# Clinical Alarm Management: A Team Effort

Joan C. Brown and Pat Anglin-Regal

Effective physiological monitoring encompasses much more than the installation of the most recent technology. It requires analysis and collaboration from both technical and clinical perspectives. Through a partnership between the Department of Biomedical Engineering and Patient Care Services at Massachusetts General Hospital in Boston, which includes professionals from nursing and respiratory care, we improved our clinical alarm management practices.

## Background

In spring 2006, a routine physiologic monitoring software upgrade prompted a discussion regarding alarm defaults between the unit's nursing leaders and the clinical engineer assigned to manage the upgrade project. Disagreements on the alarm settings quickly evolved into a major undertaking to improve the management of clinical alarms in the hospital.

The discussion began when members of the Biomedical Engineering department noticed that some alarms were inaudible at the bedside. With investigation, the team discovered that the alarm volumes were defaulted to "off" in the unit at the decision of clinicians. Although the clinicians had some valid concerns that they felt justified their alarm settings, such as patients complaining that they could not sleep due to the alarm sounds at the bedside, the clinical engineer and the biomedical engineering quality and safety program manager (a registered nurse [RN]) believed that a potential for adverse patient outcomes existed. There was not a consistent, standard process in use for establishing default settings for monitors, and practices among units were widely disparate.

Several clinical events over a period of the next several months prompted development of an alarm-specific standard investigation protocol for incidents in which a clinical alarm was a possible factor. The standard hospital procedure for patient-related incidents was general and did not include individualized instructions based on position (nurse, biomedical equipment technician, clinical engineer) or how to document the incident. The new clinical alarm protocol focused specifically on clinical alarm incidents, i.e., gathering all of the necessary alarm logs needed for vendor analysis. Biomedical Engineering created the procedure and began tracking patterns of "near misses."

A closer investigation and analysis of each clinician-reported event exposed a general lack of understanding of the methods that monitoring and alarm systems use to detect lethal arrhythmias. The misunderstandings discovered with clinical alarms were due in part to the clinicians' misperceptions about the ability of monitoring systems to flawlessly detect a lethal physiologic event. Some serious events (e.g., a monitor not alarming for a clinician-perceived lethal arrhythmia) prompted the initiation of discussions between clinicians and the manufacturer, which were greatly facilitated by the clinical engineer serving as the liaison. Biomedical Engineering was concerned that safeguards put in place by clinicians were inconsistent across units and whether a thorough risk assessment was being performed when decisions were made to use these safeguards, such as using an alternate physiologic monitor on the patient or turning the arrhythmia alarms off due to nuisance alarms.

Further analysis by the clinical engineer and safety manager uncovered evidence that stressed the need for changes in clinical practice, more intensive training, and vendor assistance to explain the gap between clinical perceptions and actual monitor performance capabilities. We reviewed a total of 17 reports collected over 18 months. Eight were determined to be related to the inability of the monitor algorithm to detect what the manufacturer referred to as "an unusually wide or narrow QRS morphology." Two events revealed an issue with "artifact before pause." The vendor pause alarm algorithm requires the detection of two beats delineating an RR interval in excess of three seconds. Because of significant artifact prior to the pause, the monitor's electrocardiogram (ECG) algorithm was unable to detect the two beats. The rest of the events were related to inaudibility or are pending investigation. After close

review of these events, the clinicians came to better appreciate the limitations in alarm accuracy (sensitivity and specificity) and the need to develop optimal alarm-setting recommendations.

## The Clinical Alarm Taskforce

Evidence from the investigation motivated the formation of a Clinical Alarm Taskforce (CTF). Its goals were to mitigate issues associated with clinicians' perceptions of clinical alarm detection and the informal policy surrounding the alarm parameter limits and volume settings. Together with members of Biomedical Engineering and Patient Care Services and a cross-section of nursing leaders, the CTF set out to make a sustainable change in the culture of how clinical alarms are applied.

Having a nurse and a clinical engineer co-lead the effort was instrumental toward reaching an effective solution. Each brought an expertise and differing perspective that helped other taskforce members feel more able to express their views. Both were passionate about the issue and shared many of the same ideas of best practices regarding alarm management. Also crucial to success was the inclusion of some of the most vocal opponents to standardizing alarm management. Major objections included setting a standard of audible alarms "on" at the bedside and whether a standard default would apply to neurological and cardiac patients. This enabled the group to explore all issues associated with misperceptions, which would otherwise have been a barrier to developing and implementing an effective plan.

The group's first goal was to decide on an acceptable shared mission. This proved challenging due to the diverse perspectives of taskforce members. The taskforce decided that changes to clinical alarm practice had to be approved by the hospital's Nursing Practice Committee, which includes representatives from nursing specialties throughout the hospital. The primary objectives of the CTF were to increase awareness among clinicians and to make recommendations based on trend observations and recorded incidents. The group came to consensus on the following mission statement:

*It is an expectation by the Joint Commission on Accreditation of Healthcare Organizations* [now The Joint Commission] *that a complete process be established regarding clinical alarms. The primary objective of the Clinical Alarm Taskforce is to evaluate alarm issues and generate recommendations to submit to the Nursing Practice Committee for consideration.*

## Issues and Recommendations

Over the course of a year, the task force met monthly for lively, often discordant, discussions as they reviewed the best way to address the issues identified both anecdotally and from safety reports. Within the first six months the taskforce discussed and agreed upon the existence of the following issues:

- **Audibility:** Alarm volume levels throughout care units are not standardized.
- **Distributed Speaker Systems:** This is not standard house-wide and the institution lacked a decision-making process for types of speaker systems.
- **Tampering and Intervention:** How can we prevent cable disconnections to avoid "nuisance" alarms?
- **Technical Issues:** A general lack of understanding existed regarding the technologies' capabilities and limitations.
- **Education:** Staff need training from vendors on monitor capability, including ways to decrease or prevent user errors. Training is often overlooked and not prioritized by staff.
- **Isolated Devices:** Systems are needed to improve the management of devices with local alarms that cannot be broadcast to the central station, such as infusion pumps or intra-aortic balloon pumps.
- **Hand-off:** Workflow does not include informing others about a change in alarm volume levels and alarm defaults when patients are transported between units or between nursing shifts.
- **Verification and Testing:** Workflow does not include a re-occurring confirmation that alarm levels and parameters are set to the correct defaults.

In addition to highlighting actual events that illustrated the issues at our institution, the taskforce used literature and documents from the American College of Clinical Engineers (ACCE).[1] It was essential to acknowledge that challenges existed on a broader scale to help create the sense of urgency needed to push any recommendations forward. The taskforce submitted the following recommendations to the Nursing Practice Committee:

1. Alarm status warrants a communication when there is a change in accountability of the caring RN. The development of an efficient routine to implement across clinical practice should be discussed and determined by the Nursing Practice Committee.
2. A standard on defaults for patient care areas

should be established. Units will maintain autonomy to change parameters for their specific patient population. Care may be individualized to meet the needs of the patient.

3. Alarm Volumes: Different monitoring systems will have separate standards, though the criteria for risk assessment will remain the same. The criteria tool should be used to justify settings outside the determined standard.

4. Determine an acceptable range for physiologic monitor audio settings. Although a floor's alarm settings may currently be within recommended range, a risk assessment should be performed on each floor to verify audibility using the criteria tool.

5. Develop criteria for risk assessment concerning alarm volume settings. The following were established as considerations for audibility for physiologic monitoring:
   - Architectural settings
   - Ante rooms
   - Open and closed doors
   - Nurse-to-patient ratios
   - Work flow
   - Day versus night
   - Competing noises
   - Presence of distributed speaker system

6. Representatives from the taskforce should meet with each unit's nursing leadership to review criteria and determine unit settings.

7. All default and audio settings should be reviewed on an annual basis.

8. Several recommendations were made relating to training:
   - Monitoring/clinical alarm training as a clinical competency should be discussed and determined by the Nursing Practice Committee.
   - Training should occur in the best learning environment for comprehensive training; nurses should be uninterrupted from daily responsibilities.
   - Additional expenses incurred to implement the best learning environment (i.e., staffing patterns) should be included in the project budget.
   - Training should include:
     - Monitoring functionality

   - Alarm volume/default settings
   - Clinical alarm algorithms and vendor interpretation
   - Individualizing alarm parameters per patient
   - Communication of parameter changes at shift change
   - Incident investigation protocol

9. Follow the facility's incident investigation protocol if an alarm investigation is requested by the clinical staff to the Biomedical Engineering staff.

These recommendations are only the beginning of the necessary changes in clinical alarm culture. Are the recommendations enough to establish a sense of urgency for the Practice Committee to change and institutionalize protocols? How will change be measured? Is it sustainable? The answers to these questions were left to the Nursing Practice Committee with continued support from Biomedical Engineering. The taskforce was created to engage stakeholders, solicit various perspectives, increase awareness of the clinical issues, and frame them in a way that encourages the development of effective clinical alarm management, and its initial goals have been met. The recommendations developed by the task force regarding clinical alarm management address physiological monitoring alarms; however, the discussion has been a springboard for a wider discussion of clinical alarm issues across the spectrum of devices and the challenges they bring to patient safety.

The taskforce began as a group of individuals with differing views. It came together with time and honest dialogue to produce a shared plan of action with consensus. We are confident that this collaboration will lead to acceptance of the recommendations and implementation of identified action items from the committee. ■

### Reference

1. ACCE Healthcare Technology Foundation: "Impact of Clinical Alarms on Patient Safety." Plymouth, PA, 2006.

Joan C. Brown holds a BS in biomedical engineering from Boston University and is an MBA candidate at Boston College. She began her career at the VA Healthcare System in 2003 and has been a clinical engineer at Massachusetts General Hospital since 2005.

Pat Anglin-Regal, RNBSN, is currently taking courses toward an MPH. Her work experience includes surgical intensive care unit, as well as extensive management experience in the public health arena. Currently she is the quality and safety program manager in biomedical engineering at Massachusetts General Hospital.