

Review Article
Laboratory Science

The Role of Clinical Laboratory Professionals and Diabetes Educators in Enhancing Diagnostic Accuracy and Patient Outcomes in Diabetes Management

Abdulaziz Abdullah Felemban^{1*}, Latifah Khaled Ahmed Alfahaid¹, Sarah Ahmed Abdurahman Alghamdi², Ahmed Mazzyd Al Mutairi³, Sulaiman Abdurahman Sulaiman Alotaib¹, Mona Sami Hamli³, Samar Sulaiman Alderaiwesh⁴, Sarah Bandar Alotaibi¹

¹Clinical Laboratory Sciences, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

²Medical Laboratories, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

³Medical Laboratory Technician, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

⁴Diabetes Education Specialist, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

DOI: <https://doi.org/10.36348/sjimps.2025.v11i07.020>

Received: 02.06.2025 | **Accepted:** 22.07.2025 | **Published:** 23.07.2025

***Corresponding author:** Abdulaziz Abdullah Felemban

Clinical Laboratory Sciences, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

Abstract

Clinical laboratory professionals and diabetes educators play pivotal roles in improving diagnostic accuracy and patient outcomes in diabetes management. Laboratory professionals are responsible for conducting precise and reliable laboratory tests, such as fasting blood glucose, HbA1c, and oral glucose tolerance tests, which are crucial for diagnosing diabetes and assessing glycemic control. Their expertise ensures that test results are accurate, timely, and interpreted correctly to aid clinicians in making informed treatment decisions. Additionally, they maintain strict quality control measures and stay updated with advancements in diagnostic technologies to minimize errors and improve the overall quality of laboratory data used in diabetes care. Diabetes educators complement this by empowering patients through education about disease management, medication adherence, lifestyle modifications, and self-monitoring techniques. They help interpret test results and translate complex medical information into understandable advice, enhancing patient compliance and engagement. This collaborative approach between laboratory professionals and educators ensures that diabetes is managed effectively, reducing the risk of complications and enhancing patient outcomes. Together, they create a comprehensive support system that promotes accurate diagnosis, personalized treatment plans, and sustained disease control.

Keywords: Clinical laboratory professionals, diabetes educators, diagnostic accuracy, patient outcomes, diabetes management, laboratory testing, HbA1c, self-monitoring, patient education, quality control, disease management.

Copyright © 2025 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

The global prevalence of diabetes mellitus has reached alarming levels, posing a significant threat to public health and placing a substantial burden on healthcare systems worldwide. Effective diabetes management is crucial for preventing or delaying the onset of debilitating complications, such as cardiovascular disease, nephropathy, neuropathy, and retinopathy. This necessitates a multidisciplinary approach involving various healthcare professionals, with clinical laboratory professionals and diabetes educators playing pivotal roles. This research aims to explore and elucidate the contributions of clinical laboratory professionals and diabetes educators in

enhancing diagnostic accuracy and patient outcomes in diabetes management [1].

Clinical laboratory professionals are instrumental in providing accurate and reliable diagnostic information essential for diabetes screening, diagnosis, and monitoring. Their expertise in performing and interpreting a wide range of laboratory tests, including glycated hemoglobin (HbA1c), fasting plasma glucose (FPG), oral glucose tolerance test (OGTT), and lipid profiles, is critical for identifying individuals at risk of developing diabetes and for guiding treatment decisions. Furthermore, clinical laboratories are increasingly utilizing advanced technologies and automation to improve the efficiency and accuracy of

diabetes-related testing. Quality control measures and adherence to established guidelines are paramount to ensure the reliability of laboratory results and minimize the potential for errors that could compromise patient care [2].

Diabetes educators, on the other hand, are healthcare professionals who possess specialized knowledge and skills in diabetes self-management education and support. They work collaboratively with individuals with diabetes to empower them with the knowledge, skills, and confidence to effectively manage their condition. Diabetes educators provide individualized education on various aspects of diabetes care, including blood glucose monitoring, medication management, nutrition therapy, exercise, and prevention of complications. They also play a vital role in promoting patient adherence to treatment plans and fostering lifestyle modifications that can improve glycemic control and overall health outcomes. The effectiveness of diabetes education programs has been well-documented, with studies demonstrating significant improvements in HbA1c levels, blood pressure, lipid profiles, and quality of life among individuals who participate in such programs [3].

The synergy between clinical laboratory professionals and diabetes educators is crucial for optimizing diabetes management. Accurate laboratory data provides the foundation for informed clinical decision-making, while effective diabetes education empowers patients to actively participate in their own care. By working together, these professionals can contribute to earlier diagnosis, improved glycemic control, reduced risk of complications, and enhanced quality of life for individuals with diabetes [4].

Overview of Diabetes Mellitus: Pathophysiology and Diagnostic Challenges:

Diabetes mellitus is a complex chronic metabolic disorder characterized chiefly by elevated blood glucose levels (hyperglycemia) resulting from defects in insulin secretion, insulin action, or both. It is a global health concern with increasing prevalence, significant morbidity, and mortality due to its associated complications. Understanding the pathophysiological mechanisms underlying diabetes is crucial for its effective diagnosis, treatment, and management. Furthermore, the diagnostic process presents considerable challenges due to the heterogeneity of the disease, variations in clinical presentation, and limitations of current diagnostic tools [5].

Pathophysiology of Diabetes Mellitus

Diabetes mellitus can be broadly categorized into two major types: Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM), alongside other less common forms such as gestational diabetes and monogenic diabetes [5].

Type 1 Diabetes Mellitus:

T1DM is an autoimmune condition characterized by the immune system-mediated destruction of pancreatic beta cells in the islets of Langerhans. The loss of these insulin-producing cells leads to absolute insulin deficiency. This autoimmune attack involves a complex interplay of genetic predisposition, environmental triggers (e.g., viral infections), and aberrant immune responses. The onset is usually acute and occurs primarily in children and young adults, although it can manifest at any age. Without insulin therapy, T1DM leads to severe hyperglycemia and metabolic derangements [6].

Type 2 Diabetes Mellitus:

T2DM accounts for approximately 90-95% of all diabetes cases worldwide. Its pathophysiology is multifactorial and includes insulin resistance combined with an inadequate compensatory insulin secretory response by pancreatic beta cells. Insulin resistance is a state where peripheral tissues—primarily muscle, fat, and liver—fail to respond effectively to circulating insulin, impairing glucose uptake and promoting hepatic glucose production. This insulin-resistant state is frequently associated with obesity, sedentary lifestyle, and genetic factors. Over time, beta cell dysfunction progresses, exacerbating hyperglycemia. Unlike T1DM, T2DM often develops gradually and is commonly diagnosed in adults, although its incidence in younger populations is rising due to increasing obesity rates [7].

Other Forms of Diabetes:

Other types include gestational diabetes mellitus (GDM), which occurs during pregnancy due to hormonal changes that induce insulin resistance, and various monogenic forms involving specific genetic mutations affecting beta cell function or insulin action. Secondary diabetes may result from diseases of the pancreas, endocrinopathies, or certain medications [8].

Diagnostic Challenges in Diabetes Mellitus

Despite advances in understanding diabetes, accurately diagnosing the condition remains challenging for several reasons.

1. Heterogeneous Clinical Presentation:

Diabetes symptoms can vary widely. While classic symptoms include polyuria, polydipsia, polyphagia, and unexplained weight loss, many individuals, particularly those with T2DM, remain asymptomatic in the early stages. This asymptomatic or subclinical phase leads to delayed diagnosis and increased risk of complications at presentation [9].

2. Variability in Diagnostic Criteria and Tests:

The diagnosis of diabetes relies largely on biochemical testing of blood glucose levels. Common diagnostic tests include fasting plasma glucose (FPG), the oral glucose tolerance test (OGTT), and measurement of glycated hemoglobin (HbA1c). Each test has its advantages and limitations [10].

- Fasting Plasma Glucose: Measures blood glucose after an overnight fast. While convenient, it may miss early postprandial hyperglycemia [10].
- Oral Glucose Tolerance Test: Measures blood glucose before and after a glucose load. It is sensitive but cumbersome and time-consuming.
- HbA1c: Reflects average blood glucose over the past 2-3 months and does not require fasting. However, its accuracy may be affected by hemoglobinopathies, anemia, and conditions altering red blood cell lifespan [11].

Different organizations such as the American Diabetes Association (ADA) and the World Health Organization (WHO) have slightly varying diagnostic thresholds, adding to the complexity.

3. Overlap Between Prediabetes and Diabetes:

Prediabetes is a state of intermediate hyperglycemia associated with increased risk of progression to diabetes. Identifying individuals with prediabetes requires sensitive and specific diagnostic criteria. However, considerable overlap exists in glucose values between normal, prediabetes, and diabetic ranges. This gray area complicates clinical decision-making [12].

Distinguishing Diabetes Types:

Differentiating T1DM from T2DM sometimes poses a challenge, particularly in adults who may present with features of both forms (e.g., latent autoimmune diabetes in adults - LADA). Misclassification can affect treatment strategy. Autoantibody testing and C-peptide measurement can aid diagnosis but are not routinely employed in all settings.

4. Impact of Comorbid Conditions:

Coexisting medical conditions such as liver disease, renal impairment, and acute illness can affect glucose metabolism and diagnostic test results. Additionally, certain ethnic groups may have different risk profiles and diagnostic characteristics, necessitating tailored approaches [13].

Functions and Responsibilities of Clinical Laboratory Professionals in Diabetes Diagnosis:

Diabetes mellitus is a chronic metabolic disease characterized by elevated blood glucose levels, which, if left unmanaged, can lead to serious complications including cardiovascular disease, kidney failure, neuropathy, and retinopathy. Accurate diagnosis and monitoring are essential in preventing these outcomes and managing patient health effectively. Clinical laboratory professionals play a crucial role in the diagnosis, monitoring, and management of diabetes through their expertise in performing and interpreting biochemical and hematological tests [14].

1. Sample Collection and Handling

One of the foundational responsibilities of clinical laboratory professionals is ensuring proper sample collection and handling. In diabetes diagnosis, blood samples—usually venous blood—are collected for various tests like fasting plasma glucose (FPG), oral glucose tolerance test (OGTT), and glycated hemoglobin (HbA1c). Accurate blood collection requires adherence to standardized procedures to avoid pre-analytical errors such as hemolysis, contamination, and incorrect anticoagulant usage. Proper labeling, storage, and timely transport to the laboratory are equally critical to maintain sample integrity and ensure reliable test results [15].

2. Performing Diagnostic Tests

Clinical laboratory professionals are responsible for performing diagnostic tests that confirm the presence of diabetes. The most common tests include:

- Fasting Plasma Glucose (FPG): Measures blood glucose after an overnight fast. An FPG level ≥ 126 mg/dL (7.0 mmol/L) is indicative of diabetes [15].
- Oral Glucose Tolerance Test (OGTT): Involves measuring blood glucose two hours after ingestion of a glucose-rich drink. A two-hour value ≥ 200 mg/dL (11.1 mmol/L) confirms diabetes.
- Glycated Hemoglobin (HbA1c): Reflects average blood glucose over 2 to 3 months. An HbA1c level $\geq 6.5\%$ is diagnostic of diabetes [16].

These tests require clinical laboratory professionals to operate and maintain advanced analytical instruments such as spectrophotometers, high-performance liquid chromatographs (HPLC), and point-of-care testing devices, ensuring precision and accuracy in results [17].

3. Quality Control and Assurance

Ensuring accuracy and reliability of laboratory results is paramount in diabetes diagnosis. Clinical laboratory professionals are responsible for implementing rigorous quality control (QC) and quality assurance (QA) protocols. This includes the use of control materials, calibration of instruments, participation in proficiency testing programs, and adherence to standardized operating procedures established by regulatory bodies such as the Clinical Laboratory Improvement Amendments (CLIA) and International Organization for Standardization (ISO). By maintaining high-quality standards, laboratory professionals help prevent diagnostic errors that could impact patient care [18].

4. Interpretation and Reporting

Beyond generating test results, clinical laboratory professionals contribute to the interpretation of findings in collaboration with physicians. While final diagnosis is a clinical task, lab professionals provide

critical insights regarding test validity, possible interferences, and recommendations for repeat testing or additional assays when results are borderline or inconsistent. They prepare clear and detailed laboratory reports that include reference ranges and comments on abnormal findings, facilitating appropriate clinical decision-making [19].

5. Patient Safety and Confidentiality

Laboratory professionals also ensure patient safety by adhering to sanitary protocols to prevent infections and cross-contamination during sample handling. Additionally, they uphold ethical standards to protect patient confidentiality by securely managing patient data and test results in compliance with regulations such as the Health Insurance Portability and Accountability Act (HIPAA) [20].

6. Continuing Education and Research

The field of clinical laboratory science is continually evolving with advances in technology and emerging biomarkers for diabetes diagnosis. Clinical laboratory professionals have the responsibility to engage in continuing education to stay abreast of current best practices, novel diagnostic techniques, and updated clinical guidelines. They may also participate in research activities to validate new diagnostic tools or improve existing methodologies, thereby contributing to enhanced diabetes care [20].

The Diagnostic Tools and Techniques Employed by Laboratory Experts:

In the realm of modern healthcare and scientific research, laboratory experts play an indispensable role in diagnosing diseases, understanding pathological conditions, and guiding therapeutic interventions. The accuracy of diagnosis and the effectiveness of subsequent treatment largely depend on the sophisticated tools and techniques employed in clinical and research laboratories [21].

Laboratory diagnostics is a multidisciplinary field encompassing clinical chemistry, microbiology, hematology, molecular biology, immunology, and pathology. Each specialty employs specific instruments and assays tailored to detect, quantify, and analyze biological markers, cells, microorganisms, or genetic material. The development and refinement of diagnostic technologies over the decades have transformed traditional laboratory practices into highly automated, precise, and rapid processes [22].

One of the fundamental tools in laboratory diagnostics is the microscope. Microscopic examination remains crucial for analyzing blood smears, tissue biopsies, microbial cultures, and cytological samples. Modern light microscopes equipped with advanced optics and digital imaging facilitate detailed visualization of cellular morphology, enabling pathologists to identify abnormalities such as cancer

cells, blood disorders, or infectious agents. In specialized laboratories, electron microscopes provide ultrastructural details at the nanometer scale, essential for understanding cellular and viral architecture [23].

Clinical biochemistry laboratories rely heavily on automated analyzers to measure concentrations of metabolites, enzymes, hormones, and electrolytes in bodily fluids. Techniques such as spectrophotometry, fluorometry, and immunoassays (including ELISA and chemiluminescence assays) allow for precise quantification of analytes that serve as biomarkers of organ function, nutritional status, or disease states. These assays are vital for detecting conditions like diabetes, liver dysfunction, cardiovascular diseases, and endocrine disorders [24].

Microbiology laboratories utilize culture methods combined with biochemical testing and susceptibility assays to identify pathogens and guide antimicrobial therapy. However, the advent of molecular diagnostics has revolutionized pathogen detection. Polymerase chain reaction (PCR) and nucleic acid amplification tests (NAATs) amplify specific DNA or RNA sequences, enabling rapid and sensitive identification of viruses, bacteria, fungi, and parasites even when the organisms are present in minute quantities. These molecular tools are invaluable during outbreaks and for diagnosing infections that are difficult to culture [25].

Hematology laboratories employ a battery of tests to evaluate blood components and coagulation profiles. Automated hematology analyzers count and characterize red blood cells, white blood cells, and platelets, providing vital information for diagnosing anemia, leukemias, clotting disorders, and infections. Coagulation studies such as prothrombin time and activated partial thromboplastin time help assess bleeding and thrombotic risks. Flow cytometry further enhances hematological diagnostics by enabling detailed phenotyping of blood and bone marrow cells, essential in leukemia and lymphoma diagnosis [26].

Immunology leverages the immune system's specificity to detect antibodies, antigens, and immune complexes that signify infection, autoimmune diseases, or allergies. Techniques such as immunofluorescence microscopy, western blotting, and radioimmunoassays complement serological testing. More recently, multiplex assays and microarrays allow simultaneous detection of multiple analytes, increasing diagnostic throughput and efficiency [27].

Molecular pathology integrates genomic and proteomic technologies to analyze genetic alterations, expression patterns, and protein modifications within tissues. Techniques like fluorescence in situ hybridization (FISH), next-generation sequencing (NGS), and mass spectrometry provide comprehensive

insights into cancer genomics, hereditary disorders, and personalized medicine. These high-throughput, data-rich platforms have expanded the diagnostic landscape beyond traditional histopathology [28].

Quality assurance is a fundamental component in laboratory diagnostics, ensuring reliability and standardization. Laboratories implement internal and external quality control programs, proficiency testing, and accreditation standards to maintain accuracy and reproducibility of results. Automation and informatics systems facilitate data management, traceability, and integration with clinical decision-making processes [29].

Strategies Employed by Diabetes Educators to Improve Patient Compliance:

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels due to defects in insulin secretion, insulin action, or both. Managing diabetes effectively requires patients to adhere to complex and often demanding treatment regimens that include medication adherence, dietary modifications, physical activity, blood glucose monitoring, and regular medical consultations. Given the multifaceted nature of diabetes management, patient compliance or adherence to prescribed treatment plans is crucial for preventing acute complications and reducing the risk of long-term sequelae such as cardiovascular disease, neuropathy, retinopathy, and nephropathy [30].

Diabetes educators play a pivotal role in improving patient compliance by employing a variety of strategies tailored to the individual needs of patients. These strategies aim to enhance patients' understanding of diabetes, motivate behavioral changes, address barriers to adherence, and provide ongoing support [31].

1. Patient-Centered Education and Personalized Care Plans

One of the fundamental strategies is delivering patient-centered education that is customized to the patient's literacy level, cultural background, and personal circumstances. Diabetes educators assess the patient's knowledge about diabetes and its complications to identify knowledge gaps and misconceptions. They then provide clear, concise, and relevant information about the pathophysiology of diabetes, the importance of glycemic control, and details about treatment options [32].

Personalized care plans are developed collaboratively, taking into account the patient's lifestyle, preferences, and challenges. By involving patients in the decision-making process, educators enhance patients' sense of ownership and commitment to the treatment plan, which improves compliance [33].

2. Behavioral Counseling and Motivational Interviewing

Behavioral counseling techniques, including motivational interviewing, are used to facilitate behavioral change and enhance self-efficacy. Motivational interviewing is a client-centered approach that helps patients resolve ambivalence about change and fosters intrinsic motivation. It involves active listening, empathy, and guiding patients to articulate their reasons for change and personal goals [34].

By focusing on patients' values and goals, educators help them build confidence to adopt healthier behaviors such as adhering to medication schedules, modifying diets, and engaging in regular physical activity [34].

3. Simplifying Treatment Regimens

Complex treatment regimens can be overwhelming, leading to poor adherence. Diabetes educators work with healthcare providers to simplify medication schedules, reduce pill burden, and coordinate treatment plans that are feasible for the patient's daily routine. They educate patients on the proper use of insulin devices and provide training on self-monitoring of blood glucose, thereby enhancing patient competence and reducing errors [35].

4. Utilizing Technology and Digital Health Tools

The incorporation of technology such as mobile health applications, telemedicine, and continuous glucose monitoring systems has become an integral strategy. Diabetes educators assist patients in using these tools to track glucose levels, medication intake, diet, and physical activity. These digital platforms often include reminders, educational content, and feedback mechanisms that promote adherence and enable timely interventions [35].

5. Providing Emotional Support and Addressing Psychosocial Barrier

Psychosocial factors such as depression, anxiety, social stigma, and limited social support can adversely affect adherence. Diabetes educators assess these barriers and provide or refer patients to appropriate counseling and support groups. Building a supportive relationship helps patients feel understood and motivated, which positively influences compliance [36].

6. Continuous Monitoring and Follow-up

Regular follow-ups are essential for reinforcing education, monitoring progress, and addressing emerging issues. Diabetes educators employ scheduled visits, phone calls, or virtual check-ins to review self-management practices, troubleshoot problems, and adjust care plans as needed. This ongoing engagement fosters accountability and sustained adherence [36].

7. Family Involvement and Support Systems

Educators recognize that family members often influence patients' health behaviors. Involving family in education sessions helps create a supportive environment that facilitates adherence. Family members can assist with medication administration, encourage healthy eating, and support lifestyle changes [37].

Training and Continuing Education for Clinical Laboratory Professionals and Diabetes Educator:

In modern healthcare, the roles of clinical laboratory professionals and diabetes educators are pivotal to ensuring accurate diagnosis, effective treatment, and ongoing patient management. These professionals wield specialized knowledge and technical skills essential for patient care, making their training and continuing education critical [38].

Training for Clinical Laboratory Professionals
Clinical laboratory professionals, including medical laboratory scientists and technicians, operate sophisticated equipment and perform complex analyses to provide vital data for patient diagnosis and treatment monitoring. Their initial training typically involves obtaining degrees in medical laboratory science, clinical pathology, or related fields, often including hands-on clinical internships [39].

The foundational education aims to equip professionals with knowledge in biochemistry, microbiology, hematology, immunology, molecular diagnostics, and laboratory safety. Accreditation by professional bodies ensures standardized curricula. Additionally, certification exams validate proficiency and competency [40].

Continuing education for these professionals is indispensable, given the rapid advancement of laboratory technologies, methods, and regulations. For example, the rise of molecular diagnostics and personalized medicine requires ongoing skill development. Continuing education programs include workshops, online courses, seminars, and professional conferences. Regulatory bodies and professional associations often mandate a certain number of continuing education credits to maintain certification and licensure [41].

Training for Diabetes Educators
Diabetes educators play a fundamental role in patient education, helping individuals manage their condition through lifestyle adjustments, medication adherence, and self-monitoring techniques. Their training centers on comprehensive understanding of diabetes pathophysiology, treatment modalities, nutrition, behavioral strategies, and counseling skills [42].

Initial certification as a diabetes educator, often attained through organizations such as the National Certification Board for Diabetes Educators (NCBDE),

requires a combination of healthcare-related educational background, clinical experience, and successful completion of an examination. This ensures educators possess both theoretical knowledge and practical skills necessary to address diverse patient needs [43].

Continuing education for diabetes educators is vital to keep pace with new research, emerging therapies such as novel insulin formulations, continuous glucose monitoring systems, and evolving clinical guidelines. Topics may also cover cultural competence, motivational interviewing, and use of digital health tools. Continuing education opportunities include webinars, refresher courses, specialized training sessions, and professional symposia [44].

Interrelationship and Importance of Lifelong Learning
Both clinical laboratory professionals and diabetes educators operate in dynamic fields influenced by scientific discoveries and technological innovation. Lifelong learning equips these practitioners to adapt to change, improve patient outcomes, and advocate for quality care [45].

Moreover, interdisciplinary collaboration between these professionals enhances comprehensive diabetes care. Accurate lab results guide treatment decisions that educators help patients implement effectively [46].

Challenges and Opportunities
Barriers to optimal training and continuing education may include limited access to programs, time constraints, and funding issues. However, advances in digital technologies provide innovative solutions, such as e-learning platforms and virtual simulations, broadening accessibility [46].

Employers and professional organizations play crucial roles by fostering supportive environments, providing resources, and recognizing professional development efforts [46].

Barriers and Challenges in Optimizing Diagnostic and Educational Practices:

Optimizing diagnostic and educational practices is critical to improving outcomes in healthcare and education systems worldwide. Despite advances in technology, research, and methodologies, numerous barriers and challenges continue to impede the full realization of effective diagnostic and educational approaches [47].

1. Systemic Barriers

One of the fundamental challenges lies within healthcare and educational systems themselves. In many regions, fragmented healthcare infrastructures lead to ineffective coordination among clinicians, diagnosticians, and specialists, thereby introducing delays and inconsistencies in diagnostic processes.

Similarly, educational systems often suffer from bureaucracy, limited funding, and unequal resource distribution. For example, schools in underprivileged areas may lack access to advanced diagnostic tools for learning disabilities or sufficient training for educators to identify such conditions early [48].

Moreover, standardized testing and rigid curricula frequently limit the ability to customize educational interventions based on accurate diagnostic information about student needs. In healthcare, rigid protocols and insurance restrictions can limit clinicians' flexibility to adopt innovative or personalized diagnostic methods. These systemic constraints create environments where optimization efforts face significant hurdles [49].

2. Technological Challenges

While technology holds promise for improving diagnostics and education, several technological barriers exist. Diagnostic tools, such as imaging modalities and biomarker assays, require high levels of technical expertise and maintenance. Health facilities that cannot afford or maintain such technology are forced to rely on less optimal methods. Additionally, the rapid evolution of technology poses challenges related to integrating new tools into existing workflows and ensuring that practitioners are adequately trained to use them effectively [50].

In education, technology-driven assessments and learning analytics depend heavily on data quality and privacy safeguards. Inadequate digital infrastructure and concerns about data security can hinder the deployment of digital diagnostic tools in classrooms. Moreover, overreliance on technology risks overlooking important qualitative nuances that human judgment and interaction can provide [51].

3. Human Factors

The human element is perhaps among the most complex barriers to optimizing both diagnostic and educational processes. In healthcare, diagnostic errors often arise from cognitive biases, lack of experience, or fatigue among medical professionals. Effective diagnostic practices require continual education and practice, yet ongoing professional development opportunities may be limited or inconsistently available [52].

In educational settings, educators' understanding of diagnostic assessments critically influences their ability to apply findings constructively. Without sufficient training in interpreting diagnostic results, teachers may struggle to tailor instructional strategies effectively. Resistance to change and varying levels of receptivity toward new diagnostic tools or methods also hinder progress [53].

Communication between diagnosticians, educators, patients, and students is essential but frequently imperfect. Misunderstandings or misinterpretations of diagnostic information can lead to inappropriate treatment or teaching approaches, exacerbating issues.

4. Socio-Cultural and Economic Factors

Socio-cultural factors play a significant role in shaping access to diagnostic and educational resources. Stigma associated with certain conditions, such as mental health disorders or learning disabilities, may prevent timely diagnosis and intervention. Cultural differences in perceptions of illness or learning challenges can affect the willingness of individuals to seek or accept diagnostic evaluations [54].

Economic disparities further amplify these issues. Populations with lower socioeconomic status often experience limited access to high-quality diagnostic services and educational support, perpetuating cycles of disadvantage. Geographic barriers in rural or underserved areas restrict availability of specialized diagnostic facilities and trained professionals [55].

Additionally, policy-level challenges, including inconsistent regulations and lack of public awareness campaigns, contribute to uneven prioritization and funding of diagnostic and educational improvements [56].

5. Ethical and Privacy Considerations

Increasingly sophisticated diagnostic and educational technologies raise ethical concerns related to privacy, consent, and data use. Ensuring that diagnostic data is collected, stored, and used responsibly is paramount to maintaining trust among patients and learners. Balancing the benefits of data-driven approaches with the risks of misuse or breaches is a continual challenge requiring robust regulatory frameworks and stakeholder engagement [57].

Future Directions in Integrating Laboratory and Educational Roles for Diabetes Management:

Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose levels resulting from defects in insulin secretion, insulin action, or both. Its management is complex, requiring ongoing monitoring, patient education, lifestyle modifications, and pharmacological interventions. The integration of laboratory services and educational roles is becoming increasingly recognized as a pivotal approach to optimize diabetes care. As the prevalence of diabetes continues to rise globally, future directions in healthcare increasingly emphasize cohesive collaboration between laboratory diagnostics and patient education to improve clinical outcomes, enhance patient engagement, and reduce the burden of complications associated with diabetes [58].

The Role of Laboratory Services in Diabetes Management

Laboratory testing plays a foundational role in both the diagnosis and ongoing management of diabetes. Key laboratory assessments include fasting plasma glucose, oral glucose tolerance tests, and glycated hemoglobin (HbA1c) measurements. HbA1c, in particular, provides a long-term glycemic control indicator, guiding therapeutic decisions and assessing the risk of complications. Beyond glucose monitoring, laboratories also assess lipid profiles, kidney function, and other parameters critical for comprehensive diabetes care [59].

Advances in laboratory technologies, such as continuous glucose monitoring systems and point-of-care testing devices, have enabled more timely and convenient assessment of blood glucose levels. These advancements facilitate tighter glycemic control and allow for rapid therapeutic adjustments. Furthermore, the emergence of biomarkers linked to inflammation, oxidative stress, and beta-cell function holds promise for personalized diabetes management strategies in the future [60].

Educational Roles in Diabetes Care

Patient education is indispensable in diabetes management. Effective education empowers patients to understand their condition, recognize symptoms of hypo/hyperglycemia, adhere to therapies, and adopt lifestyle modifications. Educational initiatives encompass dietary counseling, physical activity guidance, medication adherence, and self-monitoring techniques. Diabetes self-management education and support (DSMES) programs have demonstrated efficacy in improving glycemic outcomes and quality of life [61].

Traditionally, educational roles have been led by diabetes educators, dietitians, nurses, and physicians who provide structured counseling and resources. However, challenges such as limited access to educators, variable health literacy among patients, and socioeconomic barriers can impede effective education delivery [62].

Integrating Laboratory and Educational Roles: Current Trends

Integrating laboratory and educational functions streamlines diabetes care and promotes a comprehensive approach. Immediate feedback of laboratory results during educational sessions enables the clinician-educator to tailor advice based on real-time data. For example, reviewing HbA1c results alongside dietary and medication adherence enhances patient understanding of how specific behaviors impact glycemic control [63].

Clinical decision support tools and electronic health record (EHR) integration facilitate seamless data flow between laboratories and care providers. Patient

portals and mobile health applications allow patients to access their laboratory results and educational content remotely, fostering continuous engagement and self-management [64].

Future Directions in Integration

1. Personalized Diabetes Management Through Data Integration

The future will likely see enhanced integration of multifaceted data streams—including genomic, metabolomic, and continuous glucose monitoring data—into laboratory reports to inform personalized education plans. Tailored interventions based on an individual's unique metabolic profile and lifestyle will improve engagement and efficacy [65].

2. Artificial Intelligence (AI) and Predictive Analytics

AI algorithms applied to laboratory data and patient-reported outcomes can identify patterns predictive of disease progression or complications. These insights can trigger targeted educational interventions or therapy adjustments preemptively, thereby reducing adverse events [65].

3. Virtual and Augmented Reality (VR/AR) in Patient Education

Innovative educational tools such as VR/AR can incorporate real laboratory data to create immersive learning environments. Patients could visualize glucose fluctuations over time or understand the pathophysiology of diabetes interactively, thereby enhancing comprehension and motivation [65].

4. Interdisciplinary Collaboration and Role Expansion

Future models will emphasize interdisciplinary teams combining laboratory specialists, educators, clinicians, and technology experts. Laboratory professionals may assume expanded roles in patient education by interpreting and communicating complex test results in patient-friendly language [65].

5. Enhanced Access via Telemedicine and Mobile Health Platforms

Integration efforts will leverage telemedicine and mobile health platforms to bridge geographical gaps in diabetes education and laboratory monitoring. Patients in remote or underserved areas can receive timely lab tests and education without physical clinic visits [66].

6. Quality Improvement and Standardization

Developing standardized protocols for integrating laboratory results into educational frameworks will improve consistency and quality of care. Continuous quality improvement initiatives will monitor the effectiveness of integrated approaches and refine best practices [67].

CONCLUSION

This study highlights the critical and complementary roles of clinical laboratory professionals and diabetes educators in the effective management of diabetes. Clinical laboratory professionals ensure precise and timely diagnostic testing, which is fundamental for accurate disease detection and monitoring. Meanwhile, diabetes educators provide essential patient-centered education and support that empower individuals to manage their condition proactively. The collaboration between these professionals not only enhances diagnostic accuracy but also significantly improves patient outcomes by fostering better self-management, adherence to treatment, and early intervention strategies. Strengthening this interdisciplinary partnership is crucial to advancing diabetes care, reducing complications, and improving the quality of life for patients living with diabetes.

REFERENCES

- Editorial Board of Chinese Journal of General Practitioners of Chinese Medical Association. Working group of "Expert consensus on insulin use in primary care of type 2 diabetes mellitus". Expert consensus on insulin use in primary care of type 2 diabetes mellitus. *Chin J Gen Pract.* 2021;20(7):726-736.
- American Diabetes Association. Comprehensive medical evaluation and assessment of comorbidities: standards of medical care in diabetes-2021. *Diabet Care.* 2021;44(Suppl. 1):S40-S52. doi: 10.2337/dc21-S004
- Nayupe SF, Mbulaje P, Munharo S, *et al.*, Medical laboratory practice in Malawi—current status. *Afr J Lab Med.* 2023;12(1):1921. doi: 10.4102/ajlm.v12i1.1921
- Patterson CC, Karuranga S, Salpea P, *et al.*, Worldwide estimates of incidence, prevalence and mortality of type 1 diabetes in children and adolescents: results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabet Res Clin Pract.* 2019;157:107842. doi: 10.1016/j.diabres.2019.107842
- U. S. Preventive Services Task Force, Davidson KW, Barry MJ, *et al.*, Screening for prediabetes and type 2 diabetes: US Preventive Services Task Force recommendation statement. *JAMA.* 2021;326(8):736-743. doi: 10.1001/jama.2021.12531
- American Diabetes Association, ElSayed NA, Aleppo G, *et al.*, Standards of medical care in diabetes—2023. *Diabet Care.* 2023;46(Suppl. 1):S1-S291.
- Bossuyt X, Verweire K, Blanckaert N. Laboratory medicine: challenges and opportunities. *Clin Chem.* 2007;53(10):1730-1733. doi: 10.1373/clinchem.2007.093989
- Emerging Risk Factors C, Sarwar N, Gao P, *et al.*, Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. *Lancet.* 2010;375(9733):2215-2222. doi: 10.1016/S0140-6736(10)60484-9
- Grunberger G, Sherr J, Allende M, *et al.*, American Association of Clinical Endocrinology Clinical Practice guideline: the use of advanced technology in the management of persons with diabetes mellitus. *Endocr Pract.* 2021;27(6):505-537. doi: 10.1016/j.eprac.2021.04.008
- Riddle MC, Cefalu WT, Evans PH, *et al.*, Consensus report: definition and interpretation of remission in type 2 diabetes. *Diabet Med.* 2021;44(10):2438-2444. doi: 10.2337/dc21-0034
- Hunt D, Hemmingsen B, Matzke A, *et al.*, The WHO global diabetes compact: a new initiative to support people living with diabetes. *Lancet Diabet Endocrinol.* 2021;9(6):325-327. doi: 10.1016/S2213-8587(21)00111-X
- Dabelea D., DeGroat J., Sorrelman C., Glass M., Percy C.A., Avery C., Hu D., D'Agostino R.B., Jr., Beyer J., Imperatore G., *et al.*, Search for Diabetes in Navajo youth: Prevalence, incidence, and clinical characteristics: The Search for Diabetes in Youth Study. *Diabetes Care.* 2009;32(Suppl. 2):S141-S147. doi: 10.2337/dc09-S206.
- McKeigue P.M., Shah B., Marmot M.G. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet.* 1991;337:382-386. doi: 10.1016/0140-6736(91)91164-P.
- Chan J.C., Cheung C.K., Swaminathan R., Nicholls M.G., Cockram C.S. Obesity, albuminuria and hypertension among Hong Kong Chinese with non-insulin-dependent diabetes mellitus (NIDDM). *Postgrad. Med. J.* 1993;69:204-210. doi: 10.1136/pgmj.69.809.204.
- Liu L.L., Yi J.P., Beyer J., Mayer-Davis E.J., Dolan L.M., Dabelea D.M., Lawrence J.M., Rodriguez B.L., Marcovina S.M., Waitzfelder B.E., *et al.*, Type 1 and Type 2 diabetes in Asian and Pacific Islander U.S. youth: The SEARCH for Diabetes in Youth Study. *Diabetes Care.* 2009;32(Suppl. 2):S133-S140. doi: 10.2337/dc09-S205.
- Schwartz S.S., Epstein S., Corkey B.E., Grant S.F., Gavin J.R., 3rd, Aguilar R.B. The Time Is Right for a New Classification System for Diabetes: Rationale and Implications of the beta-Cell-Centric Classification Schema. *Diabetes Care.* 2016;39:179-186. doi: 10.2337/dc15-1585.
- Hu F.B., Manson J.E., Stampfer M.J., Colditz G., Liu S., Solomon C.G., Willett W.C. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N. Engl. J. Med.* 2001;345:790-797. doi: 10.1056/NEJMoa010492.
- Wong N.D., Zhao Y., Patel R., Patao C., Malik S., Bertoni A.G., Correa A., Folsom A.R., Kachroo S., Mukherjee J., *et al.*, Cardiovascular Risk Factor Targets and Cardiovascular Disease Event Risk in Diabetes: A Pooling Project of the Atherosclerosis Risk in Communities Study, Multi-Ethnic Study of

- Atherosclerosis, and Jackson Heart Study. *Diabetes Care*. 2016;39:668–676. doi:10.2337/dc15-2439.
19. Gaede P., Vedel P., Larsen N., Jensen G.V., Parving H.H., Pedersen O. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N. Engl. J. Med*. 2003;348:383–393. doi: 10.1056/NEJMoa021778.
20. Sarwar N., Gao P., Seshasai S.R., Gobin R., Kaptoge S., Di Angelantonio E., Ingelsson E., Lawlor D.A., Selvin E., Stampfer M., *et al*, Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: A collaborative meta-analysis of 102 prospective studies. *Lancet*. 2010;375:2215–2222. doi: 10.1016/S0140-6736(10)60484-9.
21. McCarthy M.I. Genomics, type 2 diabetes, and obesity. *N. Engl. J. Med*. 2010;363:2339–2350. doi: 10.1056/NEJMr0906948.
22. Schellenberg E.S., Dryden D.M., Vandermeer B., Ha C., Korownyk C. Lifestyle interventions for patients with and at risk for type 2 diabetes: A systematic review and meta-analysis. *Ann. Intern. Med*. 2013;159:543–551. doi: 10.7326/0003-4819-159-8-201310150-00007.
23. Grarup N., Sandholt C.H., Hansen T., Pedersen O. Genetic susceptibility to type 2 diabetes and obesity: From genome-wide association studies to rare variants and beyond. *Diabetologia*. 2014;57:1528–1541. doi: 10.1007/s00125-014-3270-4.
24. Karter A.J., Schillinger D., Adams A.S., Moffet H.H., Liu J., Adler N.E., Kanaya A.M. Elevated rates of diabetes in Pacific Islanders and Asian subgroups: The Diabetes Study of Northern California (DISTANCE). *Diabetes Care*. 2013;36:574–579. doi: 10.2337/dc12-0722.
25. Fuchsberger C., Flannick J., Teslovich T.M., Mahajan A., Agarwala V., Gaulton K.J., Ma C., Fontanillas P., Moutsianas L., McCarthy D.J., *et al*, The genetic architecture of type 2 diabetes. *Nature*. 2016;536:41–47. doi: 10.1038/nature18642.
26. Sattar N., Gill J.M. Type 2 diabetes in migrant south Asians: Mechanisms, mitigation, and management. *Lancet Diabetes Endocrinol*. 2015;3:1004–1016. doi: 10.1016/S2213-8587(15)00326-5.
27. Haines L., Wan K.C., Lynn R., Barrett T.G., Shield J.P. Rising incidence of type 2 diabetes in children in the U.K. *Diabetes Care*. 2007;30:1097–1101. doi: 10.2337/dc06-1813.
28. Carmienke S, Baumert J, Gabrys L, *et al*, Participation in structured diabetes mellitus self-management education program and association with lifestyle behavior: Results from a population-based study. *BMJ Open Diabetes Res Care*. 2020;8:e001066.
29. Sasmiyanto S. [Faktor Presdiposisi Perilaku Kesehatan Penderita Diabetes Mellitus Tipe 2 (Predisposition factors of health behavior of type 2 diabetes mellitus patients)]. [Article in Indonesian]. *J Keperawatan Silampari*. 2020;3:466-76.
30. Ramadhani S, Fidiawan A, Andayani TM, *et al*, Pengaruh Self-Care terhadap Kadar Glukosa Darah Puasa Pasien Diabetes Melitus Tipe-2 (Effect of self-care on fasting blood glucose levels in type-2 diabetes mellitus patients). [Article in Indonesian]. *Jurnal Manajemen Dan Pelayanan Farmasi*. 2019;9:118-25.
31. Lee SK, Shin DH, Kim YH, *et al*, Effect of diabetes education through pattern management on self-care and self-efficacy in patients with type 2 diabetes. *Int J Environ Res Public Health*. 2019;16:3323.
32. Azami G, Soh KL, Sazlina SG, *et al*, Effect of a nurse-led diabetes self-management education program on glycosylated hemoglobin among adults with type 2 diabetes. *J Diabetes Res*. 2018;2018:1-12.
33. Fan L, Sidani S. Factors influencing preferences of adults with type 2 diabetes for diabetes self-management education interventions. *Can J Diabetes*. 2018;42:645-51.
34. American Association of Diabetes Educators. An effective model of diabetes care and education: Revising the AADE7 Self-Care Behaviors®. *Diabetes Educ*. 2020;46:139-60.
35. WHO. World health statistics 2018: monitoring health for the SDGs. Geneva: WHO; 2018.
36. Kusnanto Widyanata KAJ, Suprajitno, *et al*, DM-calendar app as a diabetes self-management education on adult type 2 diabetes mellitus: a randomized controlled trial. *J Diabetes Metab Disord*. 2019;18:557–63.
37. Jahromi MK, Ramezanli S, Taheri L. Effectiveness of diabetes self-management education on quality of life in diabetic elderly females. *Glob J Health Sci*. 2015;7:10.
38. Cunningham AT, Crittendon DR, White N, *et al*, The effect of diabetes self-management education on HbA1c and quality of life in African-Americans: A systematic review and meta-analysis. *BMC Health Serv Res*. 2018;18:1-13.
39. Hailu FB, Moen A, Hjortdahl P. Diabetes self-management education (DSME) – Effect on knowledge, self-care behavior, and self-efficacy among type 2 diabetes patients in Ethiopia: A controlled clinical trial. *Diabetes Metab Syndr Obes*. 2019;12:2489.
40. Rasoul AM, Jalali R, Abdi A, *et al*, The effect of self-management education through weblogs on the quality of life of diabetic patients. *BMC Med Inform Decis Mak*. 2019;19:1-12.
41. Ministry of Health Republic of Indonesia. Basic Health Research 2018. Jakarta: Ministry of Health Republic of Indonesia; 2018.
42. Aschner P. New IDF clinical practice recommendations for managing type 2 diabetes in primary care. *Diabetes Res Clin Pract*. 2017;132:169-70.
43. Ghisi GLM, Aultman C, Konidis R, *et al*, Effectiveness of an education intervention associated with an exercise program in improving disease-related knowledge and health behaviours

- among diabetes patients. *Patient Educ Couns.* 2020;103:1790-7.
44. Sugiyama T, Steers WN, Wenger NS, *et al.*, Effect of a community-based diabetes self-management empowerment program on mental health-related quality of life: A causal mediation analysis from a randomized controlled trial. *BMC Health Serv Res.* 2015;15:1-9.
45. Ministry of Health Republic of Indonesia. Basic Health Research 2018. Jakarta: Ministry of Health Republic of Indonesia; 2018.
46. Villar-Álvarez F, Moreno-Zabaleta R, Mira-Solves JJ, *et al.*, Do not do in COPD: consensus statement on overuse. *Int J Chron Obstruct Pulmon Dis.* 2018;13:451–63. doi: 10.2147/COPD.S151939.
47. Francke AL, Smit MC, de Veer AJE, *et al.*, Factors influencing the implementation of clinical guidelines for health care professionals: a systematic meta-review. *BMC Med Inform Decis Mak.* 2008;8:1. doi: 10.1186/1472-6947-8-38.
48. Gagliardi AR. "More bang for the buck": exploring optimal approaches for guideline implementation through interviews with international developers. *BMC Health Serv Res.* 2012;12:404. doi: 10.1186/1472-6963-12-404.
49. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet.* 2003;362:1225–30. doi: 10.1016/S0140-6736(03)14546-1.
50. Schuster MA, McGLYNN EA, Brook RH. How good is the quality of health care in the United States? *Milbank Q.* 2005;83:843–95. doi: 10.1111/j.1468-0009.2005.00403.x.
51. Correa VC, Lugo-Agudelo LH, Aguirre-Acevedo DC, *et al.*, Individual, health system, and contextual barriers and facilitators for the implementation of clinical practice guidelines: a systematic metareview. *Health Res Policy Syst.* 2020;18:1. doi: 10.1186/s12961-020-00588-8.
52. Cutler RL, Fernandez-Llimos F, Frommer M, *et al.*, Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ Open.* 2018;8:e016982. doi: 10.1136/bmjopen-2017-016982.
53. Alañón Pardo MDM, Ferrit Martín M, Calleja Hernández Miguel Ángel, *et al.*, Adherence of psychopharmacological prescriptions to clinical practice guidelines in patients with eating behavior disorders. *Eur J Clin Pharmacol.* 2017;73:1305–13. doi: 10.1007/s00228-017-2287-2.
54. Glazsiou P, Straus S, Brownlee S, *et al.*, Evidence for underuse of effective medical services around the world. *Lancet.* 2017;390:169–77. doi: 10.1016/S0140-6736(16)30946-1.
55. Grol R, Wensing M. What drives change? barriers to and incentives for achieving evidence-based practice. *Med J Aust.* 2004;180:S57–60. doi: 10.5694/j.1326-5377.2004.tb05948.x.
56. Page MJ, McKenzie JE, Bossuyt PM. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372.
57. Flottorp SA, Oxman AD, Krause J, *et al.*, A checklist for identifying determinants of practice: a systematic review and synthesis of frameworks and taxonomies of factors that prevent or enable improvements in healthcare professional practice. *Implement Sci.* 2013;8:35. doi: 10.1186/1748-5908-8-35.
58. Castillo RC, Heins S, Feldman D, *et al.*, The impact of adherence to clinical practice guidelines on medical costs. *J Occup Environ Med.* 2020;62:712–7. doi: 10.1097/JOM.0000000000001938.
59. Johnston JL, Bennett D. Lost in translation? paradigm conflict at the primary–secondary care interface. *Med Educ.* 2019;53:56–63. doi: 10.1111/medu.13758.
60. Atkins L, Francis J, Islam R, *et al.*, A guide to using the theoretical domains framework of behaviour change to investigate implementation problems. *Implement Sci.* 2017;12:1–8. doi: 10.1186/s13012-017-0605-9.
61. Chinese Diabetes Society. Guideline for the prevention and treatment of type 2 diabetes mellitus in China (2020 edition). *Chin J Endocrinol Metab.* 2021;37(4):311-398. doi: 10.3760/cma.j.cn311282-20210105-00016.
62. Whirl-Carrillo M, McDonagh EM, Hebert JM, *et al.*, Pharmacogenomics knowledge for personalized medicine. *Clin Pharmacol Ther.* 2012;92(4):414-417. doi: 10.1038/clpt.2012.96.
63. National Center of Gerontology, Chinese Society of Geriatrics, Diabetes Professional Committee of Chinese Aging Well Association. Guideline for the management of diabetes mellitus in the elderly in China (2021 edition). *Chin J Diabet Mellitus.* 2021;13(1):14-46. doi: 10.3760/cma.j.cn115791-20210310-00143.
64. Whirl-Carrillo M, Huddart R, Gong L, *et al.*, An evidence-based framework for evaluating pharmacogenomics knowledge for personalized medicine. *Clin Pharmacol Ther.* 2021;110(3):563-572. doi: 10.1002/cpt.2350.
65. Jin S, Bajaj HS, Brazeau AS, *et al.*, Remission of type 2 diabetes: user's guide: diabetes Canada Clinical Practice Guidelines Expert Working Group. *Can J Diabet.* 2022;46(8):762-774. doi: 10.1016/j.jcjd.2022.10.005.
66. Expert Group of Chinese Society of Nephrology. Chinese Guidelines for diagnosis and treatment of diabetic kidney disease. *Chin J Nephrol.* 2021;37(3):255-304. doi: 10.3760/cma.j.cn441217-20201125-00041.
67. Diabetes Expert Committee of National, Telemedicine and Connected Healthcare Center of China, Endocrinology and Diabetes Society, Bethune's Spirit Research Association. Expert consensus on telemedicine management of diabetes. *J China-Jpn Friendsh Hosp.* 2020;34(6):323-332. doi: 10.3969/j.issn.1001-0025.2020.06.001.