ECRI

Healthcare Risk, Quality, & Safety Guidance - Guidance

Clinical Alarms

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EXECUTIVE SUMMARY

Clinical alarms are in the unique position of being both a blessing to and a curse on the delivery of healthcare services in the United States. Alarms alert staff members to dangerous or life-threatening situations that require immediate attention, but they often sound in the absence of a dangerous or life-threatening condition. The vast majority of nonurgent alarms do not require a staff member's attention at that time (Cvach et al.; Sendelbach and Funk; American Nurse). This cacophony forms the background noise of a unit's environment; the constant barrage of nuisance alarms leads to alarm fatigue, which is evidenced by slow or no response, silencing or muting the alarm, or turning off the alarm entirely. If the alarm is silenced or turned off, it can fail to warn the staff member of a true or impending emergency.

Though strategies exist, no single strategy alone will correct this problem. Mitigation requires multiple interventions, some of which may need to be tailored for the unit or patient. For example, when appropriate, alarm parameters may be adjusted so that the alarm is more likely to sound only when the patient actually needs attention. It may also be possible in certain situations to set a brief delay on the alarm; some conditions autocorrect naturally after only a few seconds. Another strategy is to employ technicians who watch the patient monitors and alert staff when an event occurs. This guidance article more fully explores these interventions.

Action Recommendations

- Assemble an interdisciplinary team to study the issue of nuisance alarms and alarm fatigue and devise strategies.
- Collect data on where alarms are most common, the types of alarms that are most common, and the number and types of alarms that do or do not require intervention by a staff member.
- Investigate possible interventions to reduce nuisance (nonactionable) physiological alarms, including breached parameters and arrhythmias.
- Investigate possible interventions to reduce nonactionable technical (equipment-related) alarms.
- Examine alarm standardization strategies. Determine the optimal strategy for the organization, such as standardizing alarm equipment, tones, levels, and response protocols, so that even in an unfamiliar unit, staff members are familiar with the technology, the level of alarm, and the response necessary.
- Consider environmental conditions when examining potential alarm solutions. The physical layout and surroundings within the care area will affect alarm system options, and vice versa.
- Develop policies and procedures to manage the program.
- Educate current staff members and orient new staff members on the requirements of the alarm-management program.
- Implement changes and collect data on alarms compared with preintervention baseline data.
- Evaluate postintervention data to determine whether there has been a significant change since baseline. Track the data according to the classes of alarms used at baseline.
- Train staff members to report injuries and near misses related to alarm hazards to the alarm team, the risk management department, or other appropriate departments.

- Review the history of the alarm-reduction program for lessons learned that can be applied to the acquisition of new monitoring equipment.

WHO SHOULD READ THIS

Administration, Cardiology, Chief medical officer, Clinical/biomedical engineering, Critical care, Information technology, Nursing, Patient safety officer, Quality improvement, Staff education, Telemetry

SHARE WITH LEADERSHIP

Ready, Set, Go: Clinical Alarms

SHARE WITH RISK MANAGEMENT

Make a Plan: Clinical Alarms

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THE ISSUE IN FOCUS

Clinical alarms are prevalent in critical care units, labor and delivery units, emergency departments, and medical and surgical nursing floors. Alarms can originate from monitors, ventilators, infusion pumps, feeding pumps, pulse oximeters, intra-aortic balloon pumps, sequential compression devices, beds, and many other devices.

Risk Manager's Toolbox

- Ready, Set, Go: Clinical Alarms
- Make a Plan: Clinical Alarms

Clinical alarms are frequent, daily occurrences. One study at a large academic medical center demonstrated that, in one week, the hospital experienced at least 74,535 alarms. Cardiology had the highest average rate of alarms at 1,304 per bed per week, while the medical telemetry unit had the lowest average rate at 185 alarms per bed per week. The overall average rate for eight units was 375 alarms per bed per week. In the cardiology unit, there were almost eight alarms per bed per hour (Cvach et al.).

Definitions

The following definitions are used to discuss alarms in this article:

- **Nuisance alarms** are alarms that sound in the absence of an event that requires the attention of a staff member. Also known as nonactionable alarms, nuisance alarms can be physiological or technical in origin.

- **Physiological alarms** can be of two types. Threshold breach alarms occur when a bodily function (e.g., heart rate, blood pressure, respiration rate) is outside the preset parameters that define the "normal" range for that function. Arrhythmia alarms occur when a bodily function is within the preset parameters, but the organ is not functioning normally (e.g., cardiac rhythms). Threshold breach alarms appear to be more frequent than arrhythmia alarms (Cvach et al.).
- **Technical alarms** occur when the alarm is directly related to the function of the monitoring equipment, rather than to a physiological event. Examples include a poor signal, an artifact in the signal, a change in position by the patient, or a "leads off" alarm in which an electrode has become unattached. (Cvach et al.)
- **Alarm fatigue** is a state in which bedside caregivers either do not hear audible alarms, delay in responding to them, or disregard them entirely. Although estimates of nuisance alarm rates vary, the consensus of opinion appears to indicate that between 75% and 99% of clinical alarms are nuisance alarms and do not require immediate attention from the staff member (Cvach et al.; Sendelbach and Funk; American Nurse). The stream of nuisance alarms leads staff to either ignore them or delay in responding to them. Staff may also turn the volume down or turn the alarm off entirely.

Alarm Fatigue

Alarm fatigue is not a new condition, but it is a condition that can have deadly consequences. In a 2013 sentinel event alert, the Joint Commission noted that its sentinel event database includes 98 reported alarm-related events occurring between January 2009 and June 2012, of which 80 resulted in death. Other outcomes included permanent loss of function and need for unexpected additional care or an extended hospital stay. According to the Joint Commission ("Medical Device Alarm Safety"), "common injuries or deaths related to alarms included those from falls, delays in treatment, ventilator use and medication errors . . ."

Alarm hazards have long been, and remain, a major patient safety concern. As of this writing, alarm hazards have appeared on ECRI's list of Top 10 Health Technology Hazards every year since the list's 2008 inception.

Injuries from Alarm Hazards

Injuries resulting from alarm hazards can cause significant patient harm and also lead to litigation and significant financial awards. For example, in a 2019 case a patient died after cardiac monitoring alarms went unheeded, and more than $1.2 million was awarded to the patient's estate (*Ashmore v. Hartford Hosp.*). The jury also awarded the patient's wife $4.5 million for loss of consortium, which the Connecticut Supreme Court directed a trial court to reconsider (because, it held, in most cases the law will presume that an award for loss of consortium should not substantially exceed the related award for wrongful death to the spouse who died).

In this case, during a routine, uncomplicated elective heart surgery, the surgeon connected epicardial pacing electrodes to the patient's heart. If an abnormal heart rhythm were to occur after surgery, the other ends of the wires were to be connected to a system that would provide electrical stimulation to correct the arrhythmia.

On the second night after surgery, the patient began experiencing atrial fibrillation. Then, over the next hour, he began to show "various signs of serious distress," and his heart rate fell precipitously. Alarms kept sounding, but staff did not connect the pacing wires or contact the surgeon until after the patient experienced cardiac arrest. Staff restarted his heart, but the 17 minutes in which he had no heartbeat had caused severe oxygen deprivation. He died after his wife decided to withdraw life support.

The patient's wife sued the hospital and other defendants. She brought two claims: a wrongful-death claim on behalf of the patient's estate and a claim for loss of consortium on her own behalf. The jury awarded the patient's estate $75,000 in economic damages and $1.2 million in noneconomic damages.

REGULATIONS AND STANDARDS

The past decade has seen the introduction of several guidelines and standards to help healthcare organizations increase the safety of their alarm usage while decreasing the occurrence of clinically insignificant alarms.

Association for the Advancement of Medical Instrumentation

A 2011 summit convened by the Association for the Advancement of Medical Instrumentation (AAMI), in conjunction with ECRI, the U.S. Food and Drug Administration, the Joint Commission, and the American College of Clinical Engineering, resulted in publication of the following seven "clarion themes," priorities in the alarm safety movement (AAMI "Clinical"):

- Expand stakeholders' understanding of the environments where alarms are used
- Improve alarm system management
- Explore methods of alarm integration
- Examine and reconcile challenges in care areas where alarms are used
- Strengthen medical equipment standards
- Clarify regulatory requirements
- Share best practices and lessons learned

In 2012, AAMI published Recommendations for alarm signal standardization and more innovation. Through an exploration of Christiana Care Health System's (Delaware) five-year alarm system implementation, AAMI presents recommendations that can benefit any organization looking to review or revise its alarm systems. The Christiana initiative found that monitoring was taking place in "silos"; each unit was in practice isolated from others and following its own system of monitoring, responding to alarms, and setting alarm parameters. Therefore, AAMI recommends that initial assessment of current alarms systems include an exploration of how frontline caregivers receive and respond to alarm conditions and of possible inconsistencies in alarm protocols in separate care areas. Christiana nurses also explained that they ignored lower-level alarms (typically nonclinical or clinically insignificant events). Therefore, part of their action plan focused on the identification of "true alarm conditions," which became reflected in new alarm settings that were then standardized across the organization. (AAMI "Recommendations")

Identifying these inconsistent alarm-management strategies helped Christiana recognize that it needed a broader approach, so it convened a task force that advocated for leadership buy-in and collaboration across the entire organization. The task force determined that the best strategy for Christiana's needs was to use wireless patient monitors and dedicated monitor technicians who alert caregivers to true alarm conditions. The wireless monitor system was implemented originally in the hospital's department of medicine, then expanded slowly until it was organization-wide.

AAMI notes that successful steps taken in this case included the recognition that alarms are a medical and patient safety concern; the creation of a multidisciplinary task force that can advocate at all levels and in all areas of the organization for a strategic solution; the commitment of support from leadership; input from would-be system users; and consultation with other organizations that have undertaken similar efforts. (AAMI "Recommendations")

Once the system was deployed, Christiana found that its lack of standardization regarding alarm settings, responses, and parameters was a hindrance. Negotiations ensued among the task force and all physicians who set alarm limits, revolving around the question, "Does this merit a phone call in the middle of the night?" Such focus, notes the task force, allowed clinicians to determine a core list of true alarm conditions, which then replaced the manufacturers' default settings. Nurses, as the care providers most likely to identify and respond to an alarm, played a key role in negotiating the standardized alarm settings. AAMI stresses how important it is to "develop a system-wide alarm system policy and protocols that define an alarm management strategy." (AAMI "Recommendations")

American Association of Critical-Care Nurses

The American Association of Critical-Care Nurses (AACN) alarm safety guidance includes the following suggested strategies to reduce alarm fatigue:

- Prepare skin properly for electrocardiogram (ECG) electrode placement.
- Change ECG electrodes daily.
- Consider customizing ECG alarm parameters based on the needs of the individual patient.
- Consider customizing parameters for pulse oximetry. Determine optimal threshold and delay settings with the input of an interdisciplinary team, including biomedical engineering.
- Offer regular education and training about alarms.
- Establish an interdisciplinary alarm safety team.
- Monitor only patients who clinically merit monitoring.

The Joint Commission

In 2013 the Joint Commission released both a sentinel event alert and a National Patient Safety Goal (NPSG) addressing alarm safety.

In the sentinel event alert, the Joint Commission ("Medical Device Alarm Safety") points to the following factors contributing to alarm hazards, which may occur alone or in conjunction with one another:

- Alarm fatigue
- Noncustomized alarm settings
- Insufficient staff education or training
- Inadequate staffing levels for alarm monitoring
- Unintegrated alarms (i.e., alarms not connected with other medical devices, systems, or networks)
- Alarm equipment failures

The sentinel event alert recommendations echo those published by AAMI and ECRI ("2019 Top 10"), namely to secure the support of leadership, assess current alarms and their settings, establish guidelines for alarm parameters (including when alarms are not necessary), create guidelines for the tailoring of alarm settings and limits on a patient-by-patient basis, and regularly review alarms to ensure proper function.

The sentinel event alert also suggests educating all members of the care team regarding safe alarm-management practices, as well as appropriate responses for alarms. Further suggestions include changing single-use sensors (such as ECG leads) per manufacturer's instructions; assessing the acoustics in each care area; prioritizing alarms as an organizational safety initiative; establishing a multidisciplinary task force to address alarm use and hazards; and sharing best practices with appropriate organizations. (Joint Commission "Medical Device Alarm Safety")

The NPSG advances the cause of alarm safety and elevates it to a higher priority. As of 2020, NPSG.06.01.01 reads: "Improve the safety of clinical alarm systems." This is a deceptively simple directive; however, the NPSG rationale also states the following:

> Universal solutions have yet to be identified, but it is important for a hospital to understand its own situation and to develop a systematic, coordinated approach to clinical alarm system management. Standardization contributes to safe alarm system management, but it is recognized that solutions may have to be customized for specific clinical units, groups of patients, or individual patients. (Joint Commission "National Patient Safety Goals")

The goal calls for organizational leaders to prioritize alarm safety and to identify the most critical alarms, considering patient safety risk, staff input, potentially unnecessary alarms, and published guidance. Management strategies are required to address appropriate alarm settings, considerations for silencing alarms, considerations for changing alarm parameters, necessary authority to set or modify alarm parameters, appropriate response protocol, and verification of individual alarm settings.

ACTION PLAN

Make a Plan: Clinical Alarms

Download this customizable document to track your implementation of these action recommendations.

Gather Baseline Data on Alarms

Action Recommendation: Assemble an interdisciplinary team to study the issue of nuisance alarms and alarm fatigue and devise strategies.

Action Recommendation: Collect data on where alarms are most common, the types of alarms that are most common, and the number and types of alarms that do or do not require intervention by a staff member.

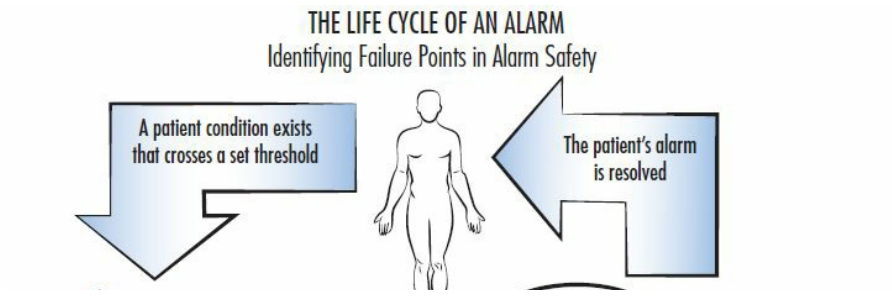
The problem of nuisance alarms is not something that a single individual or department can solve. The issue requires a team approach including input from multiple individuals with a variety of backgrounds, training, and experience.

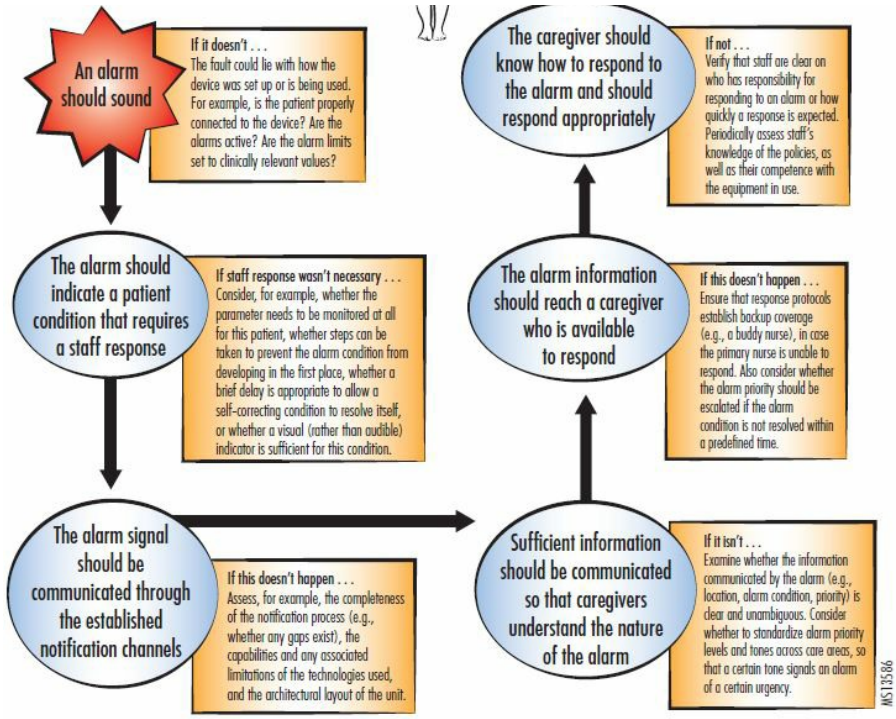
Leaders of the medical staff must be involved to determine the clinical implications of adjusting or customizing threshold parameters or to propose or evaluate other strategies to lessen alarm frequency.

Nursing leadership should also be involved because nurses are intimately familiar with the causes and effects of nuisance alarms, as well as strategies to reduce their rate of occurrence. Administration must be involved because some of the potential avenues to explore for reducing the rate of nuisance alarms may require the allocation of funds and resources (e.g., implementing a monitor watcher program or changing brands or types of monitoring equipment).

The leadership of biomedical engineering should also be involved to provide technical assistance with potential strategies that require altering monitoring equipment or to explain why an alteration may not be feasible or may be ineffective. Frontline (bedside) caregivers should also be represented, because they are experts on how alarms are used in practice. Other persons may need to be involved depending on the circumstances.

The team should begin by gathering data on where alarms are located, including nuisance alarms, what types of nuisance alarms are most common, and the nature of actionable alarms. Many of these data can be generated from smart devices, which generate activity logs. In addition to collecting data, the team should consider the steps in the alarm process, including how the alarm is communicated, the message that the alarm communicates, and how providers will know how to respond to the alarm. See The Life Cycle of an Alarm for an illustration of this concept.





View as PowerPoint slide

The team should not set out with a broad goal of eliminating *all* nuisance alarms. Rather, it should prioritize and set realistic, intermediate goals. Setting specific goals is prudent, such as reducing nuisance alarms involving threshold breaches in the intensive care unit, or reducing leads-off alarms on a telemetry unit. Analyzing the data will help the team identify where the problems lie. The organization can achieve its overall goal of reducing nuisance alarms hospital-wide, by starting with reductions where they are most common and problematic.

Identify Strategies for Physiological Alarms

> **Action Recommendation: Investigate possible interventions to reduce nuisance (nonactionable) physiological alarms, including breached parameters and arrhythmias.**

Different types of alarms will require different interventions. The team may choose to begin by working to limit nonactionable physiological alarms.

A significant amount of evidence indicates that customizing physiological alarms, on either a patient or unit basis, can reduce the rate of nuisance alarms (see Cvach et al.) This is, however, a delicate balance: reducing nuisance alarms can be advantageous, but missing a true alarm can be disastrous. Changes to alarm protocols must be approved by the medical staff, and changes to an individual patient's alarm thresholds should be approved by his or her admitting physician.

Adjust Preset Parameters

Threshold breach alarms result from events that are outside preset parameters such as blood pressure, heart rate, respirations, peripheral capillary oxygen saturation (SpO_2). These can be set by the manufacturer through a device's default settings or by the hospital medical staff or staff members. Parameters are often set for normal, healthy persons, not necessarily for patients with comorbidities that can alter what is "normal" for them.

Customizing thresholds for individual patients should be done by protocol. The protocol should specify whether the nurse can alter the thresholds according to his or her best judgment and when a physician order is necessary. The protocol should specify the ranges of thresholds that a nurse can set autonomously. If nuisance threshold-breach alarms recur for a particular patient, that does not invalidate the concept; it only means that the parameters have

not been set appropriately.

As an example, a patient with chronic obstructive pulmonary disease may have a baseline (or "normal" for him or her) SpO_2 of 88%, although "normal" in the adult population may be 96% to 99% ("What Is Oxygen Saturation?"). If the monitor has a preset alarm that sounds when the patient's SpO_2 falls below 90%, then this patient's alarm may sound frequently throughout the day and night, although the patient is not experiencing an event that requires intervention. Customizing the alarm settings can help to reduce the rate of nuisance alarms. Alarm customization can be performed by unit (if patients on the unit typically have similar "normal" ranges for physiological indicators) or by patient (i.e., on a patient-specific basis).

It may be worth exploring the possibility of adding alarm thresholds to the patient's admitting orders. The minority of patients may generate the majority of alarms, so customization may not be necessary for all patients. In one study involving a 16-bed unit, three patients accounted for 597 of 719 alarms over the course of one day. Thus, fewer than 20% of the population accounted for 83% of the alarms (Cvach et al.).

If the patient has reasonably stable vital signs and SpO_2, the responsible provider could opt for the unit default thresholds. If the patient is at risk for abnormal or unstable vital parameters, the provider could order specific customized thresholds or threshold ranges. The primary consideration for the provider should be, "When do I want the nurse to intervene or call me?"

However, at least one study has indicated that customizing alarm parameters to new defaults for a critical care unit was insufficient to reduce the overall alarm load for that unit. The authors looked at 10-week periods before and after an intervention that involved changing default settings for an entire unit rather than customizing parameters for individual patients. The intervention achieved a reduction from roughly 88 to 59 alarms per patient-day. While this reduction might seem significant, statistically it was not, and the authors concluded that "changing default alarm settings and standard in-service education on cardiac monitor use are insufficient to improve alarm systems safety." (Sowan et al.)

Self-Correcting Errors

A large number of alarms can be caused by such activities as suctioning, bathing, repositioning, and oral care. In one observational study of alarms over a 200-hour observation period, 5.7% were actionable patient-related alarms, and 17.7% were actionable technical alarms. The authors noted that implementing a 19-second delay before the alarm sounded would reduce the alarm load by 67%. (Görges et al.)

Reducing nuisance alarms generated as the result of events that will quickly autocorrect may be accomplished by setting a short delay (e.g., 15 to 20 seconds) between the event and the sounding of the alarm. Building in a delay may be appropriate because it eliminates the need for staff to remember to turn the alarm back on, or to turn the volume back up, after providing care that could cause an alarm to sound.

Setting customized alarm delays patient by patient may be too cumbersome, so delays may need to be set for an entire unit. The length of the delay, or the decision to implement a delay at all, should be based on the criticality of the event that caused the threshold breach or arrhythmia. Some parameters may be so critical that a delay of even a few seconds could be dangerous.

Monitor Watchers

Monitor watchers are persons who are specially trained to observe patient-generated signals coming to a central location, usually on a cardiac floor or unit. They can also be trained to apply and replace ECG leads, as necessary. Monitor watchers are generally not licensed healthcare personnel, but rather may have only a high school diploma and specialized training. Approximately 60% of nurses responding to a survey indicated that their hospital employed

monitor watchers. (Funk et al.) Organizations considering deploying monitor watchers should assess the required training and education for monitor watchers based on state licensure and certification requirements and the criticality of patients being monitored; in some scenarios, registered nurses may be the most clinically appropriate watchers (Ruppel and Funk).

One study demonstrated the effectiveness of monitor watchers over a two-month period. During that period, an average of 5.1 alerts were generated per patient-day, 87% of which monitor watchers determined to be nonactionable before staff were alerted. (Palchaudhuri et al.)

Some facilities may feel that the nurses on the floor or unit can handle alarms and that monitor watchers are expensive and duplicative, but they may be discounting the benefits that can be obtained in reducing alarm fatigue. The success of such a program depends heavily on the training the watchers receive, the number of monitors they observe, the regularity of breaks, and other human factors. If a critical alarm does not reach the responding staff member in an appropriate period of time, all of the monitor watchers should be retrained to be sure they know what to look for when such an alarm is generated.

Monitor watchers must understand that, if there is any question whether an arrhythmia is benign or malignant, the default is to notify the bedside caregiver at once so that the event can be investigated.

Identify Strategies for Technical Alarms

> **Action Recommendation: Investigate possible interventions to reduce nonactionable technical (equipment-related) alarms.**

Many technical, or equipment-related, alarms can be eliminated by performing good skin hygiene and implementing other control measures. The time it takes to replace electrodes on a daily basis is more than offset by time savings because nurses do not have to respond to multiple technical alarms every day. If changing electrodes every day is too burdensome for licensed staff, organizations should consider training certified nursing aides or other technicians in effective skin hygiene and task them with replacing electrodes if permitted within the scope of their licenses and certifications under state law.

Skin Hygiene

When electrodes or leads become disengaged, an alarm will sound. This also happens when skin impedance to the signal causes an artifact in the signal. Follow guidance from the manufacturer on good skin hygiene to allow the leads to remain affixed to the skin and to reduce the incidence of artifacts. For example, one manufacturer emphasizes selecting an appropriate application site, clipping hair when appropriate, keeping the site clean and dry, avoiding isopropyl alcohol for cleaning the skin, and attaching lead wires to electrodes prior to placement to limit patient discomfort (Oster).

The Society for Cardiological Science and Technology recommends the following:

- Clean the skin with mild soap or an alcohol wipe
- Exfoliate, if necessary, using a paper towel, gauze pad, or other means
- Remove chest hair, if necessary, using a clean razor or clippers (patient consent should be independently obtained before shaving or clipping)

Electrode Use and Storage

Electrode patches should be replaced on a routine basis, preferably daily. They should also be stored in accordance with the manufacturer's specifications and discarded by their expiration date. (Cosper et al.) Staff members should understand that leaving electrodes on for extended periods can lead to nuisance alarms, so they are exercising a

form of false economy by trying to obtain maximum life out of the electrode.

Examine Alarm Standardization Strategies

> **Action Recommendation: Examine alarm standardization strategies. Determine the optimal strategy for the organization, such as standardizing alarm equipment, tones, levels, and response protocols, so that even in an unfamiliar unit, staff members are familiar with the technology, the level of alarm, and the response necessary.**

This recommendation is not to suggest that alarm *settings* across the organization should be standardized. Consider for standardization the equipment used, the auditory tones and signals used, and the response protocols for staff members (Cvach).

The organization's alarm policy should echo the goal of reducing nuisance alarms and simplifying alarm-management protocols—ideally, making protocols uniform across the organization. Standardization all the way down to alarm features—tones and other signals—allows floating staff members to correctly identify alarms even in unfamiliar departments. (Cvach; ECRI "Best Practices") Using the same monitors as frequently as possible across the organization also helps eliminate the risk that staff will be unfamiliar with a particular model.

Policies should clearly explain any modifications that are made to alarm limits so that staff members may refer to them as needed.

Consider Environmental Conditions

> **Action Recommendation: Consider environmental conditions when examining potential alarm solutions. The physical layout and surroundings within the care area will affect alarm system options, and vice versa.**

Ensuring that alarms and the care environment work together to support patient safety is crucial. The layout of the unit, for example, will influence the alarm system developed and implemented, including the volume of alarms, the chosen method of monitoring patients, and the method by which alarms are communicated.

The Institute for Safe Medication Practices (ISMP) emphasizes the importance of maintaining direct line of sight between patient and nurse in the postanesthesia care unit. If a curtain is necessary, ISMP suggests that a staff member remain with the patient behind the curtain for monitoring.

Solutions tailored to the environment can include a central monitoring station, for example, to reduce the "long hallway" effect. Or consider alarms that do not sound near the patient at all but alert the care provider via a wireless receiver (Chen; AAMI "Recommendations"). However, to ensure their safety the risks of such systems must be weighed against potential merits. If using a wireless network, for example, verify that there are no "dead" areas (where the signal is inadequate) and that a backup network can handle the alarm load if necessary (AAMI "Recommendations").

Environmental considerations also include ambient noise, which should be kept to a minimum so that alarms may be heard (AORN). Reduced ambient noise will also increase patient satisfaction and reduce staff stress levels. Steps to take might include the following (Welch et al.):

- Pad trash can lids
- Replace loud paper towel dispensers
- Limit overhead paging
- Encourage staff to speak quietly

- Install sound-dampening ceiling tiles and wall coverings

The environment and intended alarm system must work together to ensure that all patients can be safely monitored and that all alarms can be identified promptly and responded to appropriately. Therefore, alarm systems should be a consideration early in renovation or new building plans, and care area layout should be a primary consideration when assessing alarm system efficacy.

Develop Policies and Procedures

> **Action Recommendation: Develop policies and procedures to manage the program.**
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> **Action Recommendation: Educate current staff members and orient new staff members on the requirements of the alarm-management program.**

ECRI RESOURCES

The Alarm Safety Game Show

The alarm safety program must be guided by policies and procedures that provide effective guidance in a user-friendly way. Policies and procedures should be consensus documents agreed upon by all members of the interdisciplinary team. If litigation results from an alarm-related injury, the facility's policies may be used to demonstrate the standard of care in a given situation, so proper preparation and implementation of policies are of paramount importance.

According to the Joint Commission ("National Patient Safety Goals"), alarm-management policies and procedures should cover the following topics:

- Clinically appropriate settings and parameters for alarm signals
- When alarm signals can be disabled
- When alarm parameters can be changed
- Who in the organization has the authority to *set* alarm parameters
- Who in the organization has the authority to *change* alarm parameters
- Who in the organization has the authority to set alarm parameters to "off"
- Monitoring and responding to alarm signals
- Checking individual alarm signals for accurate settings, proper operation, and detectability

In addition, any interventions set in place regarding alarm parameter modification or customization, monitor watchers, skin hygiene or electrode replacement, or device maintenance should be formally adopted into policies and procedures.

The effectiveness of a program to reduce nuisance alarms depends entirely on all staff members, both licensed and nonlicensed, complying with the requirements of the program. When staff are empowered to report scenarios that inhibit compliance with protocols in place, engineering or work practice interventions can be considered to enhance compliance while protecting patient safety. While interventions are being considered, however, staff will need to continue to comply with the current procedures to make the program as effective as possible.

Consequently, staff should be educated at the roll-out of the program, in regular in-services, and in new-employee orientation. Staff members must appreciate the dangers of alarm fatigue and exert their best efforts to overcome it.

For a tool that can be used to educate staff on alarm safety, see The Alarm Safety Game Show.

Monitor Interventions for Effectiveness

> **Action Recommendation: Implement changes and collect data on alarms compared with preintervention baseline data.**

Action Recommendation: Evaluate postintervention data to determine whether there has been a significant change since baseline. Track the data according to the classes of alarms used at baseline.

Action Recommendation: Train staff members to report injuries and near misses related to alarm hazards to the alarm team, the risk management department, or other appropriate departments.

The facility should consider following the standard plan, do, study, act (PDSA) framework or another similar quality-monitoring framework, to evaluate each intervention. The standard unit of measure is alarms per bed per day (or week). Facilities should plan carefully, try an intervention, study its effects, and implement permanent changes. If an intervention is not meeting the desired goal, modify or replace it. This does not necessarily mean that the intervention is ineffective; rather, the facility may not have found the proper intervention or may not have implemented it in an effective way. The status quo with nuisance alarms has become a fixture in many hospitals. Patient safety champions must address and fix the problem.

Once the team determines that the rate of nuisance alarms has been reduced to an acceptable level, it is time to reevaluate the system to see whether it can be made more effective, without making it less safe. Similar floors or units should share strategies and lessons learned. Although direct comparisons of alarm rates may not be meaningful, units are likely to encounter similar barriers and can offer each other support in overcoming them. If one unit has a higher rate than another, the facility should ask itself: Why?

Encourage Reporting

ECRI RESOURCES

Event Reporting and Response

It is not possible to manage a program without knowing whether and how it is working—or not working. Any injury related to a clinical alarm must be reported through the internal event reporting system, as should any near miss. Ensure that staff members understand that the alarms are part of a system, and that errors or malfunctions are related to a breakdown in the system, not to a personal failing. Facilities need to understand their systems in order to improve them. For recommendations on encouraging event reporting, see the guidance article Event Reporting and Response.

Apply Strategies to New Equipment

Action Recommendation: Review the history of the alarm-reduction program for lessons learned that can be applied to the acquisition of new monitoring equipment.

The organization should have a process, through its supply chain, to determine when monitoring equipment has become obsolete or no longer functional and should be replaced. The facility should review its experience with the equipment that it has been using and generate a "wish list" of features that new equipment should have. For example, if the facility wanted to implement a delay in the sounding of an alarm, but it was not possible to implement this change with the existing equipment, is a replacement available that will accommodate a delay?

Include on the list all of the features that the interdisciplinary team finds desirable. Evaluate and prioritize individual features of specific equipment models that the organization is considering purchasing. For example, features may be scored using the following, or a similar, priority scheme: 3 points if the feature is a "must have" feature; 2 points if it is a desirable feature; 1 point if it is neither a desirable nor an undesirable feature; and 0 if the model lacks the feature. The scores should then be added and the equipment that scores the highest should be given serious consideration. The facility should carefully consider whether a score of "0" rules out or vetoes the acquisition of a particular brand or type of equipment.

REFERENCES

American Association of Critical-Care Nurses (AACN). Managing alarms in acute care across the life span: electrocardiography and pulse oximetry. 2018 Apr 3 [cited 2019 Nov 21]. https://www.aacn.org/clinical-resources/practice-alerts/managing-alarms-in-acute-care-across-the-life-span

American Nurse. Do you hear what I hear? Combating alarm fatigue. 2014 Nov 10 [cited 2019 Oct 11]. https://www.americannursetoday.com/hear-hear-combating-alarm-fatigue/

Ashmore v. Hartford Hosp., 208 A.3d 256 (Conn. June 4, 2019).

Association for the Advancement of Medical Instrumentation (AAMI):

- Clinical alarms summit. 2011 [cited 2019 Nov 21]. https://www.aami.org/events/eventdetail.aspx?ItemNumber=1153
- Recommendations for alarm signal standardization and more innovation: the Christiana Care Health System experience. 2012 [cited 2019 Nov 21]. http://s3.amazonaws.com/rdcms-aami/files/production/public/FileDownloads/Foundation/SafetyInnovation/2012_SI_Alarm_Signal_Standardization_Christiana.pdf

Association of periOperative Registered Nurses (AORN). RP summary: recommended practices for a safe environment of care. AORN J 2013 Aug;98(2):167-71. PubMed: http://www.ncbi.nlm.nih.gov/pubmed/24046883 doi: 10.1016/j.aorn.2013.04.013

Chen PW. The clatter of the hospital room [blog post]. NY Times 2012 Aug 2 [cited 2020 Feb 21]. http://well.blogs.nytimes.com/2012/08/02/the-clatter-of-the-hospital-room

Cosper P, Zellinger M, Enebo A, Jacques S, Razzano L, Flack MN. Improving clinical alarm management: guidance and strategies. Biomed Instrum Technol 2017 Mar-Apr;51(2):109-15. https://www.aami-bit.org/doi/10.2345/0899-8205-51.2.109 PubMed: https://www.ncbi.nlm.nih.gov/pubmed/28296432 doi: 10.2345/0899-8205-51.2.109

Cvach M. Monitor alarm fatigue: an integrative review. Biomed Instrum Technol 2012 Jul-Aug;46(4):268-77. https://www.aami-bit.org/doi/full/10.2345/0899-8205-46.4.268 PubMed: http://www.ncbi.nlm.nih.gov/pubmed/22839984 doi: 10.2345/0899-8205-46.4.268

Cvach M, Kitchens M, Smith K, Harris P, Flack MN. Customizing alarm limits based on specific needs of patients. Biomed Instrum Technol 2017 May/June;51(3):227-34. https://www.aami-bit.org/doi/abs/10.2345/0899-8205-51.3.227 PubMed: https://www.ncbi.nlm.nih.gov/pubmed/28530858 doi: 10.2345/0899-8205-51.3.227

ECRI:

- 2019 Top 10 health technology hazards: executive brief. 2018. https://www.ecri.org/Resources/Whitepapers_and_reports/Haz_19.pdf
- Best practices in managing health technology. *Health Devices* 2013 Jan;42(1):20-8.

Funk M, Ruppel H, Blake N, Phillips J. Use of monitor watchers in hospitals: characteristics, training, and practices. Biomed Instrum Technol 2016 Nov/Dec;50(6):428-38. https://www.aami-bit.org/doi/10.2345/0899-8205-50.6.428?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%3dpubmed PubMed: https://www.ncbi.nlm.nih.gov/pubmed/27854492 doi: 10.2345/0899-8205-50.6.428

Görges M, Markewitz BA, Westenskow DR. Improving alarm performance in the medical intensive care unit using delays and clinical context. Anesth Analg 2009 May;108(5):1546-52. PubMed:

https://www.ncbi.nlm.nih.gov/pubmed/19372334 doi: 10.1213/ane.0b013e31819bdfbb

Institute for Safe Medication Practices (ISMP). Drawn curtains, muted alarms, and diverted attention lead to tragedy in the postanesthesia care unit. 2013 Mar 21 [cited 2020 Feb 21]. https://www.ismp.org/resources/drawn-curtains-muted-alarms-and-diverted-attention-lead-tragedy-postanesthesia-care-unit

Joint Commission:

> Medical device alarm safety in hospitals. Sentinel event alert issue 50. 2013 Apr 8 [cited 2019 Oct 11]. https://www.jointcommission.org/sea_issue_50/
>
> National Patient Safety Goals effective 2020. [cited 2020 Feb 27]. https://www.jointcommission.org/assets/1/6/NPSG_Chapter_HAP_Jan2020.pdf

Oster C. Proper skin prep helps ensure ECG trace quality. 3M.com. 2005 [cited 2019 Oct 18]. https://multimedia.3m.com/mws/media/3583720/proper-skin-prep-ecg-trace-quality-white-paper.pdf

Palchaudhuri S, Chen S, Clayton E, Accurso A, Zakaria S. Telemetry monitor watchers reduce bedside nurses' exposure to alarms by intercepting a high number of nonactionable alarms. J Hosp Med 2017 Jun;12(6):447-9. https://www.journalofhospitalmedicine.com/jhospmed/article/139190/hospital-medicine/telemetry-monitor-watchers-reduce-bedside-nurses-exposure PubMed: https://www.ncbi.nlm.nih.gov/pubmed/28574535 doi: 10.12788/jhm.2754

Ruppel H, Funk M. Monitor watchers and alarm fatigue: cautious optimism. J Hosp Med 2017 Jun;12(6):481-2. https://www.journalofhospitalmedicine.com/jhospmed/article/139191/hospital-medicine/monitor-watchers-and-alarm-fatigue-cautious-optimism PubMed: https://www.ncbi.nlm.nih.gov/pubmed/28574544 doi: 10.12788/jhm.2758

Sendelbach S, Funk M. Alarm fatigue: a patient safety concern. AACN Adv Crit Care 2013 Oct-Dec;24(4):378-86; quiz 387-8. https://www.nursingcenter.com/journalarticle?Article_ID=1617134&Journal_ID=230572&Issue_ID=1616941 PubMed: https://www.ncbi.nlm.nih.gov/pubmed/24153215 doi: 10.1097/NCI.0b013e3182a903f9

Society for Cardiological Science and Technology. Clinical guidelines by consensus: recording a standard 12-lead electrocardiogram. 2017 Jun [cited 2019 Oct 18]. https://www.bmj.com/sites/default/files/response_attachments/2016/09/CAC_SCST_Recording_a_12-lead_ECG_final_version_2014_CS2v2.0.pdf

Sowan AK, Gomez TM, Tarriela AF, Reed CC, Paper BM. Changes in default alarm settings and standard in-service are insufficient to improve alarm fatigue in an intensive care unit: a pilot project. JMIR Hum Factors 2016 Jan-Jun;3(1):e1. https://humanfactors.jmir.org/2016/1/e1/ PubMed: https://www.ncbi.nlm.nih.gov/pubmed/27036170 doi: 10.2196/humanfactors.5098

Welch SJ, Cheung DS, Apker J, Patterson ES. Strategies for improving communication in the emergency department: mediums and messages in a noisy environment. Jt Comm J Qual Patient Saf 2013 Jun;39(6):279-86. PubMed: http://www.ncbi.nlm.nih.gov/pubmed/23789167 doi: 10.1016/s1553-7250(13)39039-4

What is oxygen saturation (SpO2)? What is the normal range for SpO2? iHealthlabs.com. 2016 Oct 10 [cited 2019 Oct 17]. https://ihealthlabs.com/ufaqs/what-is-oxygen-saturation-spo2-what-is-the-normal-range-for-spo2/

RESOURCE LIST

Risk Manager's Toolbox

- Ready, Set, Go: Clinical Alarms
- Make a Plan: Clinical Alarms

Guidance, Assessments, and Training

- 2019 Top 10 Health Technology Hazards: Executive Brief
- Beat the Buzzer: The Alarm Safety Game Show!
- Event Reporting and Response

TOPICS AND METADATA

Topics

Alarm Management

Caresetting

Hospital Inpatient
;
Skilled-nursing Facility
;
Short-stay Facility

Roles

Allied Health Personnel
;
Clinical Practitioner
;
Healthcare Executive
;
Nurse
;
Patient/Caregiver
;
Patient Safety Officer
;
Risk Manager

Information Type

Guidance

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