[18-28] Those with active foot problems, such as ulceration, ideally should be managed by a multidisciplinary team. Loss of protective sensation, care of the foot including nail and skin care, checking of the foot on a daily basis and selection of footwear are very important for the patients with high-risk feet. Importantly, patients' understanding of these issues and their ability to conduct proper self-evaluations and care should be assessed regularly. Patients with difficulties, physical or cognitive, that impair their ability to assess their own condition in order to take the necessary steps towards seeking or initiating the appropriate care will need special attention and assistance from their care providers.[18-28]

These practical approaches to stratify high-risk patients with diabetes can be applied globally in both developing and developed countries. This method can be practised by professionals dealing with this problem all over the world. Education is a powerful tool and can be used by everyone around the world. It all depends on what and how it is used and applied to reduce rates of amputations.

Who Should Be Targeted To Reduce Amputation And Prevent Foot Ulcers?

Ideally, all the HCPs who are dealing with people with diabetes become part of the prevention team and should be able to conduct simple screening of the neurological, arterial, dermatological and musculoskeletal systems to identify those at high risk. The *SbS Diabetic Foot Program* in Tanzania targeted district and regional centres in the country with limited resources, but who were already running diabetes clinics. HCPs at these centres were not well trained in foot management.[22-25] In addition to this, there were problems due to a lack of diabetic foot management, as well as podiatrists or trained persons in this field in Tanzania. This is common in many other countries globally, as there are no proper established training programs for training HCPs on how to identify high-risk

feet and manage diabetic foot ulcers effectively. However, in many parts of the world, HCPs are not trained to deliver simple but effective care for DRFC. To bridge this gap, the *Step by Step (SbS)* diabetic foot program was launched in 2003, aiming to educate HCPs in diabetic foot care.[20] This initiative later expanded to *Train the Foot Trainer (TtFT),* and recently *Train the Foot Healthcare Professional (TtFHCP).*[2]

The *Step-by-Step (SbS)* Diabetic Foot Program For Reducing Amputation rates

The aim of SbS program was to improve diabetes-related foot complications by training HCPs. The following objectives were set: creating more awareness of DRFC; providing sustainable training to HCPs in diabetic foot management; facilitating the transfer of information and expertise among HCPs and exporting ideas to other developing countries; reducing the risk of lower limb complications in people with diabetes; and empowering people with diabetes to care for their feet better, detect problems earlier and seek timely help when problems arise.[18-22]

The *SbS* diabetic foot program in Tanzania led to better management of patients with foot ulceration, resulting in an improved outcome among people with diabetic foot ulcers at local levels and fewer referrals to the secondary and tertiary referral care centre for amputation.[20] In Tanzania, the *SbS* diabetic foot program has enabled functioning foot clinics alone, or in combination with, diabetes clinics across the country. The program has also created awareness of diabetic foot complications among patients, relatives of patients, and nursing and medical personnel involved in diabetic foot care. It has also highlighted the importance of the development and training of staff and employing additional and more skilled personnel.[20]

To determine whether the *SbS* diabetic foot program was effective in diabetic foot ulcer patients' outcomes, we monitored temporal trends in rates of major amputation among people with foot ulcers in one of the centres that already had an established surveillance system for diabetic foot ulcers.[20] For this, we chose the diabetes clinic at Muhimbili National Hospital (MNH) in Dar es Salaam, Tanzania. It showed that a significant reduction in the number of amputations was noted at MNH after implementation of the *SbS* diabetic foot program, and this may be due to early observation and management of foot complications in trained centres.[20]

Several *Step by Step* Programs Conducted From 2003 to 2012

The success of the SbS training programs led to an increasing demand for the program to be rolled out in other countries, including other African countries, such as Congo, Guinea, Botswana, Malawi, Zimbabwe, Ethiopia, Mali, Nigeria, Egypt and South Africa; as well as outside Africa, in India, Pakistan, Dubai, Barbados, St. Lucia, Sint Marteen, St Lucia, St Kitts & Nevis, British Virgin Islands, Antigua, Grenada, Dominica, Trinidad and Tobago and other Caribbean islands.[17-20]

Implementation Of the *Train the Foot Healthcare Professional (TtFHCP)* Diabetic Foot Program

In 2023 the *TtFHCP* program was started by executive committee of D-Foot International. A core team from the D-Foot International 2023–2025 term created this initiative. The idea behind *TtFHCP* was that DRFC should be the responsibility of everybody who is involved in the care of patients with diabetes. Every HCPs who works in diabetes clinics should be able to manage and disseminate the knowledge of DRFC. Secondly, the demand for the *SbS* program to be implemented in other nations has grown as a result of the training program's success. It was unable to visit each and every country to conduct the *SbS* program. The idea came to call all the experts dealing in DRFC to bring them under one roof in each region and 'train' them so when they go back home, they can conduct *SbS* programs in their countries. The program's content was based on the *SbS* curriculum, with a particular emphasis on data collecting, fundraising, strategic planning, teaching, and installing the *SbS* programs. Over

the course of two to three days, the *TtHCPs* curriculum consists of a number of formal lectures, interactive workshops, live case presentations, group discussions, and demonstrations.

Aims/Objectives Of The *TtFHCP* Program

Aims

- To train local HCPs in DRFC within a global region to deliver effective, well-structured, sustainable training programs with demonstrable outcomes.

Objectives

- To organise and implement an S*b*S training program for their own country after attending a *TtFHCP* program.
- To identify barriers to implementation and find solutions for their needs.
- To train HCPs from their own communities to deliver S*b*S training programs.
- To evaluate the delivered program by collecting and disseminating outcomes of the program on a national, regional and international scale.
- To try to ensure that health ministers, health policy makers, patients and professional groups are involved and supportive.
- To determine ways in which teams developed by the S*b*S can be sustained, supported and, where possible, incorporated into health-care systems.

In order to attend the *TtFHCP* program as a delegate, a selection process exists with certain eligibility criteria This is to try to ensure post-program implementation is successful. This is vital as generally only two delegates can attend from each representing country, however, in some cases more delegates can attend if a country is large geographically. The selection criteria include evidence of active diabetes clinic(s), organisational skills and collaboration and support from patient organisations and the relevant ministry of health. The team should comprise a physician, a nurse and a surgeon with a willingness to work collaboratively as a team.[20] On a regular basis, the team should send reports of screening of patients and education sessions among HCPs and patients.

The *TtFHCP* core team recognised from the outset there was a fundamental need for a standardised and useful dataset and collection method for all participating delegates and countries. The original intention of this was to help individuals, centres and countries collect activity and outcome data, thus helping them develop their practice and lobby for continuing support.

Equally, the team needed to be able to identify the impact of the program and use this for further fundraising, program refinement and future developments. It was also hoped that there would be the potential to compare activity and outcome data from different regions. The program is intended to develop local, regional and national networks and study/working groups with sustainability of service and education development, as well as referral pathways. It is hoped that the delegates will be instrumental in driving and implementing policy decision making in their respective regions.

Finally, another key outcome is intended to be the provision of a support mechanism for local HCPs, encouraging the development of further training programs with a national faculty to meet local needs.

Regional *TtFHCP* Programs To Date

***Train the Foot Trainer* program from 2012 to 2020**

1st Train the Foot Trainer - South and Central America. 14 countries: Brazil, Argentina, Bolivia, Chile, Cuba, Colombia, Mexico, Panama, Paraguay, Peru, Uruguay, Ecuador, Venezuela, Guatamala.

2nd *Train the Foot Trainer* – Caribbean. 20 countries: Barbados, St. Lucia, Sint Marteen, St Kitts & Nevis, St. Thomas, British Virgin Islands, Bermuda, Haiti, Jamaica, Belize, Curacao, Antigua & Barbuda, Grenada, Dominica, Trinidad and Tobago, Guatemala, Cayman Islands.

3rd *Train the Foot Trainer* – Europe. 17 countries: Albania, Armenia, Bosnia-Herzegovina, Bulgaria, Croatia, Estonia, Greece, Kosovo, Latvia, Lithuania, Poland, Romania, Serbia, Slovenia, Sweden, Turkey, Ukraine.

4th *Train the Foot Trainer* - Western Pacific. 13 countries: Australia, China, Japan, South Korea, Singapore, Malaysia, Cambodia, Indonesia, Philippines, Taiwan, Thailand, Vietnam, Mongolia.

5th *Train the Foot Trainer* – French Speaking Countries. 13 countries.

6th *Train the Foot Trainer* – MENA Region (Middle East and North Africa). 14 countries.

***Train the Foot Healthcare Professional* Programs From 2023 to 2025**

TtFHCP was conducted in six World Health Organization (WHO) regions, namely Sub-Saharan Africa, Europe, Middle East and North Africa, the South and Central America), South East Asia and the Western Pacific. We will evaluate the cascading effect of education in prevention of ulcer leading to amputation and mortality.

7th *Train the Foot HCP*s - Southeast Asia. 4 Countries: India, Bangladesh, Nepal, Siri Lanka.

8th *TtFHCP* 2023-25 - Southern and Central America. 8 Countries; Argentina, Brazil, Chile, Columbia, Honduras, Ecuador, Panama, Peru.

9th *TtFHCP* 2023-25 - Western Pacific Region. 14 Countries: Malaysia, Myanmar, Taiwan, Thailand, Vietnam, Mongolia, Australia, Cambodia, Indonesia, Philippines, South Korea, Singapore.

10th *TtFHCP* 2023-25 – Europe. 10 Countries: North Macedonia, Slovenia, Croatia, Serbia, Romania, Kosovo, Czech Republic Montenegro, Poland.

11th *TtFHCP* 2023-25 – Africa. 11 Countries: Tanzania, Kenya, Uganda, Rwanda, Ethiopia, Nigeria, Ghana, Zambia, Zimbabwe, Libya, Tunisia.

12th *TtFHCP* 2023-25 – Middle East and North Africa. 5 Countries: Pakistan, Iran, Lebanon, Syria, Sudan.

All the feedback from these regions and countries are recorded and data is collected regarding screening and training of other HCPs in their countries.

The Future

The work has so far managed to cover six regions (Sub-Saharan Africa, South and Central America, Western Pacific, Southeast Asia, Middle East and North Africa and Europe) of the seven world regions and there is a desire to cover the seventh, as well as expand coverage in each region. In addition, further implementation programs and training modalities are being developed together with a supportive networking structure for all participants.

Conclusion:

Education still remains the most effective preventative strategy and should stand as a fundamental component of all diabetic foot care preventative program. It should be straightforward, repeated, and aimed at both patients and HCPs.

The *SbS* diabetic foot program is a unique educational program started in low-income countries in 2003 in Dar es Salaam, Tanzania, then spreading to middle-income countries, and later higher-income countries. It has already touched 128 countries providing education on preventing amputation globally. While it may not be possible to completely prevent foot ulcers; early intervention can effectively stop minor foot ulcers from progressing to serious complications including infection, sepsis, osteomyelitis, or gangrene.

Patients with diabetes need to be taught the value of taking good care of their feet and the necessity of seeing a doctor as soon as possible if they experience any foot-related symptoms. Ultimately, the ability of HCPs to instil the self-help and motivation necessary for people with diabetes well-being will determine success.

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Ethical approval and consent to participate

This article did not require ethical approval. No patient identifiable information is included.

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