
RESEARCH ARTICLE

Revisiting Diabetes with a Focus on Complications, Innovations, and Care Strategies

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ABSTRACT

Diabetes mellitus (DM) is a chronic endocrine health issue characterized by persistent hyperglycemia resulting from impaired insulin excretion, insulin impact, or both. This condition poses significant challenges due to its associated complications, including macrovascular conditions like heart disease and stroke, as well as microvascular complications such as diabetic neuropathy, retinopathy, nephropathy, and cardiomyopathy. Specialist nurses are integral to comprehensive diabetes care, offering expertise that spans multiple domains. Their contributions include improving inpatient management by reducing hospital stays and enhancing clinical outcomes, providing outpatient support to foster self-management and monitor disease progression, and delivering specialized care in pediatric diabetes, diabetic foot ulcer prevention, and gestational diabetes management. Additionally, nurse-led interventions, including education programs, telehealth services, and telephone support, empower patients to better manage their condition (table 1). This paper also highlights the challenges specialist nurses face, such as limited scope of practice, inadequate remuneration, and the need for greater interprofessional collaboration. By addressing these barriers and leveraging the expertise of specialist nurses, healthcare systems can significantly enhance diabetes management, reduce complications, and improve the overall quality of life (QOL) for individuals with diabetes. The findings underscore the critical role of specialist nurses in addressing the global diabetes epidemic and the importance of supporting their continued involvement in patient-centered care.

KEYWORDS

Diabetes mellites, diabetic complications, diabetes nurse specialists, diabetic care

ARTICLE INFORMATION

ACCEPTED: 01 November 2024

PUBLISHED: 25 December 2024

DOI: 10.32996/bjns.2024.4.2.10

1. Introduction

Glucose is the primary and most accessible fuel for the body, and its breakdown occurs inside the cell through a process called glycolysis, which generates energy [1]. Blood normoglycemia is regulated by several mechanisms, including the glucose absorption/utilization ratio, endogenous glucose production, and the modulation of insulin and glucagon secretion [2, 3]. Insulin, a hormone secreted by pancreatic β -cells, regulates glucose uptake by hepatocytes, adipocytes, and myocytes, while inhibiting hepatic glucose biosynthesis. Conversely, glucagon, secreted by pancreatic α -cells, promotes glucose release from hepatocytes to avoid hypoglycemia [4]. Diabetes is a complex metabolic condition characterized by hyperglycemia. If a diabetic patient focuses solely on maintaining normal blood glucose levels, they may progress to the advanced stages of the disease, which can lead to

complications that significantly reduce quality of life (QOL) and, ultimately, result in mortality [5]. The diabetic complications are including macro-angiopathy and micro-angiopathy conditions [6]. Diabetic macro-angiopathy includes stroke, obstructive atherosclerotic, peripheral artery disorders, heart attack, and is the leading cause of mortality and morbidity in people with diabetes (PWD) [7]. While Diabetic microangiopathy is divided into four main health issues; diabetic peripheral neuropathy (DPN) which affect the nerve tissue (example of Diabetic foot complications often manifest in the advanced stages of DPN), diabetic retinopathy (DR) which affect the retina, diabetic kidney disease (DKD) which affect the kidney, and diabetic cardiomyopathy (DCM) which affect the myocardium [8, 9].

Diabetic nurse care focuses on follow up patients with diabetes to handle their condition successfully and avoid complications [10]. Nurses play a commanding role in informing patients about blood sugar monitoring, proper use of insulin or oral medications, and distinguishing symptoms of hypo- and hyperglycemia [11]. They support in developing personalized care plans that include dietary adjustments, exercise regimens, and medication adherence. Nurses also provide guidance on foot care to prevent ulcers and infections [12]. They monitor patient progress during regular follow-ups and help identify early signs of neuro and renal diabetic complications [13]. With advances in technology, nurses are increasingly involved in training patients to use devices like continuous glucose monitors and insulin pumps [14]. Nurses serve as a key link between patients and healthcare providers, ensuring comprehensive and empathetic care. This review article highlights diabetes, its complications, and the role of nursing professionals in reducing and preventing complications.

2. Research strategies

A comprehensive literature review was conducted using various databases, including Google Scholar, PubMed, SpringerLink, Saudi Digital Library, ResearchGate, BioMed Central, ScienceDirect, and Scopus. The search was limited to English-language articles published from the earliest available date to 2025, encompassing both historical and contemporary research. The keywords employed in the search were: "diabetes," "diabetic complications," "diabetes nursing specialist," and "diabetic care strategies". The review incorporates a diverse range of literature, including original research studies, review articles, viewpoints, and opinion pieces.

3. Diabetes Mellitus: A Silent Threat

Diabetes mellitus (DM) is an endocrine disorder that refers to the inability of the cells to utilize glucose from the blood and is characterized by hyperglycemia [15]. This may be due to impaired function in their action by dueling factors including but not limited to autoimmune diseases, obesity, genetic predisposition, or insulin dependency on other lifestyles [16].

The World Health Organization (WHO) reported that the incidence of this disorder has increased tremendously within the past few decades. Increases in the number of people afflicted are 200 million in 1990 and 830 million in 2022 [17]. The prevalence in low- and middle-income countries (LMICs) is rising faster than that of high-income countries [15]. Distribution of diabetes varies but generally, the highest prevalence is in urban areas and developed countries. Aging the population also poses more threats as diabetes is becoming a serious concern. Additional diabetes threatens many pregnant women and fetuses. Diabetes is being worried about because of its epidemiological picture in early detection and prevention to reduce the burdens borne by individuals and health systems globally [18].

4. Pathophysiology and Progression of DM: Insights into Type 1, Type 2, and Gestational Diabetes

Diabetes mellitus encompasses an array of pathophysiological developments that eventually lead to elevated blood glucose levels. The three main forms of DM — type 1, type 2, and gestational diabetes — each involve distinct pathophysiological pathways (Fig. 1).

The dysfunction of β -cells, hepatocytes, adipocytes, and myocytes is implicated in the pathophysiology of diabetes. Type 1 diabetes is caused by the autoimmune destruction of β -cells, resulting in absolute insulin deficiency. It is a chronic autoimmune disease with no pharmacological cure. This progression begins when a genetic predisposition is triggered by environmental factors, such as viral infections. The activated cytotoxic T-lymphocytes mistakenly identify β -cells as foreign, initiating autoimmune destruction that leads to their damage. As a result, insulin production gradually declines until it stops completely [19]. The Type 2 diabetes, also called DM type 2, does not rely exclusively on insulin deficiency. Rather, the disorder is mainly characterized by insulin resistance and impaired insulin discharge [21]. The secretion of insulin comes as insulin sensitivity becomes normoglycemic. Patients who possess type 2 diabetes may not adequately increase biosynthesis of insulin to counteract the insulin resistance. Nevertheless, patients with type 2 diabetes who are obese produce higher concentrations of insulin because of insulin resistance. The early phase of insulin production is drastically reduced or even absent when glucose stimulation occurs [22]. Patients suffering from type 2 diabetes tend to have increased proinsulin-insulin (C-peptide) ratios. Furthermore, the maximum production of insulin and the hyperglycemia-induced potentiation of insulin response to stimuli other than glucose are dramatically diminished [23]. Time brings the subjection of hyperglycemia from bad to worse and turns further tricky. Continuing β -cell function decline is another significant feature of the evolution of type 2 diabetes [24].

Hyperglycemia related to pregnancy is associated with adverse maternal, fetal, and newborn outcomes [25]. This risk applies to women developing hyperglycemia prior to or during pregnancy. Newborns born to mothers with gestational diabetes are at a greater risk of developing diabetes later in life [22]. The increased prevalence of pregnancy-related complications such as

preeclampsia, cesarean delivery less than 37 weeks, and macrosomia is related to no gestational age cutoffs. The influencing variables for the initiation of gestational diabetes could be genetic, obese, polycystic ovarian syndrome, and maternal age [26]. Only potential cures are pancreas transplantation or β -cell tissue engineering [20].

5. Diabetes Complications

Similarities exist in pathology of diabetic complications at the vascularity level, prominently as endothelial dysfunction and atherosclerosis [27]. As DM is known as a risk factor for any form of vascular diseases, the subsequent vascular comorbidities would have profound implications in patient prognosis and treatment and would thus lead to a clinical entity of "panvascular disease" [28-30]. Since the late part of the 20th century, the concept of "vessel tree," and with it the term "polyvascular atherosclerotic disease," has come into use, including within it both the identifiable atherosclerosis affecting coronary and non-coronary vascular beds, but especially peripheral arterial and cerebrovascular diseases (peripheral vascular disease and cerebrovascular disease). The term purports the idea of managing the patient more comprehensively for multivessel disease to improve patient outcomes. However, this framework cannot be applied to the microvascular disease particularly of critical organs and to the need for multidisciplinary care [31]. To expand upon this definition, we introduce the term diabetic panvascular disease, which represents a clinical syndrome characterized by the simultaneous occurrence of atherosclerosis in both macrovessels and microvessels. This condition affects multiple organ systems, including the cardiac, cerebral, renal, ophthalmic, and peripheral vascular systems, in individuals with diabetes. Cardiovascular and cerebrovascular events are the main outcomes of this condition, with prognosis potentially improved through aggressive intervention directed at metabolic abnormalities. Diabetic complications are usually classified as macro-angiopathy and micro-angiopathies or according to the organ involved (Fig. 1) [31].

Diabetic macroangiopathy is a term often used to describe large vessel disease in diabetic patients, characterized by early and severe atherosclerosis [32]. Understanding this condition involves three key points:

- **Causality:** A direct link may exist between the metabolic disturbances of diabetes and the development of vessel wall damage [33].
- **Systemic Involvement:** Large vessel changes are part of a broader diabetic angiopathy affecting the entire vascular system [34]. However, the manifestations can vary widely across different organs.
- **Diabetic Specificity:** While some of the vascular abnormalities seen in diabetes can also occur in other diseases, the specific combination of changes in diabetic patients is unique. This is analogous to DR, where individual abnormalities may be seen in other conditions, but their collective pattern is highly suggestive of diabetes.

When viewed in this light, diabetic macroangiopathy is not merely a complication of diabetes but rather an integral part of the disease itself, representing a long-term consequence. Numerous studies have highlighted the increased incidence of heart disease among diabetic patients, affecting both genders [35]. Recent research has further linked DKD to a higher risk of cardiac disease. While most studies on diabetic patients have focused on the lipid-atherosclerosis hypothesis, fewer have specifically examined diabetic macroangiopathy. The condition has been primarily investigated in large arteries of the lower extremities and coronary arteries [32].

Diabetic microangiopathy, a complication of prolonged exposure to elevated glucose and fat levels, involves significant damage to the small blood vessels in the body. This condition primarily impacts the kidneys, eyes, heart, and nerves, manifesting as DKD, DR, DCM, and DPN, respectively [36]. The underlying mechanisms are complex and not entirely understood but are believed to involve inflammation, oxidative stress, vascular endothelial cell damage, and increased vascular permeability [37,38]. Current treatments target these mechanisms to mitigate the condition's progression, though their limitations highlight the critical need for new and more effective therapies.

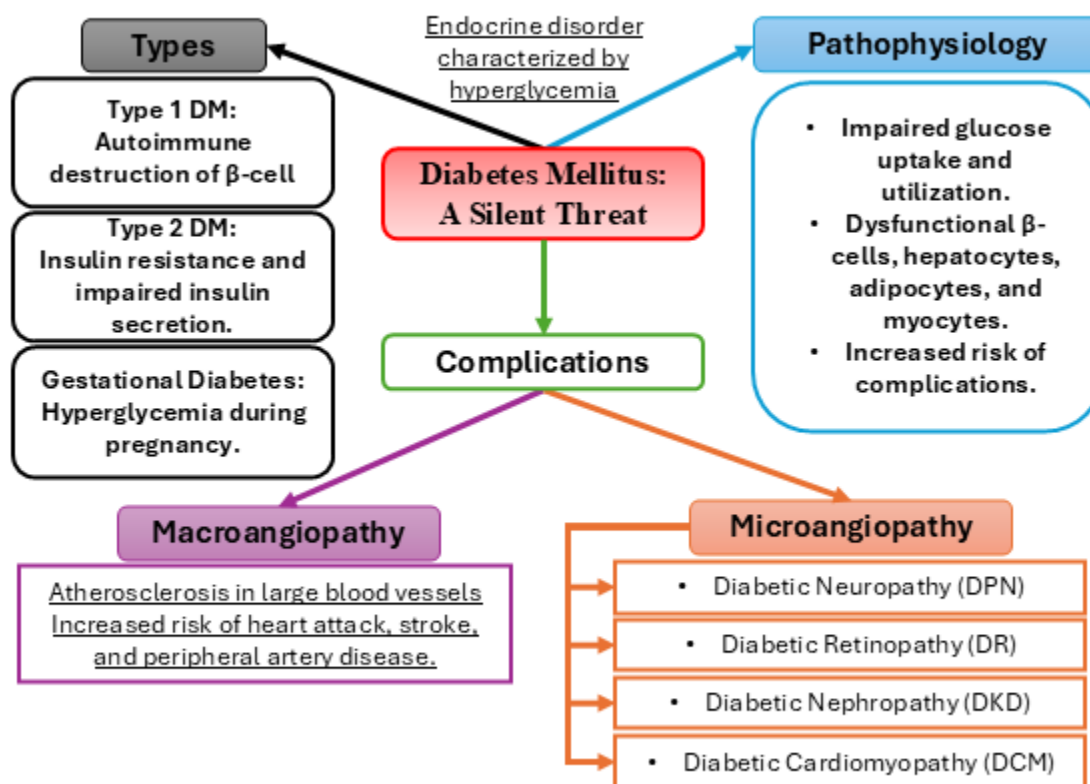


Fig. 1 Diabetes types, pathophysiology, and complications.

Diabetic neuropathy is a common complication of diabetes that affects the nerves throughout the body, manifesting in various forms such as DPN and autonomic neuropathy [39]. The DPN often begins with tingling, numbness, and pain in the feet [40-42]. As the condition progresses, it can lead to loss of sensation, muscle weakness, and impaired balance, increasing the risk of falls and injuries. In severe cases, it may result in foot ulcers and amputations. Autonomic neuropathy, on the other hand, impacts multiple systems, including cardiovascular, gastrointestinal, and urogenital functions [39]. In the cardiovascular system, it can lead to irregular heart rhythms, silent heart attacks, and orthostatic hypotension (low blood pressure upon standing). Gastrointestinal involvement may cause delayed stomach emptying, nausea, and vomiting, while urogenital effects can include bladder dysfunction, erectile dysfunction, and decreased sexual sensation [39-41]. Diagnosing DPN often involves reviewing medical history, conducting a physical examination, and performing nerve conduction studies [43]. Early diagnosis and appropriate management are critical to preventing complications. Although there is no cure, treatments can help manage symptoms and slow progression. These include medications for pain relief, physical therapy, and lifestyle modifications such as regular foot care and maintaining optimal blood sugar levels [39].

Diabetic nephropathy is a serious complication of diabetes that can lead to kidney failure, characterized by inflammation, thickening of the kidney's filtering units, and protein leakage in the urine [44]. Emerging evidence highlights the significant role of the innate immune system, the body's first line of defense, in the development and progression of diabetic nephropathy through its inflammatory responses [45]. Key components of the innate immune system contribute to diabetic nephropathy pathogenesis: Toll-like receptors (TLRs) detect harmful substances and activate immune cells, driving inflammation and kidney damage; inflammasomes, protein complexes involved in inflammation, are activated by factors like high glucose levels, exacerbating diabetic nephropathy; chemokines attract immune cells to sites of inflammation, leading to inflammatory cell accumulation in the kidneys; and the complement system, while critical in fighting infections, can intensify inflammation and tissue damage in diabetic nephropathy when overactivated [44, 46]. These insights into the role of innate immunity in diabetic nephropathy present potential therapeutic opportunities. Targeting specific components of this immune system may help reduce inflammation and slow the progression of kidney disease, offering hope for improved management of diabetic nephropathy [44].

Diabetic retinopathy is a serious eye condition that affects individuals with diabetes, resulting from high blood sugar levels damaging the blood vessels in the retina, the light-sensitive tissue at the back of the eye [47]. In its early stages, DR often presents no noticeable symptoms, but as it progresses, individuals may experience blurred vision, floaters, and difficulty seeing at night. In severe cases, DR can lead to permanent vision loss [48]. The progression of DR occurs in distinct stages: Mild Non-Proliferative

Diabetic Retinopathy (NPDR) involves microaneurysms, tiny bulges in the blood vessels; Moderate NPDR is marked by more severe blood vessel damage and increased bleeding; Severe NPDR is characterized by significant blood vessel damage and fluid leakage; and Proliferative Diabetic Retinopathy (PDR) involves abnormal blood vessel growth, which can lead to bleeding and scarring [49]. Early detection is crucial for preventing vision loss, making regular eye exams essential for individuals with diabetes, especially those with longstanding disease. Treatment options include laser therapy to seal leaky blood vessels, anti-VEGF injections to reduce swelling and block abnormal blood vessel growth, and vitrectomy, a surgical procedure to remove blood and scar tissue from the eye [50]. By emphasizing early detection and effective treatment, the burden of vision loss caused by DR can be significantly reduced [47].

Optimizing Diabetes Care: The Critical Role of Specialist Nurses

Specialist nurses are registered nurses with additional qualifications and extensive experience in a specific clinical field. They are authorized to practice independently, engaging in clinical practice, teaching, consultation, and research [51]. Specialist nurses play a crucial role in improving patient care and outcomes, including fostering patient self-management [52]. Research suggests that specialist nurses are cost-effective, enhance clinical outcomes, and shorten hospital stays [53]. While physicians make medical decisions, specialist nurses contribute unique expertise to patient management and can assist physicians in their tasks.

Specialist nurse role in DM health care

The roles of diabetes specialist nurses (DSNs) in health systems are critically established (table 1) [54]. In diabetes care, these DSNs enjoy many dimensions such as patient education, self-management support coordination. They educate patients on how to manage their disease by way of nutrition and monitoring, as well as complications to prevent, hence empowering them to take control of their blood sugar [55]. In addition, DSNs act as a mediator between patients and other healthcare providers such as medical officers, dietitians, and psychologists [56]. Comprehensive care and fostering interdisciplinary teamwork greatly improve DSNs' contributions to diabetes management and reduced burden on health systems [57].

The impact of DSNs on inpatient patient outcomes

Inpatient diabetes care is largely dependent on activities and referrals, and DSNs are known to cover such activities [58]. Newly diagnosed patients, those with acute complications due to diabetes, such as diabetic ketoacidosis or hypoglycemia, and non-satisfactory diabetes controls fall into a wide array of conditions served by DSNs. However, DSNs also review referrals by ward staff and triage those cases that require appropriate medical or nursing actions. They also provide information about insulin dosing, pump therapy, diabetes preoperative care patient care, end-of-life care in diabetes, and medication education (table 1) [55].

It is not just a one-off duty positively to engage with wards. DSNs will work together with doctors in ward rounds assessing potential patients. In that process, they also gather all the necessary information that would inform treatment choices. They educate patients on the correct injection techniques for insulin and monitoring blood glucose. Evidence shows that DSNs make a difference in inpatient care considerable, involving decreased hospital days and better clinical outcomes. Research has demonstrated noticeable reductions in bed occupancy whenever care is led by DSNs [59].

The impact of DSNs on outpatient DM management

Diabetes specialist nurses have a critical role to play in the care course, both in-patient and out-patient, for a patient with DM. In the outpatients, DSNs ensure that patients are followed up from their hospital discharge, nurse clinics, support consultants, and dietitians (table 1)[60]. Monitor progress by checking blood pressure, hemoglobin A1C concentration, medication adherence, injection sites, foot health, retinopathy screening. Results were compared between DSNs and clinical Nurse Specialist: They teach newly diagnosed patients about DM management, including insulin therapy, home glucose monitoring, oral hypoglycemic agents, and lifestyle modifications [61,62].

DSNs also offer education on the whole of insulin therapy, which includes things like insulin types, administration techniques, site rotation, storage, sharps disposal, and carbohydrate counting [63]. They will also work closely with general practitioners in educating patients on Sodium-Glucose Cotransporter 2 inhibitors and Dipeptidyl Peptidase-4 inhibitors, teaching the mechanisms of these drugs and their adverse effects [62,64]. DSNs thus empower patients with self-management skills and lifelong support, who end up contributing significantly to better diabetes management, diminished hospital care, and better patient results.

The essential role of pediatric diabetes nurse specialists in diabetes care

With the increasing incidence of diabetes among children and young adults, DSNs are becoming significant in pediatric care. Among the many areas for improvement is that which has been included in the Quality Standards published by the National Institute for Health and Care Excellence for the care of diabetes in children and young people. The audit of National Pediatrics Diabetes shows a constant increase of 4% in annual children and young people receiving treatment in special units for diabetes [65,66]. Type 1 DM among those aged 15 or younger has a prevalence in England and Wales estimated at 192 per 100,000 children for 2014-2015 [67].

Essentials of pediatric DSNs have been discovered to bring about improvement in outcomes for these young patients diagnosed with diabetes. In fact, the collaborative teamwork involving these specialized nurses has led to a reduction in hospitalizations for children newly diagnosed, shorter hospital stays, increased bed availability, and improved clinic attendance [55]. New innovative educational and support approaches are among the other benefits coming from it. Benefits of pediatric DSNs to patients have led to the creation of new posts within pediatric departments. Their degree of involvement mirrors that of the adult DSNs in that their role consists of teaching the young about their condition and how to manage it, instructing them in the administration of insulin, recognizing hypoglycemia, and other important points of management of the disease [55].

The role of DSNs in preventing and managing diabetic foot ulcers (DFUs)

The primary function of DSNs in terms of managing DFUs cannot be overstated. The DFUs are a significant health problem, and the complications they cause, including infection, gangrene, and amputation, are severe [68]. To help alleviate this issue, the American Diabetes Association has recommended a multidisciplinary approach that should incorporate medical health officers, nurses, educators, podiatrists, and departmental consultants [69]. While all help manage DFU prevention and treatment, special emphasis is placed on the role of nurses, particularly diabetic foot specialist nurses [70].

Most developed countries practice diabetic nursing specialization, and here the diabetic foot specialist nurses put emphasis on preventive care and rehabilitation for patients with DFUs [71]. According to the WHO, nurses are an important part of developing communication and techniques for diabetes prevention and detection and its complications, including DFUs. Case reports show the power of nurse-led care in preventing amputations even when such drastic measures have been recommended by medical professionals [72].

The diabetic foot specialist nurses engage in DFU prevention and management through a variety of techniques. They screen high-risk patients and provide educative interventions on factors that hinder healing such as high blood sugar, ischemia, infection, trauma, and improper wound care along with appropriate healthcare [72]. They teach self-examination techniques and daily foot-care practices to patients, including checking shoes, keeping feet clean and dry, and maintaining proper skin and nail care [73]. By early detection of skin changes and rapid intervention using specialized foot care and dressings, these nurses considerably reduce the risk of ulcer development and recurrence [74].

The mobility aids enable the assisted person to engage in rehabilitation. Also, there is help for the diabetic foot specialist nurse within a rehabilitation institution in teaching patients with DFUs or amputations how to use some aids, such as canes, walkers, or wheelchairs, when providing independent living, thereby improving their QOL [75]. The comprehensive approach above would thus augment the contribution made by DSNs in reducing amputations and enhancing the QOL of persons living with diabetes, thus strengthening their inevitable role within diabetes care [76].

Table (1). Key Roles and Focus Areas of Specialist Nurses in Diabetes Care

<i>Group name</i>	<i>Core Roles of Specialist Nurses</i>
1. Patient Education and Self-Management:	<ul style="list-style-type: none"> • Guiding patients on diet, exercise, and medication adherence. • Educating on diabetes complications prevention and management.
2. Interdisciplinary Collaboration:	<ul style="list-style-type: none"> • Partnering with healthcare teams for integrated care. • Coordinating with dietitians, psychologists, and specialists.
3. Inpatient & Outpatient Care:	<ul style="list-style-type: none"> • Managing acute cases and complex treatments. • Monitoring progress, adjusting therapies, and providing ongoing support.
4. Specialized Focus Areas:	<ul style="list-style-type: none"> • Pediatric Diabetes Care: Supporting families and improving outcomes for children. • Diabetic Foot Care: Preventing ulcers and amputations. • Gestational Diabetes: Managing risks for pregnant women and their babies.
5. Nurse-Led Interventions:	<ul style="list-style-type: none"> • Diabetes Self-Management Education (DSME). • Remote care via telehealth and telephone interventions.

The impact of DSNs prescribing on diabetes care outcomes

The implementation of nurse prescribers to manage diabetes drugs may minimize the workload of physicians, improve waiting duration, and increase efficiency in the healthcare system. This model could minimize doctor visits since prescription updates or reviews would be performed by nurses. Plus, these nurse prescribers can be well accessible through phone calls, especially for those patients initiating new treatment regimens [77].

Nurses will manage routine non-emergency outpatient prescriptions that allow physicians to spend more time on complicated and emergencies. Further, when nurses appreciate their limitations, refer to other specialists or other services when necessary;

patient confidence in the health system increases [78]. Comparative studies demonstrate that nurse prescribers have, in most cases, developed a long-term relationship with patients and spend more time compared to non-prescribing nurses. The patients also preferred that the nurse's appointments could be flexible, especially noting that it was much better than the limited nature of a physician's availability [79]. However, nurse prescribing should not be seen as without limitations. While DSNs can adjust insulin regime and oral hypoglycemic agent doses, consultation is often required with a physician when making more complex changes or when starting new medications.

The DSNs role in gestational diabetes care

Pregnancy is marked by a specific complication with adverse effects on mothers and fetuses, termed gestational diabetes mellitus as found in research literature [80,81]. The risk minimization of these complications necessitates a regimen of thorough perinatal care including counseling and individualized nursing interventions. In this context, DSNs perform crucial roles in managing diabetic patients with regards to lifestyle modifications, medication adherence, and education [82].

These evidence-based guidelines are the backbone for optimizing patient care in the screening, diagnosing, and managing of gestational diabetes mellitus, especially in the encroachment of resource-limited countries, where nurses and midwives function as primary care [83,84]. However, blood glucose levels continued to be mismanaged, and dietary intakes and timings were not met, thus removing the patient from participating in any self-care efforts.

Regular up to date materials and training should be provided to nursing staff and midwives to develop their capabilities in providing good quality care regarding diabetes. Increased patient satisfaction and outcomes will result from this effort toward enabling quality care. Cost benefits would accrue through the adoption of a patient-specific psychological theory along with health education [85,86]. Thus, to be adequately trained, nurses and midwives need to develop skills in managing high-risk pregnancies, including gestational diabetes mellitus. Through evidence-based practices, integration of quality patient education and support, and encouraging high patient empowerment, the healthcare provider can make tremendous strides toward improving the maternal and fetal outcomes resulting from such conditions.

Nurse-Led interventions to prevent diabetes complications

Nurse-led diabetes self-management education (DSME) has proven to be an effective approach for managing diabetes by enhancing self-care practices and diabetes-related knowledge. Individuals with diabetes often experience extended hospital stays, leading to diminished patient satisfaction and poorer clinical outcomes. Nurse-led diabetes management clinics represent a promising strategy to improve disease management. The DSNs have the potential to significantly contribute to enhanced diabetes care within inpatient settings [87].

Nurse-Led diabetes self-management education and support (DSMES) and educational intervention

Earlier research has shown that DSMES is quite effective in increasing knowledge and self-care practices in patients (table 1) [88,89]. This is an agreed position among major global health organizations such as the American Diabetes Association, International Diabetes Federation, Centers for Disease Control and Prevention, and the World Health Organization, such that DSMES becomes incorporated into routine diabetes care while focusing on an individual's lifestyle changes, conditions, self-management ability, and ultimately clinical outcomes.

As reported by Brunisholz et al., the extent to which DSME delivered by certified diabetes educators, such as registered nurses or dietitians, produced significant improvement in the various components of diabetes care—from examination of hemoglobin A1C concentrations, levels of LDL cholesterol, and blood pressure followed by outcomes of adherence to nephropathy screening and treatment guidelines—was achieved, importantly, on the relatively low cost [90,91]. Through studies, internet-based DSME programs are now proven effective in allowing patients to learn moving at their own pace while targeting personal goals [92]. A wealth of studies has been performed on how a multitude of educational interventions would affect the level of metabolic control, self-care activities, and diabetes knowledge-gaining practices by various such methods as conventional in-person education and innovative techniques like telephone-delivered education, multimedia programs, web-based platforms, and customized education. All studies taken together show that these approaches can yield positive results [87].

Nurses play a pivotal role in training and educating community health workers, such as promotoras, to deliver self-management interventions. A study demonstrated the effectiveness of a nurse-led training program in empowering promotoras to provide tailored educational sessions in patients' homes, with nurse support as needed [87]. Additionally, nurses can train and supervise telecarers to provide remote support to patients on topics like blood glucose control, medication adherence, and diabetes knowledge [93].

Nurse-Led telephone interventions

Telephone counseling sessions offer a valuable avenue for providing support and education to PWD. A notable study [94] involved weekly phone calls from a registered nurse over a 12-week period. These calls centered on self-monitoring of blood glucose, medication adherence, exercise routines, and dietary discussions. Participants actively engaged by asking questions and tailoring treatment plans based on their individual needs and blood glucose records.

Another study incorporated pre-recorded weekly phone calls, automated health education messages, and nurse follow-up calls based on participant responses. These approaches highlight the potential for personalized care through telephone counseling, as demonstrated by a study where questionnaires assessed DM self-management. Individualized instruction, support, and tailored phone sessions were guided by participant responses [95].

Telehealth nurses have effectively monitored insulin doses and blood glucose levels using web-based platforms [94]. By reviewing patient data, nurses proactively contacted participants to recommend follow-ups with primary care providers or treatment plan adjustments. Personalized interventions, such as modifying interventions to align with individual preferences, abilities, and needs, are crucial for successful DM management. Nurses can support individuals in adhering to treatment plans and deliver customized education plans based on patient-specific goals and assessments [96]. Educational sessions can be dynamically adapted to address participants' unique experiences and questions related to DM self-management.

Nurses often employ empirical learning strategies to facilitate problem-solving and goal setting for DM self-management. In the role of coaches, nurses guide PWD through treatment plans, assist in setting personal goals, and provide support in overcoming challenges. By leveraging their knowledge and expertise, as well as established healthcare team procedures, nurses empower individuals to problem-solve and modify their goals as needed [97].

Impact of nurse interventions on patient outcomes

Patient satisfaction: DSNs are integral players in increasing the level of patient satisfaction. A study conducted by Courtenay and others (2023) involving 214 patients in the UK proved that when consultation time was increased and the importance of patient-nurse relationships was facilitated through DSN consultations, there were higher levels of satisfaction regarding primary care services. Approximately 92% of patients have perceived DSN-led care management programs as moderate to highly beneficial in managing their condition [79,98].

Further research has also shown that DSN-led care programs for newly diagnosed type 2 DM patients were clinically effective and revealed considerable positive changes in patient motivation and satisfaction. Further, patient workshops conducted in London also underscored the gap and the need of presenting more assistance and education for type 1 DM and their families, personalized management, and regular follow-up for type 2 DM patients. These data suggest that DSNs can improve patient satisfaction by empowering self-care, supporting education as well as offering greater, more personalized consultations [53,79,99].

Prevention of hospital admissions and shorter length of hospital stay: This provision of care by Diabetes Inpatient Specialist Nurses (DISNs) will allow considerably reduced periods of hospital admission for PWD. This is supported by so many studies, including one from NHS England that states that if one DISN provides care for every 250 inpatient beds, the length of stay for inpatients with diabetes will be reduced. Like introducing a ward-based diabetes nurse advisor caused the length of stay to significantly reduce, with a median of 3 days length of stay for PWD cared for by a DSNs prescriber, it has meant huge cost savings. Moreover, a team of DISNs can ensure timely and appropriate follow-up and discharge planning [100].

People with diabetes have been known to benefit from this DISN's participation in emergency and accident (A&E) departments, since potentially more hospital admissions would be prevented due to early aversive treatment. Studies highlighted how many patients seen in A&E received attention and went home rather than staying in the hospital. This patient-centered care system can save up to GBP 35,000 due to decreased bed occupancy. Furthermore, DSN care can decrease the total burden on hospitals and represent fewer admissions and visits to emergency rooms with preventable diabetes-related causes. Furthermore, it has been established that a DISN service was linked to a decline in bed occupancy surplus to diabetes over a 6-year period. DISNs help the patient manage themselves by empowering and training them. This improves knowledge and awareness of diabetes and leads to a shorter hospital stay. Educational programs by inpatient diabetes educators have been associated with reduced readmissions [53, 99].

Enhanced diabetes knowledge: Further studies have also reported a significant change in awareness of diabetes within the intervention group post educational intervention [101,102]. Education interventions regarding diabetes in various forms to both control and experimental groups often had improvements in both groups. A video behavior support intervention using a brochure on DM self-management in the control group and telephone coaching sessions as well as a workbook supplied by a registered nurse in the experimental group was studied. Interestingly, no difference was found but a significant increase could be seen in both groups [103].

In another study, slightly increased amounts of diabetes knowledge were found between needs-driven, patient-centered pieces of information and education in the experimental group and conventional DSME in the control group. However, there was no difference between the two groups [104]. A different pilot study to assess the feasibility of the diabetes and cardiac self-management program involved three educational sessions and a follow-up telephone call by a nurse after one week after discharge, followed by text messaging on self-management-related questions one week after the telephone call. There was minimal improvement in diabetes knowledge following the intervention; however, no difference was found between the control and experimental groups [87].

Psychosocial outcomes: Research emphasizes the importance of psychosocial factors such as attitudes toward depression, diabetes, and diabetes-induced anxiety, which highly affect the QOL of the PWD. Better management of diabetes brings positive health outcomes that correlate well with emotional well-being. Nursing interventions targeting psychosocial factors have been demonstrated to improve QoL among PWD. Among the nurse-led interventions include motivational interviewing and personalized education programs which have employed self-care behaviors and decreased stress, anxiety, and depression while improving the overall QoL [105,106]. However, there is still some hope for improvement in the psychosocial outcome even for control groups, which usually receive normal care and education. This suggests that social support, as provided through diabetes clubs by using multi-disciplinary approaches, can, in fact, have a positive effect on the mental health and well-being of PWD.

Overcoming the challenges for nurses in diabetes care

To maximize the potential of nurses in addressing global diabetes challenges, comprehensive reforms are necessary across nursing education, healthcare systems, policies, and societal attitudes. This includes enhancing nursing roles in diabetes care, management, and prevention. The pivotal role of nurses is increasingly recognized worldwide. For instance, a Swiss referendum highlighted the need for an adequate nursing workforce to optimize patient care. However, despite their significant contributions, nurses often face underrepresentation in governance and leadership positions. To bridge this gap, innovative approaches like appointing cantonal nurses can empower nursing professionals and facilitate collaboration with policymakers. Expanding the scope of nursing practice and increasing remuneration for nurse-provided services are effective strategies to acknowledge their value. Identifying and addressing systemic barriers is crucial. In LMICs like Kyrgyzstan, legal restrictions on nurse prescribing hinder their full potential. Moreover, societal perceptions and healthcare provider attitudes can limit the recognition of nurses' role in non-communicable disease management, including diabetes. To fully leverage the potential of nurses, a multifaceted approach is required. This involves empowering nurses to prescribe medications, manage diabetes clinics, conduct research, and provide education. Thailand serves as a model for expanding nursing roles, with nurses assuming advanced practice roles in diabetes care. However, studies suggest that while these interventions can improve blood glucose control in LMICs, their impact may be moderate [107].

To effectively address the global diabetes epidemic, it is imperative to increase the nursing workforce, strengthen leadership, and enhance training. Fundamental changes within the nursing profession are necessary, including improved employment opportunities, career paths, and professional recognition. Additionally, addressing global migration and retention challenges is crucial to ensure a sustainable nursing workforce. To fully realize their potential, nurses require the support of healthcare systems and society. This includes providing the necessary skills, tools, and authority to deliver comprehensive diabetes care. Interprofessional collaboration, involving nurses and medical professionals working together, is essential to optimize patient outcomes. By implementing these strategies, we can harness the power of nursing to improve diabetes care and achieve global health goals [87,107].

6. Conclusion

Specialist nurses play a vital role in the management of diabetes, addressing its complex and multifaceted challenges. Through their expertise, they improve patient outcomes in various domains, including inpatient care, outpatient support, pediatric diabetes management, diabetic foot ulcer prevention, and gestational diabetes care. Nurse-led interventions such as self-management education, telehealth services, and telephone interventions further enhance patient engagement and disease management. However, DSNs face significant challenges, including limitations in scope of practice, inadequate remuneration, and the need for better interprofessional collaboration. Addressing these barriers is crucial to fully leveraging the potential of specialist nurses in diabetes care. Their continued support and recognition are essential for mitigating the global impact of diabetes and its complications, ultimately improving patient QOL and reducing mortality.

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