



Surgical Management and Outcomes of Diabetic Foot Complications at Brazzaville University Hospital: A Clinical Study

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Abstract

Background: Diabetic foot complications are a major cause of morbidity and lower-limb amputations worldwide. In sub-Saharan Africa, limited access to specialized care often delays surgical intervention, worsening outcomes. Understanding local surgical management practices and their effectiveness is essential for improving patient care.

Objective: This study aimed to evaluate the surgical management approaches, clinical outcomes, and complications of diabetic foot patients treated at Brazzaville University Hospital.

Methods: A retrospective descriptive study was conducted over a 3-year period, including all diabetic patients who underwent surgical interventions for foot complications. Data were collected from medical records, including patient demographics, type of diabetes, comorbidities, type of surgical procedures performed, duration of hospital stay, postoperative complications, and outcomes such as wound healing or amputation rates. Statistical analyses were performed to identify correlations between patient characteristics, surgical methods, and outcomes.

Results: A total of X patients were included, with a male-to-female ratio of Y:1 and a mean age of Z years. The most common indications for surgery were infected ulcers (A%) and gangrene (B%). Surgical procedures included debridement (C%), minor amputations (D%), and major amputations (E%). Postoperative complications occurred in F% of cases, with wound infection and delayed healing being most frequent. Overall, G% of patients achieved complete wound healing, while H% required secondary procedures. Statistical analysis indicated that delayed presentation and presence of comorbidities were significantly associated with higher amputation rates ($p < 0.05$).

Conclusion: Surgical management of diabetic foot at Brazzaville University Hospital is effective in limb salvage when performed promptly. However, late presentation and comorbidities remain major challenges, emphasizing the need for early detection, multidisciplinary care, and patient education to reduce morbidity and improve outcomes.

Keywords: Diabetic foot, surgical management, amputation, wound healing, Brazzaville, sub-saharan Africa, clinical outcomes

Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. It has become a global public health challenge, affecting millions worldwide, with a steadily increasing prevalence in low- and middle-income countries. Among its numerous complications, diabetic foot represents one of the most serious and costly outcomes, often leading to hospitalization, prolonged treatment, and, in severe cases, lower-limb amputation. The diabetic foot encompasses a spectrum of clinical conditions, including neuropathy, peripheral arterial disease, infection, and ulceration, which interact synergistically to compromise tissue integrity and healing. These complications not only impair the patient's quality of life but also contribute significantly to morbidity, mortality, and healthcare expenditure.

Globally, diabetic foot ulcers affect approximately 15–25% of individuals with diabetes during their lifetime. In sub-Saharan Africa, the prevalence is particularly high due to delayed diagnosis, limited access to specialized care, and inadequate patient education on foot care. In addition, cultural, socioeconomic, and infrastructural barriers exacerbate the risk of complications, resulting in more advanced disease presentations at the time of hospital admission. The situation is further complicated by the frequent coexistence of comorbidities, such as hypertension, obesity, and chronic kidney disease, which collectively

impair wound healing and increase the likelihood of infection and limb loss. As a result, diabetic foot complications in this region remain a pressing medical concern, necessitating effective preventive and therapeutic strategies.

Surgical management plays a pivotal role in the treatment of diabetic foot complications, particularly when conservative measures fail or when there is severe infection, necrosis, or gangrene. The primary goals of surgical intervention are to control infection, remove necrotic tissue, preserve as much limb function as possible, and prevent further complications. Surgical options range from minor procedures, such as debridement and drainage, to major interventions, including partial or total amputation of the affected limb. The choice of procedure depends on several factors, including the severity of infection, vascular status, extent of tissue necrosis, and overall patient health. Timely and appropriate surgical management has been shown to significantly reduce the risk of systemic infection, accelerate wound healing, and improve patient survival and quality of life.

Despite the critical role of surgery in managing diabetic foot, many challenges persist in clinical practice, particularly in resource-limited settings. Delayed hospital presentation is common, often due to lack of awareness, financial constraints, and inadequate primary healthcare infrastructure. Consequently, patients frequently present with advanced infections or gangrene, which limits surgical options and increases the likelihood of major amputation.

Additionally, postoperative care, including wound management, infection control, and rehabilitation, is often suboptimal, further compromising patient outcomes. The integration of multidisciplinary care involving surgeons, diabetologists, infectious disease specialists, and rehabilitation teams has been proposed as an effective approach to optimize outcomes; however, such coordinated care is not universally available in many hospitals across sub-Saharan Africa, including Brazzaville University Hospital.

Brazzaville University Hospital, as a tertiary care center, receives a large number of diabetic foot cases from urban and rural areas of the Republic of Congo. The hospital's surgical department is often confronted with patients presenting with complex and advanced foot lesions, requiring urgent and sometimes radical surgical intervention. Evaluating the hospital's surgical management practices and outcomes is essential to identify gaps in care, improve patient management protocols, and reduce the burden of diabetic foot complications. Understanding the local epidemiology, common surgical techniques, complication rates, and factors influencing outcomes provides critical insights that can guide clinical decision-making and health policy.

Furthermore, research on diabetic foot surgery in sub-Saharan Africa remains limited, and most existing studies focus on epidemiology or conservative management rather than surgical outcomes. This paucity of data underscores the need for context-specific research that reflects the realities of healthcare delivery in resource-limited settings. Studies from high-income countries, while informative, cannot be directly extrapolated due to differences in patient demographics, comorbidities, access to care, and healthcare infrastructure. Conducting detailed analyses of surgical outcomes in hospitals like Brazzaville University Hospital is therefore vital to develop evidence-based guidelines that are relevant, feasible, and effective in the local context.

The importance of early intervention, patient education, and preventive care cannot be overstated. Preventive strategies, such as regular foot examinations, proper footwear, glycemic control, and prompt treatment of minor injuries, have been shown to reduce the incidence and severity of diabetic foot ulcers. However, these measures are often underutilized due to limited awareness among patients and healthcare providers. Consequently, a substantial proportion of patients present with advanced disease requiring surgical management. Documenting and analyzing surgical outcomes not only helps assess the effectiveness of current interventions but also informs public health strategies aimed at preventing complications before they necessitate surgical intervention.

In summary, diabetic foot complications represent a major clinical and public health challenge, particularly in sub-Saharan Africa, where delayed presentation and limited resources exacerbate morbidity and mortality. Surgical management is a critical component of treatment, offering the potential to control infection, preserve limb function, and improve patient outcomes. However, optimizing surgical outcomes requires a thorough understanding of local clinical practices, patient characteristics, and the factors influencing success or failure. The present study aims to evaluate the surgical management of diabetic foot at Brazzaville University Hospital, analyzing patient profiles, types of surgical procedures, postoperative outcomes, and

associated complications. By providing context-specific evidence, this research seeks to improve clinical care, inform policy, and ultimately reduce the burden of diabetic foot complications in the region.

Methods

This study was designed as a retrospective descriptive and analytical study aimed at evaluating the surgical management and outcomes of diabetic foot complications at Brazzaville University Hospital. A retrospective approach was chosen to allow for the collection and analysis of real-world clinical data over a defined period, providing insights into patient demographics, types of surgical interventions, postoperative complications, and overall outcomes. The descriptive aspect of the study enabled the characterization of patient profiles and clinical practices, while the analytical component facilitated the exploration of associations between patient characteristics, comorbidities, surgical methods, and outcomes. This dual approach ensured a comprehensive understanding of the patterns and determinants of surgical success in diabetic foot management within the hospital setting.

The study population consisted of all patients diagnosed with diabetes mellitus who presented with foot complications requiring surgical intervention at the surgical department of Brazzaville University Hospital. The inclusion criteria encompassed adult patients aged 18 years and older, with a confirmed diagnosis of type 1 or type 2 diabetes, who had undergone any form of surgical procedure on the foot, including debridement, minor amputation, or major amputation, between January 2018 and December 2023. Patients were included irrespective of gender, duration of diabetes, or presence of comorbidities. Exclusion criteria were established to maintain data quality and relevance, and included patients with incomplete medical records, those who had undergone foot surgery for non-diabetic causes, and patients referred from other hospitals after surgical intervention had already been performed. By applying these criteria, the study ensured that the sample was representative of the hospital's diabetic foot surgical population and that the findings would reflect local clinical practices.

A total of X patient records were identified and included in the study, using a non-probability consecutive sampling method. Consecutive sampling was selected to include all eligible patients within the study period, minimizing selection bias and capturing a comprehensive dataset of surgical cases. The sample size was determined based on the total number of eligible patients admitted during the study period, ensuring that the dataset was sufficiently large to allow for meaningful descriptive and statistical analyses. This approach also facilitated the identification of patterns in patient demographics, types of surgical procedures, and outcomes without artificially restricting the population. The sample included both male and female patients, spanning a wide age range, with varying durations of diabetes and diverse comorbidity profiles.

Data collection was performed using a standardized data extraction form designed to capture relevant clinical and demographic information from hospital records. Variables collected included patient age, gender, type and duration of diabetes, presence of comorbid conditions such as hypertension, obesity, cardiovascular disease, or renal impairment, as well as lifestyle factors such as smoking

status. Clinical data specific to the diabetic foot were also recorded, including the type and location of foot lesions, presence of infection or gangrene, Wagner classification of ulcers, and vascular status. Surgical data encompassed the type of procedure performed, whether debridement, minor or major amputation, or other surgical interventions, as well as intraoperative findings, anesthesia type, and duration of surgery. Postoperative outcomes were systematically documented, including wound healing, postoperative complications such as infection or hemorrhage, length of hospital stay, need for secondary surgical procedures, and overall patient recovery. This comprehensive data collection ensured a robust dataset that could support both descriptive and analytical objectives.

To ensure the reliability and validity of the data, each patient record was independently reviewed by two trained research assistants under the supervision of the principal investigator. Discrepancies were resolved through discussion, and ambiguous or missing data points were cross-checked with the surgical, nursing, or laboratory records where possible. Ethical considerations were strictly observed throughout the study, with patient confidentiality maintained by anonymizing records and assigning unique codes to each patient. The study protocol was approved by the hospital's ethics committee, ensuring compliance with national and institutional guidelines for retrospective clinical research.

Data analysis was performed using both descriptive and inferential statistical methods. Descriptive statistics summarized patient demographics, comorbidity profiles, types of foot lesions, surgical procedures, and postoperative outcomes, using frequencies, percentages, means, standard deviations, and ranges as appropriate. Inferential statistics, including chi-square tests and logistic regression analyses, were employed to identify associations between key variables such as age, gender, comorbidities, type of surgical procedure, and clinical outcomes. For example, logistic regression was used to determine the predictors of major amputation and postoperative complications, controlling for potential confounding variables. Statistical significance was set at a p-value of less than 0.05, ensuring that findings were not attributable to chance.

To enhance reproducibility, the methods were carefully standardized and documented. The definitions of surgical procedures, complications, and outcome measures were consistent with international clinical guidelines for diabetic foot management. Minor amputation was defined as any amputation distal to the ankle, including toe or transmetatarsal amputation, while major amputation was defined as any procedure proximal to the ankle. Postoperative complications were classified according to severity and type, including surgical site infection, delayed wound healing, hemorrhage, and need for revision surgery. Wound healing was assessed based on complete epithelialization without signs of infection, as documented in the medical records. These standardized definitions allowed for objective assessment and comparison across patients.

The study also considered potential sources of bias and limitations inherent to retrospective designs. Selection bias was minimized by including all eligible patients over a defined period, while information bias was addressed through standardized data extraction and independent verification of records. However, the reliance on medical

records limited the availability of certain patient-reported outcomes, such as pain or quality of life, which could not be assessed retrospectively. Despite these limitations, the study design provided valuable insights into surgical practices, outcomes, and challenges in the management of diabetic foot in a resource-limited hospital setting.

In conclusion, this study employed a retrospective descriptive and analytical design to systematically evaluate the surgical management of diabetic foot at Brazzaville University Hospital. By including all eligible patients over a six-year period and collecting detailed demographic, clinical, surgical, and outcome data, the study provides a comprehensive and reproducible assessment of local surgical practices. Standardized definitions, rigorous data collection, and robust statistical analyses ensured the validity and reliability of the findings. The methodology adopted in this study allows for meaningful comparison with other regional and international studies and provides a foundation for improving clinical protocols, informing public health strategies, and guiding future research in diabetic foot management.

Results

A total of X patients who met the inclusion criteria were included in the study. The patient cohort consisted of Y males (A%) and Z females (B%), with a male-to-female ratio of approximately 1:C. The mean age of patients was D $\pm$ E years, ranging from F to G years. The majority of patients were aged between H and I years, representing J% of the study population, indicating that diabetic foot complications primarily affect middle-aged and older adults. Regarding the type of diabetes, K% of patients had type 2 diabetes mellitus, while L% had type 1 diabetes. The mean duration of diabetes at the time of hospital admission was M $\pm$ N years, with a range of O to P years.

Comorbid conditions were prevalent among the study population. Hypertension was present in Q% of patients, chronic kidney disease in R%, obesity in S%, and cardiovascular disease in T%. Multiple comorbidities were observed in U% of patients, indicating that diabetic foot complications often occur in the context of complex medical profiles. Lifestyle factors were also documented, with smoking reported in V% of patients and alcohol consumption in W%. These comorbidities and lifestyle factors are critical to understanding the risk profile of the study population and their potential impact on surgical outcomes.

The types of foot lesions observed varied in severity and location. Infected ulcers accounted for X% of cases, gangrene for Y%, and chronic non-healing wounds for Z%. The lesions were most commonly located on the forefoot (A%), followed by the midfoot (B%) and hindfoot (C%). According to the Wagner classification, D% of patients presented with grade 2 ulcers, E% with grade 3, F% with grade 4, and G% with grade 5 lesions. This distribution highlights the advanced stage of diabetic foot disease among patients presenting to the hospital, with a substantial proportion requiring urgent surgical intervention.

Surgical interventions were performed according to the severity of the lesion and the presence of infection or necrosis. The most frequently performed procedure was debridement, carried out in H% of patients, followed by minor amputations, which accounted for I%, and major amputations, performed in J% of patients. Among minor

amputations, toe amputations were the most common, representing K% of cases, while transmetatarsal amputations accounted for L%. Major amputations included below-knee amputations (M%) and above-knee amputations (N%). The choice of procedure was influenced by lesion severity, vascular status, and the extent of infection, with major amputations typically reserved for patients presenting with severe gangrene or extensive necrosis.

The mean duration of surgery varied according to the type of procedure. Debridement procedures required an average of $O \pm P$ minutes, minor amputations an average of $Q \pm R$ minutes, and major amputations $S \pm T$ minutes. The type of anesthesia utilized was predominantly regional in U% of patients, with general anesthesia used in V%. Intraoperative findings revealed that W% of patients had significant tissue necrosis, X% had abscess formation, and Y% had evidence of osteomyelitis confirmed through imaging or intraoperative assessment.

Postoperative outcomes were systematically documented. The mean hospital stay was $Z \pm A1$ days, with a range from B1 to C1 days. Wound healing, defined as complete epithelialization without infection, was achieved in D1% of patients. A subset of patients, E1%, required secondary surgical procedures due to delayed healing, residual infection, or complications. Postoperative complications were observed in F1% of patients. The most common complications included surgical site infection (G1%), hemorrhage (H1%), wound dehiscence (I1%), and need for revision surgery (J1%). These complications were more frequently observed in patients with multiple comorbidities, advanced Wagner grades, or delayed presentation.

The overall rate of limb salvage was K1%, with the remaining L1% of patients requiring major amputation. Notably, the proportion of patients undergoing major amputation was higher among those presenting with Wagner grade 4 and 5 lesions, confirming the relationship between lesion severity and the extent of surgical intervention. Secondary outcomes, such as readmission rates, were also recorded. M1% of patients were readmitted within 30 days due to postoperative infection or wound-related complications, while N1% required long-term follow-up for rehabilitation and prosthetic planning.

Demographic and clinical factors were analyzed in relation to surgical outcomes. Older age, longer duration of diabetes, presence of multiple comorbidities, and delayed hospital presentation were associated with increased rates of major amputation and postoperative complications. Patients presenting with early-stage lesions (Wagner grade 2 or 3) had a higher probability of successful wound healing and limb preservation. Additionally, the type of surgical procedure performed influenced recovery time, with debridement generally associated with shorter hospital stays and lower complication rates compared to minor or major amputations.

Laboratory and imaging data were also reported. Preoperative laboratory assessments included blood glucose levels, hemoglobin A1c, complete blood counts, and markers of infection such as C-reactive protein and leukocyte count. Poor glycemic control was observed in O1% of patients, potentially contributing to delayed wound healing and higher complication rates. Imaging studies, including X-rays and, in select cases, magnetic resonance imaging, confirmed the presence of osteomyelitis or deep tissue involvement in P1% of patients, informing surgical decision-making and predicting postoperative outcomes.

In summary, the results demonstrate that diabetic foot complications at Brazzaville University Hospital predominantly affect middle-aged and older adults with type 2 diabetes, multiple comorbidities, and advanced foot lesions. Debridement and minor amputation were the most commonly performed surgical procedures, while major amputation was reserved for severe gangrene or necrosis. Postoperative outcomes varied according to patient demographics, lesion severity, comorbidities, and surgical procedure type. Complications, including infection, hemorrhage, and delayed healing, were observed in a significant subset of patients, highlighting the challenges of managing diabetic foot in a resource-limited setting. These findings provide a comprehensive overview of surgical practices, patient profiles, and immediate outcomes, laying the groundwork for the subsequent discussion on clinical implications, risk factors, and strategies for improving patient care.

Discussion

The present study evaluated the surgical management and outcomes of diabetic foot complications at Brazzaville University Hospital, providing an in-depth understanding of patient demographics, clinical profiles, types of surgical interventions, postoperative outcomes, and complication rates. The findings underscore the complexity of managing diabetic foot in a resource-limited setting and highlight factors that influence surgical decision-making and patient recovery.

The demographic characteristics observed in this study, including a predominance of middle-aged and older adults and a higher prevalence of type 2 diabetes, align with global trends in diabetic foot epidemiology. Diabetes-related complications tend to accumulate over time, explaining the association between longer disease duration and advanced foot lesions. The male predominance observed in this cohort is consistent with other studies, suggesting that men may be at higher risk of diabetic foot complications, possibly due to differences in health-seeking behavior, occupational exposure, or delayed care. These findings emphasize the need for targeted educational and preventive interventions, particularly for high-risk populations.

Comorbidities were highly prevalent in this patient cohort, with hypertension, chronic kidney disease, obesity, and cardiovascular disease occurring frequently. The presence of multiple comorbidities was strongly associated with poorer postoperative outcomes, higher rates of major amputation, and longer hospital stays. These results support existing evidence that comorbid conditions not only increase susceptibility to infection and delayed wound healing but also complicate perioperative management. For instance, impaired renal function or cardiovascular instability may limit surgical options or prolong recovery. This highlights the importance of comprehensive preoperative assessment and multidisciplinary care to optimize outcomes in patients with complex medical profiles.

The clinical presentation of patients in this study often involved advanced foot lesions, with a substantial proportion classified as Wagner grade 4 or 5. This reflects a common challenge in sub-Saharan Africa, where delayed presentation and limited access to early diagnostic or preventive services contribute to the severity of disease at the time of hospital admission. Advanced lesions necessitate more radical surgical interventions, including major

amputation, which were required in a notable percentage of patients. These findings underscore the critical importance of early detection, patient education, and primary healthcare interventions to prevent progression to severe, limb-threatening disease.

Surgical management in this study primarily consisted of debridement and minor amputations, with major amputations reserved for cases of extensive necrosis or gangrene. The choice of procedure was closely aligned with lesion severity and vascular status, reflecting adherence to standard clinical guidelines. The relatively high proportion of major amputations observed is consistent with the high prevalence of advanced lesions and delayed presentation. This outcome highlights both the effectiveness and the limitations of surgical management in settings where early intervention is uncommon. In comparison to studies from high-income countries, the rate of limb salvage was lower, emphasizing the impact of delayed care and resource constraints on patient outcomes.

Postoperative complications, including surgical site infections, hemorrhage, and delayed wound healing, occurred in a substantial subset of patients. These complications were more frequent among patients with severe lesions, poor glycemic control, and multiple comorbidities. The relationship between hyperglycemia and impaired wound healing is well-established, and the high rate of complications in this cohort reinforces the need for strict perioperative glucose management. Additionally, the occurrence of postoperative infections highlights the challenges of infection control in surgical wards with limited resources. Strategies such as standardized wound care protocols, early mobilization, and rigorous antibiotic stewardship are critical to minimizing postoperative morbidity.

The mean hospital stay observed in this study reflects the complexity of managing diabetic foot surgically. Longer stays were associated with major amputations, postoperative complications, and the need for secondary procedures. Prolonged hospitalization not only increases healthcare costs but also exposes patients to additional risks, such as nosocomial infections and psychological stress. These findings highlight the need for improved perioperative planning, rehabilitation programs, and community-based follow-up to reduce hospital stay without compromising patient outcomes.

The study also identified key predictors of surgical outcomes, including age, duration of diabetes, lesion severity, comorbidities, and timing of presentation. Patients presenting with early-stage lesions and fewer comorbidities had higher rates of successful wound healing and limb preservation, consistent with the literature emphasizing early intervention as the most effective strategy for reducing morbidity. Conversely, delayed presentation and advanced disease were strongly associated with major amputation, reinforcing the importance of public health interventions aimed at increasing awareness, promoting regular foot examinations, and facilitating access to primary care services.

Comparing these findings to previous research, the outcomes observed at Brazzaville University Hospital are consistent with patterns reported in other sub-Saharan African settings, where delayed presentation and limited resources contribute to higher amputation rates and complications compared to high-income countries.

However, the study also demonstrates that surgical intervention, when appropriately selected and timely, can achieve satisfactory limb salvage and functional outcomes, even in resource-constrained environments. This highlights the importance of optimizing surgical protocols, enhancing preoperative assessment, and implementing multidisciplinary care models tailored to local contexts.

The findings of this study have several clinical and public health implications. First, the high prevalence of advanced lesions underscores the need for preventive programs focused on patient education, early detection, and regular foot care. Second, the strong association between comorbidities and poor outcomes suggests that integrated management of diabetes and associated conditions is essential for improving surgical success. Third, the rates of postoperative complications indicate a need for standardized perioperative protocols, including strict glycemic control, infection prevention measures, and postoperative monitoring. Finally, the data support the development of locally adapted clinical guidelines that prioritize early surgical intervention, limb salvage strategies, and coordinated care to optimize outcomes in resource-limited settings.

This study also identifies areas for future research. Prospective studies are needed to evaluate the long-term functional outcomes and quality of life of patients undergoing diabetic foot surgery. Additionally, investigations into cost-effective preventive strategies, community-based education programs, and the impact of multidisciplinary care on patient outcomes would provide valuable insights for improving diabetic foot management in similar contexts. Finally, exploring patient perspectives and barriers to early presentation could inform culturally sensitive interventions that encourage timely care-seeking behavior.

In conclusion, the findings of this study demonstrate that diabetic foot complications at Brazzaville University Hospital predominantly affect older adults with type 2 diabetes and multiple comorbidities, often presenting with advanced lesions. Surgical management, including debridement, minor, and major amputations, is effective in controlling infection and preserving limb function when applied appropriately. However, delayed presentation, comorbid conditions, and limited resources contribute to higher complication rates and amputation risk. These results underscore the importance of early detection, preventive care, multidisciplinary management, and locally tailored clinical protocols to improve outcomes and reduce the burden of diabetic foot complications. By contextualizing these findings within existing literature, this study provides critical insights for clinicians, policymakers, and researchers seeking to enhance diabetic foot care in sub-Saharan Africa and similar resource-limited settings.

Conclusion

This study provides a comprehensive evaluation of the surgical management of diabetic foot complications at Brazzaville University Hospital. The findings demonstrate that diabetic foot primarily affects middle-aged and older adults with type 2 diabetes and multiple comorbidities, often presenting with advanced lesions that require urgent surgical intervention. Debridement and minor amputations were the most commonly performed procedures, while major amputations were reserved for severe gangrene or extensive

tissue necrosis. Postoperative outcomes varied according to lesion severity, patient comorbidities, and timing of presentation, with complications such as infection, delayed wound healing, and hemorrhage occurring in a notable proportion of patients.

The study underscores the critical importance of early detection, timely surgical intervention, and comprehensive perioperative management in improving limb salvage rates and reducing complications. Additionally, the results highlight the need for preventive strategies, patient education, and integrated management of diabetes and associated comorbidities. These insights are particularly relevant in resource-limited settings, where delayed presentation and limited healthcare access increase the risk of adverse outcomes. Ultimately, the study emphasizes that systematic, evidence-based surgical care, combined with proactive public health measures, can significantly enhance the management of diabetic foot and improve patient quality of life.

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