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. It is estimated that 85 percent to 99 percent of alarms do not require an intervention. Causes include setting the alarm thresholds “too tight,” default alarms not adjusted to individual patient needs, or sensors that are not correctly applied. Clinicians overwhelmed by the sheer multitude of beeps may ignore alarms (known as alarm fatigue) sometimes with catastrophic results.

The Boston Globe published a series of articles on the results of alarm fatigue that said between January 2005 and June 2010, 200 hospital patient deaths nationwide were linked to problems with alarms on patient monitors. The articles discussed several specific cases, including an elderly man whose electrocardiogram displayed a flat line for more than two hours without caregiver response.

The 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 since 2010. Alarm hazards has been on every list since 2010, and topped the list in 2012 and 2013. As a result, ECRI published additional guidance on addressing strategies for alarm management.

**Joint Commission**

The Joint Commission released Sentinel Event Alert (SEA) #50 on Medical Device Alarm Safety in Hospitals and also issued a National Patient Safety Goal on Alarm Management. The Joint Commission acknowledged that alarm management is a problem that hospitals need to address. The SEA and patient safety goal were based on 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. SEA #50 notes that the U.S. Food and Drug Administration’s (FDA) Manufacturer and User Facility Device Experience (MAUDE) database reported 566 alarm-related patient deaths from January 2005 to June 2010, considered by industry experts to under-represent the actual number of incidents.

The Joint Commission National Patient Safety Goal (NPSG) was released on June 25, 2013 and put into effect in two phases:

- In January 2014, hospitals were required to establish alarms as an organizational priority and were advised to identify the most important alarms to manage based on their own internal situations.
- In January 2016, hospitals were expected to develop and implement specific components of policies and procedures. Education of those in the organization about alarm system management will also be required.
Smart Alarm Management

Recommendations from the Anesthesia Patient Safety Foundation on Essential Monitoring Strategies to Detect Clinically Significant Drug-Induced Respiratory Depression in the Postoperative Period recognized the need to create alarm management systems, and state that monitoring systems should offer multiple physiologic parameters to help clinicians identify clinically significant changes sooner and with greater reliability. The recommendations further explain that alarm limits with thresholds on individual physiologic parameters may not alert clinicians early enough to respond to signs of respiratory decline.1

Smart alarm management technologies from Medtronic are designed to reduce the number of nuisance alarms while alerting caregivers to clinically-significant events. Smart alarm technology has been built into both Nellcor™ pulse oximetry with OxiMax™ technology and Microstream™ capnography monitoring platforms. Nellcor™ SatSeconds alarm management technology is a clinician-controlled feature engineered to differentiate between serious hypoxemia and minor transient events without exposure to the dangers associated with alarm delays. It generates alarms based on both the depth and the duration of a patient's desaturation, helping to reduce nuisance alarms. For example, if the alarm is set by the clinician to 50, a desaturation of 5 percent lasting for 10 seconds (5% X 10 seconds = 50) or desaturation of 10 percent for 5 seconds (10% X 5 seconds = 50) would trigger an alert. (Figure 1)

This offers clinicians the opportunity to evaluate brief desaturation events in context with depth, and shallow desaturations in context with duration. For example, instead of an alarm sounding every time a patient crosses the threshold (e.g., SpO₂ < 90%), an alarm only sounds when a desaturation event is clinically significant to the patient’s condition, based on the clinician-designated settings on the monitor.

Data shows that Nellcor™ SatSeconds alarm management technology reduces the number of clinically insignificant alarms giving clinicians the opportunity to respond to alarms that are clinically relevant.12

Figure 1
Microstream™ capnography employs two important algorithms engineered to reduce clinically insignificant alarms: Smart Breath Detection™ algorithm (SBD) and Smart Alarm for Respiratory Analysis™ algorithm (SARA). SBD differentiates shallow CO₂ excursions common during activities, such as talking, eating and snoring, capturing the entire exhalation cycle (Figure 2). Without SBD, the shallow excursions would be counted as breaths, resulting in falsely elevated respiratory rate and potentially a false high respiratory rate alarm. With SBD, only the entire cycle is counted as a breath.

Once SBD is providing reliable breath detection, the SARA algorithm provides respiratory rate data. SARA calculates respiration rate by averaging a number of breath-to-breath intervals. To determine how many intervals to use, SARA evaluates the variability of breath intervals. During periods of regular breathing, SARA uses five breath intervals to calculate the RR, but as variability in the breathing pattern increases, the RR averaging is adjusted to include more breaths, capping at 11 breath intervals during periods of maximum variability.

The algorithm employed in the respiration rate calculation reduces false positive alarms by filtering out noise and instantaneous fluctuations without missing true alarms that may indicate a clinically significant change to respiration rate (Figure 3). By employing the adaptive averaging algorithm, the respiration rate reflects the patient’s condition and significantly reduces the generation of nuisance alarms by the host.13

Data shows that with SARA, respiratory rate (RR) alarms were reduced by 53 percent overall, and short duration alarms lasting less than 10 seconds were reduced by an additional 19 percent. No significant RR alarms were missed with SARA.14

Summary

Alarm fatigue is recognized by multiple clinical organizations as a significant challenge to patient safety, leading to a significant number of patient deaths and injuries. There is a need to develop more intelligent alarm management systems to reduce clinically insignificant alarms while identifying alarm conditions that require intervention. Medtronic patient monitoring solutions are designed for ease of use by busy clinicians and feature Smart Alarm Management systems that are engineered to reduce clinically insignificant alarms.
References

14. Colman J, Cohen J, Lain D. Smart Alarm Respiratory Analysis (SARA™) used in capnography to reduce alarms during spontaneous breathing. Poster presented at: Society for Technology in Anesthesia (STA) annual meeting, January 16-19, 2008; San Diego, CA.