Alarm Management on the Medical Surgical Floor

Welch Allyn Connex® Clinical Surveillance System

Alarm Fatigue

Patient 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, can be 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 to 99 percent of alarms do not require an intervention. Causes for this high percentage of alarms not requiring clinical intervention include setting the alarm thresholds ‘too tight,’ default alarms not adjusted to individual patient needs, or sensors that are not correctly applied.¹ ² 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 articles³ ⁷ 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.³ ⁷

Healthcare industry organizations have likewise expressed grave concern. 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.

In 2013, The Joint Commission released a Sentinel Event Alert (SEA) on Medical Device Alarm Safety in Hospitals and a National Patient Safety Goal on Alarm Management. The Joint Commission alert stated this issue is a “frequent and persistent problem” with 98 alarm-related events reported between January 2009 and June 2012, 80 of which resulted 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 SEA 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 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. The Joint Commission makes a number of recommendations for addressing the problem.

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

- In Phase I (beginning January 2014), hospitals will be required to establish alarms as an organization priority and identify the most important alarms to manage based on their own internal situations.
- In Phase II (beginning January 2016), hospitals will be 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 in January 2016.

Alarm fatigue is clearly a serious issue for hospitals, and unfortunately, might influence their decisions regarding the adoption of technology intended to increase patient safety. In a recent survey, alarm fatigue has been rated as a top concern by 19 out of 20 hospitals, with a third of respondents expressing concern about implementing continuous monitoring for patients on patient-controlled analgesia (PCA) because of the potential for alarm fatigue.

**Minimizing Alarm Fatigue with Connex Clinical Surveillance System**

According to ECRI, two key aspects of managing alarm fatigue should be:

1. To minimize the number of clinically insignificant or avoidable alarms so that the conditions that truly require attention can better be recognized, and
2. To optimize alarm notification and response protocols so that the patient receives the appropriate care at the time it’s needed.

The Welch Allyn Connex Clinical Surveillance System was developed with these factors in mind—with best-in-class physiological patient monitoring technologies designed to minimize the annunciation of false alarms, and alarm management features that put actionable information in the hands of clinicians, when and where they need it.

**Physiological Monitoring Technologies**

Reducing nuisance alarms starts with the quality and accuracy of the physiological parameter technologies and the features designed into these technologies that minimize the occurrence of transient alarms that are not clinically significant. The foundation of the Connex Clinical Surveillance System, the Connex Vital Signs Monitor, can be configured with technologies such as Nellcor™ or Masimo® pulse oximetry as well as Microstream® Capnography, or EarlySense® contact-free monitoring.

**Nellcor Pulse Oximetry**

Covidien® Smart Alarm Management technologies, built into Nellcor™ Oximax™ pulse oximetry, are
designed to reduce the number of nuisance alarms while alerting caregivers to clinically-significant events. Specifically, Nellcor™ SatSeconds™ alarm management differentiates between serious hypoxemia and minor transient events without exposure to the dangers associated with typical alarm delays. It generates alarms based on both the depth and the duration of a patient’s desaturation. So, rather than having an alarm sound every time a patient crosses the threshold (e.g., \( \text{SpO}_2 < 90\% \)), an alarm sounds only when a desaturation event is clinically significant to the patient’s condition, based on the clinician-designated settings. In a study of 29 NICU patients, with the use of the SatSeconds alarm management feature, total alarms were reduced by 60 percent and clinicians were able to respond to alarms that were clinically relevant.\(^{12}\)

**Masimo Pulse Oximetry**

Masimo pulse oximetry with Signal Extraction Technology\(^\text{®} \) (SET) operates under the principle that both the arterial and venous blood move as the patient moves and breathes. Masimo SET separates the arterial signal from sources of noise (including the venous signal) to measure \( \text{SpO}_2 \) and pulse rate accurately, even during motion or other environmental conditions.\(^{13}\)

The performance of Masimo SET pulse oximetry has been well-documented, with one Masimo clinical study showing 97% sensitivity and 95% specificity (i.e. 5% false alarm rate) during challenging periods of motion and low perfusion.\(^{14}\)

**Microstream CO\(_2\)**

Covidien Microstream\(^\text{®} \) capnography employs two algorithms developed to help reduce clinically insignificant alarms: Smart Breath Detection Algorithm\(^\text{™} \) (BDA) and Smart Alarm for Respiratory Analysis\(^\text{™} \) (SARA). The Smart Breath Detection Algorithm differentiates shallow CO\(_2\) excursions common during activities, such as talking, eating and snoring, capturing the entire exhalation cycle. Without BDA, the shallow excursions would be counted as breaths, resulting in a falsely elevated respiratory rate and potentially a false high respiratory rate alarm.

SARA calculates the respiration rate by averaging a number of breath-to-breath intervals. 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. By employing the adaptive averaging algorithm, the respiration rate accurately reflects the patient’s condition and significantly reduces the generation of nuisance alarms by the host.\(^{15-17}\)

Microstream capnography sampling systems also employ a Uni-junction design, which samples from both nares and across the mouth capturing quality breath samples during challenging monitoring conditions such as shallow oral breathing, mouth-only breathing, during delivery of supplemental oxygen, etc., reducing transient nuisance alarms and improving respiration monitoring accuracy.\(^{18}\)

**EarlySense Contact-Free Monitoring**

The foundation of the EarlySense technology is the under-mattress sensor. The contact-free sensor utilizes a piezoelectric technology integrated into a membrane
plate, and detects mechanical vibrations of the heart cardio ballistic (motion) effect, respiratory and patient motion. Within the CVSM, signal processing algorithms analyze the data and accurately measure pulse and respiration rates, patient motion, as well as indicate patient trends over time.

Pulse rate and respiration rate are averaged over one minute, and the default time to alert is 90 seconds for pulse rate and 180 seconds for respiration rate. Thus, EarlySense provides a reliable indication of patient trends over time, while minimizing transient alarms that may contribute to alarm fatigue. In addition, alerts for bed exit can be customized based on the choice of 6 levels of bed exit sensitivity, allowing clinicians to tailor the system for each patient’s risk level.

An EarlySense study of 1000 patients over six months on a 33-bed medical/surgical floor showed that the EarlySense System generated about 2 alerts per nurse per 12-hour shift. Patient turn and bed exit alerts comprised 58% of all alerts, while 42% were related to heart rate and respiration. Nurses found 48% of these alerts to be clinically warranted. Another study that reviewed the charts of 204 patients monitored by EarlySense documented only 1 false alarm per 80 hours of monitoring (3.4 days).

**System Design**

**CVSM Alarm Features**

The CVSM’s patient alarm functionality was designed to place control in the hands of users, so they can balance patient safety and comfort. Specifically:

- Audible alarms can be turned off at the CVSM.
- Alarms may be disabled, by parameter.
- Alarm volume can be adjusted (Low, Medium, High) for each CVSM.
- Patient Rest Mode allows user to turn audio off at the CVSM, while maintaining audible alarms at Nurse Call and/or at Central Station.
- Patient alarm limits are fully customizable for each patient.
- User can temporarily silence any parameter alarm for 60 seconds. Tapping the alarm twice then extends the silence period for up to 5 minutes (configurable).
- Configurable alarm delays are available for each physiological parameter to minimize the number of transient alarms that are annunciated. For example, the No Breath Detected alarm can be configured with a delay of 0–40 seconds.

- A Pause Mode has been incorporated into the CVSM, which allows the clinician to pause continuous monitoring and alarms for a specified period of time, while retaining patient data on the monitor.
- Nurse call thresholds set the level of alarms (Low, Medium, High) that will trigger a nurse call event.

**Central Station Alarm Features**

Similarly, the Connex Central Station provides clinicians the ability to customize how alarms are presented:

- Since the Central Station communicates bi-directionally with the CVSM, patient alarm limits can be customized, and alarms temporarily silenced, at the Central Station.
- A global alarm delay is available, which delays audible alarms at the Central Station for up to 20 seconds.
- The volume level of the Central Station can be customized for each hour of the day. In this way, alarm volumes can be lowered during nighttime hours, to help improve patient rest and satisfaction.
- The Central Station can control Patient Rest Mode for all connected, continuous devices, to support “quiet hours” on the floor.

**Alarm Notification Features**

Additionally, the Connex Clinical Surveillance System provides several options for hospitals to choose how to manage alarm notifications in each care area. For example, patient alarms and alerts can be sent to third-party communications systems, which aggregate alerts from different applications, including vital signs monitors, and deliver them directly to the appropriate clinicians via pagers, voice-activated badges, smart phones and more. Furthermore, patient alarms and alerts can be sent to a Nurse Call system, to the Connex Central Station, and to hallway display panels for increased visibility to patient status.

**Recommendations**

Clinicians should carefully consider alarm management policies for their patient care areas, taking into account:

- Categories or types of patients,
making adjustments over time as necessary to optimize it may be necessary to iterate policies and procedures, regarding alarm management protocols and policies. consider reviewing other hospital best practices patient condition, observing the patient, talking to the patient, etc. consider reviewing other hospital best practices regarding alarm management protocols and policies. it may be necessary to iterate policies and procedures, making adjustments over time as necessary to optimize alarm management to best meet clinical work flows and patient needs. patient monitor manufacturer default settings should not be considered standard practice. before new patient monitoring is deployed, all alarm management policies should be documented and trained to.

**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. Welch Allyn understands the challenges faced by clinicians on the medical/surgical floor, and the need for patient care solutions that put actionable data into the hands of clinicians without exacerbating the current environment of alarm fatigue.

**References**

2. The Joint Commission. Medical device alarm safety in hospitals. Sentinel Event Alert. April 8, 2013; issue 50. Available at: http://www.jointcommission.org/assets/1/18/SEA_50_alarms_4_5_13_FINAL1.PDF.
17. 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.