

Dra. Gloria Cánovas Molina, Dra. Soralla Civantos Modino y Dra. Azucena Rodriguez Robles.
Specialist Doctors in Endocrinology and Nutrition at Hospital Universitario de Fuenlabrada. Madrid. Spain

Alert Configuration in Continuous Glucose Monitoring Systems

Continuous glucose monitoring (CGM) has brought about a significant change for people with diabetes, enabling them to know their glucose levels in real time, identify patterns, and make more informed decisions. As a result, metabolic control has improved, the frequency of hypoglycemia and hyperglycemia has been reduced, and consequently, quality of life has been optimized. Furthermore, this technology has transformed clinical practice, providing healthcare professionals with detailed data that allow us to personalize treatments and anticipate potential complications.

One of the most significant advances in CGM is the incorporation of real-time alerts, which have been shown to improve time in range (TIR, time with interstitial glucose between 70 and 180 mg/dL), reduce glycemic variability, and decrease the frequency and severity of hypoglycemia, especially in people who use insulin. However, many people with diabetes deactivate these alerts due to lack of knowledge of their usefulness or due to the fatigue generated by constant notifications, and healthcare professionals do not always give them the importance they deserve.

For alerts to be truly useful, they must be configured in a way that always implies an action; if they do not require any response, they should not be activated. In addition, it is essential that the person with diabetes has received adequate diabetes education to know how to act in response to each alert and make the most of the information it provides.

In this article, we will analyze the impact of alerts on glycemic control and the importance of configuring them correctly. We will focus on CGMs used independently, without integration with hybrid insulin delivery systems (devices that combine an insulin pump with a CGM sensor and an algorithm that automatically adjusts insulin delivery based on glucose levels), as these have specific management that requires a different approach in their configuration and response.

TYPES OF ALERTS IN CGMS

Threshold alerts: notify when glucose exceeds or falls below a predefined value. In some sensors, it is possible to configure the repetition of the alert if glucose remains outside the established range after a certain time. There is also, in some devices, the option to delay the hyperglycemia alert, so that it is only activated if glucose remains elevated for a configurable period.

Predictive alerts: are activated before hypoglycemia or hyperglycemia occurs, based on glucose trends. This allows the user to anticipate the event and take preventive measures.

Rate of change alerts: are activated when glucose varies rapidly over a short period of time. In some devices, these alerts can be configured to activate only if glucose reaches a certain threshold, combining rate of change and absolute values.

Technical alerts: these alerts indicate possible technical problems with the sensor or situations in which user intervention is required to ensure proper system operation.

Other alerts: finally, there is a CGM on the market that, if connected to its compatible insulin pen, can generate alerts in case of omission of an insulin dose or when it is necessary to administer a correction dose to control high glucose levels.

Table 1 shows the sensors available on the market along with the alerts they offer. Some models have not been included, despite being temporarily in circulation, as they are in the process of being replaced by more modern versions.

BENEFITS OF ALERTS IN CONTINUOUS GLUCOSE MONITORING

The hypoglycemia alert has proven to be an effective tool to reduce both time in hypoglycemia and the frequency and severity of episodes. In addition, it can contribute to reducing fear and anxiety associated with hypoglycemia. Its effectiveness depends on the threshold at which it is configured: higher values provide greater protection, but can reduce time in range (TIR, 70-180 mg/dL), especially if it is not complemented with a hyperglycemia alert that helps balance control.

The predictive hypoglycemia alert, available in some systems, allows anticipating an imminent drop in glucose and acting before it occurs. Its use has been shown to decrease hypoglycemia episodes without affecting TIR, offering additional protection without compromising glycemic control.

On the other hand, the hyperglycemia alert has been shown to reduce time above range (TAR, > 180 mg/dL and > 250 mg/dL) and decrease average glucose. Configuring it at lower values improves glycemic control, but also increases the frequency of notifications, which can affect adherence. Therefore, it is essential to individualize the activation threshold for each person, ensuring a balance between effectiveness and quality of life. The option to delay the hyperglycemia alert »

FOR ALERTS TO BE TRULY USEFUL, THEY MUST BE CONFIGURED IN A WAY THAT ALWAYS REQUIRES AN ACTION

TABLA 1

ALERT TYPE	FREESTYLE LIBRE 2 PLUS	FREESTYLE LIBRE 3 PLUS	SIMPLERA (MEDTRONIC)	DEXCOM ONE+	DEXCOM G7	GLUCOMEN DAY CGM	EVERSENSE
Hypoglycemia Range Repeat Option	60-100 mg/dL No	60-100 mg/dl No	65-90 mg/dl Yes	60-150 Yes	60-150 Yes	60-80 mg/dl Yes	60-115 mg/dl No
Emergency Hypoglycemia Range Repeat Option	Not available	Not available	< 54 mg/dl Yes	Not available	⩽ 55 mg/dl Yes	< 54 mg/dl Yes	Not available
Hyperglycemia Range Repeat Option Option to Delay Start	120-400 mg/dl No No	120-400 mg/dl No No	100-400 mg/dl Yes No	100-400 mg/dl Yes Yes	100-400 mg/dl Yes Yes	120-350 mg/dl Yes No	125-350 mg/dl No No
Glucose Falling Ranges Ability to Associate with Configurable Glucose Level	Not available	Not available	1-2 mg/dl per minute 2-3 mg/dl por minuto >3 mg/dl per minute No	Not available	2-3 mg/dl per minute >3 mg/dl per minute Yes	2 mg/dl per minute 3 mg/dl per minute No	It can be configured from 1,5 to 5 mg/dl per minute No
Glucose Rising Range Ability to Associate with Configurable Glucose Level	Not available No	Not available No	2-3 mg/dl per minute >3 mg/dl per minute No	Not available	2-3 mg/dl per minute >3 mg/dl per minute Yes	2 mg/dl per minute 3 mg/dl per minute No	It can be configured from 1,5 to 5 mg/dl per minute No
Hypoglycemia Prediction	Not available	Not available	Yes (estimates reaching alert in 10-60 minutes)	Not available	⩽ 55 mg/dl in 20 minutes	Yes (estimates reaching alert in 15 minutes)	Yes (estimates reaching alert in 10-30 minutes)
Hyperglycemia Prediction	Not available	Not available	Yes (estimates reaching alert in 10-60 minutes)	Not available	Not available	Yes (estimates reaching alert in 15 minutes)	Yes (estimates reaching alert in 10-30 minutes)
Insulin Pen Alerts	Not available	Not available	Missed dose alert	Not available	Not available	Not available	Not available

IT IS ESSENTIAL TO CONFIGURE ONLY THE NECESSARY ALERTS FOR DECISION-MAKING AND ADJUST THEM TO EACH INDIVIDUAL

» (available in some devices) has been shown in some studies to reduce the incidence of hypoglycemia due to overcorrection, by avoiding unnecessary insulin administration and limiting the activation of the alert to situations in which intervention is really required.

DISADVANTAGES OF CGM ALARMS AND STRATEGIES TO MANAGE THEM

While CGM alerts provide multiple benefits, they can also present disadvantages that affect their effectiveness and user experience.

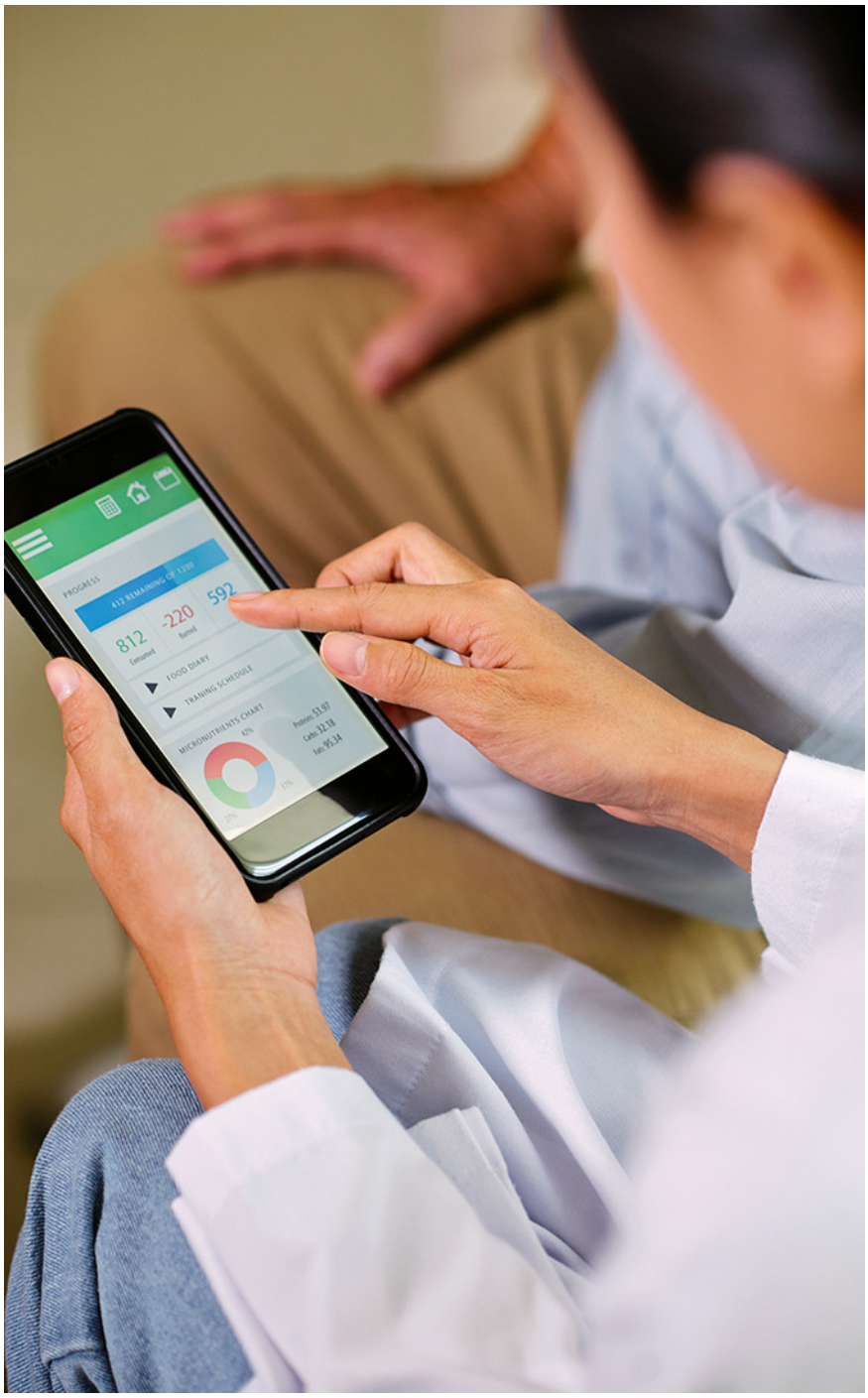
One of the main problems is alarm fatigue, which occurs when notifications are so frequent that the user ends up ignoring or deactivating them. To avoid this, it is essential to configure only the alerts necessary for decision-making and adjust them to each person. Another challenge is the possible loss of privacy and activation at inopportune times. This can be mitigated by adjusting thresholds according to time, activating vibration mode, or temporarily disabling some alerts.

In addition, some people overreact to alerts, ingesting too many carbohydrates in response to hypoglycemia or administering correction insulin too soon after a meal, which can cause imbalances in glycemic control. Diabetes education is key for the user to know how to act in response to each alert and avoid unnecessary corrections.

In summary, the configuration of alerts must be personalized and accompanied by adequate diabetes education to maximize benefits and minimize disadvantages.

CUSTOMIZED ALERT CONFIGURATION: ADJUSTING THEM TO EACH PERSON AND SITUATION

Currently, there is no clear scientific eviden- »



» ce on the optimal levels to configure alerts in continuous glucose monitoring (CGM) systems or on which are the most useful for each person. Their adjustment must achieve a balance between safety and quality of life, avoiding unnecessary notifications that can generate alarm fatigue. Below are general recommendations that should be understood as guidelines and always adapted to the clinical situation and individual preferences.

Alert configuration not only varies between people but also within the same person at different times in their life. For example, the thresholds established during pregnancy will not be the same as those recommended postpartum, as glycemic goals and associated risks change. In addition, needs can change even within the same day, as the same alerts are not required during exercise as at rest or in other daily activities.

In most people, a hypoglycemia threshold between 70 mg/dL and 75 mg/dL may be appropriate. In devices that allow it, it may be useful to program a repetition of the alert if, after 20-30 minutes, glucose remains out of the low range. For hyperglycemia, a reasonable threshold could be around 250 mg/dL. In sensors that allow it, it will be useful for the alert not to activate immediately upon reaching that value, but only when it is really necessary, for example, 2 or 3 hours above that level.

Alert configuration should also be adapted to specific situations such as physical exercise. Traditionally, it was recommended to set the hypoglycemia alert at the highest limit allowed by the sensor, generally 100 mg/dL. However, some current devices allow configuring higher »

» thresholds, allowing us to adapt it more to the type of activity.

For example, if the risk of hypoglycemia is low, it might be useful to set the alert at 125 mg/dL; if the risk is moderate or high, setting it at 150 mg/dL would be more appropriate (if the CGM used allows it). In addition, since the risk of hypoglycemia increases in the hours after exercise, keeping the hypoglycemia alert at 80-90 mg/dL during that period can be useful.

Predictive hypoglycemia or rate of change alerts are very useful in situations such as physical exercise where there can be abrupt glucose changes.

In people for whom hypoglycemia represents a significant risk, such as frail older adults, people with multiple pathologies, or professionals whose safety may be compromised by hypoglycemia (for example, drivers during working hours), it may be useful to establish more conservative alert thresholds, between 80 and 100 mg/dL.

In these cases, predictive hypoglycemia alerts can be especially useful to anticipate a drop in glucose and prevent its occurrence. Similarly, in this group of patients, the hyperglycemia alert could be configured at a higher threshold (250-300 mg/dL) and, if the sensor allows it, with a delay of approximately 3 hours, avoiding unnecessary notifications and prioritizing those that really require action.

At the other end are people who require stricter glycemic control, as occurs in pregnancy. In this group, time in range (TIR) is defined between 63 and 140 mg/dL, instead of the 70-180 mg/dL used in most patients.

In this context, it makes sense to configure lower hypoglycemia thresholds (65-70 mg/dL) and make the most of predictive alerts to prevent glucose drops. Rate of change alerts can also be very useful, especially if they can be associated with an absolute glucose value, since in pregnancy a delicate balance is required: keeping glucose as low as possible without falling into hypoglycemia.

For hyperglycemia, a lower threshold, around 180-200 mg/dL, may be an appropriate option when very thorough control is required. In addition, in sensors that allow it, establishing a delay of approximately 2 hours can help reduce unnecessary alerts without compromising safety. D

CONCLUSIONS

Alerts in CGM systems are a fundamental tool to improve glycemic control and prevent both hypoglycemia and hyperglycemia. However, their effectiveness depends on a personalized configuration that minimizes alarm fatigue and ensures that each notification implies a specific action. Adjusting thresholds according to individual needs and providing adequate diabetes education are key aspects to maximize their usefulness and avoid inappropriate responses. Ultimately, a periodically reviewed configuration allows alerts not only to optimize diabetes control but also to improve the quality of life of those who use them.

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