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Article Review

Early Detection and Risk Stratification of Diabetic Peripheral Neuropathy in Adults with Type 2 Diabetes: An Evidence-Informed Narrative Review with Implications for Nursing Practice

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Abstract

Diabetic peripheral neuropathy (DPN) is a frequent and potentially underrecognized complication of type 2 diabetes mellitus (T2DM). Early detection matters because sensory dysfunction may precede recognizable symptoms, whereas loss of protective sensation increases the risk of foot injury and ulceration. This evidence-informed narrative review integrates current clinical guidance with representative observational, diagnostic, longitudinal, and evidence-synthesis studies to examine risk stratification and practical screening strategies for adults with T2DM, with particular attention to nursing practice. Evidence supports assessment at T2DM diagnosis and at least annually thereafter, combining symptom history with small-fiber and large-fiber sensory tests and evaluation of protective sensation. Although the 10-g monofilament is useful for identifying feet at ulcer risk, it should not be treated as a stand-alone rule-out test for early neuropathy. Findings on individual test accuracy vary with reference standards, thresholds, and populations. Established risk indicators include diabetes duration, glycemic exposure, and coexisting vascular or microvascular disease; prediction algorithms and corneal confocal microscopy show promise but require careful external validation and consideration of resources. A feasible nursing pathway is proposed that links structured history-taking, multimodal bedside examination, foot-risk classification, education, documentation, and timely referral. The most important research priorities are prospective validation of integrated screening pathways, implementation in primary care, and measurement of patient-important outcomes rather than diagnostic accuracy alone.

INTRODUCTION

Diabetic neuropathies encompass a heterogeneous group of nerve disorders, of which distal symmetric polyneuropathy is the commonest presentation. In adults with type 2 diabetes mellitus (T2DM), peripheral sensory symptoms can include burning, tingling, altered temperature perception, and numbness; however, clinically

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meaningful nerve damage may also occur without pain or subjective complaints. Progressive loss of protective sensation (LOPS) may allow minor trauma to go unnoticed and contribute to diabetic foot ulceration. Neuropathy is therefore simultaneously a neurological disorder, a patient-safety concern, and a target for prevention-oriented chronic disease care.[1,2]

The 2025 American Diabetes Association (ADA) recommendations emphasize DPN assessment from the time of T2DM diagnosis and at least annually thereafter, using clinical history, assessment of small-fiber function (temperature or pinprick), large-fiber function (vibration with a 128-Hz tuning fork), and annual 10-g monofilament testing to identify feet at risk of ulceration. Neuropathy is also a diagnosis of exclusion; alternative or additional causes of peripheral nerve dysfunction should be considered when clinically indicated.[3]

The principal clinical challenge is to distinguish early nerve dysfunction from established LOPS and to link each finding to an appropriate action. Diagnostic tests, prediction models, and foot-ulcer risk classification address related but different questions. An umbrella review identified variable performance across bedside screening modalities; newer prediction and imaging approaches may add information but have not established a universally applicable workflow.[4,5] For nurses involved in diabetes follow-up, the practical questions are which symptoms to elicit, which modalities to combine, which feet require more intensive surveillance, and when to refer.

This review therefore aims to (1) summarize clinically relevant risk indicators for DPN in adults with T2DM, (2) critically compare available screening and early detection approaches, and (3) propose a pragmatic evidence-informed approach to nursing assessment and follow-up. Unlike a systematic review, it does not estimate pooled diagnostic accuracy or claim exhaustive study identification.

METHOD

Review Approach

This evidence-informed narrative review drew on a targeted literature search conducted in October 2026. Cited publications were restricted to those published on or before December 31, 2025. PubMed-indexed literature and major clinical guidance sources were searched using combinations of “diabetic peripheral neuropathy”, “type 2 diabetes”, “screening”, “monofilament”, “vibration perception”, “Ipswich touch test”, “corneal confocal microscopy”, “early detection”, and “risk prediction”. The synthesis prioritized relevant guidance, evidence syntheses, and observational, diagnostic, and longitudinal studies published mainly from 2019 to 2025, while retaining selected older foundational statements. Studies were considered descriptively in relation to design, applicability, and the risk of overinterpretation. This purposive approach was not an exhaustive, protocol-driven search; no PRISMA flow diagram, quantitative meta-analysis, or formal certainty-of-evidence rating is claimed.

Diagnostic accuracy, between-examiner reliability, prediction of incident DPN, and prediction of foot ulceration are distinct outcomes and are interpreted separately here. Evidence involving both type 1 and type 2 diabetes is identified where relevant; results from highly selected inpatient cohorts are not assumed to apply to community or primary-care populations.

Clinical Features And Risk Stratification

Recognizing different stages of neuropathy

Patients may experience positive sensory symptoms (burning pain, paresthesia, electric-shock sensations) or negative symptoms (reduced sensation and

numbness). Small-fiber dysfunction may occur before abnormalities are apparent on tests focused on large myelinated fibers. Conversely, established LOPS is particularly important for preventing unrecognized injury. Clinicians should not equate absence of pain with absence of neuropathy, nor interpret a normal monofilament result as excluding early small-fiber disease.[1,3]

Clinical risk indicators

Age, duration of diabetes, glycemic exposure, adiposity, smoking, dyslipidemia, hypertension, and coexisting microvascular disease are recurring correlates or predictors in epidemiological and risk-model literature; the strength and independence of association differ across populations. Liu X et al.[6] developed and externally evaluated a risk score informed by 18 cohorts comprising 95,604 people with T2DM, identifying age, smoking, BMI, diabetes duration, HbA1c, dyslipidemia, and diabetic microvascular and cardiovascular complications as candidate predictors. This study supports structured risk recognition, but risk-score performance should not be conflated with clinical screening test performance.

Evidence also indicates that neuropathy may already be present when T2DM is first diagnosed. Jadhao et al.[7] reported that, among 350 newly diagnosed patients, 34% met a combined symptom/disability score definition of DPN, although prevalence differed by method, underscoring the importance of test definition and case mix. Findings from one outpatient population should not be generalized as a universal prevalence estimate.

Recent machine-learning studies illustrate the attraction and limitations of multivariable prediction. Liu L et al.[8] evaluated algorithms using 3,343 hospitalized people with T2DM and reported high discrimination for DPN; however, the unusually high case prevalence in that inpatient dataset limits transportability to unselected community settings. External validation, calibration, clinical usefulness, and potential inequities should be examined before bedside implementation.

Screening Modalities And Their Clinical Roles

Symptom assessment and bedside sensory testing

A structured history should record onset, distribution, nocturnal exacerbation, burning, tingling, numbness, gait instability, previous ulceration or amputation, and relevant comorbidities and exposures. Bedside testing should address different sensory domains. Pinprick or temperature testing evaluates small-fiber-related sensation, whereas vibration testing with a 128-Hz tuning fork is used for large-fiber function; ankle reflexes and other findings may add context. The 10-g monofilament is especially valuable for detecting LOPS and assessing ulcer risk. ADA guidance advises monofilament or an equivalent protective-sensation test alongside at least one other neurological assessment.[3]

These tests answer related but different clinical questions: detection of neuropathy, detection of advanced sensory loss, prediction of incident DPN, and prediction of ulcer risk. Diagnostic accuracy estimates cannot be compared directly without accounting for reference standards. In an umbrella review encompassing seven systematic reviews with 19,531 participants, Mogilevskaya et al.[4] found wide ranges of monofilament sensitivity and specificity and heterogeneity across methods and thresholds. In a small 2025 cross-sectional diagnostic study of 39 adults with diabetes, Selvaraj et al.[9] found that biothesiometry at a study-derived threshold was more sensitive than monofilament or a symptom score against nerve conduction studies; the limited sample and limb-level analysis make these

estimates unsuitable for broad generalization.

Ipswich touch test and measurement reliability

The Ipswich touch test offers a low-equipment approach to LOPS screening and may be useful when monofilament supplies are unavailable. A Thai observational study evaluated its accuracy and reliability compared with 10-g monofilament among people attending annual diabetes foot checks.[10] Nevertheless, equivalence to objective confirmation of early small-fiber neuropathy should not be assumed. A systematic review of chairside screening reliability found acceptable inter-rater reliability for a four-site monofilament protocol, while reproducibility evidence for several other bedside methods remained limited.[11] Consistent training and standardized technique are thus essential for nursing-led screening.

Complementary testing and diagnostic performance

Different bedside tests address complementary aspects of neuropathy, but reported diagnostic gains depend on the population, threshold, and reference standard. Bönhof et al.[12] evaluated age-adjusted vibration thresholds using a graded 64-Hz Rydel-Seiffer tuning fork in a cohort including people with type 1 and type 2 diabetes. For confirmed distal symmetric sensorimotor polyneuropathy, their threshold approach yielded 73.5% sensitivity and 85.4% specificity; adding a pinprick test increased sensitivity to 83.4% while lowering specificity to 80.3%. These findings illustrate the value of assessing different sensory domains, but a graded 64-Hz instrument should not be confused with the 128-Hz tuning fork recommended for routine bedside vibration assessment in ADA guidance. The much smaller study by Selvaraj et al.[9] found that biothesiometry had higher sensitivity than monofilament against nerve conduction studies, though estimates and optimal thresholds require confirmation in larger, independent populations. These cross-sectional diagnostic results do not prove that combining tests improves future DPN prediction or prevents foot ulcers.

Emerging specialized methods

Corneal confocal microscopy (CCM) assesses corneal small-fiber morphology noninvasively and is under investigation as a marker of early nerve injury. Perkins et al.[13] studied 261 participants with type 1 or type 2 diabetes without baseline DPN who completed at least four years of follow-up, providing longitudinal evidence that baseline corneal nerve measures may help predict incident neuropathy. In a T2DM-specific longitudinal analysis, sustained corneal nerve loss was associated with later DPN and symptom progression.[14] These technologies are promising for selected specialist settings but are not currently substitutes for routine, accessible bedside foot evaluation. Cost, workforce training, thresholds, and downstream clinical benefit require further evaluation.

RESULTS

Table 1. Evidence overview of selected studies and implications for practice. The studies illustrate different forms of evidence and do not constitute an exhaustive systematic-review extraction.

Study	Design / participants	Finding relevant to practice	Interpretive caution
Jadhao et al.[7]	Cross-sectional; 350 newly diagnosed T2DM	DPN identified in 34% using combined clinical scores; varied by test	Single setting; definitions affect prevalence
Khumchum et al.[10]	Cross-sectional outpatient diagnostic comparison	Evaluated Ipswich touch test for LOPS relative to 10-g monofilament	LOPS screening is not early small-fiber diagnosis
Bönhof et al.[12]	Diagnostic study; mixed T1DM/T2DM; 373 underwent confirmatory skin biopsy	Age-adjusted graded 64-Hz vibration thresholds yielded 73.5% sensitivity and 85.4% specificity; addition of pinprick increased sensitivity	Mixed diabetes types; specialist reference testing; equipment distinct from routine 128-Hz tuning fork
Perkins et al.[13]	Multinational longitudinal subset; 261 initially DPN-free; mixed T1DM/T2DM	CCM corneal nerve fiber measures predicted incident neuropathy	Mixed diabetes types; specialist technology
Ponirakis et al.[14]	Repeated longitudinal assessments in T2DM	Sustained corneal nerve loss associated with DPN onset/progression	Requires feasible repeated CCM access
Liu, L., et al.[8]	Retrospective inpatient dataset; 3,343 T2DM	Interpretable machine-learning models showed promising discrimination	Single-center, high-risk case mix; external validation needed
Selvaraj et al.[9]	Cross-sectional diagnostic comparison; 39 T2DM patients (78 limbs)	Biothesiometry was more sensitive than monofilament against nerve conduction studies in this small sample	Small selected sample; limb-level estimates; cut-off requires external validation

An Evidence-Informed Nursing Assessment Pathway

Table 2. Proposed evidence-informed nursing assessment and follow-up pathway. This synthesis of ADA and IWGDF guidance is not a separately validated algorithm and must be adapted to local scope-of-practice rules, referral networks, and resources.

Step	Proposed nursing activity	Action / documentation
1. Identify	Assess all adults at T2DM diagnosis and at least annually; review prior abnormal findings and foot history	Record symptoms, duration, HbA1c context, previous ulcer, amputation and pertinent comorbidities
2. Ask	Elicit burning, tingling, numbness, balance difficulty and nocturnal symptoms	Document positive and negative sensory symptoms, functional impact and laterality
3. Examine	Inspect skin and deformity; test small-fiber sensation and vibration; test protective sensation with 10-g monofilament or accepted equivalent	Record sites, methods, results, and any intercurrent problems; do not rely on monofilament alone
4. Stratify	Assess LOPS, peripheral arterial disease (PAD), foot deformity, history of ulcer/amputation and kidney disease	Apply IWGDF foot-risk categories where local pathway permits
5. Respond	Offer individualized foot-care education, inspect footwear, address self-care barriers and reinforce diabetes risk-factor management	Arrange timely medical/podiatry review for abnormal tests or high risk; urgent assessment for active ulcer or suspected infection
6. Follow up	Schedule review proportionate to risk and inspect feet more frequently when sensory loss or prior ulceration exists	Ensure referral completion, treatment adherence, and repeated documentation

The IWGDF 2023 prevention guideline, published in 2024, links follow-up frequency to foot-ulcer risk. Its categories recommend approximately annual screening for risk 0, every 6–12 months for risk 1, every 3–6 months for risk 2, and every 1–3 months for risk 3; these intervals largely reflect expert opinion rather than direct trial evidence.[15] Education should address daily foot observation, footwear, early reporting of injuries, and the fact that reduced pain does not make a foot safe.

Abnormal neuropathy patterns warrant diagnostic caution. Rapidly progressive, asymmetric, predominantly motor, or otherwise atypical findings, and possible alternative causes such as vitamin B12 deficiency, thyroid disease, kidney disease, or medication-associated neuropathy, require assessment by qualified clinicians rather than automatic attribution to diabetes.[2,3]

DISCUSSION

The central finding of this narrative synthesis is that early neuropathy assessment and foot-ulcer risk assessment overlap but are not interchangeable. A monofilament result indicating LOPS has clear practical relevance to preventive foot care, whereas a normal result may leave earlier small-fiber dysfunction undetected. A symptom history and complementary sensory tests therefore remain clinically sensible. Diagnostic studies comparing vibration, pinprick, symptom scoring, biothesiometry, and monofilament provide support for assessing multiple domains, although their findings depend on equipment, cut-offs, and reference standards.[3,9,12]

A second consideration is context-dependent diagnostic accuracy. Differences in whether neuropathy is defined using nerve conduction, symptom scores, disability scales, or future occurrence help explain variability across studies. Standardized bedside procedures, examiner training, and documentation may be as important as tool procurement in busy clinics. Evidence syntheses on diagnostic accuracy and reliability do not establish that routine screening alone reduces amputations: such a conclusion requires studies following patient-important outcomes over time.[4,11,15]

Third, risk prediction models offer useful insight into whom clinicians may prioritize, but discrimination alone is insufficient for implementation. Transportability from tertiary inpatient cohorts to primary care, calibration, sensitivity at relevant thresholds, fairness across patient groups, and consequences of false reassurance need evaluation. The same caution applies to specialist biomarker approaches such as CCM, which may identify neuropathic change before traditional signs but still face cost and implementation barriers.[8,13]

For nursing practice, the most defensible immediate innovation is not a single "best test" but a standardized process that links comprehensive assessment to action. A nurse-supported care model can integrate symptom review, sensory evaluation, skin and footwear inspection, education, risk-based follow-up and escalation within multidisciplinary services. The proposed pathway should be evaluated prospectively for completion rates, inter-rater reliability, appropriate referrals, patient knowledge, foot-ulcer events, and equity of access.

Limitations And Research Implications

This narrative review used targeted rather than comprehensive searching and did not undertake duplicate independent screening, formal study-level risk-of-bias assessment, quantitative pooling, or GRADE certainty appraisal. It cannot estimate summary diagnostic performance or prove that one screening pathway reduces ulcers or amputations. Some underlying studies include both diabetes types, use single-center samples, and vary in diagnostic reference standards. Study findings have

been synthesized conservatively, but additional eligible studies may exist outside the targeted set.

Future research should (1) compare feasible combined screening strategies against well-defined reference standards, (2) test nursing-led implementation in community and primary-care settings, (3) externally validate prediction models across diverse health systems, (4) assess cost-effectiveness and patient acceptance of imaging approaches, and (5) prospectively evaluate foot ulcers, falls, quality of life, and referral completion as outcomes. An explicitly registered and exhaustively searched systematic or scoping review would be a suitable next research design if the intended journal requires comprehensive evidence mapping.

CONCLUSION

Adults with T2DM warrant systematic attention to neuropathy from diagnosis onward, including those without pain or numbness. Screening should distinguish early sensory dysfunction from established loss of protective sensation and should integrate the clinical history with complementary bedside tests. Risk indicators and newer methods such as corneal confocal microscopy and machine-learning prediction can enrich assessment, but they cannot replace a practical, standardized foot-safety pathway. For nurses, the highest immediate value lies in consistent screening, accurate documentation, tailored education, appropriate risk-based follow-up, and timely multidisciplinary referral.

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