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# Continuous Glucose Monitoring and Prediction as an Educational Tool, Beyond Trend Arrows

**Continuous Glucose Monitoring (CGM) has marked a turning point in the lives of people with Diabetes Mellitus (PDM) undergoing Multiple Daily Injections (MDI) and is a highly valuable tool for health care professionals who care for them.**

In the last decade, the funding of Interstitial Glucose Monitoring (IGM) for people with Diabetes Mellitus (PDM) treated with Multiple Daily Injections (MDI) has provided new features. Initially, with intermittent monitoring or flash monitoring, without alarms, it included trend arrows indicating the direction and speed of glucose in the previous 15 minutes, along with a record of the previous hours on the receiver screen or app. This already allowed viewing that "movie" of glucose values vs the "snapshot" of capillary blood glucose measurements. A true advance!

With the transition to Dual Monitoring (the start of the FreeStyle sensor with scanning or flash, and from there becoming continuous) and CGM, hypo and hyperglycemia alarms were added, and in subsequent devices, more types of alarms were introduced (hypo and hyperglycemia repetition alarms, hyperglycemia alert postponement, critical hypo alert < 55 mg/dL), alerts (for rapid glucose drop, rapid glucose rise, prediction of hypo below 55 mg/dL in 20 minutes), and more configuration options, making it better suited to the user's profile, providing better resources for decision-making and avoiding unwanted effects such as hyper- or hypoglycemia.

We have developed Educational Interventions in IGM, both for basic training in its use and for advanced training, with the interpretation of the data obtained from retrospective downloads through data platforms and real-time information displayed on the receiver or app screen.

Despite the advances in diabetes treatment »

» and the available technology, only between 55% and 60% of PDM achieve therapeutic goals1, which leads us to believe there are unmet needs2, 3 that our patients face daily, posing challenges that professionals must address.

Among the **unmet needs**, the following could be enumerated:

- Failing to achieve glucose targets. Considering not only the HbA1c value as a goal, since with current glucometry, we have learned that we must also achieve time in range and coefficient of variation goals.

- Failing to eliminate hypoglycemia, despite having resources such as hypo alarms, the predictive hypo alert for 20 minutes, alarm repetition, and trend arrows.

- A new burden has been introduced: alarm fatigue, more frequent than we think, evidenced by the fact that patients report deactivating them because they feel disturbed, adding tension, interfering with their daily activities, and with their professional work. Upon reviewing the device configuration after download, we observe that many do not have them activated, not even the hypoglycemia alarm.

- Some patients still fear hypoglycemia, despite having alerts and alarms, and these are customizable, allowing higher levels of 70 mg/dL to receive the warning and take preventive measures.

- Additionally, they report that their nightly rest is disturbed by the activation of alarms/alerts (although this may be a priority due to the need for urgent treatment, as in the case of hypoglycemia), affecting the desired well-being from sleep, even causing difficulty returning to sleep after the alarm, with the consequence the following day of fatigue, less energy, irritability, etc.

- On the other hand, some patients feel that wearing the sensor makes them constantly aware of the disease, as well as a stigma that marks them as sick in society. Thus, this poses challenges to reduce stress, improve control, and the quality of life of patients. A fundamental challenge is providing quality therapeutic education so that our patients can fully understand CGM and thus make the best self-care decisions.

Until now, we have used the **resources** available to us from CGM data both in real-time and retrospectively to support educational sessions.

- In the retrospective analysis, glucometry provides glucose data, and in the case that patients collect them, insulin, carbohydrate, exercise, and recorded notes are also included, which allow a more comprehensive analysis, drawing conclusions and making necessary changes to improve control. However, adherence to entering this data is not high.

- A challenge for professionals is **motivating** patients to contribute this data so that the overall picture can be assessed, encouraging trained patients to review their glucometries, make decisions, and assess results after implementing them.

- In real-time data, there are three elements: glucose reading, continuous readings from previous hours, and the trend arrow. It is necessary to clarify that the trend arrow concept is often misinterpreted as indicating "the future," the direction glucose will take, when in fact it shows the rate of change of glucose over the past 15 minutes, meaning "where it is coming from," which can cause confusion in decision-making4.

Another decision-making tool is alarms; however, their use is limited due to the lack of activation of alarms and predictive alerts, leading to the underutilization of these resources. If these situations (hypo- and hyperglycemia) could be predicted, we might be in a better position to manage these unwanted episodes.

On the other hand, **artificial intelligence** (AI) stands as a highly promising tool in the health care management of PDM. AI is revolutionizing diabetes care by predicting risks and personalizing plans to improve glycemic control outcomes. AI could be applied to existing diabetes technologies to enhance their expected benefits and address the previously described needs. Thus, the inte- »

**DESPITE ADVANCES MADE IN DIABETES TREATMENT AND THE TECHNOLOGY AVAILABLE, ONLY BETWEEN 55% AND 60% OF PDM ACHIEVE THERAPEUTIC TARGETS, WHICH MAKES US THINK THAT THERE ARE UNMET NEEDS**

» gration of AI in CGM is a major development that should be taken into consideration.

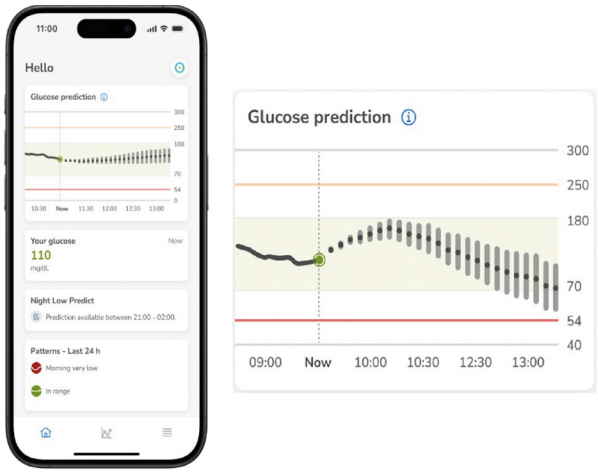
Currently, the only CGM with integrated AI is the Accu-Chek® SmartGuide system (Roche Diabetes Care), which, in addition to the known features such as retrospective and real-time glucose values and trend estimations, includes glucose predictions provided by the Accu-Chek® SmartGuide Predict app, calculated by AI, considering the user's own data. These predictions are:


Accu-Chek SmartGuide CGM Solution5

**1. Prediction of hypoglycemia risk within the next 30 minutes (Low Glucose Prediction):**

Adjustable in the range of 60 mg/dL up to to 100 mg/dL, based on CGM sensor data and, if recorded, on the last carbohydrate (CHO) intake. The prediction is continuously updated every five minutes, and this information can be used to take immediate action to prevent hypoglycemia. In case of a notification, the user can check the situation and, if necessary, follow the recommendation provided by the app to avoid hypoglycemia.

This could be very useful for people with undetected hypoglycemia or fear of hypoglycemia, who tend to maintain higher levels as an avoidance behavior or avoid activities that could be dangerous if hypoglycemia occurs, such as driving or exercising.




Glucose prediction at 2 hours (5)

**2. Prediction of how glucose will evolve in the next 2 hours (Glucose Prediction)**

Displayed as a curve, based on historical levels available from the CGM sensor, data recorded in the app such as carbohydrate intake or insulin doses, and the time of day.

The prediction covering the first 45 minutes can be used to take direct actions, while predictions beyond 45 minutes can be used to raise awareness and allow more preparation time, without requiring immediate action.

**3. Adjustable prediction of nighttime hypoglycemia risk within the next 7 hours (Nighttime Hypoglycemia Prediction)**

This feature estimates the individual risk of low glucose levels (< 70 mg/dL) within the next 7 hours during the night, or within the first or second half of the night, respectively.

This allows understanding the individual risk of nighttime hypoglycemia before going to bed and taking preventive measures if needed, ensuring a good night's rest6. While recommendations must be individualized, for hypoglycemia in the first part of the night, the recommendation would be carbohydrate intake, while for potential hypoglycemia in the second part of the night, the recommendation would be to have a mixed meal with fats and proteins 6, 7.

The user can personalize their bedtime, which is set when the nighttime hypoglycemia risk prediction is generated, and a notification is sent if there is a high-risk situation. »

## ANOTHER TOOL FOR DECISION-MAKING IS ALARMS; HOWEVER, THEIR USE IS LIMITED DUE TO THE LACK OF ACTIVATION OF ALARMS AND PREDICTIVE ALERTS, WHICH LEADS TO UNDERUTILIZATION OF THESE RESOURCES


Nighttime Hypoglycemia Prediction[5]

» This feature could have a greater impact on people with frequent nighttime hypoglycemia and those with fear of nighttime hypoglycemia, as well as on individuals who regularly maintain higher glucose levels to avoid hypoglycemia.

Therefore, this new system joins the growing group of CGM devices to help PDM, being the first of its kind to incorporate AI into glucose level predictions. Clinical studies will be needed to thoroughly understand the potential capability of this innovative technology in improving glycemic control, satisfaction, and the quality of life for PDM.

We will be watching closely to see how, once available, these predictions could help address the above-mentioned unmet needs1, 2, such as eliminating hypoglycemia and the fear of hypoglycemia, eliminating stress, alarm fatigue, and achieving 100% good metabolic control in PDM using CGM. Additionally, training in these predictions will need to be included in our educational programs to update them and continue assessing new future challenges to improve the lives of people with diabetes. D

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