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Continuous Glucose Monitoring in Hospital Care: Implementation and Clinical Use

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Abstract

Introduction:

High glycemic variability during hospitalization is associated with an increased risk of complications, prolonged hospital stay, higher costs, and mortality. Continuous glucose monitoring (CGM) enables ongoing measurement of interstitial fluid glucose concentration and reduces the incidence of hypo- and hyperglycemic episodes, glycemic variability, and the need for repeated capillary blood sampling in hospitalized patients.

Aim

To evaluate the implementation of CGM telemonitoring in the hospital setting, the indications for its use, the duration of monitoring in hospitalized patients with diabetes mellitus (DM), and to compare the economic aspects of CGM with standard monitoring using capillary blood sampling.

Methodology:

This retrospective observational study included 47 hospitalized patients with DM and non-diabetic hypoglycemia in whom a FreeStyle Libre 2 sensor was applied. The indications for CGM application, monitoring duration, economic costs, and the proportion of patients who continued using CGM after discharge home were analyzed. Given the retrospective and descriptive nature of the study, no formal statistical hypothesis testing was performed.

Results

CGM was implemented in 47 patients, of whom 43 were included in the analysis. The most common indication was metabolic decompensation of type 2 diabetes (43%). The mean monitoring duration was 8.5 ± 4.8 days, and 38% of patients continued using CGM after discharge. Although the direct costs of CGM are higher than those of capillary sampling, the difference decreases with longer monitoring duration and measurement frequency.

Conclusion

The use of CGM telemonitoring represents a safe supplementary method of glycemic monitoring in hospitalized patients with glycemic variability and differentiation of hypoglycemic states. Despite the higher direct costs, when the length of hospitalization and indirect benefits are taken into account, it may be a potentially cost-effective solution. In addition to increasing safety and individualization of glycemic

management, its use was also associated with continued monitoring after discharge to home care in a significant proportion of patients.

Introduction

Diabetes mellitus (DM) occurs in more than 25% of patients admitted to inpatient wards **(1)**. Hyperglycemia, as well as glycemic variability in patients with DM during hospitalization, is generally associated with an increased risk of complications, financial costs, and mortality, with the risks related to the degree of glycemic variability **(2,3,4)**. Paradoxically, intensive diabetic treatment is at the same time associated with an increased risk of hypoglycemia, which is independently associated with increased morbidity and mortality in hospitalized patients, with its prevalence on internal medicine and surgical wards being approximately 30% **(2,1)**. Standard methods of glycemic monitoring include capillary sampling (point-of-care testing, POC). The number of POC measurements depends on the patient's clinical status and glycemic variability. POC testing at standard time intervals may fail to detect episodes of hypoglycemia or hyperglycemia. At the same time, the rising prevalence of patients with DM and the need for frequent POC measurements leads to an increased workload for healthcare staff, as well as a higher number of patient contacts, which may represent a potential risk of exposure to infectious diseases (**5**).

One additional option for glycemic monitoring is continuous glucose monitoring (CGM), which enables continuous monitoring of interstitial glucose concentration and provides a more detailed overview of glycemic trends. In patients with DM using CGM, studies have reported a lower risk of hospitalization, a lower incidence of cardiovascular events, and lower mortality compared with patients who did not use CGM **(6)**. In addition, several studies point to good accuracy, sensitivity, and safety of CGM in hospitalized patients **(7)**. The limitations of CGM include its use in critically ill patients with impaired tissue perfusion. Recently published studies, however, point to its usability also in patients in intensive care units, demonstrating good measurement accuracy and a low MARD value (mean absolute relative difference) **(8)**.

CGM is a minimally invasive technology that enables continuous monitoring of glucose concentration in interstitial fluid. Measurement takes place at short time intervals based on an enzymatic reaction, with the system providing a detailed overview of glycemic trends throughout the day. The sensor is inserted into the subcutaneous tissue using a special applicator, where it continuously measures the glucose concentration in the interstitial space. The acquired data are then transmitted to a reader device or a compatible mobile device via NFC/Bluetooth technology, enabling regular display of current glucose values and their trends **(9)**. The system also includes trend arrows, which indicate the direction and rate of change of glucose concentration. Some CGM devices additionally allow the setting of alarm limits for hypoglycemia and hyperglycemia, which alert the patient or healthcare staff with an audible or vibrating signal when a predefined glycemic range is exceeded. This function can contribute to early identification of at-risk glycemic states and to the prevention of hypoglycemic and hyperglycemic episodes **(10)**.

CGM systems are divided, according to their role in treatment decisions, into adjunctive and non-adjunctive systems. Adjunctive systems require confirmation of the glucose value by capillary measurement before a therapeutic decision, whereas non-adjunctive systems allow treatment adjustment without the need for capillary confirmation. Non-adjunctive CGM systems include, for example, Dexcom, CareSens Air, Guardian, and FreeStyle Libre 2, which was also used in our study (**11**). CGM devices are approved by the Food and Drug Administration (FDA) for outpatient use, but not for hospital facilities, where CGM is recommended as a supplementary method to capillary sampling. However, clinical studies from recent years show their benefit specifically in hospitalized patients. The use of CGM in hospital settings has led to **(12)**:

- a reduction in hypoglycemic events compared with POC (0.67 vs. 1.69, $P = 0.024$)
- a reduction in time spent in hyperglycemia (CGM 22% vs. POC 33%)
- saving of healthcare staff time
- a reduction in capillary sampling and thus patient trauma in more than 50% of cases
- an increase in time within the target glycemic range from 62.7% to 77.6% **(13)**
- increased patient satisfaction
- a reduction in exposure of healthcare workers to infectious patients (**5**)

Methodology

At the beginning of 2025, following the development of internal guidelines, staff training, and legal preparation, a CGM system using the FreeStyle Libre 2 sensor was introduced. In order to optimize financial costs, the CGM system was indicated in patients who met the established indication criteria **(Table 1)**.
The concept of continuous glucose monitoring itself consists of:

1. **FreeStyle Libre 2 sensor** – used for continuous measurement of interstitial glucose.
2. **Mobile devices** (smartphones or a reader) that meet the technical requirements of the **LibreLink** and are used to receive data from the sensor.
3. **Internet connection**, which ensures data transfer to LibreView and LibreLinkUp.
4. **Tablet**, through which healthcare staff monitor patients' glycemic trends via the LibreLinkUp application.
5. **Software applications and cloud platform** – in particular LibreLink, LibreLinkUp a LibreView, which enable real-time collection, sharing, and analysis of glycemic data.

When a patient is admitted to the department and meets the indication criteria, they are informed about the benefits and possible risks of CGM, followed by signing of informed consent. After sensor application, the device is paired with a mobile device via the LibreLink application using NFC and Bluetooth technology. The paired mobile device is then placed at the patient's bedside, or kept near the

patient in the case of various examinations within the hospital. Via the department's internet connection, these mobile devices are linked to a tablet located in the nursing/medical staff room, where glucose values are monitored in real time using the LibreLinkUp application **(Fig. 1)**.

The data of all patients were shared via the LibreLinkUp application to a single monitoring device, which allowed continuous tracking of current glucose values, glycemic trends, and individual setting of alarm limits. The system enabled early detection of hypo- and hyperglycemia and supported rapid therapeutic intervention by healthcare staff. This system, however, does not serve as a replacement for POC but represents a supplementary monitoring method. We perform POC mainly in cases where CGM signals hypoglycemia or hyperglycemia, or in the event of an unexplained change in the patient's clinical status. Using the LibreView cloud system, we subsequently analyze glucose curves and adjust antidiabetic treatment based on the data obtained. The limitations of CGM include its use in critically ill patients with impaired tissue perfusion, particularly in states accompanied by hypotension, hypothermia, hypoxia, or the need for vasopressor support. Measurement accuracy may also be affected by interference from certain substances, which can lead to discrepancies between interstitial and capillary glucose values **(14)**.

Results

In the first year of implementation, a CGM sensor was applied in our department in 47 patients with marked glycemic variability and the need for intensive glucose monitoring and insulin therapy titration. Below we present the specific indications for CGM use in the study cohort (**Chart 1**). Of these, 43 patients were included in the analysis; 4 patients were excluded due to missing complete data. The sensor was used in patients on general wards as well as in critically ill patients in the intensive care unit. The mean duration of continuous glucose monitoring was 8.5 ± 4.8 days, with a median of 8 days (IQR 5–11). The shortest monitoring duration was 2 days (exitus letalis), and the longest was 24 days. The most common monitoring duration was 7–8 days, which roughly corresponds to the average length of hospitalization of the patients.

The above analyses show a heterogeneous group of patients with glycemic variability, as well as the potential use of CGM in diagnosing hypoglycemia. The financial aspect of CGM in hospital facilities is of particular interest. Below we present a financial comparison of POC vs. CGM in our department, after subtracting the initial costs of the mobile device and tablet, which were obtained through grants. With a classic glycemic profile, approximately 5 capillary glucose measurements are performed per day; with an extended profile, the number of measurements can reach up to 11 per day, averaging 8 measurements/24 hours. In clinical practice, however, the classic glycemic profile (5x daily) is most commonly used in our department, with daily costs of glycemic monitoring amounting to approximately €4.4 per patient. Taking into account the average hospitalization length of 8.5 days, the total cost of POC reaches approximately €37.4 per hospitalization. For the extended profile, this is €82.28 **(see Table 2)**. These costs include healthcare staff labor (labor cost and the full calculation are shown in Table 2), but do not include costs associated with managing complications such as hypoglycemia, infectious complications, or potential prolongation of hospitalization, which occur less frequently in patients using

CGM **(Table 3)**. Given the increasing number of patients with DM, labor costs were also included in the price analysis. The gross hourly wage of a nurse ranges from €10–12 per hour, depending on education, experience, and specialization (on average €11; €0.18 per minute).

When comparing the cost of the sensor FreeStyle Libre 2, which is €72.13 (€61.22 excluding VAT), the difference compared with POC over the average hospitalization period is €42.38 excluding labor costs, and €34.73 including labor costs; in the case of the extended profile, the cost of capillary sampling exceeds that of CGM. Our analysis further shows that 18 of 47 patients (38%) continued glycemic monitoring using CGM even after discharge to home care.

Discussion

Our retrospective observational study evaluates the implementation of CGM in hospitalized patients not only with DM but also in patients undergoing differential diagnosis of hypoglycemia on an internal medicine ward. CGM is currently used mainly in outpatient diabetology practice; however, in recent years an increasing number of studies have pointed to its potential benefit in hospital facilities as well. Published studies suggest that the use of CGM during hospitalization may contribute to increased patient safety through early identification of hypoglycemic and hyperglycemic episodes, thereby potentially reducing the risk of complications and mortality during hospitalization (**12,2,4,6**). In our cohort, we analyzed the use of CGM in 43 hospitalized patients, with a mean hospitalization length of 8.5 days. The study presents initial experience with the implementation of this technology and telemonitoring in clinical practice, including an analysis of the indication criteria for sensor application, the mean monitoring duration, and an approximate economic comparison with capillary glucose measurement.

Available literature points to potential economic benefits of using CGM in hospital facilities **(15)**. In this group, the direct costs of glycemic monitoring using CGM were higher compared with POC, although the economic advantage gradually shifts in favor of CGM depending on monitoring intensity and length of hospitalization. For an average hospitalization of 8.5 days, the cost of CGM was €73.24, compared with €37.40 for the classic glycemic profile and €82.28 for the extended profile. However, CGM may bring indirect economic benefits through a reduction in the number of capillary measurements, a lower workload for healthcare staff, and a reduction in hypoglycemic episodes. Taking these factors into account, CGM can be considered a potentially cost-effective alternative for glycemic monitoring in hospital facilities. CGM also enabled the detection of daily glycemic variability and served for more detailed adjustment of insulin or oral DM treatment, thereby supporting individualization of antidiabetic therapy. An interesting finding was that 18 of 47 patients (38%) continued glycemic monitoring using CGM even after discharge to home care. Studies suggest that the use of CGM in the home setting is associated with increased patient compliance and a reduced risk of readmission for any cause, as well as fewer emergency department visits, which may in turn contribute to a reduction in overall healthcare costs **(16)**. The limitations of our study include the relatively small number of patients, the observational design of the study conducted at a single center, and the potential deviation of CGM measurements in

critically ill patients with impaired peripheral perfusion. Limited awareness and practical experience of healthcare staff with this technology in hospital facilities, as well as the higher initial costs of purchasing the tablet and mobile devices, may also play a role. During CGM use, we did not observe any serious adverse events related to sensor application.

Learning Points:

- Continuous glucose monitoring can be successfully implemented in hospitalized patients using predefined clinical indications, particularly in metabolic decompensation, high glycemic variability, hypoglycemia, corticosteroid therapy, and perioperative care.
- CGM telemonitoring enables continuous remote assessment of glucose trends, supports individualized therapeutic decisions, and reduces the need for repeated capillary glucose measurements while improving patient comfort.
- Although CGM is associated with higher direct acquisition costs than conventional point-of-care testing, the economic difference decreases with increasing duration of monitoring and testing frequency, making CGM cost-effective in selected hospitalized patients.
- More than one-third of patients continued continuous glucose monitoring after discharge, suggesting successful transition from inpatient to outpatient diabetes care and sustained patient acceptance of the technology.
- Hospital implementation of CGM provides not only clinical benefits but also organizational advantages by supporting modern digital diabetes care and facilitating integration of telemedicine into routine inpatient practice.

Conclusion

CGM represents a safe supplementary method to POC that may contribute to increased safety of hospitalization for patients with DM, reduced trauma associated with repeated capillary sampling, and may also broaden diagnostic options in the differential diagnosis of hypoglycemic states. The initial economic analysis showed only a minimal difference in cost between CGM and POC monitoring, with the economic advantage gradually shifting in favor of CGM as the length of hospitalization increases. Beyond the economic benefit, CGM telemonitoring may also bring significant indirect benefits, including a reduction in healthcare staff workload, a reduction in the number of capillary samples, increased patient comfort, and a potentially lower incidence of complications (hypoglycemia, hyperglycemia, infections). Implementation of a system based on FreeStyle Libre 2 sensors, mobile devices, and remote monitoring via the LibreLinkUp platform enabled continuous tracking of glycemic trends, early identification of glycemic variability, and supported individualization of antidiabetic treatment. A notable finding was that approximately one-third of patients continued using CGM even after discharge home, indicating good acceptance of this technology and its potential benefit for long-term diabetes management. Further prospective studies with larger numbers of patients are needed to confirm the

clinical and economic benefits of CGM in the hospital setting, focusing on the incidence of hypoglycemia, glycemic variability, changes in antidiabetic treatment, length of hospitalization, readmissions, and overall healthcare costs.

Declarations

Conflict of Interest:

The authors declare no conflict of interest.

Condensed Abstract

Continuous glucose monitoring was successfully implemented in hospitalized patients according to predefined clinical indications. CGM telemonitoring supported individualized diabetes management, facilitated continuation of monitoring after discharge, reduced the need for repeated capillary testing and demonstrated favorable economic potential during prolonged hospitalization despite higher initial costs.

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Author Contribution

I. Dravecká: Contributed to the development of the telemonitoring concept, securing financial support and establishing the legislative framework for the project, as well as to the methodological training of the staff. During manuscript preparation, she provided supervision, reviewed the final text, and verified the accuracy of the analysis.S. Šikra: Was responsible for the graphic design and preparation of illustrations, tables, and graphs, and technically performed the application of CGM sensors in patients.I. Lazúrová: Provided professional oversight of the study implementation. She actively participated in the development of the methodology and in the revision of the manuscript.

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Tables

Table 1 to 3 are available in the Supplementary Files section.

Chart

Chart 1 is available in the Supplementary Files section.

Figures

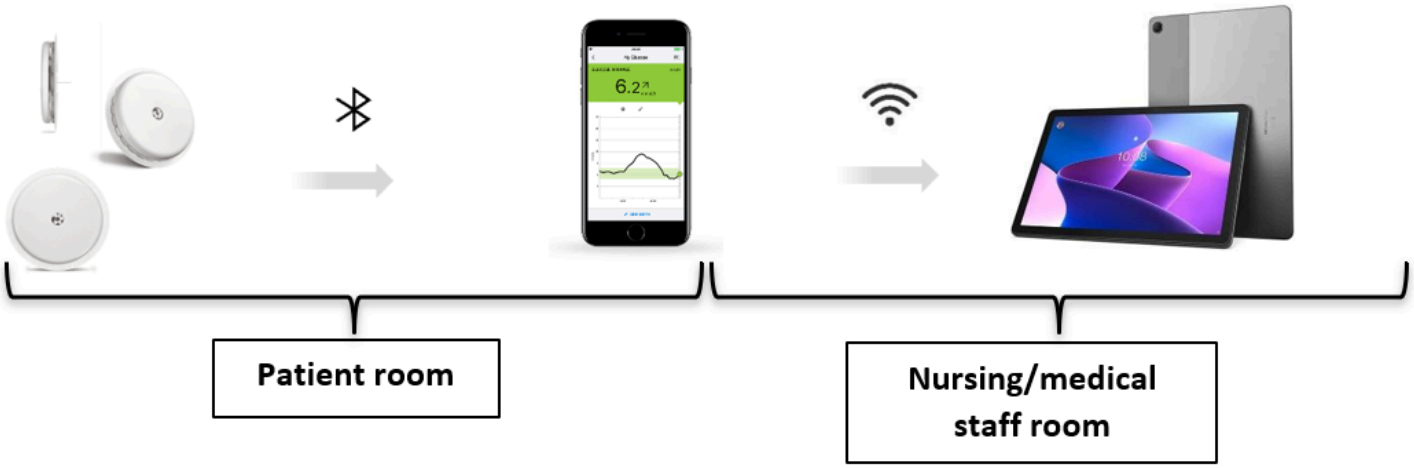


Figure 1

Illustrative depiction of the CGM system at the 1st Department of Internal Medicine, University Hospital L. Pasteur, Košice.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Chart.docx
- table.docx