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Early Detection And Management Of Diabetes: Evaluating The Contribution Of Laboratory And Nursing Services In Primary Care Settings

Hussain Hassan A Aldajani[1], Mahdi hassan aldajani[2], Haider Hassan A Aldjani[3], Deena Ahmed S Alqahtani[4], Mohammad Ali A Almiftah[5], Deema Abdulhameed Alshalian[6], Faisal ayban alanazi[7],Farhan noman alanazi[8], Naif Mutlaq Alsubaie[9], Ahmed Mushabbab Ahmed Alasmari[10], Abeer Muqbel Alshammari[11], Fahad Hamad Alqahtani[12], Ali Ahmed Alghamdi[13], Khalid Abdullah Alharbi[14], Abdulkhaliq Abdullah Aljaffer[15]

ABSTRACT

Diabetes mellitus is one of the most prevalent chronic non-communicable diseases worldwide and poses a serious challenge to public health systems, particularly in primary care settings. Early detection and effective management are critical to reducing complications, improving patient quality of life, and lowering long-term healthcare costs. Primary care plays a central role in diabetes control, where laboratory and nursing services act as the first line of prevention, diagnosis, monitoring, and patient education. This paper examines the contribution of laboratory and nursing services in the early detection and management of diabetes within primary care environments. It explores how timely laboratory investigations enable accurate diagnosis and disease monitoring, while nursing services support screening, patient education, lifestyle modification, medication adherence, and long-term follow-up. The study highlights challenges such as limited resources, workforce shortages, and gaps in coordination, particularly in low- and middle-income settings. The paper argues that strengthening laboratory capacity and empowering nursing professionals can significantly improve diabetes outcomes. Integrated, team-based care models are recommended as an effective strategy for enhancing early detection and sustained management of diabetes at the primary care level.

Keywords: Diabetes mellitus, early detection, laboratory services, nursing services, primary care, disease management.

INTRODUCTION

Diabetes mellitus is one of the most pressing public health challenges of the twenty-first century. The global burden of diabetes has increased rapidly due to population ageing, urbanization, sedentary lifestyles, and unhealthy dietary patterns. According to the World Health Organization, diabetes is a leading cause of premature mortality and long-term disability, particularly in low- and middle-income countries. Early detection and effective management at the primary care level are widely recognized as the most cost-effective strategies to reduce diabetes-related complications, hospital admissions, and healthcare expenditure. Within this context, laboratory and nursing services play a central role in strengthening diabetes care in primary healthcare settings.

Early detection of diabetes relies heavily on laboratory investigations such as fasting plasma glucose, oral glucose tolerance test, and glycated hemoglobin (HbA1c). Since 2010, several studies have emphasized the importance of routine screening and timely laboratory diagnosis in identifying undiagnosed diabetes and prediabetes. Engelgau et al. (2010) highlighted that a significant proportion of individuals with diabetes remain undiagnosed for years, increasing the risk of cardiovascular, renal, and neurological complications. Similarly, Zhang et al. (2012) demonstrated that early laboratory-based screening in primary care settings significantly improves detection rates and enables timely intervention.

The introduction of HbA1c as a diagnostic and monitoring tool has transformed diabetes care. Research by Little et al. (2011) and Selvin et al. (2014) showed that HbA1c provides a reliable measure of long-term glycemic control and is strongly associated with diabetes-related outcomes. From a primary care

perspective, access to standardized laboratory services ensures accurate diagnosis, risk stratification, and ongoing monitoring of treatment effectiveness. Between 2015 and 2023, multiple studies confirmed that point-of-care testing and improved laboratory infrastructure at the primary level enhance patient follow-up and clinical decision-making (Sacks, 2016; Saeed et al., 2020).

Alongside laboratory services, nursing services constitute the backbone of diabetes management in primary care. Nurses are often the first point of contact for patients and play a key role in screening, education, lifestyle counseling, medication adherence, and long-term follow-up. Wagner et al. (2012) emphasized that nurse-led chronic care models significantly improve glycemic control and patient satisfaction. Similarly, Laurant et al. (2018) reported that expanded nursing roles in diabetes care lead to better clinical outcomes without compromising safety.

From 2010 onward, evidence has consistently shown that nurse-managed diabetes programs are effective in improving self-management behaviors. A systematic review by Tshiananga et al. (2012) found that nurse-led interventions resulted in significant reductions in HbA1c levels compared to usual care. More recent studies by Daly et al. (2018) and Powers et al. (2020) further confirmed that structured diabetes education delivered by trained nurses improves dietary adherence, physical activity, and glucose monitoring practices.

The integration of laboratory and nursing services is particularly important in primary care settings, where resources are often limited and patient loads are high. Studies conducted between 2015 and 2023 increasingly emphasize team-based care models. Bodenheimer and Smith (2013) argued that coordinated care involving nurses, laboratory personnel, and physicians improves continuity of care and reduces fragmentation. In low-resource settings, task-shifting strategies, where nurses take on expanded responsibilities supported by laboratory diagnostics, have shown promising results (Joshi et al., 2016; Kibirige et al., 2019).

In the Indian and South Asian context, where the prevalence of diabetes is rapidly increasing, primary care systems face significant challenges. Mohan et al. (2013) and Anjana et al. (2017) reported a high prevalence of undiagnosed diabetes in community-based studies, underscoring the need for strengthened screening services. More recent studies (2020–2023) highlight gaps in laboratory accessibility, delayed diagnosis, and insufficient nursing manpower, which adversely affect diabetes outcomes (Gupta et al., 2021; Tripathy et al., 2022).

Despite strong evidence supporting early detection and integrated management, gaps remain in the effective utilization of laboratory and nursing services at the primary care level. Variations in service availability, training, and coordination limit the potential impact of these essential components. Therefore, evaluating the contribution of laboratory and nursing services is crucial for identifying system-level strengths and weaknesses and for informing policy and practice improvements.

In early detection and management of diabetes in primary care settings depend heavily on the combined efforts of laboratory and nursing services. Literature from 2010 to 2023 clearly demonstrates that timely laboratory diagnosis, continuous monitoring, and nurse-led education and follow-up significantly improve diabetes outcomes. Strengthening these services and promoting integrated care models can play a decisive role in reducing the growing burden of diabetes and its complications.

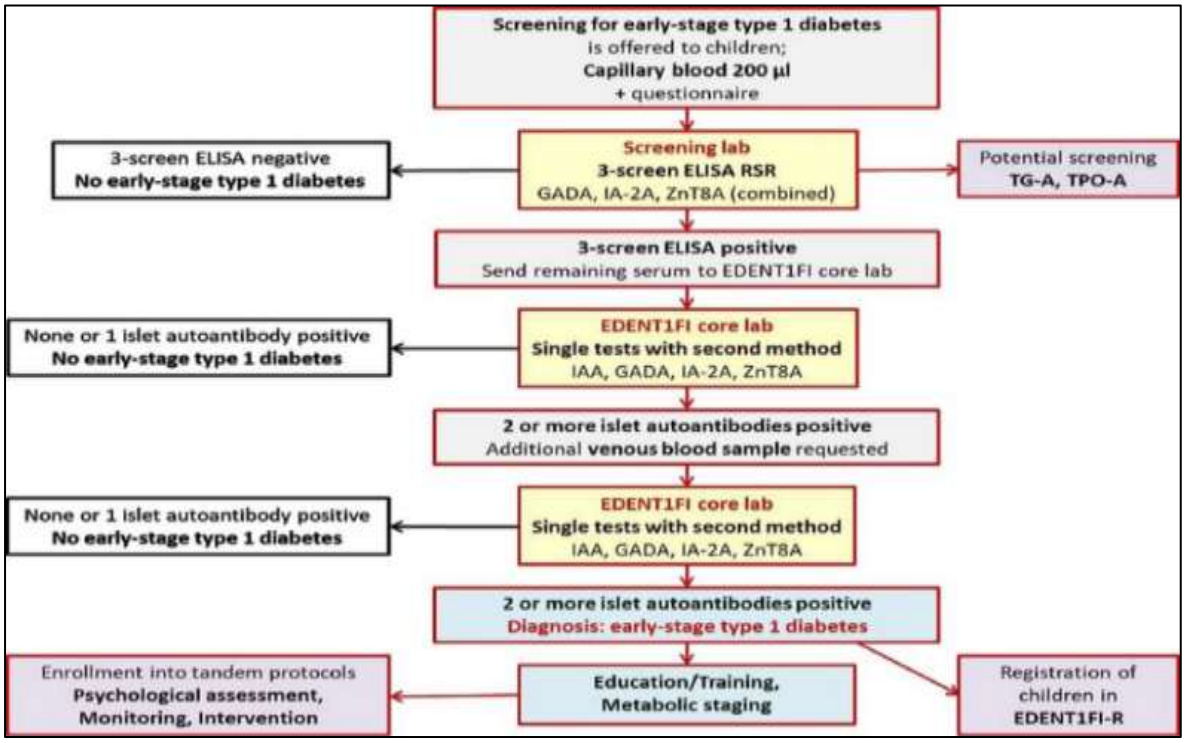
BURDEN OF DIABETES AND THE NEED FOR EARLY DETECTION

Diabetes mellitus has emerged as one of the most significant public health challenges of the twenty-first century. Its growing prevalence, long-term complications, and high economic cost place a substantial burden on individuals, families, health systems, and societies at large. The disease is no longer limited to urban or affluent populations; it increasingly affects rural communities and low- and middle-income countries, where access to timely diagnosis and continuous care is often limited. In this context, early detection of diabetes has become a critical strategy for reducing disease burden and improving health outcomes, particularly within primary care settings.

The burden of diabetes can be understood at multiple levels. At the individual level, diabetes is a lifelong condition that requires continuous self-management, including blood glucose monitoring, dietary regulation, physical activity, and medication adherence. Poorly controlled diabetes leads to serious complications such as cardiovascular disease, kidney failure, neuropathy, retinopathy, and lower-limb amputations. These complications significantly reduce quality of life and increase the risk of disability and premature mortality. Many individuals remain unaware of their diabetic status for years, during which silent damage to vital organs continues to progress.

At the health system level, diabetes imposes a heavy financial burden due to long-term treatment costs, frequent hospital admissions, and management of complications. Resources are often diverted toward treating advanced disease rather than preventing its onset or progression. This reactive approach strains primary and secondary care services, especially in resource-constrained settings. From a societal perspective, diabetes reduces workforce productivity through absenteeism, early retirement, and disability, thereby affecting economic growth and social well-being.

Fig. 1: Burden of diabetes extends



Early detection of diabetes plays a central role in addressing this burden. Diabetes often has a long asymptomatic phase, particularly in type 2 diabetes, during which individuals may feel healthy despite elevated blood glucose levels. Identifying the disease at this stage allows for timely intervention through lifestyle modification, patient education, and appropriate medical management. Evidence consistently shows that early diagnosis and prompt control of blood glucose can delay or prevent the onset of complications, reduce healthcare costs, and improve long-term outcomes.

Primary care settings are uniquely positioned to facilitate early detection of diabetes. They serve as the first point of contact for most individuals and provide continuous, community-based care. Routine screening of high-risk populations, such as individuals with obesity, family history of diabetes, sedentary lifestyles, or advancing age, can be effectively integrated into primary care services. However, successful early detection depends heavily on the coordinated contribution of laboratory and nursing services.

Laboratory services are essential for accurate and timely diagnosis of diabetes. Standard diagnostic tests such as fasting blood glucose, post-prandial glucose, and glycated hemoglobin provide objective evidence of glycemic status. Reliable laboratory support ensures early identification of undiagnosed cases and facilitates ongoing monitoring of disease control. In primary care settings, accessible and well-functioning laboratory services reduce diagnostic delays and support evidence-based clinical decision-making. Without dependable laboratory input, early detection efforts remain incomplete and ineffective.

Nursing services play an equally critical role in early detection and management of diabetes. Nurses are often the most accessible healthcare professionals in primary care and maintain close, continuous contact with patients. Their responsibilities extend beyond clinical procedures to include patient education, risk assessment, counseling, and follow-up care. Nurses can identify early warning signs,

encourage screening, and promote adherence to diagnostic testing. They also play a key role in educating patients about lifestyle changes, self-monitoring, and medication use following early diagnosis.

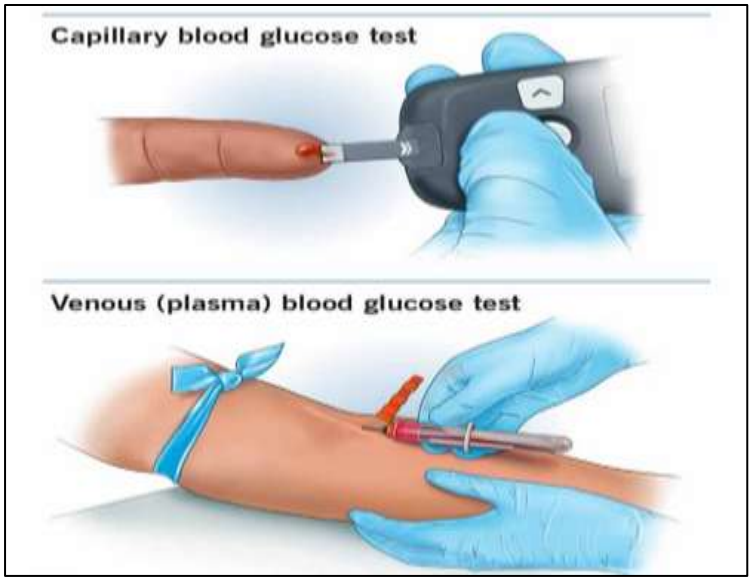
The integration of laboratory and nursing services within primary care strengthens the overall diabetes care pathway. Nurses facilitate screening and patient engagement, while laboratories provide diagnostic confirmation and monitoring data. Together, these services support a proactive approach that shifts diabetes care from late-stage treatment to early detection and prevention. This collaborative model is particularly valuable in primary care settings, where continuity of care and patient trust are central to effective disease management.

The burden of diabetes is substantial and multifaceted, affecting individuals, health systems, and society as a whole. Early detection is a powerful strategy to reduce this burden by preventing complications and improving long-term outcomes. Primary care settings, supported by efficient laboratory and nursing services, play a pivotal role in achieving early diagnosis and effective management. Strengthening these services is therefore essential for addressing the growing diabetes epidemic and improving population health outcomes.

ROLE OF LABORATORY SERVICES IN EARLY DETECTION OF DIABETES

Diabetes mellitus is a major public health concern worldwide, with a rapidly increasing prevalence, especially in low- and middle-income countries. Early detection of diabetes is essential to prevent long-term complications such as cardiovascular disease, kidney failure, neuropathy, and vision loss. In this context, laboratory services play a central role in the early identification, diagnosis, and monitoring of diabetes, particularly within primary care settings.

Fig. 2: Blood Glucose Test



Laboratory services provide objective and reliable biochemical evidence that enables early detection of abnormal glucose metabolism, often before clinical symptoms appear. Many individuals with type 2 diabetes remain asymptomatic for several years. Routine laboratory screening helps identify individuals at risk during this silent phase, allowing timely intervention through lifestyle modification and medical management.

The most important laboratory investigations for early detection of diabetes include fasting plasma glucose (FPG), post-prandial blood glucose (PPBG), glycated hemoglobin (HbA1c), and oral glucose tolerance test (OGTT). Among these, HbA1c has gained importance because it reflects average blood glucose levels over the previous two to three months and does not require fasting. Laboratory testing thus enables accurate classification of individuals into normal, pre-diabetic, and diabetic categories.

In primary care settings, laboratory services support physicians and nursing staff by confirming clinical suspicion and guiding treatment decisions. Early laboratory diagnosis allows healthcare providers to

initiate preventive strategies, such as dietary counseling, physical activity promotion, and weight management, before irreversible complications develop. This is especially important for high-risk populations, including the elderly, obese individuals, and those with a family history of diabetes.

Table 1: Contribution of Laboratory Services in Early Detection of Diabetes

Laboratory Test	Purpose	Contribution to Early Detection
Fasting Plasma Glucose (FPG)	Measures baseline blood glucose	Identifies early hyperglycemia
Post-Prandial Blood Glucose (PPBG)	Measures glucose after meals	Detects impaired glucose regulation
HbA1c	Reflects long-term glucose control	Identifies pre-diabetes and diabetes without fasting
Oral Glucose Tolerance Test (OGTT)	Assesses glucose metabolism	Detects impaired glucose tolerance
Lipid Profile	Measures cholesterol levels	Identifies metabolic risk factors

Quality laboratory services also ensure standardization, accuracy, and reliability of test results. Proper sample collection, handling, analysis, and reporting are essential for correct diagnosis. Regular calibration of equipment, adherence to quality control protocols, and trained laboratory personnel enhance the credibility of results, which directly influences patient management and outcomes.

Furthermore, laboratory services contribute to ongoing monitoring of diabetes. Periodic testing of blood glucose and HbA1c helps assess disease progression and effectiveness of treatment. Early identification of poor glycemic control through laboratory reports allows timely modification of therapy, reducing the risk of complications.

In community-based and primary healthcare programs, integration of laboratory services with nursing services strengthens early detection initiatives. Nurses often identify at-risk individuals during routine visits and refer them for laboratory testing. Thus, laboratory services act as a backbone of early detection strategies in diabetes care.

In laboratory services are indispensable in the early detection and management of diabetes. Through timely screening, accurate diagnosis, and continuous monitoring, laboratory investigations enable early intervention, improve patient outcomes, and reduce the long-term burden of diabetes on individuals and healthcare systems. Strengthening laboratory infrastructure in primary care settings is therefore crucial for effective diabetes prevention and control.

ROLE OF NURSING SERVICES IN EARLY DETECTION OF DIABETES

Early detection of diabetes is a critical component of effective disease management and prevention of long-term complications. In primary care settings, nursing services play a central role in identifying individuals at risk, facilitating timely diagnosis, and supporting early management strategies. Nurses act as the first point of contact for patients and are uniquely positioned to integrate clinical observation, health education, and community engagement into diabetes prevention efforts.

One of the most important contributions of nursing services is risk assessment. Nurses routinely collect patient histories, measure vital signs, and record anthropometric indicators such as body mass index (BMI) and waist circumference. Through these activities, they can identify common risk factors for diabetes, including obesity, family history, sedentary lifestyle, hypertension, and advancing age. By recognizing these indicators early, nurses help prioritize individuals who require further screening.

Nursing professionals are also actively involved in screening and preliminary testing. In many primary care centers, nurses conduct capillary blood glucose testing, fasting blood sugar checks, and random blood glucose measurements as part of routine health visits or community outreach programs. These basic assessments, when combined with laboratory confirmation, allow for early identification of prediabetes and undiagnosed diabetes. Nurses ensure that screening protocols are followed consistently, increasing the likelihood of detecting the disease at an early stage.

Table 2: Contribution of Nursing Services to Early Detection of Diabetes

Nursing Activity	Description	Impact on Early Detection
Risk assessment	Identification of lifestyle and clinical risk factors	Early identification of high-risk individuals
Screening support	Conducting blood glucose tests and basic assessments	Detection of undiagnosed diabetes and prediabetes
Health education	Awareness of symptoms and preventive behaviors	Increased health-seeking behavior
Coordination of care	Liaison with laboratories and physicians	Timely diagnosis and treatment initiation
Follow-up and monitoring	Tracking high-risk patients and compliance	Improved continuity and effectiveness of care

Another significant role of nursing services lies in patient education and awareness creation. Nurses educate individuals and families about early symptoms of diabetes such as excessive thirst, frequent urination, fatigue, and unexplained weight loss. They also provide guidance on healthy dietary practices, physical activity, and lifestyle modification. This educational role empowers patients to seek timely medical attention and participate actively in preventive care.

Nurses further contribute through coordination with laboratory services and physicians. They facilitate sample collection, ensure proper documentation, and communicate abnormal test results to clinicians. This coordination reduces delays in diagnosis and supports prompt initiation of management plans. In rural and resource-limited settings, nurses often serve as the link between patients and diagnostic facilities, thereby improving access to care.

Finally, nursing services support follow-up and continuity of care. Nurses track high-risk individuals, encourage regular monitoring, and reinforce adherence to recommended investigations and lifestyle changes. Early detection is most effective when combined with consistent follow-up, and nursing involvement ensures sustained patient engagement within the healthcare system.

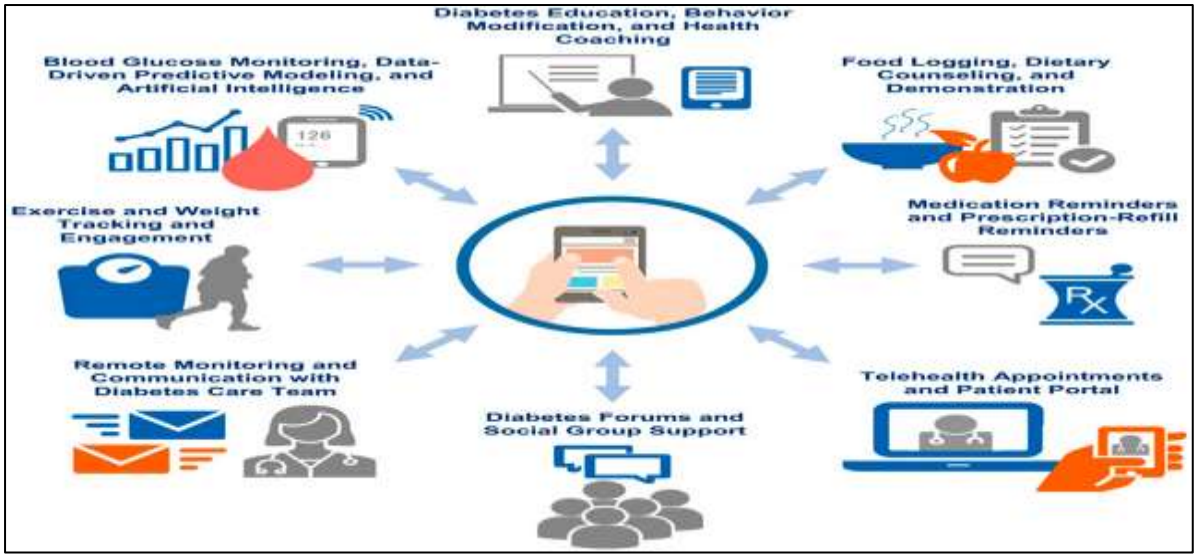
In nursing services are indispensable in the early detection of diabetes in primary care settings. Through risk assessment, screening, education, coordination, and follow-up, nurses significantly enhance early diagnosis and contribute to improved diabetes management outcomes.

NURSING SERVICES IN THE MANAGEMENT OF DIABETES

Diabetes mellitus is a major public health challenge worldwide, particularly in primary care settings where early detection and long-term management largely take place. Nursing services play a central role in the early identification, continuous monitoring, and effective management of diabetes. Along with laboratory services, nurses act as a crucial link between patients, diagnostic processes, and clinical decision-making. Their contribution is especially important in preventing complications and improving quality of life for individuals living with diabetes.

Early detection of diabetes depends not only on laboratory investigations such as fasting blood glucose, post-prandial glucose, and HbA1c levels, but also on effective nursing assessment. Nurses are often the first healthcare professionals to interact with patients in primary care. Through routine screening, history taking, and risk assessment, nurses help identify individuals at high risk, including those with obesity, family history, sedentary lifestyle, or gestational diabetes. By recognizing early symptoms such as polyuria, polydipsia, fatigue, and unexplained weight loss, nurses facilitate timely laboratory testing and diagnosis.

Fig. 3: Nursing Services



Once diabetes is diagnosed, nursing services become essential in ongoing disease management. Nurses support patients in understanding their condition, interpreting laboratory results, and adhering to treatment plans. Patient education is a key nursing responsibility and includes guidance on blood glucose monitoring, medication compliance, insulin administration, dietary modification, and physical activity. Such education empowers patients to actively participate in self-care, which is vital for long-term glycaemic control.

Nurses also play a significant role in coordinating care between laboratory services and physicians. They ensure that laboratory investigations are conducted regularly, results are properly documented, and abnormal findings are promptly communicated. This coordination helps in adjusting treatment regimens based on laboratory trends and clinical status. In primary care settings, where resources may be limited, nursing efficiency enhances the effectiveness of laboratory services by reducing delays and improving follow-up.

Another important contribution of nursing services is the prevention and early detection of diabetes-related complications. Through regular monitoring of blood pressure, foot examinations, wound assessment, and observation of signs of neuropathy or infection, nurses help identify complications at an early stage. Timely referral and intervention can significantly reduce the risk of severe outcomes such as diabetic foot ulcers, nephropathy, and cardiovascular disease.

Furthermore, nurses provide psychosocial support, which is often overlooked but essential in diabetes care. Living with a chronic condition can cause emotional stress, anxiety, and reduced treatment adherence. Nurses, through counseling and motivational support, help patients cope with lifestyle changes and maintain long-term engagement with care plans.

In nursing services are indispensable in the early detection and effective management of diabetes in primary care settings. By integrating clinical assessment, patient education, coordination with laboratory services, and continuous monitoring, nurses significantly enhance diabetes outcomes. Strengthening nursing capacity and collaboration with laboratory services can greatly improve early diagnosis, disease control, and prevention of complications, ultimately reducing the burden of diabetes on healthcare systems.

INTEGRATION OF LABORATORY AND NURSING SERVICES IN PRIMARY CARE

Diabetes mellitus has emerged as one of the most significant public health challenges worldwide, particularly in low- and middle-income countries. Early detection and timely management are essential to prevent long-term complications such as cardiovascular disease, nephropathy, neuropathy, and retinopathy. In this context, the integration of laboratory and nursing services within primary care settings plays a crucial role in strengthening diabetes prevention and control strategies.

Primary care serves as the first point of contact for individuals within the health system and is ideally positioned for early identification of diabetes. Laboratory services contribute significantly by providing essential diagnostic and monitoring tests, including fasting blood glucose, post-prandial glucose, glycated hemoglobin (HbA1c), lipid profile, and urine analysis. When these services are well integrated

into primary care, they enable prompt screening of high-risk individuals, accurate diagnosis, and continuous monitoring of disease progression. Timely laboratory results allow healthcare providers to make evidence-based decisions, adjust treatment plans, and evaluate the effectiveness of interventions. Nursing services complement laboratory functions by ensuring continuity of care and patient engagement. Nurses in primary care settings are often responsible for patient screening, risk assessment, sample collection, and follow-up. Through routine health check-ups, nurses can identify individuals with risk factors such as obesity, family history, sedentary lifestyle, and hypertension. They play a key role in coordinating laboratory investigations and ensuring that patients understand the purpose and importance of tests. This close interaction improves compliance with testing and follow-up visits.

Beyond diagnostic support, nursing services are central to diabetes management and education. Nurses provide counseling on lifestyle modification, including diet, physical activity, medication adherence, and self-monitoring of blood glucose. They also help patients interpret laboratory results in simple terms, reinforcing the link between test values and daily health behaviors. Such patient-centered education enhances self-management skills and empowers individuals to take an active role in controlling their condition.

The integration of laboratory and nursing services also improves efficiency and quality of care. Collaborative workflows reduce delays in diagnosis, minimize duplication of tests, and ensure systematic follow-up of abnormal results. In resource-limited settings, task sharing between laboratory personnel and nurses helps optimize available human resources while maintaining quality standards. This integrated approach supports early intervention, reduces the burden on tertiary care facilities, and lowers overall healthcare costs.

In the effective integration of laboratory and nursing services in primary care settings is essential for the early detection and management of diabetes. Laboratory services provide the scientific foundation for diagnosis and monitoring, while nursing services ensure patient engagement, education, and continuity of care. Strengthening this integration can lead to improved health outcomes, better disease control, and a more responsive primary healthcare system capable of addressing the growing burden of diabetes.

STRATEGIES FOR STRENGTHENING LABORATORY AND NURSING CONTRIBUTIONS

Diabetes mellitus is a growing public health challenge that requires early detection and continuous management, especially at the primary care level. Laboratory and nursing services play a central role in identifying individuals at risk, confirming diagnosis, and supporting long-term disease control. Strengthening their contributions can significantly improve diabetes outcomes, reduce complications, and lower healthcare costs.

One key strategy is enhancing the capacity of laboratory services for timely and accurate screening. Primary care laboratories should be equipped to perform essential tests such as fasting blood glucose, random blood glucose, HbA1c, and urine glucose analysis. Regular calibration of equipment, use of standardized testing protocols, and quality assurance mechanisms are necessary to ensure reliable results. Early detection depends not only on the availability of tests but also on prompt reporting and effective communication of results to clinicians and nurses for immediate action.

Nursing services are equally critical in diabetes prevention and management. Nurses are often the first point of contact in primary care settings and are well positioned to identify high-risk individuals based on age, family history, obesity, lifestyle, and pregnancy-related factors. Strengthening nurses' roles through targeted training in diabetes screening, patient counseling, and basic interpretation of laboratory results can improve early case identification. Nurses can also ensure that patients complete recommended laboratory investigations and return for follow-up visits.

Table 4: Contribution of Laboratory and Nursing Services in Diabetes Care

Component	Laboratory Services	Nursing Services
Early Detection	Blood glucose and HbA1c testing	Risk assessment and patient screening
Diagnosis	Confirmatory biochemical tests	Coordination of diagnostic procedures
Management	Monitoring glucose control	Patient education and medication adherence
Follow-up	Periodic laboratory monitoring	Continuous care and lifestyle counseling
Prevention	Community screening support	Health promotion and awareness programs

Another important strategy is integrating laboratory and nursing services through team-based care models. Effective coordination allows nurses to use laboratory data to guide patient education, medication adherence, and lifestyle modification counseling. For example, explaining HbA1c results in simple language helps patients understand long-term glucose control and motivates behavioral change. Such collaboration reduces delays in care and improves continuity of diabetes management.

Capacity building through continuous professional development is also essential. Regular training programs for laboratory technicians and nurses on updated diagnostic guidelines, new testing methods, and patient-centered care approaches strengthen service quality. In addition, adopting digital health tools, such as electronic medical records and laboratory information systems, can improve data sharing, monitoring, and follow-up of diabetic patients.

Finally, community-oriented nursing initiatives supported by laboratory screening can enhance early detection at the population level. Outreach camps, workplace screening programs, and antenatal clinics can identify undiagnosed diabetes and pre-diabetes cases. Nurses can lead these initiatives, while laboratories provide confirmatory testing, creating an effective preventive care framework.

In strengthening laboratory and nursing contributions requires improved infrastructure, skill development, service integration, and community engagement. When laboratory accuracy and nursing care coordination are optimized, primary care systems become more effective in the early detection and management of diabetes.

CONCLUSION

Early detection and effective management of diabetes are essential for reducing the burden of this chronic disease. Laboratory and nursing services play a central role in achieving these goals within primary care settings. Laboratory services provide the diagnostic and monitoring tools necessary for accurate and timely clinical decisions, while nursing services offer continuous, patient-centered care through screening, education, and support.

Strengthening these services and promoting integrated care models can significantly improve diabetes outcomes. Policymakers and healthcare administrators must recognize and invest in the contributions of laboratory and nursing professionals to build resilient primary care systems capable of addressing the growing diabetes epidemic.

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