Egypt. J. Chem. Vol. 67, SI: M. R. Mahran, pp. **1235 - 1249** (2024)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

The Role of Nursing in Diabetes Management: The Impact of Biochemical Markers on Diagnosis, Complications, and Patient Outcomes through Comprehensive Care and Support

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Abstract

Background: Diabetes mellitus (DM) is a chronic condition that requires comprehensive management to prevent complications and improve patient outcomes. Nurses, as frontline healthcare providers, play a crucial role in diabetes care through education, management, and support. Effective nursing interventions can significantly impact patient outcomes, including disease management, self-care, and overall quality of life.

Aim: This article explores the role of nursing in diabetes care, focusing on their involvement in patient education, self-management support, interprofessional teamwork, psychological care, and personalized interventions. It highlights the impact of nurse-led initiatives on diabetes-outcomes and the challenges nurses face in this area.

Methods: A review of literature and case studies is conducted to assess the effectiveness of various nurse-led diabetes interventions. These include Diabetes Self-Management Education and Support (DSMES), telephone interventions, psychological counseling, and advanced caregiver roles. The analysis also examines how these interventions influence patient satisfaction, hospital admissions, length of stay, physiological outcomes, and self-management behaviors.

Results: The findings demonstrate that nurse-led interventions, particularly in DSMES and psychological support, improve patient knowledge about diabetes, enhance self-management behaviors, and lead to better physiological outcomes. Nurse-led telephone interventions and community health advisor education further support patients in managing their condition outside clinical settings. Additionally, the implementation of interprofessional teamwork has shown to enhance the overall quality of care provided to diabetes patients.

Conclusion: Nurses play a critical role in diabetes care through direct patient education, support, and management. Nurse-led interventions, both in clinical and community settings, have been proven to enhance diabetes knowledge, reduce hospital admissions, and improve self-management behaviors. However, challenges such as limited training, role recognition, and resource constraints need to be addressed to fully maximize the potential of nursing in diabetes care.

Key Words: Diabetes Mellitus, Nursing, Self-Management, Education, Psychological Care, Interprofessional Teamwork, Nurse-Led Interventions, Patient Outcomes, Diabetes Care, Complications Prevention.

1. Introduction

Deficits in insulin action, synthesis, or both can result in diabetes mellitus (DM), a chronic metabolic disease that raises blood glucose levels [1]. DM is the most common metabolic illness and one of the top four non-communicable diseases worldwide. Type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) are the two main forms of DM; 90–95% of DM cases are T2DM, which makes up the bulk of DM cases [2,3]. Due to the ongoing rise in the

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Receive Date: 09 November 2024, Revise Date: 28 November 2024, Accept Date: 01 December 2024
DOI: 10.21608/ejchem.2024.334932.10769

number of people with diabetes (PWD), DM presents a serious global public health concern [4,5]. The World Health Organization (WHO) reports that the number of people with disabilities (PWD) increased from 108 million in 1980 to 422 million in 2014, and that figure is expected to increase to 592 million by 2025. Since 1980, the prevalence of DM in adults has nearly doubled, rising from 4.7% to 8.5%. Additionally, between 2000 and 2019, the death rate from DM climbed by 70%. With 77% of PWD living in middle- and low-income countries, DM is rapidly progressing, especially in developing countries [3,4]. By 2030, the International Diabetes Federation predicts that the number of DM cases worldwide could rise to 9.9% [6]. PWD are more likely to have protracted hospital stays and are at higher risk for problems [7]. According to the 2019 National Diabetes Inpatient Audit (NaDIA), the percentage of hospital beds occupied by PWD increased from 14% in 2010 to 18% in 2019 [8]. Because DM-related complications can have a negative influence on health outcomes and raise the demand for healthcare resources, DM needs to be given careful consideration.

PWD are frequently treated by non-specialist teams since diabetes mellitus is frequently the secondary, not the major, reason of hospitalization. Only 28% of physicians in training on these teams felt completely competent in managing DM cases, according to research, indicating that they usually lack thorough understanding in DM care [9]. Along with other professionals, nurses are playing a bigger role in PWD care by educating and supporting staff members and patients from a variety of specializations. In order to speed up patient discharge or, when necessary, avoid hospital hospitalizations, they also provide phone or clinic consultations. Nurses are better equipped than other medical professionals, including physicians, to educate and care for PWD because they spend a lot of time with patients [10]. According to Lou et al. [11], nurses typically show superior listening abilities and comprehension of PWD in comparison to other healthcare professionals. All of these results highlight the fact that nurses' commitment to and methods of providing care for PWD are frequently stronger than those of other medical specialists [10]. Diabetes inpatient specialist nurses (DISNs) are highly qualified healthcare providers who may help with PWD care management by organizing, teaching, advising, inspiring, and leading. The National Institute of Clinical Excellence (NICE) and the National Health Service (NHS) both stress the value of DISNs; NICE suggests that there should be at least one DISN for every 300 hospital beds [12]. However, according to the 2018 NaDIA, 22% of hospitals still do not have specialized DISNs, indicating that many clinical settings lack specialized DISNs [12].

The increasing prevalence of type 2 diabetes indicates a pressing need for creative approaches to care and management. According to research, providing nurses with the information they need is crucial to enabling the best practices for PWD. The duties of nurses in PWD care are still unclear, particularly in countries like Saudi Arabia where DISNs are not officially recognized. Despite their critical role in managing diabetes mellitus, nurses' coordinated efforts with other healthcare providers are frequently overlooked [13]. Nonetheless, nurse-led models—which are intended to be more patient-centered than the conventional physician-led, medically oriented care model—are becoming more and more popular in healthcare systems. Current trends indicate a shift in duties from physicians to nurses, and studies have demonstrated that nurses can effectively assume roles in DM management with the right training [13]. Additionally, nurses can supervise the administration of treatment, create, implement, and oversee DM interventions, and train non-medical workers to offer DM care to a variety of patient populations [14].

Educating Patients with Diabetes

In order to provide patients with the information and self-assurance they need to meet their self-management objectives for the treatment of diabetes mellitus (DM), diabetic nurse educators (DNEs) are becoming more and more important [15]. Healthy coping strategies, risk reduction, problem-solving abilities, consistent glucose monitoring, medication adherence, physical activity, and balanced nutrition are the seven fundamental components of effective diabetes self-management [16]. However, patients' acceptance of their condition is a major factor in the efficacy of educational therapies. Additionally, how effectively patients follow self-management techniques can be influenced by variables like educational attainment. Care delivery strategies must also be customized; for instance, patients with weaker reading levels are advised to use the teach-back method and visual aids [17]. Individual consultations are more effective than group consultations, according to studies [18, 19]. Evidence that nurse-led education enhances patient outcomes, particularly glycemic control, lends credence to the important role nurses play in teaching patients how to properly manage diabetes mellitus [20,21].

According to a recent study by Bostrom et al. [20], diabetes specialist nurses (DSNs) play a crucial role in patient education. DSNs help patients understand diabetes mellitus (DM), interpret test findings, and talk about possible complications. Wexler et al. [21] investigated the effects of diabetes education in a different study by conducting a randomized experiment with two patient groups. While the other group received systematic teaching and intervention from specialized nurses, the first group received routine care. According to the study, the intervention group's average blood glucose levels were noticeably lower than those of the standard care

group. Furthermore, the HbA1c test, which is frequently used to calculate average blood glucose during the preceding three months, revealed a lower mean HbA1c level in the year after hospital discharge for patients in the intervention group. In a similar vein, Raballo et al. [22] discovered that patients who received group care from medical professionals—such as nurses, educators, nutritionists, physicians, or psychopedagogues—had more positive views and better health outcomes than those who received routine treatment. Additionally, compared to patients receiving standard care, who tended to express negative perceptions and a sense of external control over their condition, patients in group care showed a richer understanding of the care they received, with perceptions focused more on internal control and positive self-empowerment. All of these results highlight how nurses' roles in DM education are changing, which is important for improving glycemic control [23].

Nurse-Led Diabetes Self-Management Education and Support (DSMES) and Educational Intervention

Research indicates that diabetes self-management education (DSME) and support greatly enhance patients' understanding of and behavior related to self-care. The American Diabetes Association (ADA) acknowledges the importance of nurse-led DSMES and suggests its inclusion in diabetes care for individuals with diabetes (PWD) [18]. The World Health Organization, the Centers for Disease Control and Prevention, and the International Diabetes Federation are among the groups that support nurse-led DSMES as a vital part of diabetes care. Enhancing patients' quality of life (QoL), health status, self-management abilities, and clinical results are the main objectives of DSMES in routine care [3,31].

DSME provided by certified diabetes educators, including nurses and dietitians, improved several important diabetes care indicators, including HbA1c (below 8.0%), low-density lipoprotein (below 100 mg/dL), blood pressure (below 140/90 mmHg), nephropathy screening or use of angiotensin-converting enzyme inhibitors, and retinal eye exams, according to a study conducted at an ADA-certified center by Brunisholz et al. [32]. These enhancements demonstrate the beneficial effects and affordability of DSME in the treatment of diabetes [32]. Additionally, nurses use a variety of tactics in a range of contexts. Sherifali et al. [33], for example, showed that computer-generated, tailored feedback treatments significantly enhanced glycemic control. Glycemic control was also improved in other studies, including one that evaluated a hospital-based clinic intervention [34]. Furthermore, Kang et al. [35] found that a family-centered strategy was more successful in managing diabetes than traditional therapy [36]. Socially appropriate interventions are commonly used in nurse-led research to improve patient participation and accessibility [37].

The effects of nurse-led educational programs, which are frequently customized to meet the unique requirements of individuals with Type 2 diabetes (T2DM), have been the subject of additional research. To identify educational requirements and create focused interventions, for instance, focus group insights were utilized [38]. Patients were given the opportunity to select self-management techniques according to their own preferences through an educational intervention that was symptom-focused. Additionally, web-based DSME programs have been created, allowing patients to reach personalized objectives and learn at their own speed. Research assessing these programs has demonstrated improvements in diabetes knowledge, self-management practices, and HbA1c levels [38, 39]. Other cutting-edge teaching strategies have also shown promise in the treatment of diabetes, including web-based platforms, multimedia modules, telephone-based instruction, and customized programs [14, 40]. When taken as a whole, these results highlight the significant advantages of various teaching strategies for improving diabetic self-management.

Interprofessional Teamwork in Diabetes Care

Nurses are integral members of interprofessional healthcare teams, collaborating with other healthcare professionals to support the self-management of people with diabetes (PWD). Nutritionists and nurses often work together to assist individuals in making proper dietary choices, a key challenge in diabetes self-management [41,42,43]. Additionally, nurses collaborate with psychologists to provide counseling and emotional support for PWD [44]. They also work closely with physicians to screen patients and adjust healthcare plans as necessary. The American Diabetes Association (ADA) recommends that PWD receive diabetes self-management education (DSME) at diagnosis and as needed thereafter. This education can be delivered through nurse-led group or individual sessions [34,37,39,41,42,44,45], and may also be provided via web-based platforms. Including family members or partners in educational sessions is encouraged, as they can play a vital role in supporting diabetes care at home [14].

Nurse Prescribing in Diabetes Care

With some clinics using nurse-led models that may involve medication management and prescription writing, the role of nurses in diabetes care has changed. Recently, nurse-led diabetes management clinics have emerged, providing a chance for nurses to take a more active role in managing the condition [46,47,48]. Although the layout of these clinics varies, nurses usually concentrate on patient education and assistance with insulin administration. In certain situations, nurses assist doctors by prescribing drugs and keeping an eye on drug therapy. The provision of prompt and efficient patient care is the main goal of nurse-led clinics. Initiating, modifying, or stopping medication is something that

nurse prescribers are trained to do. Depending on local laws and training requirements, their prescribing responsibilities might range from following certain protocols to having more autonomy [49]. For example, after earning a post-graduate diploma authorized by the Nursing Council of New Zealand, registered nurses working in primary and specialty health settings in New Zealand are permitted to dispense antidiabetic drugs.
Research has demonstrated the beneficial effects of nurse-led diabetes care treatments. A 2010 meta-analysis, for instance, discovered that nurse-led case management treatments considerably enhanced glycemic control, as seen by lower HbA1c values. Other research has connected improved management of cardiovascular disease risk variables, like high blood pressure, in diabetic patients with nurse-led interventions, such as organized care algorithms. Nonetheless, studies indicate that both physician-led and nurse-led treatment have comparable results in reducing HbA1c levels, indicating that nurses might be extremely important in managing diabetes without sacrificing the standard of care [50,51].

Education and Support for Community Health Advisors

Community health advisors, including lay health workers or promotoras, can play an important role in diabetes care and education. Nurses support these community health workers by providing training and ongoing education. For example, in one study, nurses trained promotoras over an 8-week period, and after completing the training, promotoras conducted diabetes educational courses. These courses were followed by home visits where promotoras, with nurse consultation as needed, provided tailored educational sessions for individuals with diabetes [37]. Additionally, telecare professionals can also be trained to deliver diabetes self-management education and support. Nurses can supervise and educate telecarers, who then provide telephone-based education and support, including advice on blood glucose control, medication adherence, and general diabetes knowledge. One study comparing printed and telephone-delivered diabetes education found that telephone conversations with trained health educators, supervised by a diabetes nurse educator, focused on medication adherence and lifestyle changes, such as physical activity and healthy eating [14,40].

Nurse-Led Telephone Interventions

Telephone interventions are an effective means of providing ongoing diabetes support and education. In one study, registered nurses contacted participants weekly for 12 weeks to discuss topics such as blood glucose monitoring, medications, exercise, and diet. The calls also allowed participants to ask questions and adjust their treatment plans based on their dietary intake and blood glucose records. Another study used pre-recorded calls supplemented by nurse follow-up, where nurses tailored their advice based on participants' responses. Nurses can also use telephone interventions to offer individualized care. For instance, in one study, telehealth nurses monitored blood glucose and insulin doses via the web, contacting participants as necessary to review data and recommend follow-ups or treatment adjustments based on their findings [52,53].

Personalized Interventions

Personalized care is a key element of effective diabetes management. Nurses can modify interventions to meet the specific needs, preferences, and abilities of individuals with diabetes. This includes delivering customized education plans based on individual goals and assessments. Nurses often focus on empirical learning to help patients address challenges in their self-management and to set specific targets for managing diabetes [44]. Additionally, nurses act as coaches, guiding patients through their treatment plans and helping them to set personal self-management goals. They also assist patients in problem-solving and adjusting their goals when challenges arise, using their own expertise or team-established procedures to support the patient's journey [14,55]. This individualized approach ensures that each patient receives the tailored care they need for effective diabetes management.

Psychological Care and Counselling

In basic and secondary care settings, diabetes specialist nurses (DSNs) are crucial in offering psychological support and counseling. According to research, patients frequently choose to seek support from their DSNs rather than their general practitioners (GPs). DSNs play a crucial role in providing patients and their families with social, psychological, and emotional support in addition to clinical care. DSNs have a favorable effect on patient outcomes and well-being, as evidenced by the greater satisfaction levels reported by patients who stay in touch with them. Additionally, DSNs support the development of confidence and trust between patients and medical professionals, which is essential for treating chronic illnesses like diabetes and encouraging the best possible health outcomes [57].

Closing communication gaps between patients and other clinical professionals is one of DSNs' main responsibilities. When patients need changes to their treatment plan, such adding new drugs (like insulin) or changing dosages, this function becomes even more important. DSNs can ensure that patients are educated and competent in controlling their care, particularly if their illness worsens, by communicating effectively to avoid misunderstandings and issue escalation.
For individuals with diabetes (PWD), psychological treatment is very important, especially if they are dealing with medical issues or poor metabolic control. Because they frequently feel overpowered by the difficulties of controlling their condition, PWD frequently experience anxiety and panic as

psychological reactions. In one instance, a patient voiced worry and anxiety because hospital staff members lacked specific diabetes care training. These circumstances highlight the value of emotional support and psychological counseling in hospital settings, when patients may be especially at risk [59,60].

Nurses' Role in Psychological Support

When it comes to meeting the psychological needs of PWD, nurses are essential. Because they frequently have more direct and regular contact with their patients than doctors do, research has shown that nurses are more sensitive to their psychosocial needs. Nurses are in a better position to identify and address psychological problems including stress, anxiety, and depression that can have a major influence on diabetes management and self-care. Nurses can provide psychological assistance, but they frequently feel less prepared to manage patients' complicated emotional demands than their physical care needs. Because of this, nurses often refer patients to psychosocial or mental health professionals when needed. Nurses use a variety of techniques to promote the psychological health of their patients. They seek to establish relationships that promote open communication and trust by establishing a humanized and sympathetic atmosphere. In order to empower patients to manage their diabetes, nurses also advocate patient-centered behaviors and practice reflectively. By using these techniques, nurses improve patients' emotional resilience and enhance their capacity to effectively manage diabetes by assisting them in addressing problems like illiteracy, denial of the illness, and lack of desire [61,62].

Nurses as Advanced Caregivers

With a range of responsibilities that support both direct patient care and the larger healthcare system, advanced practice nurses (APNs) are essential to the management and education of people with diabetes (PWD). APNs are qualified professionals who manage healthcare teams, perform physical examinations, make treatment decisions, and guarantee that care is founded on best practices, according to definitions given by the UK regulatory body and the Nursing and Midwifery Council. This illustrates the growing range of nursing responsibilities, particularly in the treatment of long-term illnesses like diabetes [62]. The prescription of drugs is one important area where APNs have shown their influence. According to studies, nurses in the UK are now responsible for prescription medications to treat frequent consequences of diabetes, including hypertension, hyperlipidemia, and cardiovascular disease. But the majority of nurses only spent a little percentage of their time writing prescriptions—less than 20% of their weekly workload. This implies that even while nurses are receiving more training in drug management, their major responsibilities still center on other facets of patient care, like nursing evaluations and interventions. Concerns about nurses' actual engagement in prescribing procedures persist despite their increasing proficiency in pharmacological treatment because there are currently no clear criteria defining their scope of practice [62].

APNs have a significant role in screening for problems associated to diabetes in addition to managing medication. Studies have shown how important they are for keeping an eye on common side effects of the disease, like diabetic retinopathy and foot ulcers. Additionally, nurses are responsible for doing routine exams, managing administrative tasks associated with diabetes care, and informing doctors about complications. In order to guarantee efficient diabetic care delivery, APNs also frequently have managerial duties, supervising care coordination and operating within administrative and regulatory frameworks [20]. Collaboration and assistance within healthcare teams are two other important roles that nurses play. In order to help doctors make clinical decisions, nurses provide essential information from patient assessments. Given that nurses frequently act as a liaison between patients and doctors, this confidence in their judgment highlights the value of nurses in the healthcare system. In addition to assisting physicians, nurses also help organize and plan diabetic care in conjunction with other medical specialists, offer advice on treatment strategies, and help recommend medications. By fulfilling these diverse responsibilities, nurses guarantee that patients receive thorough and well-coordinated care, highlighting their critical role in diabetes treatment [63].

Impact of Nurse Interventions on Patient Outcomes

Increased Patient Satisfaction

Nurse-led therapies, especially those conducted by Diabetes Specialist Nurses (DSNs), have demonstrated a substantial improvement in patient satisfaction. A study of 214 patients in the UK revealed that diabetic patients exhibited greater satisfaction when consulted by prescribing nurses, mostly attributable to extended consultation durations and the development of more robust patient-nurse relationships [64]. Approximately 92% of patients indicated that the diabetes management programs administered by DSNs were somewhat to highly beneficial in treating their condition. A further study indicated that DSN-led initiatives for newly diagnosed Type 2 diabetes patients produced elevated levels of motivation and patient satisfaction. Furthermore, workshops in London underscored the need for enhanced assistance for families of patients with Type 1 diabetes and indicated a preference among Type 2 diabetes patients for more individualized care with regular engagement with the same healthcare practitioner. These findings highlight the significance of DSNs in enhancing patient satisfaction via empowerment, education, and individualized care [60].

Prevention of Hospital Admissions and Shorter Length of Hospital Stay

Nurse interventions, especially by Diabetes Inpatient Specialist Nurses (DISNs), can markedly decrease hospital stay durations and avert superfluous hospital admissions. NHS England has indicated that the presence of one DISN for every 250 inpatient beds correlates with decreased hospital durations for diabetic patients, a conclusion corroborated by other research. The implementation of a ward-based diabetic nurse advisor led to a notable decrease in the median length of stay for diabetes patients. In a research, the involvement of DSN prescribers decreased the average length of stay to 3 days, resulting in significant cost savings. Moreover, the inclusion of DISNs in Accident & Emergency (A&E) departments contributed to the avoidance of superfluous hospitalizations, resulting in a cost reduction for the hospital of roughly GBP 35,000 over a period of 3.5 years. A study revealed that patients receiving DSN treatment utilized fewer hospital resources, exhibiting a considerable reduction in hospitalizations and emergency visits for diabetes-related complications. DISNs facilitate a reduction in hospital admissions while simultaneously enhancing patient self-management and education, resulting in improved outcomes and abbreviated hospital stays [14,60].

Enhanced Diabetes Knowledge

Nursing interventions frequently result in substantial enhancements in diabetes knowledge, essential for proficient self-management. A study comprising 52 hours of instructional sessions and support on diabetes self-management over one year yielded significant enhancements in diabetes knowledge relative to a control group. A further study demonstrated that the utilization of multimedia resources, such as nursing and medical instructions on compact discs, resulted in improved knowledge within the intervention group. Diabetes self-management counseling resulted in enhanced knowledge relative to the control group. Moreover, a study that included monthly telephone chats and training sessions with family participation revealed that the intervention group achieved markedly superior knowledge levels compared to the control group. Numerous studies have consistently shown that nurse-led educational programs, whether conducted in group formats or through individual interventions, enhance patient understanding of diabetes, metabolic regulation, physical activity, nutrition, and associated problems [32,39,42,52]. Educational interventions, including video behavior support and workbook-guided telephone coaching, have been linked to enhanced knowledge in both control and experimental groups, although the differences between the groups were not consistently significant. Furthermore, pilot studies examining diabetic and cardiac self-management programs with follow-up support via phone calls and text messaging demonstrated marginal enhancements in knowledge; nevertheless, no substantial changes were noted between the experimental and control groups [14,55,65]. These studies highlight the significance of nursing interventions in augmenting diabetes knowledge, which is crucial for improved self-management and long-term outcomes for diabetic patients.

Reduction in Inpatient Harm

Medication errors frequently occur in inpatients due to the intricate nature of diabetes mellitus. In 2017, the NaDIA disclosed that 31% of research participants encountered at least one diabetic medication mistake throughout their hospital stay. The errors encompassed both medication management and prescription inaccuracies. Moreover, these errors were significantly more pronounced than those associated with other disorders in hospitals. In 2014, hospitals in the United Kingdom reported an average medication administration error rate of 3–8% and a prescribing error rate of 7%. NHS England has reported that DISNs can reduce inpatient harm by diminishing hypoglycaemic incidents and medication mistakes. In 2016, the NaDIA underscored the imperative for healthcare workers to possess the confidence, expertise, and understanding required to manage diabetes drugs in order to mitigate medication errors. Furthermore, the Royal College of Nursing, Trend UK, and Diabetes UK evidenced that there were markedly diminished levels of insulin errors and thus reduced lengths of stay (LOS) associated with Diabetes Specialist Nurses (DSNs), especially among registered nurse prescribers.

In 2017, the NaDIA reported that almost 1 in 800 in-patients with T2DM and approximately 1 in 25 in-patients with T1DM experienced diabetic ketoacidosis during their hospitalization. The previously described hospital-acquired emergency conditions are potentially lethal and highly severe; yet these conditions are preventable and should not arise during hospital admission. Consequently, diabetes specialist teams must possess adequate skill, capability, and knowledge to mitigate these emergency situations through personalized and targeted drug management [58]. Data from 56 individuals with disabilities were gathered during an 8-month inpatient care study. The study demonstrated a favorable result for medicine delivery systems, with a markedly reduced incidence of medication errors noted in the DSN study group. Enhanced glucose levels were noted in persons with diabetes following insulin dosage modification as recommended by a diabetes nurse educator. Vissarion et al. [57] demonstrated that DSNs play a substantial role in crisis management. Regrettably, the quantity of DSNs is not rising, notwithstanding the escalating need for diabetic services. Moreover, 78% of DSNs expressed apprehension that their workload was compromising patient care and/or safety.

Self-Management Behaviors

Persons with disabilities (PWD) are actively involved in the planning and implementation of their care. Healthcare practitioners should assist patients in self-management to enable individuals with diabetes to effectively and confidently manage their condition. Nurses aid and support individuals with disabilities in problem-solving and establishing objectives for good diabetes management. The ADA demonstrated that individuals with disabilities receive assistance in self-management behaviors, including complication monitoring, prescription administration, self-blood glucose monitoring, physical activity, and nutritious eating. Nursing interventions facilitate patients in modifying their behavior for better diabetes management. Nurse-led interventions were shown to promote healthy behaviors in adult individuals with disabilities. This patient education program included visual aids, problem-solving activities, discussions, and information delivery. A statistically significant improvement was noted in health-promoting behaviors, such as complication prevention, hygiene, medication administration, exercise, and dietary practices, in the experimental group relative to the control group receiving standard care. A comparable trial revealed significant improvements in glucose self-monitoring, medication adherence, physical activity, and dietary habits among adult patients with T2DM in the experimental group [43].

A symptom-oriented, nurse-administered, in-home counseling and educational intervention offered diabetes management modules for individuals with type 2 diabetes mellitus (T2DM). A significant enhancement was noted in glucose monitoring, dietary habits, and medication adherence within the experimental group. Nonetheless, no substantial variations were noted between the groups regarding activity. A study assessed the effectiveness of a structured diabetes education program on self-care. Nurses conducted telephone and in-person teaching sessions focused on problem-solving and self-care. The experimental group exhibited significant improvements in physical activity and self-blood glucose monitoring, with notable differences compared to the control group [66]. A psychologist and a trained diabetes education nurse co-facilitated sessions that specifically emphasized diabetes self-management problem-solving, goal-setting, coping strategies, experiential learning, and inquiries in a 24-month trial. A significant improvement was noted in foot problems, blood glucose monitoring, and dietary practices after six months. Conversely, significant enhancements in insulin utilization and dietary practices were noted after 24 months [44]. Multiple research have indicated that nursing treatments can result in significant enhancements in both the control and intervention groups [14,15,33,55].

Physiological Outcomes

Nurse intervention studies frequently assess physiological outcomes such as blood pressure, weight, body mass index (BMI), lipid levels, fasting blood glucose, and HbA1c. A notable enhancement was noted in BMI, lipid levels, fasting blood glucose, and HbA1c following the implementation of support and educational interventions by a nurse. Significant enhancements in low-density lipoproteins and HbA1c levels were noted in the experimental group after a telemedicine intervention with nurse-led instructional sessions. Nonetheless, no variations were detected regarding BMI or blood pressure (42). A study revealed significant enhancements in daily fasting blood glucose levels in the intervention group compared to the control group, following a nurse-directed telephone follow-up. A study was done to assess the efficacy of a controlled nurse intervention centered on counseling and education, which resulted in a significant improvement in the HbA1c levels in the experimental group relative to the control group. Investigators evaluated the efficacy of a culturally sensitive, multidimensional, primary care-based behavioral intervention administered by a nurse case manager and/or a community health advisor in improving blood pressure, cholesterol levels, and HbA1c levels. The team of a community health adviser and nurse had the highest effectiveness, accompanied by a significant decrease in cholesterol levels and diastolic blood pressure. A decrease in HbA1c levels was noted; however, the results lacked statistical significance. A study was conducted to mitigate cardiovascular risk in persons with T2DM, featuring a nurse-led program that included both group and individual sessions to support participants in addressing self-care domains and achieving self-care objectives. This study demonstrated a significant reduction in both systolic blood pressure and BMI within the experimental group.

A randomized controlled experiment shown a substantial enhancement in the cholesterol levels of PWD after 20 months of algorithm-driven nurse-led telephone care. In this trial, nurses contacted patients via telephone, assessed their cholesterol levels, and commenced and adjusted lipid-lowering medications. Furthermore, individuals in the experimental group utilized less healthcare services and demonstrated enhanced lipid regulation (67). Patients participated in a half-day DSME class and were then randomized into either the intervention or usual care group to assess the effect of web-based care management on blood pressure and glucose regulation in adults with poorly managed diabetes mellitus. The experimental group was provided with a blood pressure monitor, glucose meter, and a laptop computer, enabling them to access educational modules, upload blood pressure and glucose data, and utilize the laptop. A significant decrease was noted in systolic blood pressure and HbA1c among participants in the intervention group. A notable disparity was noted between the control and intervention groups. In lieu of group lessons, another study, following the provision of web-based DSME, noted significant improvements in HbA1c levels

relative to the control group, which engaged in traditional DSME classes. Several research have documented significant improvements in HbA1c levels following nursing treatments; however, several studies reported no differences or changes between the control and experimental groups (37, 39, 45). Several investigations indicated notable enhancements in additional physiological outcomes for both the control and intervention groups (14, 33, 68).

Overcoming the Challenges for Nurses in Diabetes Care

Alongside adequate training, it is imperative to implement fundamental modifications in nursing education, health systems, policies, and societal frameworks to enhance the role of nurses in diabetes care, management, and prevention. These measures are essential to enable nurses to realize their potential in addressing global concerns. In 2021, a vote in Switzerland underscored the importance of nursing and the nation's obligation to maintain sufficient nurse numbers to enhance the recognition of nurses' roles. Nurses, despite their substantial contributions, are frequently inadequately acknowledged in governance frameworks. In Switzerland, the leadership deficit in the nursing profession is mitigated by appointing a cantonal nurse responsible for articulating the distinct perspectives of nurses and liaising with policymakers and other stakeholders. Modifying the kind of services offered and increasing compensation for nurse-delivered services are effective methods to acknowledge the significance of nurses' roles. In a healthcare system, it is essential to identify the obstacles to the enhancement of nurses' duties. The prohibition against nurses prescribing medications constitutes the only systemic or legal impediment in Kyrgyzstan, a low- and middle-income country (LMIC). The view of nurses' involvement in managing non-communicable diseases, such as diabetes, among the general public and physicians is a further limitation to their responsibilities.

It is essential to consider practical aspects alongside the implementation of DSNs to empower nurses in prescription medications, managing nurse-led diabetes clinics, conducting diabetes research, and delivering diabetes education. In Thailand, a successful expansion of nursing responsibilities has been established, with nurses serving as advanced practice nurses, case managers, and educators in diabetes care. Nevertheless, research indicates that these interventions in LMICs yielded a moderate effect on diabetes management, correlating with decreased blood glucose levels (70). Nurses should play a crucial role in management and prevention to guarantee access to diabetes care and achieve global objectives. In conjunction with the worldwide growth in the incidence of diabetes mellitus, it is essential to augment the nursing workforce and enhance leadership and training initiatives. Furthermore, it is essential to implement basic alterations within the overall nursing environment. Enhancing work prospects with defined career trajectories and improved professional acknowledgment is also essential. Global migration and retention challenges require tailored solutions to prevent the alleviation of staff shortages in one nation from resulting in the attrition of nurses in others. The health system must fully recognize the importance of nurses' roles, with social acknowledgment from the population and legislators.

This acknowledgment should also address the gender-specific nursing issue, as it predominantly remains a female profession within the healthcare system, which is male-dominated in many nations. Nurses necessitate explicitly delineated tasks and roles to deliver optimal diabetes treatment within a healthcare system for the benefit of their patients. Nurses necessitate expertise and instruments to do their duties in various environments. This methodology may encompass the utilization or enhancement of diagnostic instruments, collaborative patient education, supportive oversight, task delegation, specialized training in specific disease domains, and pharmacological prescribing. These positions necessitate acknowledgment about roles and credentials, as well as prospects for career advancement and increased remuneration. The enhancement of an interprofessional approach may facilitate ways nursing and medical students collaborate during their formative training, so preparing them to function effectively as a team in future professional contexts (71). The health system should create an atmosphere that enables various health professionals to collaborate effectively for the benefit of persons with disabilities (PWD) (72).

Role in Diagnosis and Prevention of Complications:

Diagnosis of Diabetes Using Biomarkers:

Untreated diabetes mellitus (DM) can lead to severe complications, making early diagnosis crucial in preventing these adverse outcomes. The primary symptoms of diabetes include prolonged hyperglycemia, frequent urination, excessive thirst, and increased hunger. Biochemical tests are routinely conducted to diagnose prediabetes or diabetes. Commonly used tests include glycosylated hemoglobin (HbA1c) and the oral glucose tolerance test (OGTT). The OGTT assesses the body’s ability to absorb glucose after ingesting a specified amount of sugar, typically 75 g of glucose. Plasma glucose levels are measured 2 hours post-consumption, and a level of ≥11.1 mmol/L confirms a diagnosis of diabetes [73]. Another reliable diagnostic method is the fasting plasma glucose test, where a level of ≥7.0 mmol/L indicates diabetes. If a person’s plasma glucose level is ≥7.8 mmol/L two hours after consuming 75 g glucose, this suggests impaired glucose tolerance [74-77]. HbA1c testing is widely utilized to diagnose diabetes, with individuals suffering from Type 2

diabetes mellitus (T2DM) typically showing HbA1c levels ≥48 mmol/mol (≥6.5% DCCT) [78]. Random blood glucose testing is another predictive tool for diagnosing diabetes.

Nurses play a vital role in the early diagnosis of diabetes through routine screening and assessment. They are often the first healthcare professionals to identify risk factors or symptoms that suggest a potential diabetes diagnosis. Nurses can monitor patients for common signs of diabetes such as increased thirst, frequent urination, unexplained weight loss, and fatigue. They assist in the administration of diagnostic tests, such as measuring blood glucose levels and performing the oral glucose tolerance test (OGTT) or HbA1c tests, under the guidance of physicians. Nurses also provide valuable patient education on understanding the importance of these tests and help patients comprehend the results, facilitating timely intervention. By recognizing symptoms early and coordinating with other healthcare professionals, nurses are integral to diagnosing diabetes before it progresses to more severe stages.

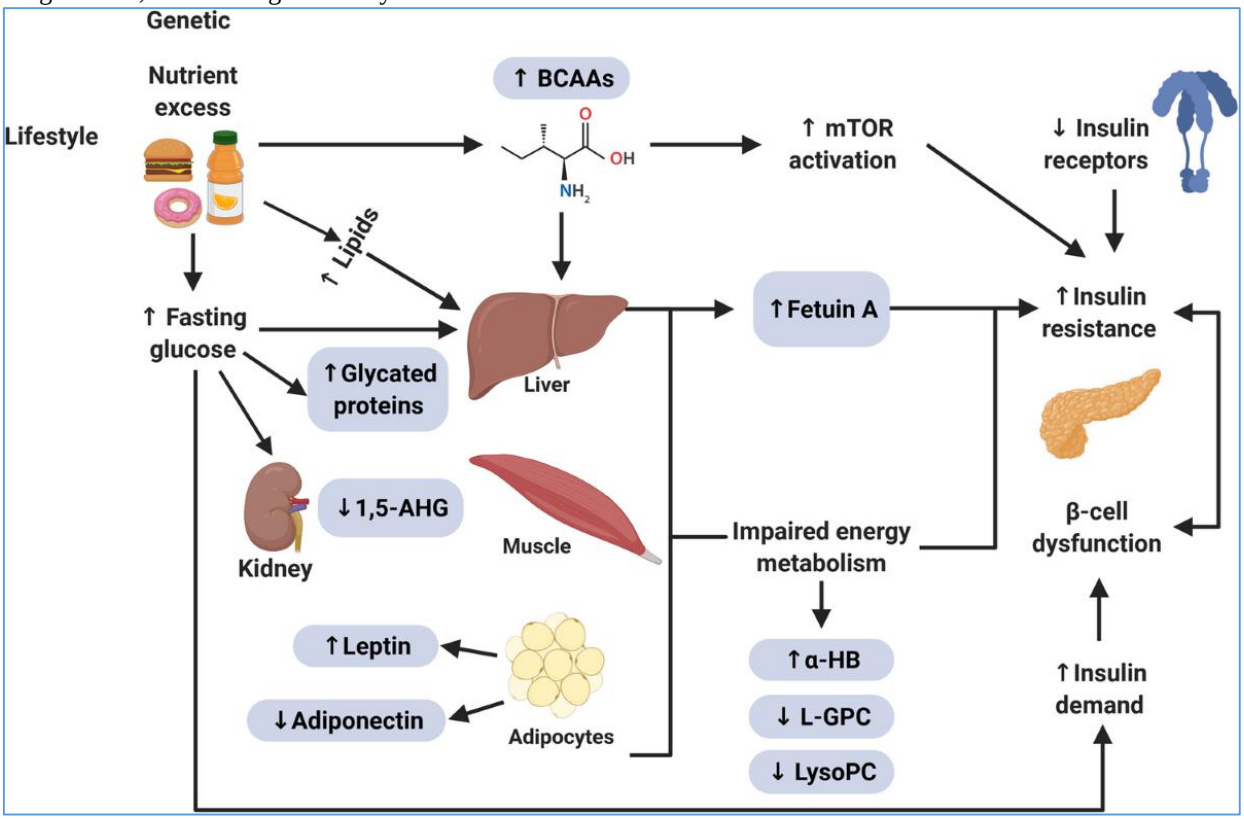

Figure 1: Biomarkers of Diabetes.

Complications of Diabetes

Prolonged exposure to DM can lead to various complications. Diabetic nephropathy and diabetic retinopathy, which are caused by extended periods of hyperglycemia, are among the most common complications. Chronic high blood glucose levels activate myo-inositol oxygenase (MIOX) enzyme activity, which enhances the catabolism of myo-inositol. This enzymatic breakdown disrupts the function of Na^+/K^+ ATPase and phosphatidylinositol synthases, molecules essential for secondary signaling pathways [79]. As a result, prolonged hyperglycemia contributes to diabetic nephropathy, retinopathy, neuropathy, and cataracts. In cases of uncontrolled diabetes, elevated glucose levels in the delicate retinal vessels increase osmotic pressure, leading to vessel leakage or rupture and impairing retinal blood supply. To compensate for the damaged vessels, new collateral vessels form, causing scar tissue and impaired vision [80,81]. Diabetes can also damage the kidneys, specifically the glomerular capillary basement membrane, disrupting protein crosslinking and allowing proteins to leak into the urine, a condition known as diabetic nephropathy [82]. Diabetic ketoacidosis (DKA) is another common complication, arising from the continuous production of ketone bodies [83]. DKA is more characteristic of insulin deficiency than resistance, which is typical of T2DM. In a case study in China, a 52-year-old diabetic patient developed Fournier's gangrene, a rare condition associated with severe DKA [84]. T1DM patients may also experience obstructive pancreatitis due to inflammation in the pancreas and hyperplasia of the pancreatic duct, leading to duct obstruction [85].

Diabetic patients are at a heightened risk of oxidative stress, which contributes to the development of atherosclerosis, cardiovascular diseases, and hypertension. The prevalence of coronary artery disease (CAD), heart disease, and sudden cardiac death is higher among diabetic individuals. Elevated blood glucose levels stimulate superoxide production

through the Maillard reaction. Several studies suggest that T2DM is associated with cognitive dysfunction, affecting intelligence, attention, memory, learning, and perception. Additionally, diabetes is considered a significant risk factor for cancer, sharing several common risk factors such as age, obesity, diet, smoking, and alcohol consumption [86-91]. The link between DM and cancer can be attributed to the dysregulation of insulin signaling in T2DM, which decreases hepatic production of insulin-like growth factor (IGF) binding protein and increases circulating IGF-1 levels. The overactivation of mTOR in T2DM further disrupts insulin signaling by phosphorylating IRS-1 and attenuating its metabolic pathway, while upregulation of IRS-2 activates the MAPK pathway, promoting cell proliferation [92,93]. Other studies have shown that diabetic patients have an increased prevalence of liver cancer, pancreatic cancer, and non-Hodgkin's lymphoma. Furthermore, chronic hepatitis C (CHC) in diabetic individuals accelerates cirrhosis progression and heightens the risk of hepatocellular carcinoma [94,95]. T2DM also affects magnesium (Mg) levels in the blood, as high blood glucose reduces the tubular reabsorption of Mg, resulting in lower serum magnesium levels [96]. This deficiency can lead to various health complications associated with low magnesium levels.

Nurses are crucial in preventing complications associated with diabetes by implementing and reinforcing preventive strategies. They assess patients' overall health, focusing on monitoring blood glucose levels and encouraging adherence to prescribed medication regimens. Nurses educate patients on lifestyle modifications, including proper diet, exercise, and weight management, which are essential for managing blood sugar levels and preventing complications like diabetic neuropathy, nephropathy, and retinopathy. They also teach patients how to monitor their feet regularly to prevent diabetic foot ulcers, a common complication. By providing emotional support and addressing barriers to self-management, nurses help improve patient outcomes and prevent long-term complications. Furthermore, nurses advocate for regular screenings, such as eye and kidney exams, to detect early signs of complications and ensure timely treatment. Their comprehensive approach to patient care significantly reduces the risk of diabetes-related complications, promoting better long-term health for diabetic individuals.

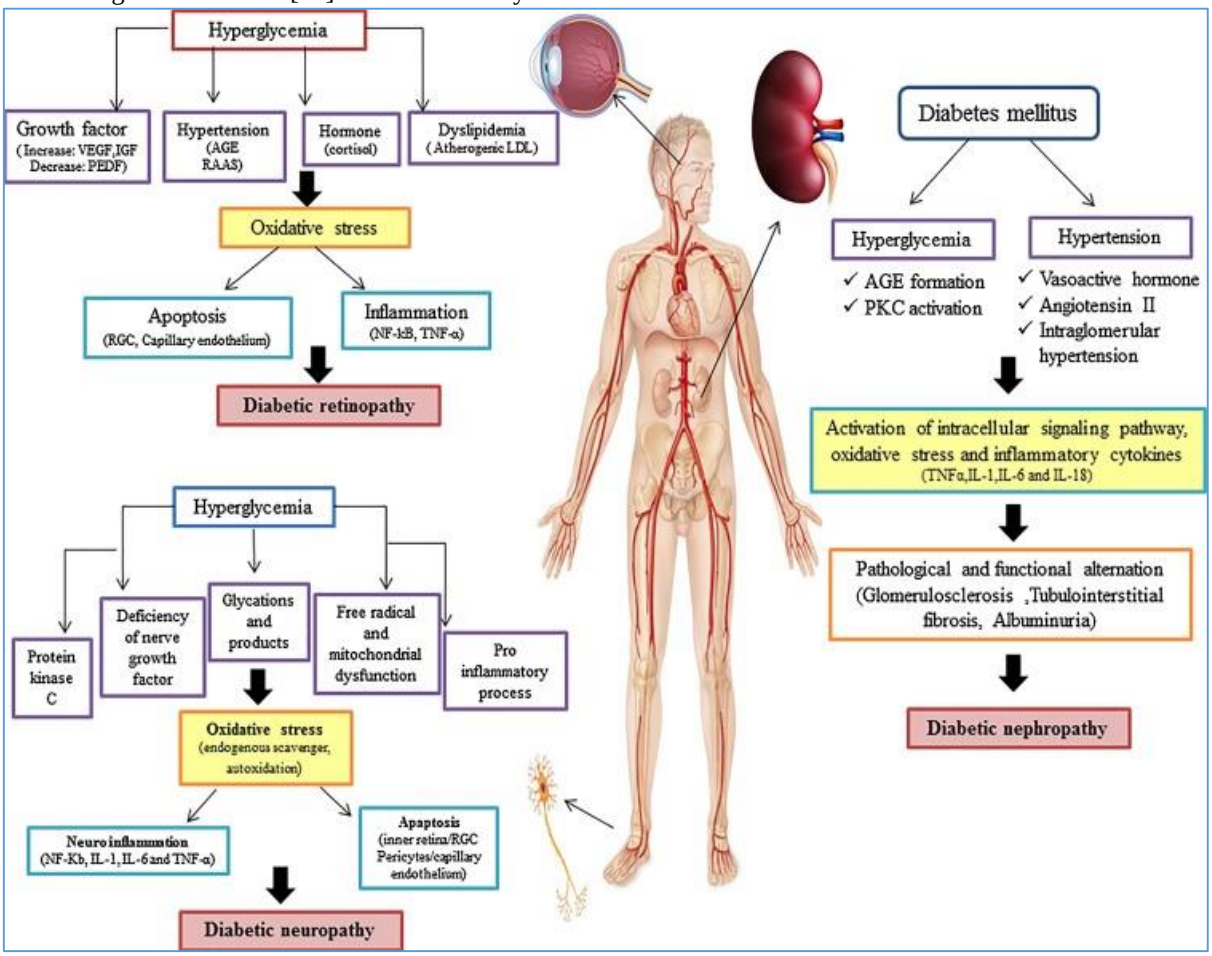

Figure 2: Complications of Diabetes.

Conclusion:

The role of nurses in diabetes care is both vital and multifaceted, extending far beyond traditional clinical duties. Nurses are integral to the successful management of diabetes through their involvement in patient education, supporting self-management behaviors, and offering psychological care. Evidence shows that nurse-led interventions, particularly those in Diabetes Self-Management Education and Support (DSMES), have a significant positive impact on patient outcomes. Nurses, by providing personalized care and supporting behavior change, help patients achieve better blood glucose control, reduce the risk of complications, and improve overall health outcomes. Furthermore, the importance of interprofessional teamwork in diabetes care cannot be overstated. Nurses collaborate effectively with physicians, dietitians, and other healthcare professionals to provide holistic care that addresses the physical, emotional, and social aspects of living with diabetes. This collaborative approach not only enhances patient satisfaction but also reduces unnecessary hospital admissions and improves patient adherence to treatment plans, contributing to a more efficient healthcare system. In addition to clinical care, nurses also serve in advanced roles, including prescribing medications and leading telephone interventions for patients in remote or underserved areas. These innovations in nursing practice ensure that diabetes care is accessible, timely, and consistent. Nurses also play a key role in providing psychological support to individuals with diabetes, helping to address the emotional burden of the disease and reduce stress, which can otherwise complicate disease management. Despite these advancements, challenges remain, including insufficient recognition of the full scope of nursing roles and limitations in training and resources. Addressing these challenges is crucial to expanding the impact of nursing in diabetes care. Ultimately, by enhancing nursing education, leadership, and support systems, healthcare systems can better utilize nurses to combat the global diabetes epidemic and improve patient outcomes. By fully harnessing the capabilities of nurses in diabetes care, healthcare systems can ensure more effective, patient-centered care that not only addresses immediate health concerns but also contributes to the long-term well-being of individuals with diabetes.

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