Interventional Radiology for Diabetic Foot Disease: Imaging-Guided Therapies, Nursing Pathways, and Health Informatics for Safer Care

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Abstract

Diabetic foot disease represents a major cause of morbidity, limb loss, and healthcare burden among individuals with diabetes, particularly when compounded by peripheral arterial disease and chronic limb-threatening ischemia. Interventional radiology has become a cornerstone in limb salvage through minimally invasive, imaging-guided endovascular therapies. However, optimal clinical outcomes depend not only on technical success but also on coordinated nursing care and effective use of health informatics to enhance patient safety.

This integrative review examines the role of interventional radiology in diabetic foot disease through a multidisciplinary framework that incorporates imaging-guided therapies, structured nursing pathways, and health informatics–supported care. A structured literature review of peer-reviewed studies published between 2010 and 2024 was conducted across major biomedical databases, focusing on endovascular interventions, nursing roles across procedural phases, and informatics applications relevant to safety and continuity of care, in alignment with international vascular and diabetic foot management guidelines (Hingorani et al., 2016; Conte et al., 2019).

The findings indicate that imaging-guided endovascular interventions, including percutaneous transluminal angioplasty and adjunctive technologies, are associated with improved limb salvage and wound healing when appropriately planned using advanced imaging modalities. Structured nursing pathways significantly contribute to risk mitigation through pre-procedural assessment, intra-procedural monitoring, and post-procedural surveillance and education. Health informatics systems, including electronic health records and imaging informatics, facilitate interdisciplinary communication, clinical decision support, and longitudinal outcome tracking, thereby reducing preventable complications. Synthesized clinical case studies further demonstrate how integration of these domains enhances safety and patient-centered outcomes.

In conclusion, interventional radiology achieves its greatest impact in diabetic foot disease when embedded within standardized nursing pathways and supported by robust health informatics infrastructure. This integrated, safety-oriented model offers a scalable approach to improving limb preservation and quality of care in high-risk diabetic populations.

Introduction

Diabetic foot disease (DFD) represents one of the most severe and costly complications of diabetes mellitus, contributing substantially to morbidity, lower-limb amputations, prolonged hospital stays, and increased healthcare expenditures worldwide. It is estimated that up to 25% of individuals with diabetes

will develop a diabetic foot ulcer during their lifetime, with peripheral arterial disease (PAD) and infection being the principal drivers of poor outcomes and limb loss (Armstrong et al., 2017; Hingorani et al., 2016). Despite advances in glycemic control and wound care, delayed diagnosis of ischemia and fragmented care pathways continue to compromise patient safety and treatment effectiveness.

Interventional radiology (IR) has emerged as a cornerstone in the contemporary management of diabetic foot disease, particularly in patients with critical limb-threatening ischemia (CLTI). Imaging-guided endovascular therapies—such as percutaneous transluminal angioplasty, drug-coated balloons, stent placement, and atherectomy—enable limb salvage by restoring distal perfusion with lower procedural risk compared to open surgical revascularization (Conte et al., 2019). High-resolution imaging modalities, including digital subtraction angiography (DSA), duplex ultrasound, computed tomography angiography (CTA), and magnetic resonance angiography (MRA), play a pivotal role in lesion characterization, procedural planning, and post-intervention assessment, thereby directly influencing clinical decision-making and patient outcomes (Mustapha et al., 2020).

However, successful interventional radiology outcomes in diabetic foot disease extend beyond technical procedural success. Nursing pathways are critical in ensuring patient safety across the continuum of care, encompassing pre-procedural assessment, peri-procedural monitoring, contrast-induced nephropathy prevention, access-site management, pain control, infection surveillance, and patient education. Specialized nursing care has been shown to reduce procedure-related complications, improve adherence to follow-up protocols, and enhance patient-centered outcomes, particularly in high-risk diabetic populations (Hennessey et al., 2021; Smilowitz et al., 2018). Despite this, nursing roles in IR-led diabetic foot management are often underreported or insufficiently integrated into formal care models.

Health informatics further strengthens the safety and effectiveness of interventional radiology–based care for diabetic foot disease by enabling structured documentation, clinical decision support, and interdisciplinary communication. Electronic health records (EHRs), imaging informatics systems (PACS), and data-driven risk stratification tools facilitate early identification of ischemic risk, optimization of contrast use, monitoring of renal function, and longitudinal tracking of limb outcomes (Bashshur et al., 2020). Informatics-driven integration of radiology, nursing, vascular medicine, and wound care data is increasingly recognized as essential for reducing preventable adverse events and ensuring continuity of care in complex diabetic foot cases.

Despite the growing body of literature on endovascular interventions for diabetic foot disease, gaps remain in the integrated examination of imaging-guided therapies alongside structured nursing pathways and health informatics frameworks. Most existing studies focus predominantly on procedural efficacy or vascular outcomes, with limited attention to interdisciplinary safety models that align technological innovation with nursing practice and digital health systems. Addressing this gap is crucial, particularly in healthcare settings managing increasing diabetes prevalence and striving to implement safer, value-based, and patient-centered care models.

Accordingly, this article examines interventional radiology for diabetic foot disease through a multidisciplinary lens, highlighting imaging-guided therapeutic strategies, nursing pathways across the care continuum, and the role of health informatics in enhancing patient safety and clinical outcomes. By synthesizing evidence from radiology, nursing, and informatics literature, this review aims to support the development of integrated, safer care pathways for patients with diabetic foot disease.

Objectives

This article aims to provide an integrated, multidisciplinary examination of interventional radiology in the management of diabetic foot disease, with a specific focus on patient safety and coordinated care. The primary objectives are to:

Examine the role of imaging-guided interventional radiology techniques in improving perfusion, limb salvage, and clinical outcomes in patients with diabetic foot disease and chronic limb-threatening ischemia, as supported by contemporary vascular and radiology literature (Conte et al., 2019; Mustapha et al., 2020).

Analyze structured nursing pathways across the pre-procedural, intra-procedural, and post-procedural phases of interventional radiology care, highlighting their contribution to complication prevention, patient education, and continuity of care in high-risk diabetic populations (Hennessey et al., 2021; Smilowitz et al., 2018).

Explore the role of health informatics—including electronic health records, imaging informatics, and clinical decision support systems—in enhancing risk stratification, interdisciplinary communication, and safety monitoring throughout the diabetic foot care continuum (Bashshur et al., 2020; Topol, 2019). Identify gaps in the existing literature regarding the integration of interventional radiology, nursing practice, and health informatics, and propose evidence-informed recommendations to support safer, more coordinated care models for patients with diabetic foot disease.

Methodology
This article adopts an integrative narrative review methodology, which allows for the synthesis of evidence from diverse study designs and disciplinary perspectives, including interventional radiology, nursing science, vascular medicine, and health informatics. This approach is particularly suitable for complex clinical conditions such as diabetic foot disease, where patient outcomes depend on the interaction of technical procedures, clinical workflows, and digital health systems rather than isolated interventions (Whittemore & Knafl, 2005).

A structured literature search was conducted across major biomedical and health sciences databases, including PubMed, Scopus, Web of Science, and CINAHL. The search strategy combined controlled vocabulary and free-text terms related to diabetic foot disease, interventional radiology, endovascular therapy, nursing care, patient safety, and health informatics. Boolean operators were used to refine results and ensure comprehensive coverage of multidisciplinary evidence (Page et al., 2021).

The review prioritized peer-reviewed articles published between 2010 and 2024 to reflect contemporary clinical practice and technological advancements. Eligible sources included clinical trials, observational studies, practice guidelines, systematic reviews, and high-quality narrative reviews. Grey literature, editorials, and non-peer-reviewed reports were excluded to maintain methodological rigor and reliability of evidence.

Study selection focused on publications that explicitly addressed one or more of the following domains: imaging-guided interventions for diabetic foot disease, nursing roles and pathways in interventional radiology or vascular care, and the application of health informatics to enhance safety and clinical decision-making. Articles were screened based on relevance to patient safety, interdisciplinary integration, and applicability to real-world clinical settings.

Data extraction emphasized key variables relevant to this review's objectives, including imaging modality, type of interventional procedure, nursing responsibilities across care phases, informatics tools utilized, reported outcomes, and safety-related findings. Rather than performing a meta-analysis, findings were synthesized thematically to allow comparison across disciplines and identification of converging evidence, practice gaps, and emerging trends.

The results are presented through thematic synthesis supported by summary tables, enabling structured comparison of interventional strategies, nursing pathways, and informatics applications. This methodological approach aligns with integrative review standards and supports the development of practical, safety-oriented recommendations for multidisciplinary diabetic foot care (ICMJE, 2023).

Results and Discussion
The reviewed literature demonstrates that interventional radiology plays a central role in the contemporary management of diabetic foot disease, particularly in patients with peripheral arterial disease and chronic limb-threatening ischemia. Across studies, imaging-guided endovascular therapies consistently show favorable outcomes in limb salvage, wound healing acceleration, and reduction of major amputations when compared with conservative management alone.

Imaging-Guided Interventional Therapies
Evidence indicates that digital subtraction angiography remains the reference standard for procedural planning and real-time guidance during endovascular interventions in diabetic foot disease. DSA enables precise visualization of infrapopliteal and pedal vessel anatomy, which is especially critical in diabetic patients who frequently present with diffuse, calcified, and multilevel arterial lesions. Studies report that detailed angiographic mapping allows tailored revascularization strategies targeting angiosome-specific perfusion, resulting in improved ulcer healing rates and tissue viability (Conte et al., 2019; Mustapha et al., 2020).

Percutaneous transluminal angioplasty emerges as the most frequently utilized intervention, with reported technical success rates exceeding 80% in many cohorts. The use of drug-coated balloons has been associated with reduced restenosis rates and prolonged vessel patency, particularly in below-the-knee interventions. While stent placement is generally reserved for flow-limiting dissections or recoil, selected studies demonstrate acceptable safety profiles when stents are used judiciously in diabetic populations with complex vascular anatomy.

Advanced imaging modalities such as computed tomography angiography and magnetic resonance angiography are increasingly employed during pre-procedural assessment. CTA provides high spatial resolution and rapid evaluation of vascular calcification, aiding procedural feasibility assessment, whereas MRA offers contrast-sparing alternatives for patients at high risk of contrast-induced nephropathy. The literature highlights that appropriate modality selection contributes directly to procedural safety and optimization of interventional outcomes.

Nursing Pathways in Interventional Radiology Care

Findings across nursing and radiology literature emphasize that structured nursing pathways are integral to safe interventional radiology care for diabetic foot disease. Pre-procedural nursing assessments frequently include evaluation of renal function, glycemic control, infection status, anticoagulation therapy, and vascular access suitability. Studies consistently report that proactive nursing-led screening reduces peri-procedural complications such as contrast nephropathy, bleeding, and access-site infections (Hennessey et al., 2021).

During the intra-procedural phase, nursing roles extend to hemodynamic monitoring, pain management, sterile field maintenance, and early recognition of adverse events. Evidence suggests that trained interventional radiology nurses contribute significantly to procedural efficiency and patient stability, particularly in prolonged infrapopliteal interventions common among diabetic patients.

Post-procedural nursing care is repeatedly identified as a determinant of successful outcomes. Effective access-site surveillance, wound monitoring, patient education on limb protection, and coordination of follow-up appointments are associated with lower readmission rates and improved adherence to multidisciplinary care plans. Several studies highlight that nursing-led discharge education improves patient understanding of warning signs, medication adherence, and the importance of ongoing wound and vascular surveillance.

Role of Health Informatics in Enhancing Safety

The results also demonstrate a growing reliance on health informatics to support safer interventional radiology workflows in diabetic foot management. Integrated electronic health records enable real-time access to laboratory values, imaging reports, medication histories, and nursing assessments, facilitating informed decision-making before and after interventions. Clinical decision support tools embedded within EHR systems have been shown to assist in identifying patients at elevated risk for contrast nephropathy or procedural complications, prompting preventive measures such as hydration protocols or alternative imaging strategies (Bashshur et al., 2020).

Picture archiving and communication systems play a critical role in longitudinal outcome assessment, allowing comparison of pre- and post-intervention imaging and supporting multidisciplinary case discussions. Studies further report that informatics-driven data integration enhances communication between interventional radiologists, nurses, vascular surgeons, and wound care teams, reducing fragmentation of care and minimizing preventable safety events.

Collectively, the results indicate that optimal outcomes in diabetic foot disease are achieved not through isolated technical interventions, but through the integration of imaging-guided therapies, structured nursing pathways, and informatics-supported clinical workflows. These elements function synergistically to improve procedural safety, continuity of care, and patient-centered outcomes.

The findings of this integrative review underscore that interventional radiology has evolved from a purely technical specialty into a central component of multidisciplinary diabetic foot care. Imaging-guided endovascular therapies demonstrate consistent benefits in limb salvage and wound healing; however, the literature clearly indicates that procedural success alone is insufficient to ensure optimal patient outcomes. Instead, safety and effectiveness are strongly influenced by coordinated nursing pathways and informatics-enabled care integration.

From a radiological perspective, the emphasis on angiosome-directed revascularization reflects a paradigm shift toward precision-based interventions in diabetic foot disease. Studies consistently suggest that tailoring revascularization strategies to wound location improves tissue perfusion and healing rates. Nevertheless, diabetic vascular pathology—characterized by diffuse distal disease and heavy calcification—continues to challenge procedural durability. This highlights the importance of careful patient selection and pre-procedural imaging assessment, where CTA and MRA complement DSA in reducing procedural risk, particularly among patients with renal impairment.

Nursing pathways emerge as a critical safety mechanism across all phases of interventional radiology care. Pre-procedural nursing assessments play a preventive role by identifying modifiable risk factors such as uncontrolled hyperglycemia, infection, or nephrotoxic exposure. The literature suggests that when nursing protocols are standardized and integrated into IR workflows, complication rates related to access sites, contrast use, and post-procedural infections are significantly reduced. Importantly, post-intervention nursing surveillance and patient education appear to be decisive in preventing re-ulceration, delayed healing, and avoidable readmissions—outcomes that are frequently overlooked in procedure-centered studies.

Health informatics acts as the connective infrastructure linking imaging, nursing, and clinical decision-making. The reviewed evidence indicates that electronic health records and imaging informatics systems enhance situational awareness and continuity of care, particularly in complex diabetic foot cases requiring repeated interventions and long-term follow-up. Decision support tools embedded within EHRs contribute to safer contrast administration, early detection of renal deterioration, and adherence to evidence-based protocols. However, the literature also reveals variability in informatics maturity across institutions, suggesting that benefits are contingent upon system interoperability, data quality, and staff training.

Despite these strengths, several gaps persist in the existing body of evidence. Most studies prioritize vascular or technical outcomes, with limited reporting on nursing-sensitive indicators or informatics-driven safety metrics. Additionally, few investigations adopt a truly integrated framework that evaluates interventional radiology, nursing care, and digital health systems as interdependent components of a unified care pathway. This fragmentation restricts the generalizability of findings and limits the translation of evidence into comprehensive safety-oriented models.

Future research should therefore move beyond siloed evaluations and adopt interdisciplinary study designs that incorporate clinical, nursing, and informatics outcomes simultaneously. Prospective studies examining standardized nursing pathways supported by informatics-driven monitoring within interventional radiology units may provide more robust evidence on safety optimization and cost-effectiveness in diabetic foot management.

Clinical Case Studies

The inclusion of real-world clinical cases provides practical insight into how imaging-guided interventional radiology, structured nursing pathways, and health informatics interact to enhance safety and outcomes in diabetic foot disease. The following cases are synthesized from patterns consistently reported in the literature and reflect typical multidisciplinary care scenarios.

Case 1: Limb Salvage Through Angiosome-Directed Endovascular Intervention

A 62-year-old male with long-standing type 2 diabetes mellitus and poorly controlled glycemia presented with a non-healing plantar ulcer and signs of critical limb-threatening ischemia. Duplex ultrasound and computed tomography angiography revealed multilevel infrapopliteal arterial disease with severe tibial artery stenosis. Digital subtraction angiography was performed to guide angiosome-directed percutaneous transluminal angioplasty targeting the artery supplying the ulcerated region.

Pre-procedural nursing assessment identified mild renal impairment, prompting hydration protocols and contrast minimization strategies. During the procedure, continuous nursing-led hemodynamic monitoring enabled early detection of transient hypotension, which was promptly managed without procedural interruption. Post-intervention, the patient was enrolled in a nursing-led wound care and education pathway, with close follow-up coordinated through the electronic health record.

Within 12 weeks, significant wound healing was observed, and no major complications occurred. This case illustrates how imaging precision combined with nursing vigilance and informatics-supported

follow-up contributes to limb preservation and patient safety, as supported by contemporary vascular and IR evidence (Conte et al., 2019; Mustapha et al., 2020).

Case 2: Prevention of Contrast-Induced Nephropathy Through Informatics-Supported Nursing Care

A 70-year-old female with diabetes, hypertension, and stage 3 chronic kidney disease was referred for endovascular revascularization due to ischemic diabetic foot ulcers. Pre-procedural evaluation utilized integrated EHR alerts that flagged elevated nephropathy risk based on recent laboratory values.

Nursing staff implemented evidence-based renal protection protocols, including tailored hydration, avoidance of nephrotoxic medications, and selection of low-contrast imaging strategies. Magnetic resonance angiography was used for pre-procedural planning, followed by contrast-sparing DSA during angioplasty.

Post-procedural nursing monitoring documented stable renal function, with no rise in serum creatinine during hospitalization or follow-up. Informatics-enabled alerts facilitated coordinated communication between interventional radiology, nephrology, and wound care teams. This case highlights the role of health informatics and nursing pathways in mitigating procedure-related risks in vulnerable diabetic patients (Bashshur et al., 2020).

Case 3: Nursing-Led Surveillance and Early Complication Detection After IR Intervention

A 58-year-old patient with diabetic foot infection and peripheral arterial disease underwent infrapopliteal angioplasty following angiographic confirmation of critical stenosis. Although the procedure was technically successful, post-procedural nursing surveillance identified early signs of access-site hematoma and localized infection risk.

Prompt nursing intervention, including pressure management, sterile dressing reinforcement, and early antimicrobial coordination, prevented progression to severe complications. Follow-up documentation through PACS and EHR systems supported multidisciplinary review and timely wound reassessment. The patient achieved ulcer stabilization without readmission or further intervention.

This case underscores the importance of nursing-sensitive indicators and post-procedural surveillance in safeguarding outcomes beyond the angiography suite (Hennessey et al., 2021; Smilowitz et al., 2018)

Conclusion

This review demonstrates that the management of diabetic foot disease extends beyond isolated technical success in revascularization and requires an integrated, safety-oriented care model. The presented clinical cases reinforce the evidence that imaging-guided interventional radiology achieves optimal outcomes when combined with structured nursing pathways and informatics-supported clinical decision-making. Together, these elements form a cohesive framework that enhances limb salvage, minimizes procedural risks, and improves continuity of care for high-risk diabetic patients.

Interventional radiology offers precise, minimally invasive solutions for complex vascular pathology in diabetic foot disease; however, its full potential is realized only through proactive nursing involvement across the pre-, intra-, and post-procedural phases. Nursing-led assessments, surveillance, and patient education emerge as decisive factors in preventing complications, ensuring adherence to follow-up, and supporting long-term wound healing, as illustrated in the clinical scenarios.

Health informatics further strengthens this integrated approach by enabling real-time data access, risk stratification, and interdisciplinary communication. The effective use of electronic health records, imaging systems, and decision support tools facilitates safer contrast use, early detection of complications, and coordinated long-term management. The convergence of these domains supports a shift toward patient-centered, value-based care in diabetic foot management.

In conclusion, embedding interventional radiology within standardized nursing pathways and robust informatics infrastructures represents a scalable and evidence-informed strategy for improving safety and outcomes in diabetic foot disease. Future clinical practice and research should prioritize interdisciplinary integration, nursing-sensitive outcome measurement, and digital health optimization to further advance limb preservation and patient safety.

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