Original Article

Optimizing Capillary Blood Glucose Monitoring Frequency in Hospitalized Patients with Diabetes: Development of a Nursing Evidence-Based Protocol

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Abstract

Background: Diabetes mellitus is a highly prevalent chronic metabolic disorder associated with significant morbidity, mortality, and healthcare burden. In hospitalized patients, glycemic dysregulation is common due to stress responses, comorbidities, and therapeutic interventions. Capillary blood glucose (CBG) monitoring is essential for glycemic control; however, the optimal frequency of monitoring remains unclear, with existing guidelines lacking specific, evidence-based recommendations. Nurses play a central role in monitoring and managing glycemic levels, highlighting the need for structured protocols based on nursing evidence.

Objectives: This study aimed to develop an evidence-based protocol for determining the optimal frequency of CBG monitoring in hospitalized patients with diabetes mellitus.

Methods: A prospective observational study was conducted in a tertiary hospital, including 30 hospitalized patients with diabetes mellitus. Continuous glucose monitoring (CGM) sensors were used alongside routine capillary measurements. Demographic and clinical data were collected. Statistical analysis was performed using IBM SPSS Statistics, including descriptive statistics, one-way ANOVA, independent samples t-test, and chi-square tests, with significance set at $p < 0.05$.

Results: Monitoring frequency varied significantly by treatment regimen ($F(3,26) = 32.45$, $p < 0.001$), with patients on intensive insulin therapy demonstrating the highest frequency. Structured monitoring was associated with significantly lower HbA1c levels (7.2% vs 8.6%, $t(28) = -4.12$, $p < 0.001$) and fewer hypoglycemic episodes ($\chi^2 = 4.21$, $p = 0.040$). Patient education was significantly associated with improved adherence to monitoring practices ($\chi^2 = 5.00$, $p = 0.025$). Key barriers included knowledge deficits, perceived burden, and incorrect technique.

Conclusions: Individualized and structured CBG monitoring is strongly associated with improved glycemic control and patient safety. Adopting protocol-driven, nurse-led monitoring strategies can improve adherence, standardize care, reduce complications, and support high-quality, patient-centered diabetes management.

Key words: Diabetes Mellitus; Continuous Monitoring; Clinical Protocols;

Introduction

Diabetes mellitus (DM) is a complex, multifactorial syndrome characterized by impaired metabolism of carbohydrates, fats, and proteins due to absolute or relative insulin deficiency (HAD, 2017). As one of the most common metabolic diseases globally, the rising prevalence of DM poses a severe threat to public health and the global economy. By 2030, it is estimated that the number of patients will rise to 552 million (IDF, 2023). Consequently, the number of hospitalized patients with diabetes is increasing. This population includes patients admitted for acute or long-term complications of diabetes, as well as those presenting with unrelated medical or surgical conditions requiring hospital care (Fountouki, 2021).

Hospitalized diabetic patients face a severe risk of plasma glucose dysregulation. The body's neuroendocrine response to the stress of illness activates the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, triggering the secretion of stress hormones such as catecholamines and cortisol (Morales-Brown et al., 2024). In addition to stress-induced hormonal changes, corticosteroid therapy, enteral and parenteral nutrition, and reduced mobility frequently lead to hyperglycemia. This cascade can result in a reduced immune response, impaired wound healing, increased oxidative stress, endothelial dysfunction, a prothrombotic state, fluid shifts, electrolyte imbalances, and ischemia. These conditions exacerbate the patient's acute state, perpetuating a cycle of metabolic dysregulation (Dennick et al., 2017; ADA 2004).

Retrospective studies consistently demonstrate that stress-induced hyperglycemia is positively associated with poor prognoses in cardiology, cardiac surgery, general surgery, and intensive care unit (ICU) patients (Tian et al., 2024). Consequently, systematic glycemic control is imperative. Nurses, as frontline healthcare professionals who perform blood glucose monitoring and continuously observe clinical changes, are uniquely positioned to recognize the manifestations of glycemic dysregulation and implement care protocols in collaboration with the medical team (Theofanidis, 2017; Finfer et al., 2009).

Modern hospital management of patients with diabetes includes systematic CBG monitoring performed via bedside glucometers. Glucose monitoring could be categorized as a vital sign, equal in clinical importance to temperature, blood pressure, pulse, and respiration. Early recognition, rapid intervention, and prompt therapeutic decision-making reduce complication risks and shorten hospital stays (Adolfsson et al., 2018). However, the optimal frequency of capillary testing remains a clinical judgment typically determined by the patient's overall condition, diabetes type, medical history, and initial laboratory parameters. The Hellenic Diabetes Association guidelines (HAD, 2017). do not specify standard monitoring frequencies, and many informal clinical protocols rely heavily on clinical experience rather than empirical evidence. The American Diabetes Association (2024) recommends maintaining plasma glucose between 140–180 mg/dL to balance glycemic control with the risk of iatrogenic hypoglycemia, yet specific, universally applicable monitoring frequencies to achieve this target remain undefined (De Block et al., 2006).

Despite their contribution to diabetes management, CBG meters have limitations. Measurements reflect a single point in time, complicating the assessment of glucose trends, fluctuations, or nocturnal events. Furthermore, testing causes patient discomfort and poses infection control risks (Friesner et al., 2020). The need for comprehensive monitoring has driven the use of continuous glucose monitoring (CGM) systems, which provide continuous data and serve as a milestone toward the artificial pancreas (Kitagawa et al., 2025).

Research utilizing CGM in ICUs has revealed that normoglycemia is often achieved in only a small fraction of patients, highlighting the inadequacy of standard insulin administration protocols (Luijf et al., 2013. Similarly, Burt et al. demonstrated that CGM detected significantly more postprandial hyperglycemic and hypoglycemic episodes than routine CBG checks performed four times daily (Burtet al., 2013).

While CGM systems are excellent research tools for assessing the accuracy of capillary tests and evaluating treatment efficacy, the development of a structured, evidence-based protocol for determining the optimal frequency of routine CBG monitoring is essential for standard hospital wards. Such a protocol should be grounded in current research, aligned with international guidelines, and informed by nursing expertise (Powers et al., 2020).

This paper aims to address this gap by developing a nursing evidence-based protocol to guide the optimal frequency of capillary blood glucose monitoring in hospitalized patients with diabetes mellitus. By synthesizing current evidence and emphasizing the role of nursing practice, the proposed protocol seeks to enhance clinical decision-making, improve glycemic outcomes, and support high-quality, individualized care.

Materials and Methods

This observational study was conducted at the First Department of Internal Medicine at a major hospital in Northern Greece. The sample consisted of 30 patients with DM who had been hospitalized for >48 hours. A statistical a priori power analysis was performed using G*Power software, revealing a minimum requirement of 25 patients to achieve a significance level of 0.05 and a power level of 0.8. Patients admitted primarily for acute respiratory diseases, stroke, or other major diagnoses where DM was only a concomitant co-morbidity, were excluded.

Ethical approval was obtained from the hospital's Scientific Council (Approval No. 6209/16-2-2026) prior to data collection. As an observational study designed not to interfere with routine daily management, blind glucose sensors were utilized. This ensured that real-time continuous monitoring could not influence or modify planned interventions or emergency treatments by the ward staff. Sensors were placed on patients the day following their admission shift and remained in situ for up to 7 days, or until discharge. Written informed consent was obtained from all patients; for those with impaired consciousness, consent was provided by their next of kin.

In addition to sensor data, medical records were reviewed to extract demographic data, diabetes type, glycated hemoglobin (HbA1c), admission glucose levels, and current treatment regimens.

Data were analyzed using IBM SPSS Statistics. Descriptive and inferential statistical methods were applied. The distribution of continuous variables was assessed using the Shapiro–Wilk test, histograms, and Q–Q plots. Homogeneity of variances was evaluated using Levene's test.

A one-way Analysis of Variance (ANOVA) followed by Tukey's Honestly Significant Difference (HSD) post hoc test was used to compare monitoring frequency across treatment regimens. An independent samples t-test was utilized to compare mean HbA1c levels between regular and irregular monitoring patterns. Associations between categorical variables were examined using the Chi-square test of independence (χ^2), with Fisher's exact test applied where expected cell counts were less than 5. A p-value of < 0.05 was considered statistically significant.

Results

Sample Characteristics

***Demographic and Clinical Characteristics of Participants*).**

The study included 30 patients with a mean age of 62.4 years (SD = 10.2). The majority were diagnosed with Type 2 DM (80%). Treatment regimens varied, with the highest proportion receiving intensive insulin therapy (33.3%), followed by oral agents only (30.0%). (*Table 1:*

Capillary Blood Glucose Monitoring Practices

Baseline assessments revealed significant variability in CBG monitoring frequency, highly dependent on the prescribed treatment regimen (Table 2). Patients on intensive insulin regimens monitored most frequently, while those managed with lifestyle interventions monitored rarely. Irregular monitoring patterns—including missed measurements and inconsistent timing relative to meals—were identified in 40% of the participants (n=12). (*Table 2: Frequency of Capillary Blood Glucose Monitoring by Treatment Regimen*)

Glycemic Control Outcomes Patients engaging in regular, structured monitoring demonstrated significantly better glycemic control. The mean HbA1c for those with structured monitoring (n=18) was 7.2% (SD=0.8), compared to 8.6% (SD=1.0) for those with irregular monitoring ($t(28) = -4.12$, $p < 0.001$). Furthermore, episodes of hypoglycemia were more prevalent among patients with irregular monitoring patterns, particularly those on insulin therapy (Table 3 Monitoring Patterns and Glycemic Control).

Nursing Assessment and Identified Needs

Nursing assessments identified multiple barriers to optimal monitoring. The perceived burden of frequent testing was the most common barrier (43.3%), followed by knowledge deficits (36.7%) and incorrect monitoring technique (30.0%). Crucially, adherence to recommended monitoring was positively associated with recent diabetes education; patients who received structured education within the past six months demonstrated significantly higher adherence rates ($\chi^2(1) = 5.00$, $p = 0.025$). **(***Table 4) Nursing Assessment Findings and Patient-Related Factors***)**

Table 1: Demographic and Clinical Characteristics of Participants (N = 30)

Variable	n (%) / Mean ± SD
Age (years)	62.4 ± 10.2
Gender	
Male	16 (53.3%)
Female	14 (46.7%)
Type of Diabetes	
Type 1	6 (20.0%)
Type 2	24 (80.0%)
Treatment Regimen	
Intensive insulin therapy	10 (33.3%)
Basal insulin + oral agents	8 (26.7%)
Oral agents only	9 (30.0%)
Lifestyle only	3 (10.0%)
HbA1c (%)	7.8 ± 1.1

Table 2: Frequency of Capillary Blood Glucose Monitoring by Treatment Regimen

Treatment Regimen	Mean Frequency (times/day)	SD
Intensive insulin therapy	4.6	1.2
Basal insulin + oral agents	2.1	0.8
Oral agents only	0.9	0.6
Lifestyle only	0.3	0.2

Note: One-way ANOVA $F(3, 26) = 32.45$, $p < 0.001$

Table 3: **Monitoring Patterns and Glycemic Control**

Variable	n (%) / Mean ± SD
Monitoring Pattern	
Regular/structured	18 (60.0%)
Irregular	12 (40.0%)
HbA1c (%)	
Regular monitoring	7.2 ± 0.8
Irregular monitoring	8.6 ± 1.0
Hypoglycemic Episodes (past month)	
Patients reporting ≥1 episode	7 (23.3%)
Insulin-treated patients with hypoglycemia	7/18 (38.9%)

Table 4: Nursing Assessment Findings and Patient-Related Factors

Factor Identified	n (%)
Knowledge deficits	11 (36.7%)
Fear of hypoglycemia	8 (26.7%)
Perceived burden of frequent testing	13 (43.3%)

Factor Identified	n (%)
Incorrect monitoring technique	9 (30.0%)
Recent diabetes education (≤6 months)	15 (50.0%)

Discussion

Maintaining euglycemia is the cornerstone of the therapeutic approach for patients with diabetes. However, in standard hospital wards, plasma glucose monitoring protocols are frequently based on the subjective experience of treating physicians rather than robust evidence (Davies et al., 2018; Farmer et al., 2012). The present study aimed to develop an evidence-based approach to determining the optimal frequency of CBG monitoring, with a strong emphasis on nursing practice and autonomy (Muazu et al., 2025).

Our findings demonstrate that monitoring frequency varies significantly according to the treatment regimen and is directly associated with glycemic outcomes. Patients receiving intensive insulin therapy exhibited the highest frequency of CBG monitoring, aligning with current ADA and IDF guidelines (NICE, 2022). These guidelines emphasize the necessity of frequent monitoring in patients at increased risk of glycemic variability and hypoglycemia.

Conversely, patients managed with oral agents or lifestyle interventions demonstrated substantially lower frequencies, reflecting a gap in clear, standardized recommendations for these cohorts (Olokoba et al., 2012).

A vital finding of this study is the significant association between structured monitoring and improved glycemic control. Patients who adhered to regular schedules had significantly lower HbA1c levels and fewer hypoglycemic events. From a nursing perspective, this underscores that merely ordering a glucose check is insufficient; nurses must ensure that monitoring is performed in a structured, consistent, and patient-centered manner. Patients with irregular monitoring were far more likely to experience hypoglycemia, highlighting a critical patient safety issue that nurses are well-positioned to mitigate through education and symptom recognition (Polonsky et al., 2016).

Furthermore, this study identified multidimensional barriers to adherence, including knowledge deficits, fear of hypoglycemia, and incorrect technique. The statistically significant correlation between recent nursing-led diabetes education and improved monitoring practices illustrates the profound impact of structured nursing interventions.

The proposed protocol for the optimal frequency of CBG monitoring serves as an evidence-based clinical guideline that expands the scope of autonomous nursing decision-making. By utilizing initial laboratory parameters (e.g., HbA1c, admission glucose) and current treatment regimens, nurses can definitively stratify patients to require 2, 3, 4, or more checks per 24-hour period. Establishing this standardized protocol reduces the clinical risk for both nurses and patients, providing professional and legal protection while ensuring high-quality care.

Implications for Nursing Practice Nurses are uniquely positioned to champion the implementation of individualized monitoring strategies. Integrating this structured protocol into routine care will establish a standard of care for the management of diabetic patients on general wards, reduce complication rates associated with poor glucose control, and decrease the duration and cost of hospital stays. Furthermore, it will prevent patient discomfort resulting from unnecessary, unguided capillary checks and ensure safe, legally protected patient management based on universally accepted scientific parameters. Ultimately, this empowers nursing staff to determine the appropriate frequency of glucose monitoring based on a robust, peerreviewed framework rather than subjective routine.

Limitations and Future Research: The primary limitations of this study are its relatively small sample size (N = 30) and single-center design, which may limit the generalizability of the findings. Future research utilizing larger, multicenter populations is recommended to validate and refine the proposed protocol. Additionally, longitudinal studies are necessary to assess the long-term impact of nurse-led optimized monitoring frequencies on extended clinical outcomes and patient quality of life.

Conclusions: Individualized and structured CBG monitoring is critically important in the effective management of hospitalized patients with diabetes mellitus. This study confirms that regular monitoring is associated with significantly improved glycemic control and a reduced incidence of hypoglycemia. Furthermore, it emphasizes the central role of nursing practice in optimizing diabetes management, highlighting that patient education and the resolution of knowledge barriers directly influence monitoring adherence. The development of an evidence-based protocol for determining the optimal frequency of CBG monitoring represents a meaningful contribution to clinical practice. Grounded in patient-specific factors and supported by nursing expertise, this protocol has the potential to standardize care, enhance patient safety, and improve clinical outcomes while preventing the burden of unnecessary over-testing.

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