Experiences and mediating factors in nurses' responses to electronic device alarms. A phenomenological study.

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Abstract

Aim: To explore the experiences and mediating factors of nurses' responses to electronic device alarms in critical care units (CCUs).

Background: Alarm fatigue occasionally has adverse consequences for patient safety.

Methods: This qualitative study was designed and analyzed following Giorgi's descriptive phenomenological approach. Seventeen nurses were theoretically sampled, reaching information saturation. Semistructured interviews were used to collect the data.

Results: Three central themes explained nurses' experiences: general perceptions about alarms (basic equipment of the CCU); strategies to reduce false alarms (training in the configuration of monitors; customization of the alarms to fit he patient´s condition; teamwork; and taking advantage of the development of technology) and key elements of the response to alarms (information about patient's condition; nurses' clinical experience; type of CCU; "cry-wolf" phenomenon; and nurse/patient ratio).

Conclusions: To reduce false alarms, nurses need further postgraduate training, training on monitors, and customizing alarms to fit the patient's health status. The complex process of deciding to respond to an alarm includes environmental, professional variables and patient status.

Implications for Nursing Management: Nurse managers should ensure that nurses have sufficient experience and training in the CCU, improve the nurse/patient ratio, promote teamwork and ensure that the devices are the latest generation.

Keywords: Nursing; clinical alarms; fatigue alarm; critical care unit; monitor alarms; patient safety; monitor surveillance; management alarm

BACKGROUND

The technology that has been designed to save lives has become a problem in critical care units (CCUs). Thus, the Emergency Care Research Institute (ECRI) considered that alarm fatigue and alarm hazards (such as the lack of an adequate reaction to an alarm and poor management of alarms or their settings) are among the most important hazards caused by medical technology (ECRI, 2020; Sowan el al., 2017). Today, more than ever before, nursing staff must divide their attention between caring for patients and reacting to signals from numerous medical devices (ECRI, 2020).

Monitors and various devices in the CCU have alarms to detect life-threatening situations, imminent danger, life-threatening device malfunction, and imminent device malfunction or to aid in diagnosis (e.g., shock) (Meng'anyi et al., 2017). Although monitoring information increases patient safety, there are also drawbacks, and some alarms are often clinically irrelevant or false, which can complicate nurses' work, their work environment (Freysdóttir et al., 2019; Phillips, et al., 2020) and compromise patient safety.

Proper management of a clinical alarm system is a multifaceted challenge (The Joint Commission, 2020). Alarms are designed to be very sensitive but not very specific. Problematic types of alarms include false alarms (invalid) and true alarms that are clinically irrelevant (nonactionable) (Ruppel et al., 2018a). Moreover, the burden of responding to numerous nonactionable alarms leads to error, fatigue, burnout, and alarm apathy, which increases the stress level of nurses (Jeong, et al., 2022; Casey, et al. 2018). Casey's (2018) study shows that nurses believe that there are numerous false alarms. Thus, 90% of the nurses stated that nuisance alarms were frequent, disruptive to patient care (91%) and reduced trust in alarms, causing nurses to disable them (81%).

Alarm fatigue is a complex cognitive process that is often cited as a cause of alarm adverse events and is not voluntarily controllable. Researchers have described this as the "cry-wolf" phenomenon, which means that nurses who experience a high number of false alarms may respond slowly to alarms or ignore alarms completely, which is directly contingent on the number of false alarms produced by a system (Manzey, et al., 2014; Ruskin et al., 2015).

Patient deaths have been attributed to alarm fatigue (Lewandowska, 2021). Moreover, alarm safety was considered a national patient safety goal for several years in 2020 by The Joint Commission (The Joint Commission, 2020).

Previous studies have shown that monitor use is coupled with a high frequency of unnecessary warning bells or up to 250 alarms per day per patient, and most of them have no clinical relevance (Freysdóttir et al., 2019). In the study conducted by Cho et al., the number of alarms generated by a CCU over 48 hours was 2184, 63.8% of which were false (Cho, 2016). Another study in a neurological critical care unit determined an average of 34.7 daily alarms per bed, corresponding

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to one alarm every 41.4 minutes, which generated an important portion of the workload (Unal et al., 2021).

Critical care nurses are responsible for detecting and rapidly acting upon changes in patients' clinical conditions, and monitoring patients' physiologic parameters and intervening when needed are among their key responsibilities (Ruppel et al., 2019).

The complexity of factors that influence nurses' responses to alarms includes an increase in the types and numbers of alarms in the clinical environment, alarms that are highly sensitive and lack specificity, high false alarm rates, alarms that have little clinical relevance, overuse of clinical alarms, clinician desensitization, complexity of multiple devices and lack of clinician knowledge (Gazarian et al., 2015).

A previous qualitative study analyzed the point of view of other professionals, such as doctors or anesthetists (Poncette et al., 2019), but to the best of our knowledge, few qualitative studies have analyzed nurses' perceptions of this phenomenon. This phenomenon has not been analyzed in the Spanish context. In Spain, the health system is public, and the university training of generalist nurses is four years and does not yet require a CCU qualification.

The purpose of this study was to explore the experiences and mediating factors in nurses' responses to electronic device alarms in the CCU.

METHODS

A qualitative study designed and with analysis following the descriptive phenomenological approach of Giorgi (Willig & Rogers, 2017) was used to describe the meanings of the phenomenon from the nurses' experience (Giorgi, 2009) through a psychological phenomenological analysis of (and in) their own words (Willig & Rogers, 2017).

Participants

Seventeen nurses were theoretically sampled. This type of purposeful sampling is based on concepts/themes derived from data. Thus, the researcher initially chooses participants with broad general knowledge of the topic or those who have undergone the experience. When the study progresses, the description expands with more specific information, and participants with that

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particular knowledge are deliberately sought (Gentles, 2015). We used the following criteria to select the sample. The inclusion criteria were as follows: 1) nurses working in the CCU with more than 2 years of experience and 2) nurses working in hospitals in the Spanish Public Health System Network. The exclusion criteria were as follows: 1) nurses who had language difficulties. Moreover, the following nurses' variables were considered to obtain the greatest possible variability of nurses' demographics: age, total working experience, and type of unit (adult CCU, neonates' units, coronary units, postanesthesia units). Prior to the interview, a sociodemographic and employment characteristics questionnaire was completed. Participants were recruited by contacting several CCU supervisors from public hospitals who were gatekeepers.

Data collection

We chose semistructured interviews to provide a "naïve description" of this phenomenon from the words of the participants (Englander, 2012).

The interviews were conducted from 2018 to June 2019 in an office by a single interviewer and lasted from 25 to 50 minutes, were audio-recorded and transcribed for further analysis.

Furthermore, no prior interaction occurred between the researcher who conducted the interview and the participants. This helped to minimize the influence of the researcher over the participants during the interviews.

The interviewer had a topic script (Table 1) with the main topics that the researchers wanted to review during the semistructured interviews to "lead the participant discourse", which was refined throughout the research (Englander, 2012). If a topic did not appear openly in the participant's speech, the researcher asked about it directly.

Data collection and analysis were carried out simultaneously. Thus, following the constant comparison method, the discourse of each participant was compared with the previous discourses (Boeije, 2002). Sample collection continued until the data were saturated, at which point expanding the sample stopped providing new information (Saunders, et al., 2018).

Data analysis

Giorgi's phenomenological method was used as an analytic strategy following the steps of (1) collecting and describing phenomenological data, (2) reading the whole description, (3) breaking

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descriptions into units of meaning, (4) transforming units of meaning, (5) identifying the essential structure of the phenomenon, and (6) integrating features into the essential structure of the phenomenon (Giorgi, 2009). Theoretical reflective writing was constant during the analysis process. The Atlas-ti version 8.0 program was used to aid in data analysis.

Trustworthiness

The criteria of credibility, transferability, dependability, and confirmability were used to establish study trustworthiness (Guba, 1989). Credibility was strengthened by summarizing and clarifying interpretations during interviews, triangulating data (obtaining data on nurses with different characteristics according to the variables analyzed) and conducting regular team meetings to discuss the findings until a consensus was reached.

Dependability was achieved by having the same researcher conduct in all the interviews. Keeping an audit trail of the entire research process and a reflexive diary chronicling individual interviews and emerging themes promoted the confirmability of the findings. The Consolidated Criteria for Reporting Qualitative Research (COREQ) recommendations were followed to guarantee the quality of the study (Tong, et al., 2007).

Ethical considerations

This study was conducted following the Declaration of Helsinki and was approved by the Ethics Committee of the ████████████████████████ and the work team ensured adherence to the ethical principles. We explained confidentiality, discontinuation of participation, and withdrawal of consent before obtaining consent for participation in the study and recording the interviews. Consent was signed before the start of the interview.

The transcripts of the interviews were anonymized and kept by the principal investigator, then destroyed once the research was completed.

RESULTS

Seventeen nurses participated in the interviews; the main sociodemographic characteristics are summarized in Table 2.

Three major themes emerged from the participants' verbalizations and included the following topics: general perceptions about alarms, strategies to reduce false alarms and key elements in

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the response to alarms. The categories, codes and verbatims are presented in Tables 3, 4 and 5, including the participant's code, unit, and age.

Theme 1: General perceptions about alarms.

All participants agreed that alarms and electronic devices were basic equipment in these units, but we found a certain ambivalence in the nurses' perceptions since, on the one hand, they considered the monitors to be utility devices, but on the other hand, they considered that on some occasions they could add extra work as they have to respond to the false alarms. Additionally, they depended on and greatly trusted these electronic devices concerning surveillance of the patient, resulting in the nurses having considerable confidence in the devices. They also highlighted that they could not work without the devices (dependence) and that they would not be able to work in another unit that does not offer as much control over monitoring of the patient (Table 3).

The nurses also highlighted the overload caused by false alarms. Sometimes the monitors do not work properly, and false alarms can cause unnecessary interruptions that are time-consuming, disrupt patient care and cause stress, which nurses try to reduce or avoid. These nuisance alarms were perceived as a normal background sound in the unit, and there were always alarm sounds in the CCU. That ambient noise in the background even led some nurses to hear the alarms in their own heads (Table 3).

Theme 2: Strategies to reduce false alarms.

Four categories were included in nurses' strategies to reduce false alarms (Table 4).

A- Training in the configuration of monitors.

Monitors are becoming increasingly complex and frequently cause stress and other problems,. It is sometimes difficult to take advantage of the technology when so often there are false alarms. For this reason, the nurses considered that they needed training and learning in managing alarms. In this sense, the nurses described the need for advanced knowledge and specialized training in

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monitor surveillance and considered that preliminary training was essential to providing safety and quality care in all CCU areas.

The participants perceived that it was not feasible to attempt to train nurses during the workday due to work overload. Moreover, it was also not possible to increase the number of nurses on a rotation due to the incorporation of new nurses who do not yet have extensive experience. According to the participants, new nurses often only receive training during clinical practice from other colleagues and rarely receive formal institutional training or training prior to starting work in the CCU. Finally, the nurses highlighted that in Spain, there was no speciality in critical care, and in many cases, due to staffing needs, nurses with little or no experience in working the CCU were hired for these units.

B- Customization of the alarms to the patient's condition.

In the CCU, there is continuous, stressful, and annoying background noise from alarms. The nurses revealed that they acted to reduce or prevent annoying alarms (nuisances) and customized the alarms to the patient's condition.

The nurses used proactive measures to reduce potential nuisance alarms. When a patient's clinical condition could lead to multiple alarms, nurses recognized that, without the ability to reverse the patient's medical circumstances, there may be ways to adjust alarm limit settings to decrease nuisance alarms.

Furthermore, nurses silenced the monitors, without turning them off, when a patient was terminal, and nothing further could be done for him or her. This enabled the patient's relatives to say goodbye without noise.

C- Teamwork

The nurses stated that teamwork was essential in responding to alarms. In this regard, they felt it was necessary for all nurses to know all patients in the unit so they could respond to alarms as a team, thus reducing delays. In addition, due to staff shortages and shift work, the nurses reported having an internal peer-to-peer training network, which they used particularly when there was a new device or a new professional coming to the unit.

Teamwork is key to patient safety and is also important to nurses' mental health knowing that in any situation with a patient, they will not be alone.

D- Taking advantage of the development of technology.

These advantages imply the existence of different tones that help determine the level of severity. These are improvements in signal detection algorithms that reduce the number of false alarms that are clinically irrelevant. The participants highlighted the improvements in this area but indicated that there is still much to be done to ensure better monitoring and to reduce false alarms and interruptions.

In addition, the nurses considered that mobile devices, such as tablets or smartphones, could be very useful to know and be able to silence the alarm anywhere without having to go to the central monitor, which would reduce response time and enable staff to visualize the patient on the mobile devices through the surveillance camera.

Theme 3: Key elements in the response to alarms

Five categories were highlighted in the nurses' alarm response in the CCU (Table 5).

A-   Information about the patient's condition.

All participants emphasized the importance of clear and unambiguous communication between nurses about the patient's condition during the shift change because this accurate information guided their patient-centered actions and allowed them to anticipate sudden changes in the patient's clinical situation.

Furthermore, the type of alarm helped nurses look for other signs in the patient to determine its relative importance (patient's face, skin color, temperature, eyes, etc.) and it aided them in their response to an alarm.

B- Nurse clinical experience

Not all alarms are equally important to nurses. Nurses' perceptions of the level of importance of alarms are influenced by their clinical experience, which allows them to work faster, safer, and more efficiently and to discern among various alarm levels and their importance (e.g., consider tachycardia or ventricular fibrillation or a ventilator monitor more important than others, such as oxygen saturation or a perfusion pump).

with regards to reactions to alarms, nurses' levels of experience were related to their over- or underconfidence in responding to alarms, sometimes leading to misconceptions. Thus, more experienced nurses felt that they were better at responding to alarms than the inexperienced nurses. The inexperienced nurses felt that they did not know when to react immediately to an alarm. However, the less experienced nurses felt that they had a better attitude toward responding to alarms and responding to all alarms than the more experienced nurses, who tended to think more often that the alarm may be false.

C- Type of the Critical Care Unit

The importance of certain alarms, and therefore nurses' response to them, depends on the type of CCU; in neonatal units, nurses focus on bradycardia and desaturation, and in adult units, nurses focus on ventilators and hemofilters, among other equipment.

D- "Cry-wolf" phenomenon and presence of excessive clinically irrelevant alarms

Most of the participants stated they had firsthand experience with the "cry-wolf" phenomenon. The frequency of these events combined with the sense of alarms as a nuisance and the presence of excessive clinically irrelevant alarms can sometimes make it more likely that nurses will delay in response to the alarm and their assistance to the patient, endangering the health and safety of the patient.

E- Nurse/patient ratio

The nurse/patient ratio influenced the response to alarms. In emergency situations when staffing levels were low, nurses prioritized attending to an emergency patient over responding to alarms for more stable patients; thus response times to those alarms may be longer.

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DISCUSSION

Nurses' experiences with electronic device alarms in the CCU focus on three main themes: general perceptions about alarms (basic equipment of the CCU); strategies to reduce false alarms (training in the configuration of monitors; customization of the alarms to the patient´s condition; teamwork; and taking advantage of the development of technology) and key elements of the response to alarms (information about the patient's condition; nurses' clinical experience; type of CCU; "cry-wolf" phenomenon; and nurse/patient ratio).

Critical care nurses are exposed to excessive clinical alarms in the patient care environment. Being repeatedly exposed to false alarms can desensitize nurses to incidents requiring immediate intervention and may lead nurses to miss potentially adverse events for a patient. When an alarm sounds in the CCU, nurses go on alert, trying to determine what alarm is sounding and why it is sounding; for a variety of reasons, nurses may give alarms more or less attention. Depending on a patient's condition, a nurse may respond by urgently addressing an alarm on a patient who is not yet stable, while possibly delaying the response to an alarm for a patient who is stable.

This study validates what has previously been described related to alarm monitoring and management and expands on the existing knowledge regarding nurses' management of alarms in CCUs (ECRI, 2020; Poncette et al., 2019; Ruppel et al., 2018b).

General perceptions about alarms

An excessive number of irrelevant or false alarms is a problem that leads to stress, alarm fatigue, overload and strain for most nurses working in CCUs (Casey et al., 2018; Poncette et al., 2019). However, nurses also consider monitors to be an important device in their work and the surveillance of patients. Following an earlier study (Freysdóttir et al., 2019), our results show that monitors are regarded as an integral part of nursing care in the unit and are considered by nurses to be helpful devices to facilitate patient surveillance and enhance patient safety. Moreover, having the patient monitored increases a sense of safety for nurses, in that they would prefer to work in a unit where patients are monitored by devices.

Previous studies have shown that the effect of noise in the CCU can place a heavy burden on the care system, negatively impacting the performance of nurses and causing annoyance, alarm fatigue and slowness in response to alarms (Casey et al., 2018; Meng'anyi et al., 2017). Noise reduction can improve patient safety, as the background noise in these units is continuous (e.g., ringing telephones, clinically irrelevant alarms, and people talking) and can cause alarm fatigue and distraction and missed relevant monitor alarms may compromise a patient's life. Up to 36% of nurses agreed that alarms were frequently not heard or were missed (Casey et al., 2018; Freysdóttir et al., 2019). We know that the morning shift is usually the noisiest with the highest number of alarms. Noise from the environment is added as a result of increased health care activity (doctors' visits, invasive tests, imaging tests, etc.), while the night shift usually has the lowest number of alarms; despite the above, response time to alarms tends to increase during the night shift (Poncette et al., 2021). According to our results, the nurse/patient ratio, which is lower at night, may be another reason for delayed response time to alarms. Although the World Health Organization recommends noise levels less than 35 decibels (dB) for daytime and 30 dB during night-time in a patient room, these noise levels are exceeded in most hospitals with consequent discomfort for patients as well (Darbyshire, et al., 2013; Jeong et al., 2022).

Strategies to reduce false alarms.

The high frequency of unnecessary alarms can cause "alarm fatigue", resulting in delayed responses, which are a threat to patient safety (Casey et al., 2018). Our results are in line with previous studies that showed that nurses were concerned about the impact of alarms on patients and families, and they acknowledged that unnecessary alarms caused worry and stress (Simpson et al., 2019); therefore, they employed strategies to reduce the number of clinically irrelevant alarms.

Although organizations such as the American Association of Critical-Care Nurses (AACN, 2018) recommend that institutions provide initial and continuing education in monitoring devices with alarms, our participants yearned for more education and training in the configuration of monitors within the work shifts and felt that the nurses hired for work in the CCU have a minimum of

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knowledge about alarms. Another study recommended that education should cover surveillance systems and alarms and verify the effectiveness of this training in newly recruited nurses (Phillips, et al., 2020). Adjusting alarms to the actual needs of patients increases the likelihood that the alarms will be valid and will provide early warning of possible critical situations; regardless, alarms can still be false (Brantley et al., 2016; Pater et al., 2020; Simpson et al., 2019; Yue et al., 2017). The participating nurses highlight the absence of a specialty in intensive care and the lack of commitment on the part of managers to facilitate learning and training within the working day as contributing to their lack of competence in the use of some devices. In addition, they emphasize that they acquire the necessary skills for alarm management through practice in their work environment along with peer education. This situation is not only specific to Spain but seems to be frequent in the CCU elsewhere (McKenzie et al., 2021; Stewart, 2021).

A recent study showed a lack of training and clinical skills among nurses concerning monitor use and settings; only half of them believed that they had received sufficient in-service training on monitors (Mirhafez et al., 2019). Other studies reported that nurses found it difficult to set alarm parameters on complex devices and highlighted the need for nurses to receive more supervision and training, especially in setting alarm parameters on a per-patient basis (Freysdóttir et al., 2019; Schondelmeyer et al., 2019). Sowan et al. (2017) showed that 3–40% of nurses reported that they had never heard of 27 basic monitoring functions and, thus, did not use them. Our results show that nurses feel the full potential and advantages of the new electronic devices to reduce false alarms and alarm fatigue in CCUs are not fully exploited.

Previous research has shown that inadequate adjustment is a contributing factor to the excessive number of disruptive alarms and that nurses fail to adapt alarm settings appropriate to their patients (AACN, 2018; Yue et al., 2017). Customizing the alarm parameters on these devices can help nurses to better monitor their patients and reduce the number of clinically irrelevant alarms, all of which can reduce the problem of alarm fatigue (Ruppel et al., 2019; Schondelmeyer et al., 2019). Patient-based alarm training and personalized training programs on the customization of alarm settings on bedside monitors decreased alarms in the CCU; i.e., after staff education, low peripheral oxygen saturation (SpO2) alarms were statistically reduced by 39%; furthermore, other

nurses perceived a significant decrease in nuisance alarm occurrence (68% to 44%) (Brantley et al., 2016; Lewis and Oster, 2019; Ruppel et al., 2018a).

As reflected in other studies, teamwork is important in responding to alarms (Ruppel et al., 2019; Lewis & Oster, 2019). The entire team of nurses contributed to identifying clinically appropriate monitoring requirements and customized to patient-specific needs (Lewis & Oster, 2019). The key to this is to know the status of the other patients and to have confidence in your partner (Johnson, et al., 2017).

The participants' experiences suggest that our results show that the current technology should allow the quality of alarms to be improved and should minimize the amount of clinical time/effort wasted on false or nonactionable interruptions. Other robust studies also confirm that the use of the latest technologies, such as central monitors, wearable monitoring systems, smartphones with access to the monitor, and the use of cameras pointed toward the patient's bed, increase patient safety by providing a more adequate response to the clinical alarm and making it possible to reduce acoustic contamination and the number of alarm notifications by 68% (Areia, et al., 2021; Hyland et al., 2020; Pater et al., 2020; Ruppel et al., 2018a). Modern automated vigilance technologies have already been implemented for the monitoring and generation of alarm signals as well as transmission to nurses through smartphones (Pater et al., 2020; Ruppel et al., 2018b). However, more research is needed to determine the effectiveness, cost, and implementation challenges for interventions related to alarm technology (Poncette et al., 2019).

This need to reduce clinically irrelevant alarms should be addressed in collaboration with key stakeholders (e.g., patients, engineers) and health services, taking advantage of the development of technology with better algorithms that reduce false alarms (Hyland et al., 2020; Ruppel et al., 2018a; Wilken et al., 2019; Bollepalli, et al., 2021). In addition, the devices must be useful, adjusting the sensitivity and specificity of the alarms, and their operation must be easy to learn (Muroi, et al., 2021; Fernandes et al., 2021). Nurse managers must acquire modern devices and facilitate the training and expertise of nurses in the use of those devices.

Key elements in the response to alarms

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As in the study of Meng'anyi et al. (2017), the participants revealed that a broad range of information is needed to properly identify and interpret monitor alarms, and they described how they used that information to contextualize the alarms based on each patient's condition and their own clinical experience.

The participants highlighted how some device alarms are more important than others (e.g., alarms from a ventilator are always considered urgent); this prioritization is linked to the patient's state of health, type of CCU and the information the nurses obtained from previous shifts. These findings corroborate those reported by previous studies (Despins, 2017; Phillips, et al., 2020), where the clinical experience and clinical reasoning competencies of the nurse dictate how she evaluates her patients' risks as currently represented by monitor alarms.

It is known that nurses are overwhelmed by the high volume of alarms, resulting in serious levels of apathy. Research has shown that when there is a low rate of false alarms, human responses to alarms are more appropriate; with high false alarm rates, the natural human response is to respond less frequently; for example, it was confirmed that when nuisance alarms became frequent, the response time of nurses to warning alarms was longer (Gazarian, 2015; Phillips, et al., 2020). Freysdóttir et al. (2019), in their ethnographic study, found that alarms were so frequent that they had become a normal environmental sound, and delays in responding to the alarms were observed; this is evidence that when alarm response increases, task performance deteriorates.

When experiencing fatigue by alarms, nurses may ignore, silence, or deactivate alarms, which can contribute to overlooking serious and important changes in a patient's condition. This can lead to a delay in responding to important alarms and can be one of the major threats to patient safety (Brantley et al., 2016; Poncette et al., 2019; Ruppel et al., 2018a). Other studies have reported that nurses have witnessed or experienced the "cry-wolf" phenomenon (Johnson et al., 2017), and one study found that many institutions have experienced unfavorable patient events related to clinical alarms. One study reported that 54% of the consulted sample had experienced the "cry-wolf" phenomenon (Casey et al., 2018).

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The nurse/patient ratio, representing the nurse's workload, was associated with indicators of alarm fatigue and apathy (Claudio, et al., 2021; Storm, et al., 2020). In fact, our participants stated that when there were fewer nurses on shift, seemingly less important alarms were left unaddressed, as nurses were attending to other emergency situations. Storm (2020) reported finding response times to alarms very long (10 minutes) in cases such as this.

Strengths and limitations

This study included nurses with a broad range of experiences in different CCUs, which lends credibility to our findings.

Regarding the limitations of this study, we must consider that none of the participants had an unpleasant experience (serious adverse event) as a result of not responding to a patient alarm; future studies should perhaps actively seek participants with such experiences in the sample. Moreover, there is a possibility that nurses who participated in the study held less polarized views than those who did not participate, thus creating a biased selection. To avoid these biases, an atmosphere of trust and confidence was created.

Furthermore, the presentation of a clear description of the study setting, the participants' characteristics, and interview excerpts will enable readers to exercise judgment on the transferability of our findings. On the other hand, the sample is mostly female, with only three men participating, reflecting the feminization of the profession in Spain.

This study used semistructured interviews to collect the data, and it would be interesting if future studies could use other data collection techniques, such as participant observation or a mixed design, to delve deeper into the phenomenon.

Finally, this study only included the perceptions of nurses working in CCUs, so future studies should investigate whether there are differences in the perceptions of these nurses compared to other units with alarm devices, e.g., emergency services.

CONCLUSION

Nurses feel overburdened by the excessive number of clinical alarms. Monitors are very helpful devices in the surveillance, care and safety of critically ill patients. However, due to the high frequency of nuisance alarms, monitors are also considered to be stressful, exhausting, and labor intensive.

Nurses seek to reduce the number of alarms by expanding education and training on monitors and making the most of these devices through technological advances and customizing alarms to the patient's health status. Therefore, this training should be conducted at an advanced level and cover not only the basic functions of the monitors, but advanced features as well.

Nurse managers should ensure that nurses working in CCUs have sufficient experience and training in the handling of alarms, improve the nurse/patient ratio and promote teamwork

In the complex process of deciding how to respond to an alarm, the nurse includes numerous environmental variables in the triad: patient status and professional experience. Despite this, the "cry-wolf" phenomenon is frequent, which can endanger the life and safety of the patient.

Therefore, we suggest that technological advances (use of smartphones, artificial intelligence; appropriate algorithms) also be incorporated into the decision-making process for responding to alarms and not just focused on reducing clinically irrelevant or false alarms. Future studies should examine whether the incorporation of these technological advances is effective and improves nurses' perceptions of alarm management in critical care units.

IMPLICATIONS FOR NURSING MANAGEMENT

The overload and fatigue experienced by nurses due to nuisance and false alarms compromise patient safety and staff work satisfaction.

Our results call for alarm management interventions that effectively reduce the number of alarms to increase patient safety.

Nurse managers should facilitate the training of nurses on electronic devices within their working day, ensure that nurses working in CCUs have sufficient experience and training in the handling of alarms, improve the nurse/patient ratio, promote teamwork and make available state-of-the-art devices according to existing technological advances to facilitate the work of nurses.

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REFERENCES

American Association of Critical-Care Nurses (AACN), 2018. Managing alarms in Acute Care Across the Life Span: Electrocardiography and Pulse Oximetry. Crit. Care. Nurse. 38 (2), e16-e20. doi: 10.4037/ccn2018468.

Areia, C., Biggs, C., Santos, M., Thurley, N., Gerry, S., Tarassenko, L., Watkinson, P., Vollam, S., 2021. The impact of wearable continuous vital sign monitoring on deterioration detection and clinical outcomes in hospitalised patients: a systematic review and meta-analysis. Crit. Care. 25(1), 351. doi: 10.1186/s13054-021-03766-4.

Boeije, H., 2002. A purposeful approach to the constant comparative method in the analysis of qualitative interviews. Quality and quantity, 36(4), 391-409.

Bollepalli, S.C., Sevakula, R.K., Au-Yeung, W.M., Kassab, M.B., Merchant, F.M., Bazoukis, G., Boyer, R., Isselbacher, E.M., Armoundas, A.A., 2021. Real-Time Arrhythmia Detection Using Hybrid Convolutional Neural Networks. J. Am. Heart. Assoc. 10(23), e023222. doi: 10.1161/JAHA.121.023222.

Brantley, A., Collins-Brown, S., Kirkland, J., Knapp, M., Pressley, J., Higgins, M., McMurtry, J.P., 2016. Clinical Trial of an Educational Program to Decrease Monitor Alarms in a Medical Intensive Care Unit. AACN. Adv. Crit. Care. 27 (3), 283-289. doi: 10.4037/aacnacc2016110.

Burdick, K.J., Jorgensen, S.K., Combs, T.N., Holmberg, M.O, Kultgen, S.P., Schlesinger, J.J., 2020. SAVIOR ICU: sonification and vibrotactile interface for the operating room and intensive care unit. J. Clin. Monit. Comput. 34 (4), 787-796. doi: 10.1007/s10877-019-00381-1.

Casey, S., Avalos, G., Dowling, M., 2018. Critical care nurses' knowledge of alarm fatigue and practices towards alarms: A multicentre study. Intensive. Crit. Care. Nurs. 48, 36-41. doi: 10.1016/j.iccn.2018.05.004.

Cho, O.M., Kim, H., Lee, Y.W., Cho, I., 2016. Clinical alarms in intensive care units: Perceived obstacles of alarm management and alarm fatigue in nurses. Health. Inform. Res. (1), 46-53. doi: 10.4258/hir.2016.22.1.46.

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Claudio, D., Deb, S., Diegel, E., 2021. A Framework to Assess Alarm Fatigue Indicators in Critical Care Staff. Crit. Care. Explor. 3(6), e0464. doi: 10.1097/CCE.0000000000000464.

Darbyshire, J.L., Young, J.D., 2013. An investigation of sound levels on intensive care units with reference to the WHO guidelines. Crit. Care. 17(5), R187. doi: 10.1186/cc12870.

Despins, L.A., 2017. Factors influencing when intensive care unit nurses go to the bedside to investigate patient related alarms: a descriptive qualitative study. Intens. Crit. Care. Nurs. 43, 101-107. doi: 10.1016/j.iccn.2017.04.003.

Emergency Care Research Institute (ECRI), 2020. Top 10 health Technology Hazards for 2020. Health Devices. 2020. Available online: https://elautoclave.files.wordpress.com/2019/10/ecri-top-10-technology-hazards-2020.pdf (Accessed 20.10.21).

Englander, M., 2012. The Interview: Data Collection in Descriptive Phenomenological Human Scientific Research. Journal of Phenomenological Psychology 43 13–35

Fernandes, C., Miles, S., Lucena, C.J., 2020. Detecting False Alarms by Analyzing Alarm-Context Information: Algorithm Development and Validation. JMIR. Med. Inform. 8(5), e15407. doi: 10.2196/15407.

Freysdóttir, G.,R., Björnsdóttir, K., Svavarsdóttir, M.H., 2019. Nurses' use of monitors in patient surveillance: an ethnographic study on a coronary care unit. Eur. J. Cardiovasc. Nurs. 18 (4), 272-279. doi: 10.1177/1474515118816930.

Gazarian, P.K., Carrier, N., Cohen, R., Schram, H., Shiromani, S., 2015. A description of nurses´ decision-making in managing electrocardiographic monitor alarms. J. Clin. Nurs. 24 (1-2), 151-9. doi: 10.1111/jocn.12625.

Gentles, S. J., Charles, C., Ploeg, J., & McKibbon, K. A., 2015. Sampling in qualitative research: Insights from an overview of the methods literature. The qualitative report, 20(11), 1772-1789.

Giorgi, A. (2009). The descriptive phenomenological method in psychology: A modified Husserlian approach. Duquesne University Press.

Guba, E.G, Lincoln, Y.S., 1989.Fourth Generation Evaluation. Sage, Newbury Park, CA.

18

Hyland, S.L., Faltys, M., Hüser M., Lyu, X., Gumbsch, T., Esteban, C., Bock, C., Horn, M., Moor, M., Rieck, B., Zimmermann, M., Bodenham, D., Borgwardt, K., Rätsch, G., Merz, T.M., 2020. Early prediction of circulatory failure in the intensive care unit using machine learning. Nat. Med. (3), 364-373. doi: 10.1038/s41591-020-0789-4.

Jeong, Y.J., Kim, H., 2022. Critical care nurses' perceptions and practices towards clinical alarms. Nurs. Crit. Care. 1-8 doi: 10.1111/nicc.12751.

Johnson, K.R., Hagadorn, J.I., Sink, D.W., 2017. Alarm Safety and Alarm Fatigue. Clin. Perinatol. 44 (3), 713-728. doi: 10.1016/j.clp.2017.05.005.

Lewandowska, K., Weisbrot, M., Cieloszyk, A., Mędrzycka-Dąbrowska, W., Krupa, S., & Ozga, D., 2020. Impact of Alarm Fatigue on the Work of Nurses in an Intensive Care Environment-A Systematic Review. Int J Environ Res Public Health. 17(22), 8409. https://doi.org/10.3390/ijerph17228409

Lewis, C.L., Oster, C.A., 2019. Research Outcomes of Implementing CEASE: An Innovative, Nurse-Driven, Evidence-Based, Patient-Customized Monitoring Bundle to Decrease Alarm Fatigue in the Intensive Care Unit/Step-down Unit. Dimens. Crit. Care. Nurs. 38 (3), 160-173. doi: 10.1097/DCC.0000000000000357.

Manzey, D., Gérard, N., Wiczorek, R., 2014. Decision-making and response strategies in interaction with alarms: the impact of alarm reliability, availability of alarm validity information and workload. Ergonomics. 57(12),1 833-55. doi: 10.1080/00140139.2014.957732.

McKenzie, R., Miller, S., Cope, V., Brand, G., 2021. Transition experiences of newly qualified registered graduate nurses employed in a Neonatal Intensive Care Unit. Intensive Crit. Care. Nurs. 67, 103112. doi: 10.1016/j.iccn.2021.103112.

Meng'anyi, L.W., Omondi, L.A., Muiva, M.N., 2017. Assessment of nurses interventions in the Management of Clinical Alarms in the critical care unit, Kenyatta National Hospital, a cross sectional study. BMC. Nurs. 16, 41. doi: 10.1186/s12912-017-0235-1.

Mirhafez, S.R., Movahedi, A., Moghadam-Pasha, A., Mohammadi, G., Moeini, V., Moradi, Z., Kavosi, A., Aryayi, Far, M., 2019. Perceptions and practices related to clinical alarms. Nurs. Forum. 54 (3), 369-375. doi: 10.1111/nuf.12338.

19

Muroi, C., Meier, S., De Luca, V., Mack, D.J., Strässle, C., Schwab, P., Karlen, W., Keller, E., 2020. Automated False Alarm Reduction in a Real-Life Intensive Care Setting Using Motion Detection. Neurocrit, Care. 32(2),419-426. doi: 10.1007/s12028-019-00711-w.

Pater, C.M., Sosa, T.K., Boyer, J., Cable, R., Egan, M., Knilans, T.K., Schondelmeyer, A.C., Schuler, C.L., Madsen, N.L., 2020. Time series evaluation of improvement interventions to reduce alarm notifications in a paediatric hospital. BMJ. Qual. Saf. 29 (9), 717-726. doi: 10.1136/bmjqs-2019-010368.

Petersen, E.M., Costanzo, C.L., 2017. Assessment of clinical alarms influencing nurses' perceptions of alarm fatigue. Dimens. Crit. Care. Nurs. 36 (1), 36-44. doi: 10.1097/DCC.0000000000000220.

Phillips, J., Sowan, A., Ruppel, H., Magness, R., 2020. Educational Program for Physiologic Monitor Use and Alarm Systems Safety: A Toolkit. Clin. Nurse. Spec. 34 (2), 50-62. doi: 10.1097/NUR.0000000000000507.

Poncette, A.S., Spies, C., Mosch, L., Schieler, M., Weber-Carstens, S., Krampe, H., Balzer, F., 2019. Clinical Requirements of Future Patient Monitoring in the Intensive Care Unit: Qualitative Study. JMIR. Med. Inform. 7 (2), e13064. doi: 10.2196/13064

Ruppel, H., De Vaux, L., Cooper, D., Kunz, S., Duller, B., Funk, M., 2018. Testing physiologic monitor alarm customization software to reduce alarm rates and improve nurses' experience of alarms in a medical intensive care unit. PLoS. ONE. 13 (10), e0205901. https://doi.org/10.1371/journal. pone.0205901

Ruppel, H., Funk, M., Clark, J.T., Gieras, I., David, Y., Bauld, T.J., Coss, P., Holland, M.L., 2018. Attitudes and Practices Related to Clinical Alarms: A Follow-up Survey. Am. J. Crit. Care. 27 (2), 114-123. doi: 10.4037/ajcc2018185.

Ruppel, H., Funk, M., Whittemore, R., Wung, S.F., Bonafide, C.P., Powell, Kennedy, H., 2019. Critical care nurses' clinical reasoning about physiologic monitor alarm customisation: An interpretive descriptive study. J. Clin. Nurs. 28.(15-16), 3033-3041. doi: 10.1111/jocn.14866.

Ruskin, K.J., Hueske-Kraus, D., 2015. Alarm fatigue: impacts on patient safety. Curr. Opin. Anaesthesiol. 28(6),685-90. doi: 10.1097/ACO.0000000000000260.

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., Jinks, C., 2018. Saturation in qualitative research: exploring its conceptualization and operationalization. Qual. Quantity.52 (4), 1893-1907. doi: 10.1007/s11135-017-0574-8.

Schondelmeyer, A.C., Daraiseh, N.M., Allison, B., Acree, C., Loechtenfeldt, A.M., Timmons, K.M., Mangeot, C., Brady, P.W., 2019. Nurse Responses to Physiologic Monitor Alarms on a General Pediatric Unit. J. Hosp. Med. 14 (10), 602-606. doi: 10.12788/jhm.3234.

Simpson, K.R., Lyndon, A., 2018. False Alarms and Overmonitoring: Major Factors in Alarm Fatigue Among Labor Nurses. J Nurs. Care. Qual. 34(1),66-72. doi: 10.1097/NCQ.0000000000000335.

Sowan, A.K., Vera, A.G., Fonseca, E.I., Reed, C.C., Tarriela, A.F., Berndt, A.E.,2017. Nurse competence on physiologic monitors use: toward eliminating alarm fatigue in intensive care units. Open. Med. Inform. J. 11, 1-11. doi: 10.2174/1874431101711010001

Stewart, C., 2021. Understanding new nurses' learning experiences in intensive care. Intensive. Crit. Care. Nurs. 67,103094. doi: 10.1016/j.iccn.2021.103094.

Storm, J., Chen, H.C., 2021. The relationships among alarm fatigue, compassion fatigue, burnout and compassion satisfaction in critical care and step-down nurses. J. Clin. Nurs. 30(3-4), 443-453. doi: 10.1111/jocn.15555.

The Joint Commission. National Patient Safety Goals Effective January 2020. Hospital Accreditation Program. https://www.jointcommission.org/-/media/tjc/documents/standards/national-patient-safety-goals/2020-hap-npsg-goals-final.pdf. (Accessed 2.11.2021).

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International journal for quality in health care, 19(6), 349-357.

Unal, A., Arsava, E.M., Caglar, G., Topcuoglu, M.A., 2021. Alarms in a neurocritical care unit: a prospective study. J. Clin. Monit. Comput. 27,1-7. doi: 10.1007/s10877-021-00724-x.

Wilken, M., Hüske-Kraus, D., Röhrig, R., 2019. Alarm Fatigue: Using Alarm Data from a Patient Data Monitoring System on an Intensive Care Unit to Improve the Alarm Management. Stud. Health. Technol. Inform. 267, 273-281. doi: 10.3233/SHTI190838.

Willig, C., & Rogers, W. S. (Eds.). (2017). The SAGE handbook of qualitative research in psychology. Sage.

Yue, L., Plummer, V., Cross, W., 2017. The effectiveness of nurse education and training for clinical alarm response and management: a systematic review. J. Clin. Nurs. 26 (17-18), 2511-2526. doi: 10.1111/jocn.13605.

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Table 1. Topic list from the interview guide.
Perceptions of the benefits of monitor use: positive aspects and how they help in the daily tasks.
Perceptions of the negative aspects of monitor use: disadvantages and limitations.
Perceptions of monitor changes and improvements in recent years: format, management, utilities and security.
Conceptualizations of the strategies to reduce false alarms
Perceptions of key elements in the response to alarms
Personal awareness and skills related to working with monitors.
Personal response and behavior when monitor alarms or any electronic medical device buzz: feelings, perceptions, alarm response strategies, alarm prioritization and factors influencing their personal response to alarms.
Perceptions of false alarms: personal experience, behavior, feelings.

Code	Age	Sex	Type of critical care unit	Employment relationship	Years since graduation	Years working in high monitoring unit	Specific training/formation/education in critical patient care
NUR1	58	Female	Adult CCU	Permanent	33	18	Nonregulated training
NUR 2	52	Female	Adult CCU	Permanent	28	5	Nonregulated training
NUR 3	49	Female	Adult CCU	Temporary	25	16	Nonregulated training
NUR 4	40	Female	Adult CCU	Permanent	19	15	Nonregulated training
NUR 5	46	Female	Adult CCU	Permanent	18	9	Nonregulated training
NUR 6	46	Female	Neonatal CCU	Permanent	20	11	Nonregulated training
NUR 7	26	Female	Adult CCU	Temporary	4	2	Postgraduate
NUR 8	26	Female	Adult CCU	Temporary	3	2	Postgraduate
NUR 9	29	Female	Neonatal CCU	Temporary	7	2	Nonregulated training
NUR 10	37	Female	Neonatal CCU	Interim official	9	6	Nonregulated training
NUR 11	61	Male	Coronary unit	Permanent	30	15	Nonregulated training
NUR 12	53	Female	Adult CCU	Permanent	28	15	Nonregulated training
NUR 13	58	Male	Adult CCU	Permanent	33	27	Nonregulated training
NUR 14	55	Female	Adult CCU	Permanent	30	22	Nonregulated training
NUR 15	48	Male	Adult CCU	Permanent	24	12	Nonregulated training
NUR 16	38	Female	Adult CCU	Temporary	13	5	Nonregulated training
NUR 17	47	Female	Neonatal CCU	Permanent	23	5	Nonregulated training

Table 2. Sociodemographic characteristics of the participants

Table 3. Categories, codes and verbatims of theme 1: General perceptions about alarms.

Theme 1: General perceptions about alarms		
Categories	**Codes**	**Verbatims**
Basic equipment of critical care units	Dependence	**NUR7 (27 years; Adult CCU):** "There is a high dependence on clinical alarms... too much trust... That you rely on the monitor to go on, and then maybe it does not... It is like, what if something happens? I just do not know!".
	Confidence	**NUR8 (26 years; Adult CCU):** Sometimes as we know the alarms we trust, as it does not beep... you are calm...
	Useful devices vs. extra work.	**NUR15 (48 years; Adult CCU):** Alarms are very useful... the problem is the number of times they go off without being true... but what would we do in a CCU without monitors and alarms... the whole shift at the foot of the bed?
	Overload	**NUR10 (37 years; Neonatal CCU):** When alarms are false, they don't allow you to work well and at ease, because you are continually stopping other things to attend to that... which you know is a false alarm on top of it all.
	Noise pollution	**NUR4 (40 years; Adult CCU):** There is always an alarm going off, there is always a lot of noise. Sometimes I think there is a pump beeping... and I am told... it is not beeping!"

Table 4. Categories, codes and verbatims of theme 2: Strategies to reduce false alarms

Theme 2: Strategies to reduce false alarms		
Categories	**Codes**	**Verbatims**
Training in the configuration of monitors.	Need for advanced knowledge and specialized training in monitor surveillance.	***NUR2 (52 years; Adult CCU):*** Not only do we need knowledge of nursing techniques but we also need to know all the equipment that is in the ICU and sometimes we only know the basics, we don't get the most out of it... we need more education and training with these devices...…
	There is no time for formal training during the workday.	***NUR4 (40 years; Adult CCU):*** When someone new comes in, there is no time for formal training, but rather they acquire knowledge as they work and the colleagues teach them during the working day...…
	No specialty in critical care.	***NUR12 (53 years; Adult CCU):*** *One of our problems is that there is no speciality and often nurses who have never been in an ICU in their lives come to work, especially when the job vacancies run out or when they are on permanent contracts...*
Customization of the alarms to the patient's condition	Modifying monitor's limits.	***NUR14 (55 years; Adult CCU):*** *"I changed the limits because it was beeping all the time and was not clinically relevant, so I changed the configuration of the monitor… It does not let the patient rest either because the bedside monitor also sounds the alarm, so if it is beeping all night, the patient does not rest either".*
	Silencing the monitor for the well-being of the patient and family.	***NUR7 (26 years; Adult CCU):*** *"When a patient is in an irreversible situation... when we have already done the impossible, what I want is that when the relatives are present, they don't hear any alarm on those monitors. I think it must be very distressing for the relatives to know that their loved one is leaving. …In those cases, we silence them, and we modify all the parameters of the equipment".*
Teamwork	Responding to alarms as a team	***NUR5 (46 years; Adult CCU):*** We work a lot as a team because we also know all the patients in the unit... and we help each other... if I'm with another patient, and I can't get out of the box,

		I call a colleague, please check out what it is sounding...
	Peer-to-peer training	**NUR3** *(49 years; Adult CCU):* In many cases, we train each other, either when new nurses come and they don't know how to use all the monitors or devices... or when a new device has been installed and someone has not been in the training because it doesn't coincide with their shift or because they are on days off... in general, the training they receive is from those of us who are there".
Taking advantage of the development of technology	Different tones of alarm depending on the level of severity.	*NUR1 (58 years; Adult CCU):* "Some devices have different levels of alarm and sound depending on the severity... we learn that quickly, it helps that some alarms sound differently to help us identify the severity of the situation".
	Need to improve signal detection algorithms.	**NUR15** *(48 years; Adult CCU):* ..."I think that the devices could be improved with more precise algorithms that exchange information between one device and another... although of course it is better to detect everything and let the human decide whether it is true or not... this avoids problems...but this aspect could be improved.".
	Support from mobile devices (Tablet or smartphone).	**NUR8** *(26 years; Adult CCU): "*... we could have a tablet or smartphone, from which we could see the monitor and access the surveillance camera of that unit and turn it off from there... even if you then go... but that would greatly reduce the noise and the alarm fatigue...".

Table 5. Categories, codes and verbatims of theme 3: Key elements in the response to alarms.

Theme 3: Key elements in the response to alarms.		
Categories	**Codes**	**Verbatims**
Information about patient's condition	Clear and unambiguous communication between nurses about the patient's condition.	**NUR16 (38 years, Adult CCU):** "...although each one brings her own patient, at the change of shift we receive information from all the patients, so that we all know the situation of the patients...".
	Accurate information about patient's condition.	**NUR10 (37 years; Neonatal CCU):** "To be able to determine if an alarm is an urgent matter, you must know what the patient's condition is. In the most critical patients, we normally have all five senses on them, we do not wait for the second warning from the monitor. As soon as you hear the first sound you attend, you do not wait, always depending on the seriousness of each one of them".
	Signs of the patient.	**NUR2 (52 years; Adult CCU):** "The alarm is beeping, but the first thing I do is to look at the patient's face, which determines if it's relevant or not, then I take a quick look at the box and what the patient is doing".
Nurse clinical Experience	Nurse's perception about alarm importance level.	**NUR10 (37 years; Neonatal CCU):** "Well there is a great variety, you find some inexperienced nurses that you say, oh my God, an alarm is sounding..., there are other colleagues that are not, that are the contrary, as they are inexperienced and they do not know the sounds, they run away maybe by the sensor of a temperature, and you say to them calmly, calm, that it is the temperature! it is nothing...! Everything is there, but the more experienced nurses are a little more relaxed because as you are already aware of what it is, we try to take it more calmly, with more composure..."
	Over confidence in responding to alarms.	**NUR4 (40 years; Adult CCU):** "The alarm that stresses me out the most is asystole and VF, VT because it gives me no chance to do anything with the patient so let's run. It is the same with the hemofilter and mechanical ventilation alarm... I go there every time".
	Under confidence in responding to alarms.	**NUR5 (46 years; Adult CCU):** "No, if that is... that is... and maybe it is not and then many times for having the experience you believe that you already know everything, and sometimes not"

Type of the Critical Care Unit	Neonatal unit: nurses focus on bradycardia and desaturation.	***NUR9 (29 years; Neonatal CCU):*** "We are mainly looking at bradycardia, tachycardia, or desaturation, so we're mainly based on that... on the heart rate and saturation part, because these kids tend to do that, they're premature".
	Adult units: nurses focus on ventilation and hemofilter.	***NUR1 (58 years; Adult CCU):*** "In the case of a mechanical ventilation or hemofilter alarm, of course, you always have to be with the patient and in these cases I go immediately to see why it beeps... because the equipment does not always describe the patient's needs... for example, in an apnoea you check that it is connected, that the tube is not clamped... or in the hemofilter to see if it has clotted or anything else... but in these alarms, you have to run out and act immediately..."
"Cry-wolf" phenomenon	Delay in response to the alarm.	***NUR11 (61 years; Coronary):*** *"The excess number of so many false alarms cause the staff to be careless... like the famous wolf story, right? (cry-wolf phenomenon)... the alarm is beeping all the time and you have already got up a thousand times, of course... once, it happened that a cardiac patient had low blood pressure and was always beeping and was on the ventilator weaning... it was already 6am and he was still beeping and when we went to the room he had disconnected his femoral artery and was bleeding to death... luckily we caught him in time, he was transfused some blood concentrates and he recovered... but what a shock...*
Nurse/patient ratio	Prioritize emergency situations over response to stable patient alarms.	***NUR12*** *(53 years; Adult CCU):* ..."Sometimes it happens that there are fewer nurses on shift and there is an emergency, and we are attending to that emergency ... and of course, it's not that we have neglected the alarms of other patients, it's just that there are less staff and we can't cope".