Case Study

Reduction of Nonactionable Alarms in Medical Intensive Care

Laura De Vaux, Dawn Cooper, Krista Knudson, Monica Gasperini, Kris Rodgerson, and Marjorie Funk

About the Authors

Laura De Vaux, BSN, RN, is a patient safety nurse for medical critical care at Yale New Haven Hospital in New Haven, CT, and a member of the AAMI Foundation's ventilator alarm management workgroup. Email: laura.devaux@ynhh.org

Dawn Cooper, MSN, RN, is the service line educator for medical critical care at Yale New Haven Hospital in New Haven, CT. Email: dawn.cooper@ynhh.org

Krista Knudson, MSN, RN, ACNP, is a PhD candidate at the Yale University School of Nursing in Orange, CT. Email: krista.knudson@yale.edu

Alarm fatigue is described as desensitization of the clinician to alarms due to the number of false or nonactionable alarms. Nonactionable alarms can be defined as alarms that do not require an active clinical intervention. Due to the proliferation of medical devices and technology used to support the delivery of patient care, alarm fatigue is a frequent occurrence in critical care settings. An increase in the number of nonactionable alarms has contributed to clinician cognitive and sensory overload, which can lead to actionable alarm signals being silenced, ignored, or turned off inappropriately.[1]

A collaborative summit was convened in 2011 by the Association for the Advancement of Medical Instrumentation (AAMI), the Food and Drug Administration, The Joint Commission (TJC), the American College of Clinical Engineering, and the ECRI Institute to address clinical alarm safety with the goal of eliminating adverse events related to alarms by 2017. Following the summit, AAMI released the top 10 actions healthcare organizations can do to improve alarm safety.[2] In May 2013, the American Association of Critical-Care Nurses (AACN) released a practice alert and toolkit that sought to heighten awareness of the consequences of alarm fatigue and provide evidence-based interventions to improve the safety of alarm management.[3] Recognizing the threat to patient safety, TJC named clinical alarm safety as a National Patient Safety Goal (NPSG) by issuing NPSG.06.01.01 in June 2013.[4]

In response to these calls to action to improve clinical alarm safety, the medical critical care leadership team at Yale New Haven Hospital organized an interdisciplinary group to assess the problem at the unit level.

Identifying the Problem

In 2010, the medical intensive care are step-down unit (SDU) at the York Street campus of Yale New Haven expanded into two 28-bed units housed on two floors, each encompassing 33,000 square feet. The increased size posed new challenges for clinical staff with regard to alarm management. Crisis monitor alarms were programmed to populate the bedside physiologic monitoring screens in zoned clinical areas referenced as care groups. This allowed clinicians to view remote alarm conditions and respond appropriately to area alarms.

The units established an alarm management team in 2013 with the goal to meet the requirements of NPSG.06.01.01. The team consisted of representatives from clinical engineering, the Yale School of Nursing, information technology, nursing management, performance improvement, physician leadership, and bedside clinical staff. The team began by using the gap analysis assessment tool provided by AACN.[3]

During the initial planning period, clinical staff members responded to an open invitation for alarm management committee participation. Ten staff nurses shared their ideas about improving alarm management. Pulmonary critical care physicians verbalized that alarm

noise detracted from the team's ability to interact with the patient and family at the bedside during rounds. Clinical staff members were engaged in the project using shift change huddles, patient safety and quality briefings, pulmonary critical care provider meetings, and alarm management meetings. The performance improvement team addressed staff feedback regarding noise levels. Decibel meters were placed in a central location in the intensive care unit to obtain measurements of noise from all sources. The team identified audible alarms from bedside physiologic monitors as the largest contributor to the noise levels in the units. Overall, noise levels in the units averaged 68.4 dB.

Leadership applied the recommendations of AACN's clinical toolkit[3] to the units in fall 2013, and distributed toolkit materials to clinical staff. The initial interventions consisted of implementing best practices for electrocardiogram electrode placement and alarm troubleshooting. Guidelines for alarm management include using zones of responsibility—where designated

nurses respond to alarms in specific areas of the unit—to supplement the existing bedside crisis alarm programming. Following the initial interventions, the team turned to collecting and analyzing alarm data in addition to assessing default settings to reduce the number of nonactionable alarms.

Collection and Analysis of Alarm Data

In March 2014, bedside physiologic alarm data were collected using direct observation methods and recorded using an alarm code dictionary developed by content experts from the Yale School of Nursing (K.K. and M.F.). A total of 23 patients were observed in 45-minute increments over a 2-week period by a trained RN observer. The RN observer (K.K.) used paper documentation to record alarms from the central monitors and clinical staff response to the alarm.

In the pre-intervention period in March 2014, 23 patients were observed over a total of 17.25 hours for monitor alarm conditions and clinician response. During that time period,

About the Authors

Monica Gasperini, BSN, RN, is a registered nurse on staff in the Yale New Haven Hospital medical ICU in New Haven, CT, and a clinical instructor for the Center for Professional Practice Excellence at Yale New Haven Hospital. Email: monica.gasperini@ynhh.org

Kris Rodgerson is the manager of technical services for information technology at Yale New Haven Hospital in New Haven, CT. Email: kris.rodgerson@ynhh.org

Marjorie Funk, PhD, RN, FAHA, FAAN, is the Helen Porter Jayne and Martha Prosser Jayne Professor of Nursing at the Yale University School of Nursing in Orange, CT, and a current member of the AAMI Foundation's National Coalition for Alarm Management Safety. Email: marjorie.funk@yale.edu

10 Actions Healthcare Organizations Can Take Now to Improve Alarm Safety[2]

Issues identified by attendees at the 2011 summit on clinical alarms

1. **Gain cross-disciplinary leadership support.**

2. **Establish a cross-functional team with clinical leadership to address alarm fatigue across all environments of care.**

3. **Re-establish priorities: Process should drive technology adoption rather than allowing technology to drive the process.**

4. **Develop a continuous improvement process for constantly optimizing alarm system policies and configurations.**

5. **Conduct clinical testing and analyze alarm data to implement optimized alarm lists and delays (both alarm condition and alarm signal) and reduce clinically nonactionable alarm conditions.**

6. **Test acoustics on clinical floors.**

7. **Implement an alarm system configuration policy based on clinical evidence.**

8. **Change single-use sensors more frequently to reduce nuisance alarm conditions (except in pediatric units).**

9. **Mandate alarm system management training for all clinical supervisors.**

10. **Share experiences with AAMI, the Food and Drug Administration, TJC, ECRI Institute, and others with problem reporting systems so everyone can benefit from your efforts in a cross-disciplinary way.**

a total of 251 alarms were recorded, 84% of which were audible. Nearly half of the alarms were nonactionable. The most frequent audible alarm recorded during that time period was for premature ventricular contraction (PVC). Sendelbach and Funk[5] recommended evaluating the use of alarms for conditions that are no longer actively treated, including PVCs. Yet, default PVC alarms are rarely deactivated on bedside physiologic monitors.

The team determined that nonactionable alarms could be reduced by changing the default settings for PVCs. In July 2014, the team implemented changes to the default settings for PVC alarms to "off" (Table 1). The team further decided to default the parameter for continuous QTc monitoring to "on" to allow for early identification of QTc prolongation and the associated risk of the life-threatening arrhythmia torsade de pointes. Clinical staff were educated regarding the changes to the default settings during the intervention. They also provided feedback about the proposed changes.

Two trained RN observers (K.K. and M.G.) collected and analyzed postintervention data using the same observational methods as used previously. Three distinct periods of data collection using observational methods occurred in the 6-month period following the default setting changes. The patient safety nurse for medical critical care (L.D.) monitored the event reporting system for adverse clinical events related to the changes. In September 2014, data collected from 26 patients yielded 98 total alarms. The number of audible alarms from March to September decreased from 210 to 48, demonstrating a 77% reduction in audible alarms. In November, data collected from 24 patients demonstrated a further decrease in nonactionable alarms to 23 in the data collection period. Six months from the intervention in February 2015, data collected from 24 patients demonstrated a decrease in nonactionable alarms to six from the original 122 in the pre-intervention period (Figure 1). There were no adverse patient events related to the changes reported in the event reporting system or by clinical staff during the post-intervention observational period.

An incidental finding showed that default setting parameters for individual patients were more often customized to match the patient's clinical condition (Figure 2). In the February 2014 pre-intervention period, 39% of patient alarms were customized from default settings. In February 2015, 87.5% of patients had customized alarm settings based on their clinical condition. The team attributed the increases in alarm setting customization to a cumulative effect of staff education and best practice interventions implemented since the inception of the project.

Outcomes

The medical critical care team shared the project findings with hospital leadership. In response, the St. Raphael's campus of Yale New Haven Hospital also adopted the default setting changes for PVCs for their medical ICU and medical SDU in June 2016. Staff responded positively to the changes in the telemetry default settings and reductions in numbers of alarms. The adverse event reporting system was monitored for any reports of clinical condition changes or cardiac arrests related to the default alarm setting changes. No adverse patient events were reported in the system during this time period related to the default alarm setting changes.

In summary, the medical critical care units at Yale New Haven Hospital reduced the numbers of nonactionable alarms through "Plan, Do, Study, Act" methods of performance improvement. An interdisciplinary team implemented best practices for alarm management at the unit level. Using data collected by observational methods, the team identified PVCs as the most frequent cause of nonactionable alarms contributing to alarm fatigue. Changes to default settings for PVCs within bedside physiologic monitoring systems were implemented, resulting in sustainable reductions in numbers of nonactionable alarms. ■

Acknowledgments

Alarm	Description
Ventricular Rhythm > 14 PVCs	Senses adjacent PVCs and the HR $\leq$ the V-tach HR limit
Run PVCs (> 2 PVCs)	More than 2 consecutive PVCs in the last minute
Pair PVCs	Pair PVCs within the last minute
R-on-T PVC	R-on-T PVC detected within the last minute
Ventricular Bigeminy	A rhythm with every other beat being a PVC
Ventricular Trigeminy	A rhythm with every third beat being a PVC
PVC rate (> 10 min.)	More than 10 PVCs per minute
Multiform PVC	Multiform PVCs detected within the last minute

Table 1. Default setting changes for premature ventricular contractions (PVCs). Abbreviations used: HR, heart rate; V-tach, ventricular tachycardia.

sponsoring this work. We would also like to acknowledge the contributions of our staff in the medical ICU and SDUs at Yale New Haven Hospital.

References

1. **Graham KC, Cvach M.** Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms. *Am J Crit Care.* 2010;19(1):28–34.

2. **Association for the Advancement of Medical Instrumentation.** A Siren Call to Action: Priority Issues from the Medical Device Alarms Summit. Available at: www.aami.org/alarmsummit. Accessed Feb. 1, 2017.

3. **Funk M, Sendelbach S.** Strategies for Managing Alarm Fatigue. Available at: www.aacn.org/clinical-resources/clinical-toolkits/ strategies-for-managing-alarm-fatigue. Accessed Nov. 30, 2016.

4. **The Joint Commission.** R3 Report: Alarm System Safety. Available at: www.jointcommission.org/r3_report_issue5. Accessed Nov. 30, 2016.

5. **Sendelbach S, Funk M.** Alarm Fatigue: A Patient Safety Concern. *AACN Adv Crit Care.* 2013;24(4):378–86.
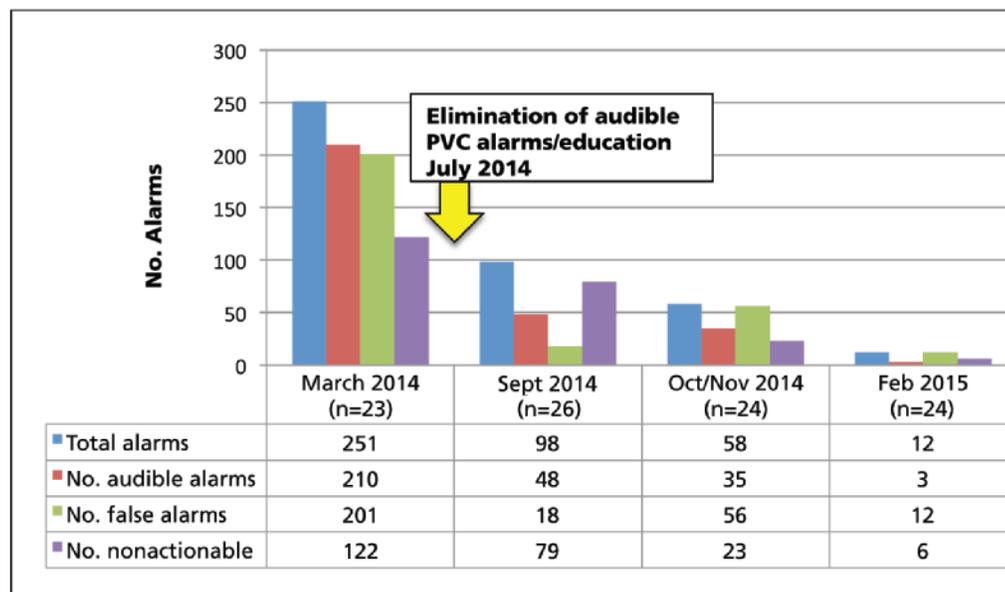

	March 2014 (n=23)	Sept 2014 (n=26)	Oct/Nov 2014 (n=24)	Feb 2015 (n=24)
■ Total alarms	251	98	58	12
■ No. audible alarms	210	48	35	3
■ No. false alarms	201	18	56	12
■ No. nonactionable	122	79	23	6

Figure 1. Alarm data for a medical intensive care unit pre- and postintervention. Abbreviations used: PVC, premature ventricular contraction.

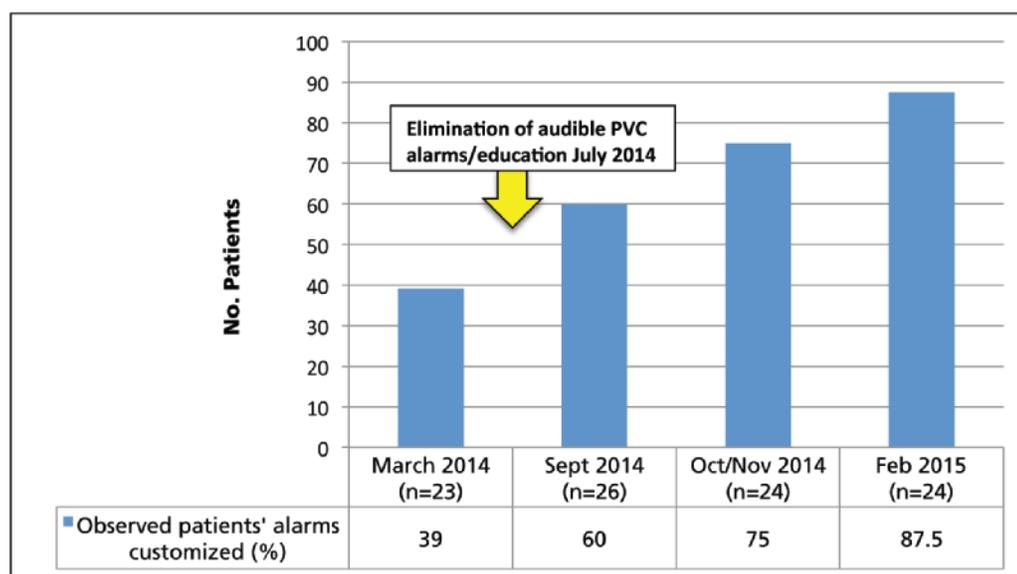|	March 2014 (n=23)	Sept 2014 (n=26)	Oct/Nov 2014 (n=24)	Feb 2015 (n=24)
■ Observed patients' alarms customized (%)	39	60	75	87.5

Figure 2. Customization of alarm data pre- and postintervention in a medical intensive care unit. Abbreviations used: PVC, premature ventricular contraction.