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The Role Of Point-Of-Care Inflammatory Biomarkers In Nursing-Led Screening For Periodontal Disease Risk In Patients With Type 2 Diabetes

Hamoud Abdullah Hassan Mawkili[1] , Modi Saud Mohammed Alqahtani[2] , Amal Mohammed Yahya Zogail[3] , Manal Qarmosh Mohammed Majrabi[4] , Somaiah Qarmosh Mohammed Majrabi[5] , Asma Hassan Ahmed Alshehri[6] , Abdulrahman Mmonji Alshalwi[7] , Joud Saud Alruwais[8] , Mohammed Eid Obeid Allah Almehmadi[9] , Afaf Hassan Alabwi[10]

[1]Medical laboratory technician, Vector Borne and Zoonotic Diseases, Aseer Region, Saudi Arabia.
[2]Laboratory technician, Hotat Sudair Hospital, Saudi Arabia.
[3]Nursing Specialist, Prince Mohammed Bin Nasser, Saudi Arabia.
[4]Nursing, Prince Mohammed Bin Nasser Hospital, Saudi Arabia.
[5]Nursing, Prince Mohammed Bin Nasser Hospital, Saudi Arabia.
[6]Nurse, Alzahir Primary Health Care, Saudi Arabia.
[7]General Dentist, Ministry of Health, Erada Hospital for Mental Health in Al-Kharj, Saudi Arabia.
[8]Nursing Specialist, Shaqra General Hospital, Saudi Arabia.
[9]Laboratory Specialist, Badr General Hospital, Saudi Arabia.
[10]Nursing Specialist, Aljaber Eye And ENT Hospital, Saudi Arabia.

Abstract

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and systemic inflammation, which significantly increases susceptibility to periodontal disease. Periodontitis, a chronic inflammatory condition of the supporting tissues of the teeth, is now recognized as both a complication and a modifier of diabetes, contributing to poor glycemic control and increased risk of systemic complications. Despite this bidirectional relationship, periodontal disease often remains undiagnosed in individuals with T2DM, particularly in non-dental healthcare settings. Nurses, as frontline providers in diabetes management, are uniquely positioned to contribute to early identification of periodontal disease risk.

Objective: This narrative literature review aims to explore the role of point-of-care (POC) inflammatory biomarkers in supporting nursing-led screening for periodontal disease risk among patients with T2DM, emphasizing interprofessional integration between nursing, laboratory diagnostics, and periodontal care.

Methods: A narrative synthesis of the literature was conducted using major biomedical and nursing databases, focusing on studies addressing inflammatory biomarkers, point-of-care testing, periodontal disease, and diabetes care. Emphasis was placed on biomarkers measurable through rapid or near-patient testing methods and their feasibility within nursing-led clinical settings.

Results: Emerging evidence suggests that inflammatory biomarkers such as C-reactive protein (CRP), matrix metalloproteinase-8 (MMP-8), interleukins, and calprotectin reflect periodontal inflammatory burden and may be detected using point-of-care assays. These biomarkers demonstrate potential utility in identifying individuals at increased periodontal disease risk, particularly among patients with T2DM who exhibit heightened inflammatory responses. Nursing-led implementation of POC testing offers a practical approach to bridging gaps between medical and dental care, promoting early referral and integrated management.

Conclusion: Point-of-care inflammatory biomarker testing represents a promising adjunct to nursing-led screening strategies for periodontal disease risk in patients with T2DM. Integrating such approaches into diabetes care pathways may enhance early detection, interdisciplinary collaboration, and overall patient outcomes. Further research is needed to standardize biomarker thresholds, validate nursing workflows, and assess long-term clinical impact.

1. Introduction

1.1 Type 2 Diabetes Mellitus as a Systemic Inflammatory Disorder

Type 2 diabetes mellitus (T2DM) represents one of the most prevalent chronic non-communicable diseases worldwide and poses a significant burden on healthcare systems due to its high morbidity, mortality, and associated complications (American Diabetes Association [ADA], 2023). Traditionally defined by chronic hyperglycemia resulting from insulin resistance and relative insulin deficiency, T2DM is now widely recognized as a condition characterized by persistent low-grade systemic inflammation (Donath & Shoelson, 2011). This inflammatory state contributes not only to metabolic dysregulation but also to the development and progression of multiple diabetes-related comorbidities.

Chronic hyperglycemia promotes the formation of advanced glycation end products (AGEs), oxidative stress, and endothelial dysfunction, all of which stimulate the release of pro-inflammatory cytokines and acute-phase reactants (Brownlee, 2005). Elevated circulating levels of inflammatory mediators such as C-reactive protein (CRP), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and interleukin-1 beta (IL-1β) have been consistently documented in individuals with T2DM and are associated with insulin resistance and disease progression (Pickup, 2004). These inflammatory processes exert systemic effects, influencing vascular integrity, immune responses, and tissue repair mechanisms.

From a nursing and clinical care perspective, T2DM management extends beyond glycemic control to encompass the prevention and early detection of inflammation-driven complications. Nurses play a central role in monitoring disease progression, educating patients, and implementing screening strategies that address the multisystem nature of diabetes (Powers et al., 2020). Within this context, increasing attention has been directed toward oral health—particularly periodontal disease—as an important yet frequently overlooked component of comprehensive diabetes care.

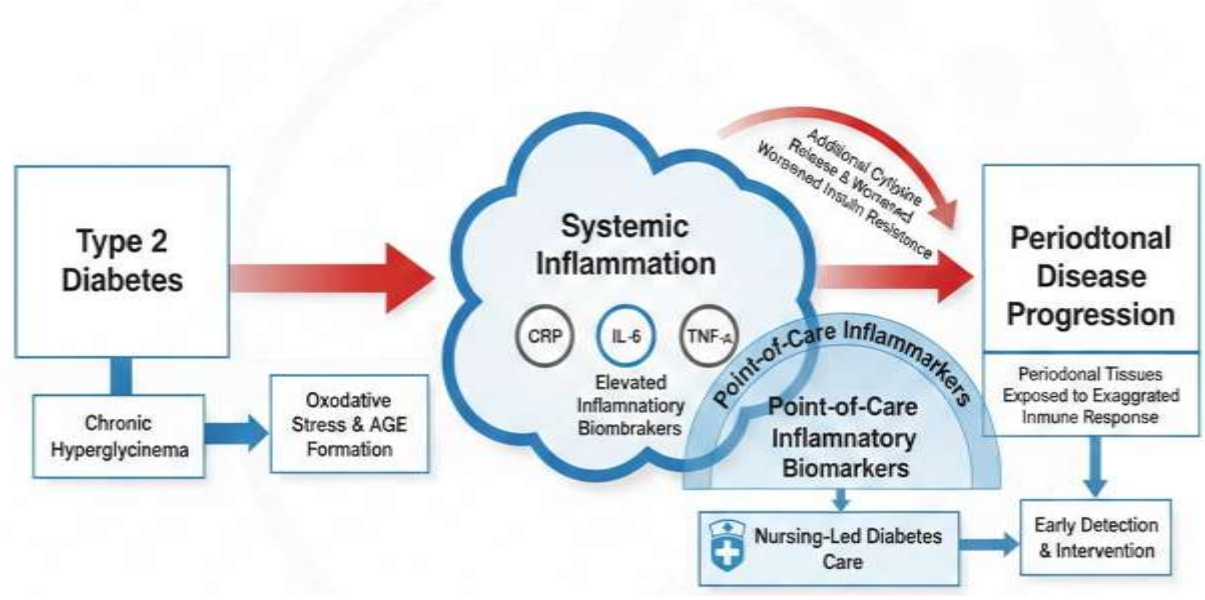

Figure 1. Conceptual Model Linking Type 2 Diabetes, Systemic Inflammation, and Periodontal Disease

1.2 Periodontal Disease: A Chronic Inflammatory Condition with Systemic Implications

Periodontal disease encompasses a spectrum of inflammatory conditions affecting the supporting structures of the teeth, ranging from reversible gingivitis to destructive periodontitis characterized by alveolar bone loss and eventual tooth loss (Kinane et al., 2017). Periodontitis is initiated by dysbiotic dental biofilms; however, disease severity and progression are largely determined by the host inflammatory and immune response (Hajishengallis, 2015). This host-mediated inflammatory response leads to the release of cytokines, proteolytic enzymes, and matrix metalloproteinases that drive connective tissue degradation.

Importantly, periodontal disease is no longer viewed as a localized oral condition but rather as a chronic inflammatory disease with systemic consequences. Epidemiological and clinical studies have demonstrated associations between periodontitis and cardiovascular disease, adverse pregnancy outcomes, respiratory infections, and metabolic disorders, including T2DM (Preshaw et al., 2012). Among these, the relationship between periodontal disease and diabetes is particularly robust and biologically plausible.

Patients with T2DM exhibit an increased prevalence, severity, and progression of periodontal disease compared to non-diabetic individuals (Taylor & Borgnakke, 2008). Hyperglycemia-induced alterations in immune function, impaired neutrophil activity, and exaggerated inflammatory responses contribute to increased periodontal tissue destruction in diabetic patients (Lalla & Papapanou, 2011). Conversely, periodontal inflammation may exacerbate systemic inflammatory burden, impair insulin signaling, and worsen glycemic control, establishing a bidirectional relationship between the two conditions.

1.3. The Bidirectional Relationship Between Periodontal Disease and Type 2 Diabetes

The bidirectional association between T2DM and periodontal disease has been extensively documented in observational, interventional, and mechanistic studies (Preshaw et al., 2012). On one hand, diabetes increases susceptibility to periodontal disease by altering host defense mechanisms and enhancing inflammatory responses. On the other hand, periodontal disease acts as a chronic inflammatory stimulus that may adversely affect metabolic control.

Periodontal tissues affected by active disease release inflammatory mediators such as IL-6, TNF-α, prostaglandin E2, and matrix metalloproteinases into systemic circulation (Loos, 2005). These mediators can contribute to insulin resistance by interfering with insulin receptor signaling pathways and promoting hepatic glucose production (Hotamisligil, 2006). Clinical studies have shown that periodontal treatment can lead to modest but clinically significant reductions in glycated hemoglobin (HbA1c) levels, supporting the concept that periodontal inflammation influences glycemic control (D'Aiuto et al., 2018).

Despite this evidence, periodontal disease screening is rarely integrated into routine diabetes care, particularly in non-dental settings. This gap highlights the need for practical, accessible screening tools that can be implemented by non-dental healthcare professionals, especially nurses who provide ongoing care to patients with T2DM.

14. Gaps in Periodontal Disease Detection in Diabetes Care

One of the major challenges in addressing periodontal disease among patients with T2DM is underdiagnosis. A comprehensive periodontal examination requires specialized dental training and equipment, which limits its availability in primary care or diabetes clinics (Chapple et al., 2013). As a result,

many patients with early or moderate periodontal disease remain undetected until advanced stages, when irreversible tissue damage occurs.

From a health services perspective, fragmentation between medical and dental care systems further exacerbates this issue. Diabetes management is typically conducted in medical settings, whereas periodontal care is delivered separately within dental services, often without structured communication or referral pathways (Lamster et al., 2016). This separation undermines opportunities for early identification and integrated management of periodontal disease in diabetic populations. Nurses are ideally positioned to address this gap due to their central role in chronic disease management, patient education, and preventive care. Expanding nursing responsibilities to include oral-systemic health screening aligns with contemporary models of holistic and patient-centered care (World Health Organization, 2022). However, for such integration to be feasible, screening tools must be rapid, minimally invasive, cost-effective, and easy to interpret—characteristics that align with point-of-care testing technologies.

1.5. Inflammatory Biomarkers as Indicators of Periodontal Disease Activity

Inflammatory biomarkers represent measurable indicators of biological processes associated with disease activity and progression. In periodontal disease, both local and systemic biomarkers reflect the inflammatory and tissue-destructive processes occurring within periodontal tissues (Teles et al., 2013). Biomarkers such as CRP, IL-6, IL-1β, TNF-α, and matrix metalloproteinase-8 (MMP-8) have been extensively studied in relation to periodontal inflammation.

Among these, MMP-8—a neutrophil-derived collagenase—is considered a key biomarker of active periodontal tissue destruction and has demonstrated strong correlations with disease severity and progression (Sorsa et al., 2016). Elevated salivary and gingival crevicular fluid (GCF) levels of MMP-8 have been reported in patients with periodontitis, including those with T2DM. Similarly, systemic markers such as CRP reflect both periodontal and metabolic inflammatory burden, making them particularly relevant in diabetic populations. The measurement of these biomarkers traditionally relies on laboratory-based assays such as enzyme-linked immunosorbent assays (ELISA), which require specialized infrastructure and trained personnel. While accurate, these methods are not practical for routine screening in nursing or primary care settings. This limitation has driven interest in point-of-care testing modalities capable of delivering rapid results at or near the site of patient care.

1.6. Point-of-Care Testing: Bridging Laboratory Science and Nursing Practice

Point-of-care testing (POCT) refers to diagnostic testing performed at or near the patient, outside conventional laboratory environments, to provide immediate results to inform clinical decision-making (Price, 2001). Advances in biosensor technology, microfluidics, and lateral-flow immunoassays have facilitated the development of portable devices capable of detecting inflammatory biomarkers using saliva, finger-prick blood, or GCF samples.

From a nursing perspective, POCT offers several advantages, including reduced turnaround time, enhanced patient engagement, and the ability to integrate screening into routine clinical encounters. Nurses are already experienced in performing bedside tests such as glucose monitoring and rapid infection screening, making POCT for inflammatory biomarkers a logical extension of existing practice (O'Kane et al., 2015). In the context of T2DM, POCT-based inflammatory biomarker screening may enable nurses to identify patients at increased risk of periodontal disease, initiate timely referrals to dental services, and reinforce oral health education. Such an approach supports interprofessional collaboration and aligns with preventive care models that emphasize early detection and intervention.

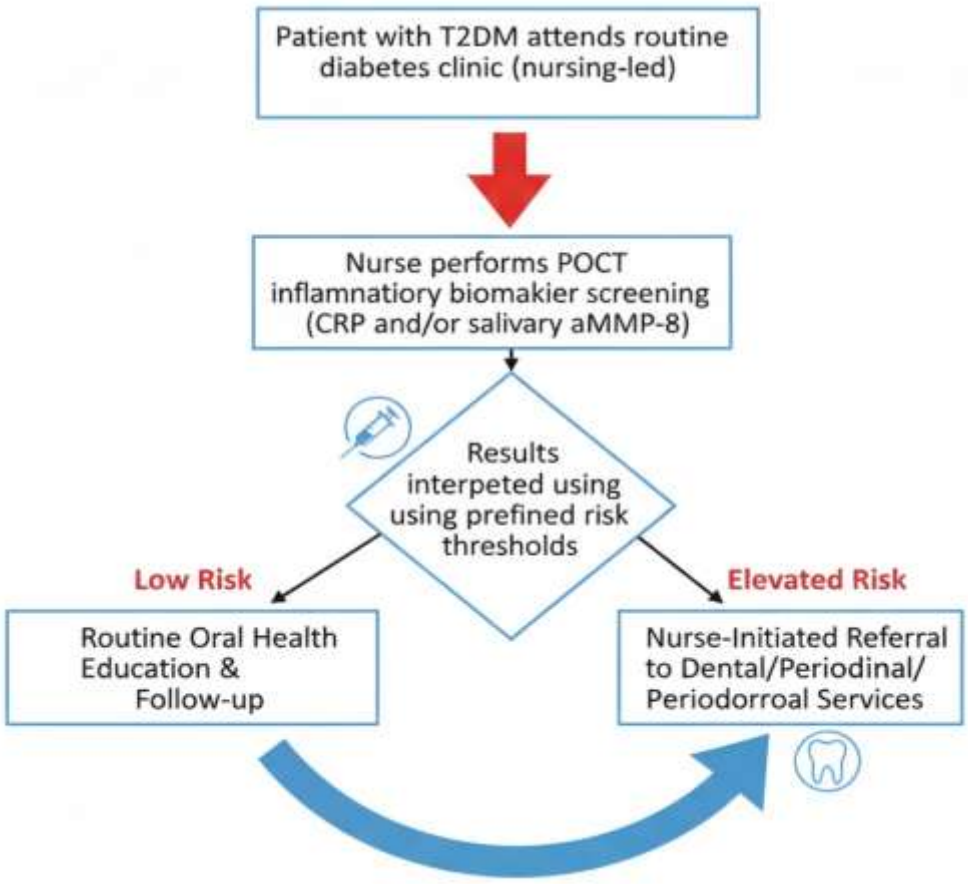

Figure 2. Proposed Nursing-Led Screening and Referral Pathway Using POCT

1.7. Rationale for Nursing-Led Screening Using Point-of-Care Biomarkers

The integration of point-of-care inflammatory biomarker testing into nursing-led diabetes care represents a convergence of multiple disciplines: nursing, laboratory diagnostics, periodontal medicine, and chronic disease management. This approach acknowledges the systemic nature of periodontal disease, the central role of inflammation in T2DM, and the expanding scope of nursing practice. By leveraging POCT technologies, nurses may serve as critical links between medical and dental care, facilitating early identification of periodontal disease risk and contributing to more comprehensive diabetes management. However, despite growing interest, the evidence supporting this approach remains fragmented across disciplines and study designs.

Therefore, a narrative synthesis of the literature is warranted to critically examine current evidence, identify promising biomarkers and testing modalities, and explore the feasibility and implications of nursing-led screening models. Such a review can inform future research, guide clinical practice, and support the development of integrated care pathways that address the oral-systemic health needs of patients with T2DM.

Table 1. Key Inflammatory Biomarkers Relevant to Periodontal Disease in Patients with Type 2 Diabetes

Biomarker	Biological Source	Sample Type	Pathophysiological Role	Relevance to T2DM	Suitability for POCT	Nursing Relevance
C-Reactive Protein (CRP)	Liver (acute-phase protein)	Capillary blood	Marker of systemic inflammation	Elevated in insulin resistance and poor glycemic control	High (validated finger-prick POCT devices)	Easy to perform; rapid risk stratification
Matrix Metalloproteinase-8 (aMMP-8)	Neutrophils	Saliva / Gingival crevicular fluid	Collagen degradation; active periodontal tissue destruction	Elevated due to amplified inflammatory response	High (lateral-flow chairside tests)	Non-invasive; periodontal-specific
Interleukin-6 (IL-6)	Immune cells	Blood / Saliva	Cytokine driving CRP production and insulin resistance	Strongly linked to metabolic dysregulation	Moderate (emerging biosensors)	Future screening potential
Interleukin-1β (IL-1β)	Macrophages	Saliva / GCF	Bone resorption and tissue breakdown	Elevated in diabetic periodontitis	Low–Moderate	Research/advanced settings
TNF-α	Immune cells	Blood / Saliva	Insulin resistance; inflammatory amplification	Central mediator in T2DM	Low (complex assays)	Limited routine use
Calprotectin	Neutrophils	Saliva	Marker of neutrophil-driven inflammation	Elevated in chronic inflammatory states	Emerging	Promising future POCT

2. Methods

2.1 Study Design

This study was conducted as a narrative literature review aimed at synthesizing and critically discussing existing evidence on the role of point-of-care (POC) inflammatory biomarkers in nursing-led screening for periodontal disease risk among patients with Type 2 diabetes mellitus (T2DM). A narrative review methodology was selected due to the heterogeneity of available evidence, including variability in study

designs, biomarker types, biological specimens, testing platforms, and clinical settings. Additionally, the emerging nature of nursing-led periodontal screening using POC diagnostics necessitates a flexible, interpretive approach that allows integration of findings across nursing, laboratory medicine, diabetes care, and periodontal research.

2.2 Literature Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including PubMed/MEDLINE, CINAHL, Scopus, Web of Science, and Google Scholar. These databases were selected to ensure coverage of biomedical, nursing, dental, and laboratory science literature. Manual searches of reference lists from key articles and relevant reviews were also performed to identify additional studies. Search terms were developed to reflect the interdisciplinary scope of the review and included combinations of keywords and subject headings related to:

- Type 2 diabetes mellitus (e.g., "Type 2 diabetes," "T2DM," "diabetes mellitus")
- Periodontal disease (e.g., "periodontitis," "periodontal inflammation," "oral health")
- Inflammatory biomarkers (e.g., "C-reactive protein," "CRP," "interleukin-6," "IL-6," "tumor necrosis factor-alpha," "TNF-α," "matrix metalloproteinase-8," "MMP-8," "calprotectin")
- Point-of-care testing (e.g., "point-of-care," "POCT," "chairside testing," "rapid test")
- Nursing and screening (e.g., "nursing-led," "screening," "primary care nursing," "diabetes nursing")

Boolean operators (AND, OR) were used to combine terms appropriately. The search was limited to studies published in English involving adult populations.

2.2.1 Inclusion and Exclusion Criteria

Studies were included if they:

1. Involved adults diagnosed with Type 2 diabetes mellitus.
2. Examined inflammatory biomarkers associated with periodontal disease.
3. Evaluated biomarkers measurable through point-of-care or near-patient testing.
4. Reported outcomes relevant to screening, risk identification, feasibility, or clinical applicability.
5. Were relevant to nursing practice, diabetes care, periodontal health, or laboratory diagnostics.

Studies were excluded if they:

- Were animal or in vitro studies.
- Focused exclusively on pediatric populations.
- Did not address periodontal disease or inflammatory biomarkers.
- Were case reports or opinion-only articles without empirical or conceptual contribution.

2.3 Data Extraction and Synthesis

Relevant data were extracted narratively, focusing on study context, population characteristics, biomarker type, testing modality, clinical relevance, and implications for nursing-led screening. Given the narrative nature of the review, findings were synthesized thematically rather than quantitatively. The results are presented in structured subsections reflecting biological mechanisms, biomarker evidence, nursing practice implications, and interprofessional integration.

3.Results

3.1. Systemic Inflammation in Type 2 Diabetes and Its Relevance to Periodontal Disease Risk

The literature consistently identifies T2DM as a chronic inflammatory condition characterized by sustained activation of innate immune pathways and elevated circulating inflammatory mediators (Donath & Shoelson, 2011). Hyperglycemia-induced oxidative stress, accumulation of advanced glycation end products (AGEs), and endothelial dysfunction collectively contribute to a pro-inflammatory systemic environment (Brownlee, 2005). This inflammatory milieu has direct implications for periodontal tissues, which are highly susceptible to immune-mediated damage.

Multiple studies demonstrate that patients with T2DM exhibit significantly higher levels of systemic inflammatory biomarkers, including CRP, IL-6, and TNF-α, compared to non-diabetic controls (Pickup, 2004). These biomarkers not only reflect metabolic dysregulation but also correlate with periodontal disease severity, suggesting shared inflammatory pathways. The convergence of diabetes-related inflammation and periodontal immune responses creates a biological basis for increased periodontal disease risk in diabetic populations.

From a nursing and clinical management perspective, recognition of systemic inflammation as a common denominator underscores the need for integrated screening approaches. The literature supports the concept that inflammatory biomarkers measurable at the point of care may provide valuable insights into both metabolic and periodontal health, particularly in high-risk groups such as patients with T2DM.

3.2. Periodontal Disease as an Inflammatory Complication of Type 2 Diabetes

Extensive epidemiological evidence indicates that individuals with T2DM are at a significantly increased risk of developing periodontal disease, with greater severity and faster progression compared to non-diabetic populations (Taylor & Borgnakke, 2008). Poor glycemic control has been repeatedly associated with deeper periodontal pockets, greater attachment loss, and increased alveolar bone resorption (Lalla & Papapanou, 2011).

The inflammatory response in periodontal disease is amplified in the presence of diabetes. Neutrophil dysfunction, impaired macrophage activity, and altered cytokine profiles contribute to exaggerated tissue destruction (Preshaw et al., 2012). Studies have demonstrated elevated local concentrations of IL-1β, IL-6, TNF-α, and MMPs in gingival crevicular fluid and saliva of diabetic patients with periodontitis compared to non-diabetic individuals (Teles et al., 2013).

Importantly, periodontal disease also exerts systemic effects that may worsen diabetic control. Chronic periodontal inflammation contributes to systemic cytokine release, promoting insulin resistance and impaired glucose metabolism (Hotamisligil, 2006). Intervention studies have shown that periodontal treatment can lead to modest reductions in HbA1c levels, reinforcing the bidirectional relationship between the two conditions (D'Aiuto et al., 2018). Despite these findings, periodontal disease remains under-recognized in routine diabetes care, highlighting a critical gap that nursing-led screening may help address.

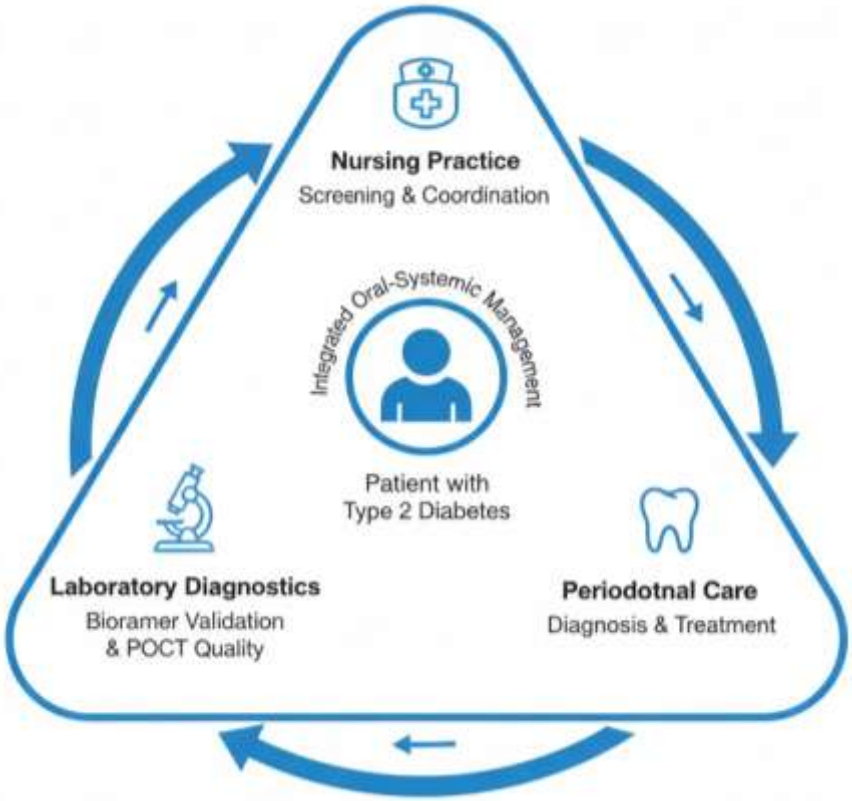

Figure 3. Interprofessional Integration Framework

3.3. Inflammatory Biomarkers Associated With Periodontal Disease in T2DM

3.3.1 C-Reactive Protein (CRP)

CRP is one of the most extensively studied systemic inflammatory biomarkers in both diabetes and periodontal disease. Elevated CRP levels are consistently reported in patients with T2DM and are associated with insulin resistance, cardiovascular risk, and chronic inflammation (Pickup, 2004). Periodontal disease has also been shown to independently increase CRP levels, suggesting that oral inflammation contributes to systemic inflammatory burden (Loos, 2005).

Several studies indicate that CRP levels are higher in diabetic patients with periodontitis than in those without periodontal disease, supporting its potential role as a screening marker (Preshaw et al., 2012). The availability of finger-prick POC CRP assays enhances its feasibility for nursing-led screening. However, CRP lacks specificity for periodontal disease, as it reflects generalized inflammation, necessitating cautious interpretation within a broader clinical context.

3.3.2 Matrix Metalloproteinase-8 (MMP-8)

Matrix metalloproteinase-8 (MMP-8), also known as neutrophil collagenase, is a key enzyme involved in periodontal connective tissue breakdown. Elevated levels of active MMP-8 (aMMP-8) have been strongly associated with active periodontal disease and disease progression (Sorsa et al., 2016).

Salivary and gingival crevicular fluid-based POC lateral-flow tests for aMMP-8 have been developed and validated in multiple clinical studies. These tests demonstrate strong correlations with clinical periodontal parameters such as pocket depth and bleeding on probing (Sorsa et al., 2016). Importantly, elevated aMMP-8 levels have been reported in patients with T2DM, reflecting heightened periodontal inflammatory activity. From a nursing perspective, aMMP-8 represents a promising biomarker due to its relative specificity for periodontal tissue destruction and the availability of non-invasive, rapid POC testing formats.

3.3.3 Interleukins (IL-6 and IL-1β)

Interleukin-6 and interleukin-1 beta are central mediators of both periodontal inflammation and insulin resistance. Elevated salivary and systemic levels of these cytokines have been observed in patients with T2DM and periodontal disease (Teles et al., 2013).

IL-6 plays a critical role in hepatic CRP production and has been implicated in impaired insulin signaling (Hotamisligil, 2006). IL-1β contributes to bone resorption and connective tissue destruction in periodontal disease. While laboratory-based measurement of these cytokines is well established, their translation into POC formats remains limited. Nevertheless, emerging biosensor technologies suggest future potential for nursing-led screening applications.

3.3.4 Tumor Necrosis Factor-Alpha (TNF-α)

TNF-α is a key pro-inflammatory cytokine involved in insulin resistance and periodontal tissue destruction. Elevated TNF-α levels have been detected in gingival tissues, saliva, and serum of diabetic patients with periodontitis (Lalla & Papapanou, 2011). While its biological relevance is well established, TNF-α measurement at the point of care remains challenging due to assay sensitivity requirements.

3.3.5 Emerging Biomarkers: Calprotectin and Others

Calprotectin, a neutrophil-derived protein, has gained attention as a potential marker of oral and systemic inflammation. Studies indicate elevated salivary calprotectin levels in periodontal disease and T2DM, suggesting its potential utility as a screening biomarker (Kido et al., 2020). However, evidence remains preliminary, and standardized POC assays are still under development.

3.4. Point-of-Care Testing Technologies Relevant to Nursing Practice

Advances in POCT technologies have enabled the detection of inflammatory biomarkers using minimally invasive samples such as saliva and finger-prick blood. Lateral-flow immunoassays, portable readers, and biosensor-based platforms have been adapted for chairside use with minimal training requirements (Price, 2001). Nursing practice has a long history of integrating POCT into routine care, including glucose monitoring, rapid infection tests, and coagulation screening. The literature suggests that nurses can effectively perform and interpret POC inflammatory biomarker tests when provided with appropriate training and clinical protocols (O'Kane et al., 2015).

Table 2. Point-of-Care Testing Characteristics of Inflammatory Biomarkers

Biomarker	POCT Method	Sample Collection	Time to Result	Training Level Required	Advantages	Limitations

CRP	Immunoassay (finger-prick)	Capillary blood	3–5 minutes	Basic nursing training	Widely available; standardized	Low periodontal specificity
aMMP-8	Lateral-flow immunoassay	Saliva / GCF	5–10 minutes	Minimal	Periodontal-specific; non-invasive	Limited availability in some regions
IL-6	Biosensor / microfluidic	Blood/saliva	10–20 minutes	Advanced	High biological relevance	Not yet routine
Calprotectin	Lateral-flow / ELISA-based POCT	Saliva	5–10 minutes	Moderate	Reflects neutrophil activity	Cutoffs not standardized

3.5. Nursing-Led Screening Models for Periodontal Disease Risk

The concept of nursing-led screening aligns with expanded nursing roles in preventive and chronic disease management. Studies in diabetes care demonstrate that nurse-led screening programs improve early detection of complications and enhance patient engagement (Powers et al., 2020). Applying this model to periodontal disease risk, nurses may incorporate POC biomarker testing into routine diabetes visits, identify patients at increased risk, provide oral health education, and facilitate referrals to dental services. Such models promote interprofessional collaboration and address longstanding gaps between medical and dental care systems (Lamster et al., 2016).

3.6. Interprofessional and Health System Implications

The integration of POC inflammatory biomarker screening into nursing-led diabetes care represents a paradigm shift toward oral-systemic health integration. The literature emphasizes the need for clear referral pathways, shared clinical guidelines, and collaborative communication between nurses, dentists, physicians, and laboratory professionals.

Health services research suggests that early screening may reduce long-term healthcare costs by preventing advanced periodontal disease and improving glycemic control (Chapple et al., 2013). However, robust implementation studies are needed to validate these outcomes.

Table 3. Clinical Implications of Nursing-Led Periodontal Risk Screening by Specialty

Specialty	Role in Screening Model	Key Contribution
Nursing	Frontline screening, POCT performance, education	Early risk identification; patient counseling
Diabetes Care	Chronic disease management	Integration of oral health into diabetes protocols
Periodontology	Definitive diagnosis and treatment	Confirmation and management of periodontal disease
Laboratory Medicine	Assay validation and quality control	Ensuring accuracy and reliability of POCT

Health Services Management	Workflow and policy integration	Sustainable implementation

3.7. Summary of Evidence

Collectively, the literature supports the biological plausibility and clinical potential of using point-of-care inflammatory biomarkers in nursing-led screening for periodontal disease risk among patients with T2DM. Biomarkers such as CRP and aMMP-8 show particular promise due to their detectability via POC platforms and relevance to both systemic and periodontal inflammation. Nevertheless, variability in biomarker thresholds, testing platforms, and clinical workflows highlights the need for further standardization and nursing-centered research.

4. Discussion

This narrative literature review examined the role of point-of-care (POC) inflammatory biomarkers in supporting nursing-led screening for periodontal disease risk among patients with Type 2 diabetes mellitus (T2DM). The synthesized evidence highlights a strong biological, clinical, and organizational rationale for integrating inflammatory biomarker assessment into routine diabetes care, particularly within nursing practice. The findings underscore the interconnected nature of systemic inflammation, periodontal disease, and metabolic dysregulation, positioning nurses as pivotal agents in bridging medical, dental, and laboratory disciplines.

Across the reviewed literature, inflammatory biomarkers emerged as valuable indicators of periodontal disease activity and systemic inflammatory burden in patients with T2DM. Biomarkers such as C-reactive protein (CRP), matrix metalloproteinase-8 (MMP-8), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) were consistently associated with both periodontal inflammation and diabetes-related immune dysfunction (Preshaw et al., 2012; Sorsa et al., 2016). The availability of POC testing platforms for selected biomarkers, particularly CRP and active MMP-8 (aMMP-8), provides a practical foundation for nurse-led screening initiatives in non-dental clinical settings. Importantly, this review demonstrates that the value of POC biomarkers lies not in replacing comprehensive periodontal examination but in risk stratification and early identification, enabling timely referral and preventive intervention. This perspective aligns with contemporary models of integrated, patient-centered care and reinforces the expanding role of nursing in chronic disease management.

4.1 Biological Plausibility and the Oral–Systemic Inflammatory Axis

A central strength of the evidence base supporting biomarker-guided screening is the well-established biological plausibility linking T2DM and periodontal disease through shared inflammatory pathways. Chronic hyperglycemia promotes oxidative stress, AGE formation, and immune dysregulation, resulting in persistent low-grade systemic inflammation (Brownlee, 2005; Donath & Shoelson, 2011). Periodontal tissues, which are highly vascularized and immunologically active, are particularly susceptible to these inflammatory insults.

Literature consistently demonstrates elevated levels of inflammatory mediators in both systemic circulation and oral fluids of patients with T2DM and periodontal disease (Teles et al., 2013). Neutrophil hyper-responsiveness and impaired resolution of inflammation contribute to excessive release of cytokines and proteolytic enzymes, accelerating periodontal tissue destruction (Hajishengallis, 2015). Biomarkers such as MMP-8 directly reflect collagen degradation and periodontal breakdown, making them particularly relevant for disease activity assessment.

From a nursing and laboratory medicine perspective, this shared inflammatory axis supports the use of biomarkers as surrogate indicators of periodontal disease risk in diabetic populations. The ability to detect these biomarkers using minimally invasive POC tests represents a convergence of biological insight and technological advancement, enabling translation into clinical practice.

4.2 Clinical Significance of Inflammatory Biomarkers in T2DM

4.2.1 C-Reactive Protein: Utility and Limitations

CRP remains one of the most extensively studied inflammatory biomarkers due to its stability, ease of measurement, and established role in cardiovascular and metabolic risk assessment. Elevated CRP levels have been consistently reported in patients with T2DM and are further increased in the presence of periodontal disease (Pickup, 2004; Loos, 2005). The availability of validated finger-prick POC CRP assays enhances feasibility for nursing-led screening.

However, the nonspecific nature of CRP represents a key limitation. CRP reflects generalized systemic inflammation and may be influenced by obesity, infections, and other chronic conditions common in diabetic populations. As such, CRP alone cannot distinguish periodontal inflammation from other inflammatory sources. The literature suggests that CRP is most valuable when interpreted in combination with clinical assessment and more periodontal-specific biomarkers (Preshaw et al., 2012).

4.2.2 MMP-8 as a Periodontal-Specific Biomarker

Active MMP-8 has emerged as one of the most promising biomarkers for periodontal disease due to its strong association with active tissue destruction. Studies evaluating salivary and gingival crevicular fluid aMMP-8 POC tests demonstrate good correlation with clinical periodontal parameters, including pocket depth and bleeding on probing (Sorsa et al., 2016).

In patients with T2DM, elevated aMMP-8 levels reflect the amplified inflammatory response characteristic of diabetic periodontal disease. The non-invasive nature of saliva-based testing and the rapid turnaround time make aMMP-8 particularly suitable for nursing-led screening. From a laboratory science perspective, the specificity of aMMP-8 for periodontal pathology enhances its clinical relevance compared to systemic markers alone.

4.2.3 Cytokines and Emerging Biomarkers

Cytokines such as IL-6, IL-1β, and TNF-α play central roles in both insulin resistance and periodontal inflammation (Hotamisligil, 2006). While their diagnostic potential is well supported biologically, translation into routine POC testing remains limited due to assay complexity and sensitivity requirements. Emerging biomarkers such as calprotectin show promise, particularly in saliva-based diagnostics, but require further validation and standardization before widespread clinical adoption (Kido et al., 2020).

4.3 Point-of-Care Testing as an Enabler of Nursing-Led Screening

The integration of POCT into nursing practice is supported by decades of experience in glucose monitoring, infectious disease screening, and coagulation testing. The literature emphasizes that POCT enhances clinical efficiency, reduces diagnostic delays, and improves patient engagement (Price, 2001; O'Kane et al., 2015). Extending POCT to inflammatory biomarker screening for periodontal disease represents a logical progression in diabetes care.

Nurses are uniquely positioned to implement POCT due to their frequent patient contact, holistic assessment approach, and central role in chronic disease education. Studies indicate that with appropriate training and quality assurance protocols, nurses can perform and interpret POC tests with accuracy comparable to laboratory settings (O'Kane et al., 2015).

In diabetes clinics, nursing-led POC biomarker screening may be incorporated into routine visits without significant disruption to workflow. Saliva-based tests, in particular, minimize invasiveness and enhance patient acceptability. These features support feasibility in diverse clinical settings, including primary care, outpatient clinics, and community health programs.

4.4 Implications for Nursing Practice and Professional Scope

The findings of this review have important implications for nursing practice and professional development. Expanding nursing roles to include oral-systemic health screening aligns with contemporary models of advanced and extended nursing practice. Such roles emphasize prevention, early detection, and interprofessional collaboration (World Health Organization, 2022).

Nursing-led periodontal risk screening using POC biomarkers may enhance holistic diabetes care by addressing an often-neglected determinant of metabolic control. In addition to performing tests, nurses play a critical role in patient education, reinforcing oral hygiene practices, and promoting adherence to dental referrals. This multifaceted contribution extends beyond diagnostic testing and reflects the core values of nursing care.

However, successful implementation requires clear clinical protocols, defined referral pathways, and interprofessional agreement regarding interpretation and follow-up. Nursing education curricula and continuing professional development programs must also incorporate oral-systemic health and POCT competencies to support safe and effective practice.

4.5 Interprofessional Collaboration and Health System Integration

A recurring theme in the literature is the fragmentation between medical and dental care systems, which undermines comprehensive management of patients with T2DM (Lamster et al., 2016). Nursing-led screening using POC biomarkers offers a practical mechanism for enhancing integration by creating structured links between diabetes care and dental services.

Effective implementation requires collaboration among nurses, physicians, dentists, and laboratory professionals. Laboratory expertise is essential for assay validation, quality control, and interpretation of biomarker results. Dental professionals provide definitive diagnosis and treatment, while physicians oversee metabolic management. Nurses function as coordinators, facilitating communication and continuity of care.

From a health services management perspective, integrated screening models may improve efficiency, reduce duplication of services, and potentially lower long-term healthcare costs by preventing advanced periodontal disease and improving glycemic control (Chapple et al., 2013). However, economic evaluations and implementation research remain limited and represent important areas for future investigation.

4.6 Strengths and Limitations of the Existing Evidence

The literature reviewed demonstrates several strengths, including strong biological plausibility, consistent associations between inflammation, T2DM, and periodontal disease, and growing availability of POC

testing technologies. Nevertheless, important limitations must be acknowledged. First, heterogeneity in biomarker selection, assay platforms, and cutoff values limits comparability across studies. Second, many studies involve small sample sizes and cross-sectional designs, restricting causal inference. Third, evidence specific to nursing-led implementation remains sparse, with most studies focusing on biomarker validation rather than clinical workflow integration. Additionally, potential conflicts of interest related to commercial POC devices warrant careful consideration. Future research should prioritize independent validation studies, standardized protocols, and nursing-centered implementation trials.

4.7 Future Research Directions

Based on the synthesized evidence, several priorities for future research emerge. Longitudinal studies are needed to evaluate whether nursing-led POC biomarker screening leads to improved periodontal and glycemic outcomes. Randomized controlled trials assessing integrated care models would provide high-quality evidence to support guideline development. Research should also focus on establishing standardized biomarker thresholds, evaluating cost-effectiveness, and exploring patient perspectives on nurse-led oral health screening. From a laboratory science perspective, continued innovation in biosensor technology may expand the range of biomarkers suitable for POC testing.

6. Conclusion

Type 2 diabetes mellitus and periodontal disease are interconnected chronic inflammatory conditions that exert reciprocal influences on disease progression and patient outcomes. Despite robust evidence supporting this bidirectional relationship, periodontal disease remains underdiagnosed and undertreated in individuals with T2DM, particularly within non-dental healthcare settings. This narrative literature review highlights the potential of point-of-care inflammatory biomarkers as practical tools to support nursing-led screening for periodontal disease risk in diabetic populations.

The reviewed evidence demonstrates that inflammatory biomarkers such as C-reactive protein and active matrix metalloproteinase-8 reflect systemic and periodontal inflammatory burden and can be detected using minimally invasive point-of-care testing platforms. These technologies align well with nursing practice, offering rapid results, ease of use, and opportunities for integration into routine diabetes care. Nursing-led screening initiatives leveraging such biomarkers may facilitate early risk identification, promote timely dental referral, and contribute to more comprehensive and preventive models of diabetes management.

Importantly, the value of point-of-care biomarker testing lies in its role as an adjunct to, rather than a replacement for, comprehensive periodontal examination. When embedded within structured clinical pathways and supported by interprofessional collaboration, nursing-led screening has the potential to bridge longstanding gaps between medical and dental care systems. This integrated approach aligns with contemporary healthcare priorities emphasizing holistic, patient-centered, and preventive care.

Nevertheless, the current evidence base is characterized by heterogeneity in biomarker selection, testing platforms, and study design. Further research is required to standardize biomarker thresholds, validate nursing workflows, and evaluate long-term clinical and economic outcomes. Investment in nursing education, laboratory support, and health system infrastructure will be essential to translate this promising approach into routine practice.

In conclusion, point-of-care inflammatory biomarker testing represents a promising strategy to enhance nursing-led screening for periodontal disease risk in patients with Type 2 diabetes. By integrating laboratory science, nursing practice, and periodontal care, this approach has the potential to improve early detection,

foster interprofessional collaboration, and ultimately enhance health outcomes for individuals living with diabetes.

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