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3 STEPS TO REDUCING ALARM FATIGUE AND IMPROVING PATIENT SAFETY

Patient monitors are designed to serve as an extension of the nurse and other clinicians for observing changes to key physiologic parameters. Monitor alarms are designed to alert caregivers to changes in the patient's condition that may indicate the need for intervention. These alarms are essential to patient safety across the healthcare continuum and in many cases, are lifesaving.

Due to the proliferation of monitors designed to provide clinicians with more physiologic information and improve patient safety, the number of alarms encountered by clinicians has risen proportionally. Studies indicate that the majority of alarms do not require a clinician intervention.[1,2] Clinicians overwhelmed by the sheer multitude of beeps may ignore alarms (i.e., "alarm fatigue") sometimes with catastrophic results.

What is "alarm fatigue"?

While there's not a standard definition around alarm fatigue, a 2011 summit convened by AAMI, FDA, TJC, ACCE, and ECRI Institute exploring clinical alarms had this to say.[3]

- Alarm fatigue is when a nurse or other caregiver is overwhelmed with 350 alarm conditions per patient per day.
- Alarm fatigue is when a patient can't rest with the multitude of alarm signals going off in the room.
- Alarm fatigue is when a true life-threatening event is lost in a cacophony of noise because of the multitude of devices with competing alarm signals, all trying to capture someone's attention, without clarity around what that someone is supposed to do.
- Alarm fatigue is compounded by inconsistent alarm system functions (alerting, providing information, suggesting action, directing action, or taking action) or inconsistent alarm system characteristics (information provided, integration, degree of processing, prioritization).
- Alarm fatigue is a systems failure that results from technology driving processes rather than processes driving technology.

ECRI, an independent, nonprofit organization that researches the best approaches to improving the safety, quality, and cost-effectiveness of patient care, has published the Top 10 Health Technology Hazards list annually.[4] Alarm hazards has been on every list since 2010, and topped the list in 2012 - 2014.

The Joint Commission released a Sentinel Event Alert (SEA)[8] on Medical Device Alarm Safety in Hospitals and a National Patient Safety Goal on Alarm Management.[5] The SEA stated alarm hazards are a "frequent and persistent problem" with 98 alarm-related events reported between January 2009 and June 2012— 80 resulting in death and 13 in permanent loss of function. The organization also recognized that alarm-related injuries are significantly under-reported, and that the total number is likely much higher.

The Joint Commission cites "alarm fatigue" as the most common contributing factor to alarm-related events. Many of the events occurred in areas with lower clinician-to-patient ratios including telemetry units, the emergency department and the intensive care unit.

In addition to the potential hazard to patient safety from alarm fatigue, numerous alarms that don't require intervention also create disruption to the clinician's work, which has led to the term 'nuisance alarm'. These disruptions may detract from the care and oversight of other patients, consume time from a busy schedule, and cause a loss of confidence in the monitors.

Much of the discussion around alarm management centers on the development of better technology. While manufacturers have released a number of alarm reduction software solutions shown to reduce alarms[6], three relatively easy steps can be taken today to significantly reduce your non-actionable alarms using any monitor.

Step 1 - Managing Default Alarms

The Joint Commission cited that common causes of alarms include setting the alarm thresholds "too tight," and default alarms not adjusted to individual patient needs.[7,8] When establishing a monitoring protocol for the post-operative general care floor (GCF), it is not uncommon for the facility to look to traditional monitoring environments such as the ICU for establishing default alarm settings. ICU patients are generally at a much higher acuity level where alarm thresholds are set relatively close to the patient's baseline values to provide early warning to small patient changes.

Experienced users report that alarm settings on the post-op GCF and other lower acuity areas can be set 'wider' while still providing adequate notification of significant changes in the patient's condition. In a survey of 21 experienced capnography users, alarm limits for high/low $etCO_2$ and high/low respiratory rate were set differently based on the care environment being monitored (See Table 1).[9] For example, high/low RR alarms were set at average values of 45.0 and 4.5 breaths per minute respectively on the GCF compared to 32.0 and 9.0 in the ICU. High/low $etCO_2$ alarms were set at average values of 60.0 and 8.5 on the GCF compared to 50.0 and 25.0 in the ICU. Reported GCF alarm settings from this survey correspond to other reports from the literature.[10,11]

Environment	$etCO_2$ High	$etCO_2$ Low	RR High	RR Low	No Breath Delay
Procedural Sedation	52.5	23.0	24.0	6.6	17.1
Emergency Depart.	50.8	24.5	28.3	8.3	13.2
General Floor	60.0	8.5	45.0	4.5	27.5
OR-PACU	56.7	19.3	24.0	8.0	19.3
Intensive Care Unit	50.0	25.0	32.0	9.0	15.0
All	53.8	20.2	30.3	7.1	18.3

Table 1: Average Capnography Alarm Limits Used by Care Environment

In a study of alarms on the medical/surgical floors of a community hospital, alarms for heart rate were reduced by more than 50% with a simple limit adjustment of high HR from 120 to 130 bpm and a 36% or 65% reduction in SpO_2 alarm load was achieved by reducing the SpO_2 limit from 90% to 85% or 80% respectively.[12]

A similar study on a cardiac telemetry unit found that small adjustments including changes to the low and high HR limits resulted in an overall 89% reduction in audible alarms without requirement for additional resources or technology.[13] Staff and patient satisfaction also improved. There were no adverse events related to missed cardiac monitoring events, and the incidence of code blues decreased by 50%.

Customizing Alarm Settings to Individual Patient Needs

Over-reliance on a standard set of default alarms for all patients ('one size fits all') may also contribute to the alarm burden. Alarm settings should be customized based on individual patients when appropriate. For example, baseline $etCO_2$ and SpO_2 values for a patient with severe COPD would be significantly different than for a patient with normal lungs.

In a study of changes in alarm management in a medical progressive care unit, nurses were trained to individualize patients' alarm parameter limits and levels.[14] Critical monitor alarms were reduced 43% from baseline data.

In an AACN Practice Alert on alarm management, there is a recommendation to customize the alarms to meet the needs of individual patients.[15] They recommend, "Set customized alarms within 1 hour of assuming care of a patient and as the patient's condition changes."

Step 2 - Patient Education

Another cause of alarms is the patient removing a monitor sensor. Too often, patients aren't properly instructed about why they are being monitored. If patients are not educated about why the monitor is being used and do not understand the benefit it provides, there is a greater chance that he or she will remove the interface. Experienced users report that by educating the patient and family prior to the procedure and reinforcing it during monitoring, patients are more likely to be compliant.

"Patient education is the key. A well-educated patient and family is a key to having successful compliance with using [capnography]. Once the patients and the families understand that it's being done for safety, for their safety, they're much more compliant. They don't have any issues wearing the cannulas."
– Harold Oglesby RRT, Director of Respiratory Care
St. Joseph / Candler Hospital[16]

"We've experienced really high compliance with our patients who have been using the end tidal CO2 monitoring. It's very rare that once we've explained how important it is, that a patient says I don't want that on my nose. Most patients do very well with it."
– Joan Kohorst, MA, RRT,
Director of Infusion and Medication Administration Safety
Sisters of Mercy Health System, St. Louis, Mo[17]

"Patient education is the key to patient compliance. It would be ideal to educate patients prior to surgery."
– Debra Fox, RRT, Director of Respiratory Care,
Wesley Medical Center, Wichita, Kansas[18]

"Newer nasal-oral cannulas used to measure capnography in spontaneously breathing patients are very well tolerated by children."
– Melissa Langhan, M.D., Associate Professor of Pediatrics
Yale School of Medicine, New Haven, Conn[19]

"Observational studies substantiate our finding that continuous monitoring by capnography is feasible in very young children."
– Jenifer R. Lightdale, M.D., MPH
Children's Hospital Boston, Boston, Mass[20]

Education of the patient and family is most effective when it is simple and brief. Tools are often available from the manufacturer to assist with the education. Key components of education include:

- Explain that the medication that will be given can make breathing slow or shallow, which could be dangerous if not monitored. State that the monitor will alert clinicians to changes in breathing before any harm occurs.
- Let patients and family members know that alarms alert clinicians to a change in breathing. Explain that alarms can serve as a reminder to the patient and family of the need to take deeper breaths.

- Remind the patient that if the interface is removed for brief periods, for activities such as eating or getting out of bed, it should be replaced immediately after the activity.
- Routine postsurgical activity, like sipping water or eating ice chips, does not interfere with ventilation monitor-ing. But care should be taken not to introduce liquids into the sampling ports as this will block the sample line and create an alarm.
- Explain that generally, patients will be monitored until the physician believes there is no longer a risk of slow or shallow breathing. This period depends on the type and duration of medication prescribed, as well as the patient's response to the medication.

Step 3 - Staff Education

A clear knowledge of the operation, alarm features, and limitations of monitors by the clinicians using the monitor is a key to assessing and understanding causes of alarms, and taking steps to reducing alarms. The AACN Practice Alert on Alarm Management lists "Provide initial and ongoing education on devices with alarms" among their recommendations.[15]

Education increases the understanding of how monitoring systems and their alarms function and should be managed. The American College of Clinical Engineering (ACCE) points out that, "Such learning must reach the level of operational effectiveness rather than just intellectual knowledge."[22] In a quality improvement project, retraining nurses was the first step in a multipronged approach to reduce the number of false alarms.[1] This project demonstrated that after receiving education and retraining, nurses individualized alarm settings at the outset, instead of adjusting settings in response to continual activation of an alarm.

Such training should include discussion of proper sensor selection, application, and replacement.[15]

Clinicians should be aware of monitor limitations that reduce effectiveness based on patient characteristics (e.g., use of oximetry with certain pigmentations or drugs).

As mentioned previously, a retrospective analysis of alarm data has been key to several efforts that have shown positive results.[12,13] A clear understanding of how to review alarm data, trends, waveforms, and other available data can be invaluable in identifying causes of alarms. In many cases, a review of such data may reveal that multiple alarms thought to be 'false' are indeed real when explored in more detail.

Papers from Maddox describe several case studies where retrospective review of monitor alarm data and trends was useful in identifying underlying causes of alarms that resulted in changes to management correcting the underlying problem.[11,23]

One such example cited by Maddox is patients with underlying sleep apnea or hypoventilation syndromes. Sleep apnea is common in hospitalized patients and the vast majority may be undiagnosed. Commonly used sedatives, sleep aids, analgesics, and even antihistamines may exacerbate the condition. Patients with sleep apnea may trigger repetitive apnea, low RR, SpO_2 or $etCO_2$ alarms and the sound of the alarm or the nurse entering the room may wake the patient resulting in 'self-correction' from the alarm. This can lead to the perception that the alarm was 'false'. Review of trend data is helpful in identifying these conditions leading to appropriate management and elimination of many alarms.

Along with implementation training, education should continue at the bedside. Several programs have identified the benefit of utilizing Respiratory Therapists' expertise in respiratory monitoring to help educate other clinicians that may be less familiar with its benefits and limitations.[25,26]

Summary

Reduction of non-actionable alarms is an ongoing challenge as monitoring proliferates throughout and outside the hospital. By adjusting alarm default values, educating the patient and family, and ensuring clinicians using the monitors understand its operation, studies show that significant reductions in 'nuisance' can be accomplished.

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