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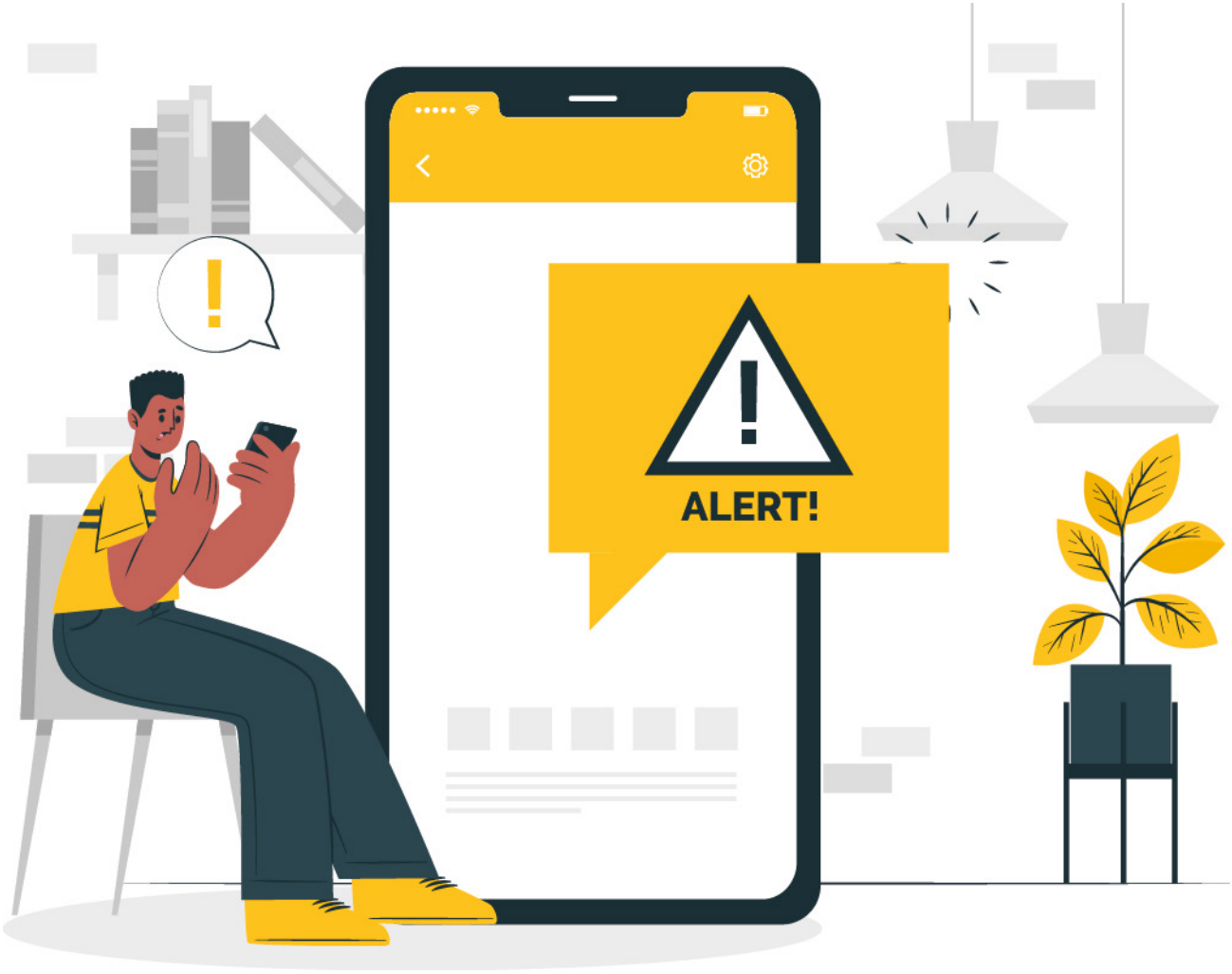

Maximizing the Use of Alarms and Alerts in Continuous Glucose Monitoring Systems

The use of continuous glucose monitoring (CGM) has become a standard of care for people with type 1 diabetes mellitus and those with type 2 diabetes on insulin therapy (1, 2).

In addition to the continuous improvements in accuracy and reliability, current CGM (Continuous Glucose Monitoring) systems offer a range of safety features that allow people with diabetes and their caregivers to manage diabetes more effectively. These systems measure glucose in the subcutaneous interstitial space and provide real-time glucose information continuously and dynamically. It has been shown that CGM systems improve hemoglobin A1c (HbA1c) and mean glucose levels (3, 4), and reduce the percentage of time in hypoglycemia and severe hypoglycemic episodes in patients with type 1 diabetes (T1D).

Among the features of CGM systems, the ability to generate alarms and alerts to notify users under certain circumstances stands out. It is important to differentiate between the concepts of alarm (current risk situation) and alert (future risk situation, where decisions can be made safely and ACT).

Alerts can be a valuable tool in **preventing hypo/hyperglycemic events in patients**. However, not all they provide are benefits, as alarms generated by CGM systems for pending or ongoing hypo/hyperglycemic events can cause disruptions in daily life or sleep (5). This phenomenon is called **alarm fatigue**, which describes how patients become overwhelmed by the number of alarms and, as a result, do not respond to them or simply disable them (6).

Figures 1 and 2 show two images published on the Instagram profiles of @diabetesatiras and @ire_riera, which are very representative of what this alert fatigue means for people with diabetes and/or caregivers of users of these systems.

Currently, not all systems offer the same possibilities in configuring alerts.

While some CGM systems provide alarms and alerts that warn users about current or imminent glycemic events, the functionality and usability of these features differ between systems, making this factor important for individualizing the management of these features based on the patient's needs, increasing therapeutic adherence and preventing alarm fatigue. We have already discussed the importance of personalizing CGM alerts (7). »

IT IS IMPORTANT TO DISTINGUISH BETWEEN THE CONCEPTS OF ALARM (PRESENT RISK SITUATION) AND ALERT (FUTURE RISK SITUATION, WHICH ALLOWS FOR SAFE DECISION-MAKING AND ACTION).

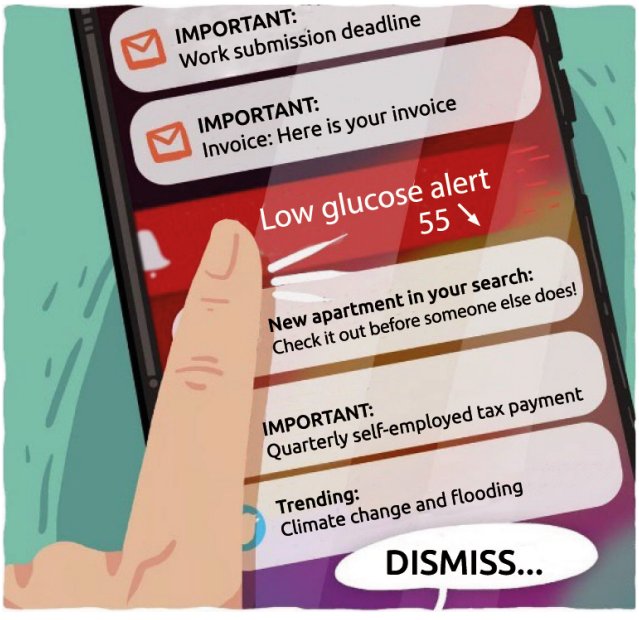

FIGURE 1. @diabetesatiras

FIGURE 2. @ire_riera

* Transfer of images by the authors for publication

Characteristics	DEXCOM ONE +	DEXCOM G7	GUARDIAN	SIMPLERA	FSL 2 (DUAL)	FSL3	EVERSENSE XL
Alarms	Yes Optional	Yes Optional/Mandatory (able to be silenced)	Yes Optional/Mandatory	Yes Optional/Mandatory	Yes Acoustic which require examination for confirmation	Yes Optional	Yes Optional/Mandatory
Low-High Alarms	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Alerts	Yes Prolonged hyperglycemia Configurable hypo and hyperglycemia repetitions	Yes Predictive < 55 mg/dL (repeats > 5 min) Low glucose + value Postpone 1st hyperglycemia alert (15m-4h)	Yes Predictive hypo and hyperglycemia within 10-60 min Rapid increase rate Alert program (ranges based on time of day)	Yes Predictive hypo and hyperglycemia within 10-60 min Rapid increase rate Alert program (ranges based on time of day	NO	NO	Yes Predictive hypo and hyperglycemia at configurable times (10, 20, or 30 min) Sensor temperature Rate of increase or decrease
Device	Own device and/or Smartphone and/or Smartwatch	Own device and/or Smartphone and/or Smartwatch	CSII	Smartphone	Own device or Smartphone	Smartph one	Smartphone

TABLE 1

» As we can see in **Table 1**, the options for configuring alerts in the various devices vary greatly, from those with basic alerts to advanced configurations.

Basic hypo- and hyperglycemia alarms are configured by setting a threshold without considering the rate of glucose rise or fall. Advanced alerts allow for consideration of the rate of rise or fall, making them predictive, and the time at which glucose changes can also be set (at 20', 60', etc.). The implantable sensor also generates alerts related to body temperature changes (7).

The use of these alert functions has been associated with improvements in glycemia.

In the study by Acciaroli et al. (8), conducted in several European countries with 47,784 Dexcom G6 users, all alert functions were used by > 75% of users. Enabling the hypoglycemia alert and the emergency low-level alert (predictive) was associated with a lower percentage of time below range vs disabling the hypoglycemia alert. Enabling the hyperglycemia alert was associated with a higher percentage of time in range (%TIR) and a lower percentage of time above range (%TAR) vs disabling it. Pediatric patients and older adults tended to set a higher threshold for hyper/hypo alerts, while younger adults tended to use lower threshold values for high/low alerts.

In another study (Abraham et al.) (9) conducted in real life with 3133 people who used the Guardian™ Connect CGM system, with multiple daily injections (MDI) or continuous subcutaneous insulin infusion (CSII), durations and risks of low and high glycemic excursions after threshold alerts were evaluated. During periods when alerts were not enabled, time points were identified where a predictive alert would have been triggered. The excursions were prevented after 59% and 39% of predictive low and high glucose alerts, respectively. The risk of a low or high excursion was 1.9 and 3.3 times higher, respectively, when alerts were not enabled.

On the other hand, CGM with predictive alarms that warn of impending hypoglycemia may improve self-management of diabetes during exercise. In another study conducted with 24 participants (8 men, 16 women) who used the real-time Dexcom G6 CGM system, it was observed that the predictive hypoglycemia alert reduced exposure to hypoglycemia < 50 mg/dL overall and in the 24 hours after exercise vs a threshold alert (10).

In conclusion, regarding the use of **alarms and alerts**, it is important to know that their use shows **better glycemic** »

control, particularly among those who used more sensitive high and low alert configurations vs users who did not use the system functions. Additionally, the ability to use devices with predictive alerts can help people living with diabetes prevent some high and low glucose excursions in real life. This can be especially important for those who cannot achieve or maintain glycemic control with basic real-time CGM therapy or CSII.

Health care teams caring for people with diabetes should have the ability to prescribe devices that meet the needs of each patient, thus favoring the individualization of treatment. We must not forget that **each patient is unique**, and these devices should adapt to the different situations of their daily life. As an example, this could include the possibility of silencing all alarms and alerts for a specified period (during exposures, talks, etc.), the possibility of scheduling delayed alerts for hyperglycemia (reducing alert fatigue during postprandial peaks and reducing overcorrections), and the possibility of activating only alarms for caregivers, in the case of young children or situations where one wishes to make the disease situation less visible (at your wedding, a conference, etc.).

A key aspect is that in CGM educational programs, personalized alert settings should be included, taking into account the type of patient, their life stage, and the level of the educational process.

The management of alerts and alarms should be a constant in the care of users of these systems. D

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