A Conceptual Amputation Prevention Protocol For Diabetes-Related Foot Disease In South Africa: Insights From A Regional Public Hospital

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Abstract: Diabetes-related foot disease (DFD) remains one of the most common causes of non-traumatic lower-limb amputations worldwide, with the most significant impact in low- and middle-income countries (LMICs). In South Africa, rising diabetes rates, coupled with strained health systems, hinder early detection, coordinated care and limb preservation. Although global research confirms that many diabetes-related amputations can be prevented, public health-care settings continue to experience high rates of avoidable limb loss. This article presents a conceptual Amputation Prevention Protocol (APP), developed from practical experience in a public regional hospital in Gauteng Province, South Africa and informed by global and LMIC-specific literature reviews. Rather than prescribing a rigid clinical pathway, the APP serves as a flexible decision-making and coordination tool to address key systemic issues, including the late detection of peripheral artery disease (PAD), fragmented referral processes and delayed involvement of multidisciplinary teams. This manuscript outlines the APP's rationale, core components and intended use. It promotes early risk screening, accessible vascular assessments, podiatry-led coordination and team-based care, all tailored to resource-limited settings.

Key words: *diabetic foot disease, peripheral artery disease, amputation prevention, limb preservation, South Africa, regional hospital, low- and middle-income countries, public-sector podiatry*

How to cite: Njokweni M. A conceptual amputation prevention protocol for diabetes-related foot disease in South Africa: insights from a regional public hospital. Limb Preservation Journal. 2026;7(1): 64-69
DOI: 10.56885/040931vlppwo

Diabetes mellitus (DM) has become one of the most significant public health concerns of the 21st century. According to the International Diabetes Federation (IDF), approximately 589 million adults worldwide will have diabetes in 2024, accounting for 11.1% of the global adult population. This number is projected to rise sharply, reaching 853 million by 2050.[1] Notably, over 80% of individuals with diabetes reside in low- and middle-income countries (LMICs), where health-care systems often struggle with staff shortages, limited diagnostic tools and poorly coordinated referral systems.[1,2]

Among the many complications of diabetes, diabetes-related foot disease (DFD) is particularly severe. The lifetime risk of developing a diabetic foot ulcer (DFU) is estimated to be up to 34%, and diabetes is responsible for 40–60% of all non-traumatic lower-limb amputations globally.[3-5] Alarmingly, five-year survival rates after major lower-limb amputation are similar to, or worse than, those for some cancers.[6] Beyond the risk of death, amputation leads to serious consequences, including physical disability, emotional distress, caregiving demands and high financial costs for both families and the health-care system.

Encouragingly, a significant proportion of amputations can be prevented through timely intervention. Studies have shown that up to 85% of diabetes-related amputations are avoidable

with timely risk assessment, proper foot care and coordinated, team-based management.[7-9] Despite the availability of international guidelines and growing awareness of effective practices, unnecessary amputations remain common, particularly in public health systems and LMIC settings. This ongoing gap highlights the need to move beyond merely sharing clinical guidelines and instead focus on building health-care system frameworks that promote timely, equitable and well-integrated care.

Global, Regional And South African Burden Of Diabetes-Related Foot Disease

Worldwide, diabetes-related foot disease (DFD) significantly adds to the burden of disease, contributing to disability, health-care costs and lost productivity. In high-income countries, advances in foot care and vascular interventions have reduced amputation rates. However, these improvements have not reached many LMICs, where challenges such as late presentation, limited access to specialised care and inconsistent screening practices remain widespread.[7,10]

South Africa reflects many of these issues. The national prevalence of diabetes has risen steadily, primarily due to population ageing, increasing urbanization and persistent social inequalities. In the public health sector, patients often present to hospitals with advanced foot ulcers, complicated by infection or reduced blood flow. These delays are frequently the result of late referrals from primary care, limited access to vascular testing and poor coordination across different areas of the health-care system, all of which increase the likelihood of amputation.

Peripheral Artery Disease And Diagnostic Blind Spots In Diabetes

Peripheral artery disease (PAD) plays a crucial role in determining the outcomes of diabetes-related foot disease. Among individuals with diabetes, PAD affects approximately 20% to 40% of individuals and the risk increases with age, longer duration of diabetes and the presence of other health conditions.[11] When PAD occurs alongside nerve damage (neuropathy), it severely affects the body's ability to heal wounds and dramatically increases the risk of infection and major amputation.

The ankle-brachial pressure index (ABPI) is a standard, inexpensive and easy-to-use tool for detecting PAD. However, in individuals with diabetes, arterial calcification can make the arteries stiff and difficult to compress, often producing falsely normal or elevated ABPI readings.[12,13] This can lead to missed diagnoses of serious blood flow problems and delays in receiving appropriate care.

To improve detection, other tests, such as toe systolic pressure and the toe-brachial index (TBI), offer greater sensitivity in identifying reduced blood flow in the feet. These recommendations align with international clinical guidelines.[14,15] Unfortunately, access to these additional tools is limited in many public-sector facilities and they are not routinely used. As a result, essential signs of poor circulation may be overlooked, creating serious diagnostic challenges.

Table 1: Global, Low- And Middle-Income Countries (LMICs) And South African Burden Of Diabetes-Related Foot Disease

Indicator	Global	LMICs	South Africa (Public Sector)
Adults living with diabetes	589 million (2024)	>80% of global burden	Rising prevalence
Lifetime DFU risk	Up to 34%	Higher due to late presentation	High
Diabetes-related amputations	40–60% of non-traumatic	Disproportionately high	High
Preventable amputations	Up to 85%	Under-realised	Under-realised
Post-amputation mortality	50–70% at 5 years	Often higher	High

Sources: IDF [1], Armstrong et al.[4], Abbas ZG et al.

Limitations Of PAD Diagnostic Technologies In Resource-Constrained Settings

Systematic reviews demonstrate that while automated ankle-brachial index devices improve the feasibility and scalability of vascular screening in primary care and low-resource environments, their diagnostic sensitivity is reduced in patients with diabetes and medial arterial calcification when compared with Doppler-derived measurements and toe pressure assessment.[20,21] This highlights the need to interpret test results within a broader clinical context rather than rely on a single measurement to guide care.

In many low- and middle-income countries, the problem extends beyond access to the right technology. Even the most advanced diagnostic tools must be integrated into a well-coordinated system that ensures timely referrals, collaborative team reviews and early intervention. Without these system-level supports, even the best diagnostic devices are unlikely to significantly reduce amputation rates.

Rationale For A Coordinated Amputation Prevention Approach

There is strong global guidance on preventing and managing diabetes-related foot disease, with the International Working Group on Diabetic Foot (IWGDF) being a leading voice in setting standards. However, these guidelines are not consistently applied, particularly in public health systems and LMICs.[14,17] Common challenges include shortages of trained staff, limited access to education and upskilling, poor communication among health professionals and a lack of coordination models tailored to the local context.

Research shows that coordinated, team-based care is far more effective in preventing amputations than isolated clinical actions. Multidisciplinary foot care programs that integrate screening, diagnosis, treatment and follow-up have repeatedly demonstrated better outcomes.[7,18] For example, the 'Step-by-Step' program has led to significant reductions in amputation rates when applied within structured care pathways in LMICs.[9]

These insights highlight the urgent need for a unifying coordination framework that can streamline screening, vascular assessment, referrals and care escalation, while also being flexible enough to function in resource-limited environments.

The Amputation Prevention Protocol: A Conceptual Coordination Framework

The Amputation Prevention Protocol (APP) was introduced as a flexible, high-level framework to improve diabetic foot care in regional public hospitals. Rather than acting as a strict clinical guideline or prescribing diagnostic thresholds and treatments, the APP focuses on how care is structured, coordinated and escalated within the health-care system.

Its purpose is to address the gaps in communication, referral and early risk detection, which often contribute to avoidable limb loss. It is not meant to replace existing best practices but to strengthen how those practices are implemented in real-world, resource-limited settings.

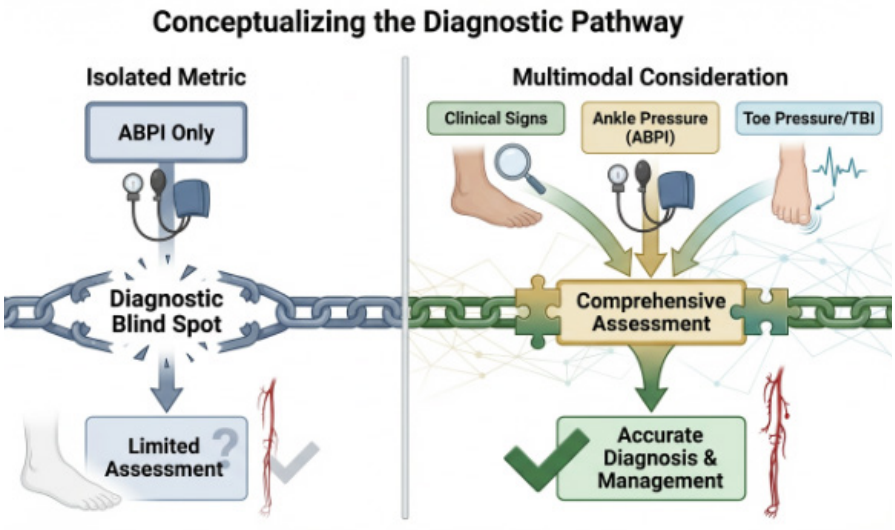

Figure 1: Conceptual Illustration of PAD Diagnostic Blind Spots in Diabetes

Key Components Of The APP Framework

Key components of the APP Framework include:

1. ***Early Risk Identification:*** Routine and structured foot screenings, including checks for peripheral artery disease (PAD), are prioritised to detect problems early.
2. ***Appropriate Vascular Assessment:*** PAD screening is built into the protocol, with the recognition that ABPI alone may not be reliable in patients with diabetes. A broader approach to vascular evaluation is therefore encouraged.
3. ***Podiatry-led Coordination***: Podiatrists play a central role in triaging patients, monitoring progress and facilitating communication across care teams.
4. ***Multidisciplinary Collaboration***: The APP promotes teamwork among nurses, primary care providers, vascular specialists, surgeons and rehabilitation professionals.
5. ***Continuous Learning and Quality Improvement:*** Regular feedback loops and audits are built to track outcomes and guide ongoing improvements in care delivery.

Scope And Intended Use Of The APP

The Amputation Prevention Protocol is shared solely as a conceptual framework. It aims to guide service planning, inform training efforts and support the phased implementation strategies. It is not a clinical practice guideline, diagnostic tool or operational protocol.

Specific thresholds, detailed procedures and implementation materials were omitted. These elements will be developed through future academic work and system-level evaluations to ensure the protocol remains evidence-based and context-appropriate.

Clinical Insight From A South African Regional Hospital

The experience at Leratong Regional Hospital in Gauteng Province, part of South Africa's public health-care system, underscores the tangible repercussions of inadequate coordination and postponed vascular evaluation in the management of diabetic foot conditions. Patients presenting with diabetic foot ulcers (DFUs) frequently arrive at advanced disease stages, thereby exemplifying systemic barriers such as insufficient screening programs, delayed health-care access and ineffective referral mechanisms.

In one illustrative case, a patient with diabetes presented with foot ulcers. An initial ankle-brachial pressure index test suggested adequate blood flow to the limb. However, a follow-up toe pressure assessment revealed significant ischaemia that had been missed. By the time the correct diagnosis was made, opportunities for earlier intervention had passed, and the tissue damage had progressed.

This case occurred before the development of the APP and became a key learning moment, prompting a reevaluation of how vascular assessments are coordinated in diabetic foot care settings.

Table 2: System Gaps And Conceptual APP Responses

Identified System Gap	Conceptual APP Response
Late PAD recognition	Prompted vascular consideration
Fragmented referrals	Coordinated MDT communication
Reactive care models	Early risk identification
Resource limitations	Scalable, low-cost focus

Figure 2: Conceptual Amputation Prevention Protocol Coordination Framework

Broader Impacts: Caregiver Burden And System Costs

The impact of major lower-limb amputation extends well beyond the physical loss of a limb. Research shows that it imposes a significant emotional and practical burden on caregivers, reduces patients' quality of life and creates lasting financial strain for individuals and families.[17] These challenges are even more severe in LMICs where access to rehabilitation services, prosthetics and social support is often limited or unavailable.

From the perspective of the health system, preventable amputations place a heavy burden on already stretched resources. They often require extended hospital stays, multiple surgical procedures and long-term care and support. This makes early prevention and coordinated care not only a medical priority, but also a necessary strategy for maintaining sustainable health-care systems.

Policy Alignment And Health-System Relevance

The Amputation Prevention Protocol closely aligns with the goals outlined in *South Africa's National Department of Health Strategic Plan for 2025–2030*. This national plan prioritizes improvements in primary health care, more efficient referral systems and the reduction of preventable illnesses and disabilities.[18]

By promoting early risk detection, timely vascular assessment and improved coordination across care levels, the APP supports key national objectives, particularly in the management of non-communicable diseases. It also contributes to broader efforts to build a more resilient and responsive public health system in the country.

Conclusion And Call To Action

When a diabetes-related amputation occurs that could have been prevented, it reflects not just a clinical shortcoming, but also a failure of the health system. Despite overwhelming evidence that many of these amputations are avoidable, public health-care systems, especially in low- and middle-income countries, still struggle with poor coordination, late diagnosis of PAD and fragmented care pathways.

Rather than adding complexity, the Amputation Prevention Protocol offers a structured yet flexible approach that prioritizes timely coordination, early risk detection and system-wide collaboration. This study lays the groundwork for improving diabetic foot care at every level of the health-care system.

Health professionals, policymakers, researchers and system leaders are encouraged to prioritize coordination science as a key component of limb preservation strategies. Strengthening podiatry-led care models, ensuring that vascular assessments are routinely included in diabetic foot care and rigorously evaluating system-wide interventions can help reduce the rate of preventable amputations.

Looking ahead, research should focus on how coordination frameworks, such as the APP, can be implemented in phases and evaluated in real-world settings. These efforts are essential to developing sustainable, context-sensitive solutions that work in both resource-limited and mainstream health-care settings.

Statement of Originality: This manuscript introduces a novel conceptual framework developed by the author, drawing on direct experience in public-sector clinical settings, academic research, and relevant global literature. The Amputation Prevention Protocol (APP) has not been previously published or implemented as a clinical pathway in the literature. All elements presented here are original and intended to stimulate academic dialogue and guide future evaluations.

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