Postprint: Current Research Status on the Application of Continuous Glucose Monitoring in Patients with Type 2 Diabetes

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Date: 2023-05-12T00:00:00+00:00

Abstract

Continuous Glucose Monitoring System (CGMS) enables continuous glucose monitoring in diabetic patients, providing dynamic glucose profiles that serve as reliable evidence for clinical decision-making by healthcare professionals. This review summarizes the principles of CGMS, its application advantages, and current status in the management of patients with type 2 diabetes mellitus (T2DM), aiming to provide a reliable reference for the treatment and nursing care of T2DM patients.

Full Text

Preamble

Platform: NursRxiv (Nursing Preprint Paper Network First Release Platform)

Peer Review Status: Not Peer Reviewed
Title: Research Status of Ambulatory Blood Glucose Monitoring in Patients with Type 2 Diabetes Mellitus
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Abstract

Continuous Glucose Monitoring System (CGMS) enables continuous blood glucose monitoring in diabetic patients, providing dynamic glucose profiles that offer reliable evidence for clinical diagnosis and treatment. This study reviews the principles of CGMS, its application advantages, and current status in the treatment of type 2 diabetes mellitus (T2DM) patients, aiming to provide a reliable reference for the clinical management and nursing care of T2DM patients.

Keywords: continuous glucose monitoring; type 2 diabetes mellitus; hypoglycemia; glucose profile; insulin

Introduction

In recent years, the incidence of diabetes has been rising alongside population aging and lifestyle changes. Diabetes-related complications can damage multiple organ systems, seriously affecting patients' health and even endangering their lives. Blood glucose monitoring represents a critical component in controlling diabetes progression, as strict monitoring and glycemic control can significantly reduce and delay the development of diabetic complications. Currently, fingertip blood glucose testing, widely used in clinical practice, has inherent limitations. Continuous Glucose Monitoring System (CGMS) can effectively capture comprehensive blood glucose changes, enabling clinicians to develop more personalized treatment plans and substantially improve patient outcomes. The treatment and management of T2DM requires not only precise medical intervention but also active patient cooperation and diligent self-management. While effective blood glucose monitoring is essential for T2DM patients, intermittent monitoring cannot accommodate personalized diabetes management. CGMS is a novel monitoring approach that provides both instantaneous glucose concentration measurements and retrospective analysis of glucose patterns, thereby improving patients' glycemic control efficiency. This paper reviews the current application status of CGMS in T2DM patients.

1. Introduction to CGMS

Continuous glucose monitoring technology serves as an important adjunct to conventional blood glucose monitoring, providing real-time, comprehensive blood glucose data throughout the day. The system comprises software analysis components, an information extractor, a recorder, cables, and a glucose sensor probe. The sensor probe is a platinum electrode containing glucose oxidase with a semipermeable membrane that is inserted subcutaneously. Glucose passes through this membrane and reacts with glucose oxidase, generating an electrical signal corresponding to the blood glucose concentration, which is transmitted via cable to the recorder and converted into glucose values.

The International Consensus on Continuous Glucose Monitoring, published at

the Advanced Technologies & Treatments for Diabetes conference, classifies CGMS into three types: retrospective, real-time, and on-demand [2]. Retrospective CGMS provides monitoring data after completion of the wear period, while real-time CGMS offers timely glucose information to patients, including high/low glucose alarms and predictive alerts, combining both retrospective and real-time data collection functions. Instantaneous CGM (iCGM) is a newer real-time monitoring technology that requires no fingerstick calibration—users obtain real-time glucose data simply by scanning—and can display glucose trends for up to 14 days, making it a highly practical technology [3].

2. Application of CGMS in T2DM Patients

2.1 Timely Detection of Hypoglycemia and Reduction of Patient Fear

CGMS not only better reflects hypoglycemic events but also provides timely and effective follow-up tracking. In a study by Chen Zhigang et al. [4], 120 elderly T2DM patients were randomly divided into experimental and control groups. The experimental group used CGMS for blood glucose monitoring, while the control group used self-monitoring of blood glucose (SMBG) seven times daily. Results demonstrated that CGMS maximized detection of hypoglycemic symptoms in elderly diabetic patients, thereby enhancing their self-care capabilities. Wang Xiufang [5] compared CGMS with fingertip blood glucose monitoring in elderly T2DM patients, finding that CGMS detected hypoglycemia in 9 patients (including 7 asymptomatic cases) among 60 elderly T2DM patients, while fingertip monitoring detected none. Wang Chunling [6] monitored hypoglycemia in 80 hospitalized T2DM patients using both CGMS and portable glucose meters, discovering significantly higher detection rates of hypoglycemia, asymptomatic hypoglycemia, and nocturnal asymptomatic hypoglycemia with CGMS, confirming its superior monitoring effectiveness.

CGMS is a minimally invasive monitoring system similar to Holter that comprehensively analyzes blood glucose fluctuation trends, amplitude, frequency, timing, and underlying causes [7]. Through continuous real-time monitoring, it constructs detailed glucose profiles, providing clinicians with comprehensive information for diagnosis and treatment, facilitating the development of detailed treatment plans and appropriate insulin dosage adjustments [8]. These findings indicate that CGMS monitoring demonstrates good efficacy in T2DM patients and holds significant value for broader clinical application.

2.2 Provision of Blood Glucose Fluctuation Data

The development and progression of T2DM are closely related to blood glucose control and chronic complications. While HbA1c serves as an indicator of glycemic control status, it only reflects average blood glucose over 2-3 months and cannot capture detailed glucose variations. CGMS provides more precise information about blood glucose fluctuations, enabling more scientific and precise diabetes management. CGMS can generate extensive blood glucose variation

data, including 24-hour mean blood glucose levels, standard deviation, maximum glucose values, fluctuation amplitude, and mean amplitude of glycemic excursions [9].

A study by Zhang Ying et al. [10] examined 120 T2DM patients, with the control group using traditional fingerstick monitoring and the observation group using instantaneous scanning CGMS for real-time monitoring and insulin dose analysis. Results showed that the observation group experienced significantly shorter periods for glucose observation, insulin dose adjustment, stabilization of glucose and insulin doses, and time to target glucose levels ($P<0.05$). Through real-time dynamic monitoring, CGM can promptly detect abnormal glucose states and reduce patients' fear of hypoglycemia [11]. Factors such as poor medication adherence, improper diet, and mood disturbances can cause blood glucose fluctuations leading to T2DM. CGMS dynamically monitors the impact of diet, exercise, sleep, and hypoglycemic medications, helping patients develop proper eating habits.

2.3 Promotion of Treatment Compliance and Self-Management

A survey by Xu Yifeng [12] selected 120 T2DM patients, with the study group wearing dynamic glucose monitors and the control group using conventional glucose meters for daily monitoring. Results demonstrated that after discharge, the study group showed higher rates of medical compliance behavior and diabetes self-management ability 达标率 ($P<0.05$), indicating that CGMS promotes patient compliance—crucial for effective blood glucose control. Continuous monitoring enables patients to understand how diet, exercise, and mood affect blood glucose, facilitating more personalized and precise treatment approaches [13].

2.4 Significant Therapeutic Effects When Combined with Insulin Pump Therapy

CGMS can accurately reflect 24-hour blood glucose changes in diabetic patients, providing significant support for intensive insulin pump therapy. Studies by Du Zhenling et al. [14] and Liu Jianwen [15] both demonstrated that using CGMS during insulin pump therapy in T2DM patients can reflect 24-hour glucose fluctuations, clarify patient indicators, and facilitate timely adjustment of insulin pump dosage, achieving glucose targets faster while detecting hypoglycemic tendencies and reducing adverse events. Li Xiaolei et al. [16] found that combining CGMS with insulin pump therapy in newly diagnosed T2DM patients enables more precise insulin dosage regulation and faster glycemic control with more stable effects. During insulin pump therapy, CGMS data helps clinicians better understand patients' glycemic variability, improving treatment efficiency and quality, reducing glucose fluctuations, and enhancing quality of life [17].

3. Summary

CGMS offers several advantages: accurate reflection of blood glucose fluctuations, minimal invasiveness, comfortable wear, and avoidance of pain from repeated fingertip punctures. However, it is currently a self-paid item with high cost, resulting in poor patient acceptance. Additionally, compared with traditional monitoring methods, diabetic patients lack understanding of CGMS technology. CGMS provides dynamic glucose profiles that help observe the impact of diet, exercise, medications, and mood fluctuations, enabling clinicians to understand patients' conditions and identify causes of glucose changes, thereby guiding proper diet, exercise, and medication/insulin adjustments. Glucose profiles guide doctors in developing scientific, detailed, and personalized treatment plans, particularly for insulin pump users, ensuring short-term glucose control to delay or prevent complications, which is clinically significant. Combined use of CGMS and insulin pump therapy can improve medical staff efficiency, reduce glucose fluctuation frequency, stabilize patient visit cycles, and enhance doctor-patient cooperation, fostering good clinical relationships.

Conflict of Interest Statement: The authors declare no conflict of interest.

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Note: Figure translations are in progress. See original paper for figures.