Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms

By Kelly Creighton Graham, RN, BS, and Maria Cvach, RN, MSN, CCRN

CE 1.0 Hour

Notice to CE enrollees:
A closed-book, multiple-choice examination following this article tests your understanding of the following objectives:

1. Describe causes of increased nuisance and false-positive alarms, and appropriate nursing interventions to decrease their occurrence.
2. Identify the effects of frequent false-positive physiological monitor alarms and their relationship to the potential for compromised patient safety.
3. Discuss ways nurses can appropriately tailor parameters for monitoring system alarms to meet the specific needs of each patient.

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EBR Evidence-Based Review on pp 36-37

This article is followed by an *AJCC* Patient Care Page on page 38.

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Background Reliance on physiological monitors to continuously "watch" patients and to alert the nurse when a serious rhythm problem occurs is standard practice on monitored units. Alarms are intended to alert clinicians to deviations from a predetermined "normal" status. However, alarm fatigue may occur when the sheer number of monitor alarms overwhelms clinicians, possibly leading to alarms being disabled, silenced, or ignored.
Purpose Excessive numbers of monitor alarms and fear that nurses have become desensitized to these alarms was the impetus for a unit-based quality improvement project.
Methods Small tests of change to improve alarm management were conducted on a medical progressive care unit. The types and frequency of monitor alarms in the unit were assessed. Nurses were trained to individualize patients' alarm parameter limits and levels. Monitor software was modified to promote audibility of critical alarms.
Results Critical monitor alarms were reduced 43% from baseline data. The reduction of alarms could be attributed to adjustment of monitor alarm defaults, careful assessment and customization of monitor alarm parameter limits and levels, and implementation of an interdisciplinary monitor policy.
Discussion Although alarms are important and sometimes life-saving, they can compromise patients' safety if ignored. This unit-based quality improvement initiative was beneficial as a starting point for revamping alarm management throughout the institution. (*American Journal of Critical Care.* 2010; 19:28-37)

Reliance on physiological monitors to continuously "watch" patients and to alert the nurse when set parameters are exceeded or a serious rhythm problem occurs is standard practice in intensive care, progressive care, and telemetry units. Alarm fatigue may occur when the sheer number of monitor alarms overwhelms clinicians and, ultimately, could compromise patients' safety if alarms are disabled, silenced, or ignored. Physiological monitors are only as reliable as the clinicians who use them. Nurses who work with monitors must be knowledgeable about their physiological monitoring systems and how to appropriately tailor parameters for monitor alarms to meet the specific needs of each patient.

When alarm frequency is high, nurses are at risk for becoming desensitized to the alarms that are intended to protect their patients. Cardiac monitor algorithms are intentionally set for high sensitivity at the expense of specificity. As a result, numerous false alarms occur.[1] A 2006 American College of Clinical Engineering survey of more than 1300 health care professionals showed that a large percentage of respondents believed that what are commonly called "nuisance" alarms occur frequently (81%), disrupt patient care (77%), and can reduce trust in alarms, causing clinicians to disable them (78%).[1] In other studies,[2-4] researchers have reported a high percentage (86%-99.4%) of false-positive alarms produced by physiological monitors, stating that alarms result in a change in the management of the patient less than 1% of the time.

The probability of responding to an alarm is lower if the false-alarm rate is high, and alarms in use today do not convey the intended sense of urgency.[3,5-7] Nurses in intensive care units stated that the primary problem with alarms is that they are continuously going off and that the largest contributor to the number of false alarms in intensive care units is the pulse oximetry alarm.[8-10] "Smart alarms," which analyze multiple parameter changes in a patient's condition, may be a solution, but not all monitors currently in use have such features.

Excessive numbers of cardiac monitor alarms and fear that nurses have become desensitized to these alarms were identified as a safety concern by nurses in a 950-bed, northeastern academic medical center. An interdisciplinary alarm management task force was created and charged with (1) evaluating excessive equipment alarms that obscure and desensitize clinicians, (2) standardizing the hospital's approach to alarm management, (3) assessing the reliability of secondary or adjunct alarm notification devices, (4) determining the educational needs of clinicians regarding alarm management, and (5) assessing new technology and systems that may improve alarm management. The purpose of this article is to describe a unit-based quality improvement initiative that enabled the task force to quantify the frequency of cardiac monitor alarms on a single unit and to perform small tests of change to improve management of monitor alarms.

When alarm frequency is high, nurses can become desensitized and develop "alarm fatigue."

Description of the Test Unit

The medical progressive care unit (MPCU), a 15-bed unit with 30 nurses, was selected as the pilot area because of its diverse population of patients with various medical conditions such as chronic respiratory illness, renal disease, gastrointestinal disease, and sepsis. These conditions generate many types of alarm states including dysrhythmias, low saturation, hypotension, and hypertension. Progressive care patients generally have wide fluctuations in vital signs and are at risk for rapid changes in hemodynamic status, rendering it difficult to establish alarm parameters. When this project was undertaken, the hospital did not have a centralized monitor watch program, so each patient's nurse was responsible for managing the patient's physiological monitor and alarms.

A 12-lead electrocardiography hard-wire monitoring system was in use on the unit, with a bedside display and the capability of switching to telemetry

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Table 1
Monitor alarms in the medical progressive care unit

Alarm levels	Examples	Alarm tone
1, Crisis	Asystole Ventricular tachycardia Ventricular fibrillation Ventricular bradycardia	Triple beep
2, Warning	Tachycardia Bradycardia Ventricular tachycardia > 2	Double beep
3, Advisory	Pulse oximetry Premature ventricular contractions	Single beep
4, Message	Irregular couplet	None
5, System warning	Lead failure Arrhythmia suspend	Fog horn

mode as needed. This type of monitoring system allows multilead continuous analysis. Although multilead analysis is performed, typically leads II and V_1 are viewed. The only time this is changed is when there is difficulty viewing either lead because of its shape or voltage, in which case an alternative lead is selected.

During telemetry, the patient is placed on a 5-lead analysis monitoring system and can be monitored only within the antenna range, which spans the length of the MPCU hallway. A central monitor is available at the nursing station. When patients are transported off the unit, a transport monitor is used and staff trained in physiological monitoring interpretation accompany the monitored patient. Nurses on this unit monitor many types of physiological parameters, including invasive and noninvasive blood pressure, central venous pressure, and oxygen saturation, as well as dysrhythmias. ST-segment analysis is available but is activated only for cardiac conditions such as chest pain of suspected cardiac origin or ischemia. The unit does not have an assigned house staff physician; consequently, a physician is not physically present on the unit at all times. MPCU nurses therefore must be skilled in customizing and responding to physiological monitor alarms.

The largest contributor to the number of false alarms was the pulse oximetry alarm.

The MPCU has a high degree of patient activity, particularly on the day and evening shifts. Patients move about frequently in their rooms as they engage in physical and occupational therapy, visit with friends and family, and leave the unit for tests and procedures. Physiological monitor alarms add to the chaos created by other types of extraneous noise.

As the test unit, the MPCU participated in quality monitoring activities aimed at quantifying the numbers of crises, warning, and system warning monitor alarms on the unit. These activities were followed by small tests of change by using a systematic approach to reducing the number of alarms and to test the effects of published "best practices" related to management of physiological monitor alarms.

Methods

This quality improvement project began in January 2006 with analysis of alarm data on the test unit and ended in June 2007 after tests of change were completed and desired outcomes were obtained. The MPCU's Comprehensive Unit-Based Safety Program (CUSP) team led these small tests of change. The goals of a CUSP team are to (1) improve the culture of safety on the unit, (2) allow staff to focus safety efforts on unit-specific problems, and (3) collect and analyze data to improve patients' safety. The CUSP team includes the nurse manager, the unit-based quality improvement and safety representative, the safety executive, the medical director, and the safety coach. The CUSP team oversaw the project and approved changes to be tested.

The initial process began with collection of baseline alarm data. Two types of alarms occur with the MPCU monitoring system: patient status alarms and system status alarms. Patient status alarms are divided into 4 types: crisis, warning, advisory, and message. System status alarms are triggered by mechanical or electrical problems (Table 1). Clinical engineers used a monitoring device that counted all cardiac alarms and system status alarms sounding at the central monitoring station for an 18-day period in January 2006. After analyzing the data and the existing monitoring system, the task force decided to focus on managing the most serious monitor alarms and system status alarms; that is, the crisis alarms, warning alarms, and system warnings. Advisory alarms such as those for low oxygen saturation (pulse oximetry), premature ventricular contractions, and ST-segment changes, which accounted for more than 90% of cardiac monitor alarms, were not included. A future project is planned to address advisory alarms in the cardiology care unit. The hospital's monitor vendor attended meetings of the task force and assisted the team by providing requested monitor information, literature, and clinical consultants during the initiative.

The Alarm Management Task Force began a yearlong process of testing interventions that informed the development of an interdisciplinary hospitalwide cardiac monitoring protocol. MPCU nurses began

with their unit-based standard for management of cardiac monitors, which included setting appropriate alarm limits (20 ± patient's heart rate; mean arterial pressure) within 1 hour of assuming care for a patient and as the patient's condition changed. An alarm is triggered when threshold parameters are exceeded. To maximize the relevance of alarms, these parameters must be set specifically to each patient's individualized needs. When high and low levels are set, the cardiac monitoring system will alarm if the patient's vital signs are outside the established range for the parameter. The MPCU's standard did not have an alarm response time for the nurses, so it was important to include this in the hospitalwide protocol.

In April 2006, MPCU nursing staff completed a pretest questionnaire (Appendix 1, www.ajcconline.org) developed by the CUSP team to assess monitor knowledge and unit noise level. The same questionnaire was administered after the tests of change.

The first test of change, which took place during the unit-based annual review process in April 2006, was to implement a retraining program for all MPCU nurses regarding the "best practices" in managing cardiac monitoring systems.[1] Nurses were presented with MPCU baseline data on the monitor alarms. The importance of customizing alarm parameters was thoroughly explained. Nurses were also provided with information on troubleshooting common physiological monitor problems. The MPCU quality improvement/safety officer presented feedback from the pretest questionnaire regarding nurses' practices and opinions about monitor alarms. Creative teaching strategies, such as an "Alarm Jeopardy" game, allowed each nurse to become actively involved in the learning process. Staff members were extremely positive about monitor education and were motivated to use this information to decrease monitor alarms on the unit.

The second test of change was to revise the default settings for the unit's monitor alarms, including parameter limits and levels, so that alarms that occurred were actionable and clinically significant. Cardiac monitors have default parameter limits and levels set by the manufacturer. These are modified by the hospital's clinical engineering department per unit request before installation. Default settings take effect each time a patient is discharged and a new patient is admitted to the room with that monitor. The hospital did not have an institutional standard for default settings when this quality improvement initiative was started. The focus was on determining (1) the most frequent alarms, (2) duplicate alarms, and (3) perceived "nuisance" alarms.

Table 2
Changes in default settings on monitors in the medical progressive care unit

Parameter	Before intervention	After intervention
Heart rate, beats per minute		
Low	60	50
High	120	150
Oxygen saturation, %	90	88
Limit on premature ventricular contractions, per minute	6	10
Heart rate high and low	Warning	Message
Bradycardia and tachycardia	Advisory	Warning
Couplet	Warning	Message

Before making any changes to alarm parameter limits and levels, the Alarm Management Task Force verified the definitions of each setting to ensure that the ramification of any changes made would be anticipated. Initial default changes were made in June 2006 and additional changes were made in November 2006. Data collected between changes showed a reduction in alarms. Table 2 shows the default changes made as of November 2006.

The alarm defaults were safely changed to levels at which staff would typically intervene (Table 2). The task force intended for all alarms to be actionable in order for nurses to respond to them promptly and correctly. Analysis of the MPCU data indicated that the 2 most common alarms were for high and low heart rates. Heart rate high and low levels were widened because MPCU patients often work with physical therapy and/or get out of bed, resulting in tremendous variations in heart rate throughout the day. Oxygen saturation was the fourth most frequent alarm. The unit has many patients with respiratory issues who constantly have decreases in saturation. It was decided that a small decrease in the oxygen saturation default would be safe because oxygen saturation varies depending on the amount of oxygen used by the tissues and by activities such as ambulation or positioning.[11]

The task force intended for all alarms to be actionable.

Another default change was to increase the premature ventricular contraction limit. This limit was increased from 6 to 10 per minute in order to decrease the number of alarms caused by benign premature atrial, junctional, and ventricular beats. Because an increase in premature beats also could be indicative of electrolyte disturbances, the task force agreed on 10 as the default limit. This limit ensured that an increase in ectopy would trigger the nurse to evaluate for electrolyte disturbances.

Table 3
Changes in alarm data on monitors in the medical progressive care unit[a]

Alarm type	Before intervention, January 2006		After intervention, January 2007	
	Frequency	%	Frequency	%
Bradycardia	4533	26.74	1432	14.84
Heart rate low	2598	15.32	310	3.21
Heart rate high	1949	11.50	294	3.05
Oxygen saturation low	1685	9.94	623	6.46
RR leads fail	1652	9.74	2137	22.15
Tachycardia	1351	7.97	980	10.16
Leads fail	1251	7.38	1565	16.22
Ventricular tachycardia >2	636	3.75	506	5.25
Arrhythmia suspend	634	3.74	1116	11.57
Ventricular tachycardia	159	0.94	82	0.85
Asystole	154	0.91	168	1.74
No telemetry	143	0.84	193	2.00
Pause	119	0.70	153	1.59
Noninvasive blood pressure, maximum time	27	0.16	5	0.05
Ventricular fibrillation/ ventricular tachycardia	22	0.13	9	0.09
Arterial catheter disconnect	20	0.12	66	0.68
Ventricular bradycardia	20	0.12	8	0.08
Total	**16 953**		**9647**	
Mean no. of patients monitored	**12**		**13.3**	

[a] Advisory alarms were not represented in this table.

The task force also noted duplicate alarms when reviewing the data. The alarms for high and low heart rate were the same as the bradycardia and tachycardia alarms. Although how the monitor calculates bradycardia varies somewhat from how it calculates heart rate low, and how the monitor calculates tachycardia differs from how it calculates heart rate high, the task force thought that the monitor alarm did not need to sound twice; therefore, the alarms for heart rate high and low were moved to message level and the alarms for bradycardia and tachycardia were increased to warning level.

The final test of change, a software addition to the unit's physiological monitoring system in November 2006, allowed a remote auto view of alarms at each patient's bedside. With this type of notification, a crisis alarm sounds at the central monitor station and at all bedside monitors. This additional software displays the patient's vital signs and rhythm in a split-screen view, allowing all staff to see these alarms and act swiftly. The sound of the alarm is unique and can be customized to be a one-time, double-beep alarm or a continuous, double-beep alarm. When this software addition was introduced, the unit's quality improvement/safety representative reinforced the new default changes and encouraged nurses to customize and individualize monitor alarms on the basis of each patient's needs. Nurses were trained to respond to this alarm as they would respond to any crisis alarm. Additionally, MPCU has a secondary notification system that uses a one-way pager carried by the charge nurse for alarm notification.

The final MPCU alarm data collection occurred between December 2006 and January 2007. These data were analyzed and compared with previous results. In May 2007, the postintervention survey was completed and compared with the preintervention survey that had been completed 1 year prior.

Results

The institution uses 5 physiological alarm levels that are defined in Table 1.[12] MPCU baseline alarm data included the following alarm levels: crisis, warning, and system warnings. During an 18-day period, the number of alarms totaled 16 953, equating to 942 alarms per day or 1 critical alarm (crisis alarm, warning alarm, or system warning alarm) every 92 seconds. Table 3 shows the breakdown of alarms and percentage of occurrence. The total number of alarms went from 16 953 to 9647, which is a 43% reduction in critical physiological monitor alarms from the baseline data collected approximately 1 year prior. Census data were not included in the analysis; however, the MPCU had a mean census of 12 (of 15 beds) during the baseline collection period, and 13.3 during the postintervention collection period. This positive trend was used by the Alarm Management Task Force to make recommendations to other units in setting default parameters for alarms.

A pretest survey (Appendix 1, www.ajcconline.org) was completed by those registered nurses in the MPCU who chose to participate. The survey gave an indication of the baseline knowledge of nursing staff about monitor alarms and the perceived response of the nurses to these alarms. Of the total 30 nurses employed on the unit, 23 volunteered to complete the preintervention survey (see Figure). The survey results indicated that 83% changed alarm parameters when a patient's vital signs changed and 78% changed parameters at the beginning of their shift. When asked if nurses

changed alarm parameters after patients returned from temporary care sites, such as radiology or the catheterization laboratory, only 41% reported compliance. It was apparent from the initial survey that MPCU nurses were more likely to change default parameters when the patient's monitor began to alarm continually rather than prospectively. The postintervention survey was completed by 16 volunteer nurses. The results (see Figure) revealed that 94% were changing their parameters at the beginning of their shift and 94% were changing their parameters when patients' vital signs changed. However, the number of nurses who changed alarm parameters after patients returned from temporary care sites increased only from 41% to 56%.

Nurses were also asked to rank the overall noise level on MPCU from 1 (least) to 5 (most) and to rank their perception of how much physiological monitor alarms contributed to the overall noise level on the unit. On average, nurses ranked the noise level as 4.0 and ranked monitor alarms as 3.1 in contributing to the noise level. After the intervention, nurses ranked overall perceived noise level as 3.5 and monitor alarms as 2.97 in contributing to the noise level. Thus nurses perceived the unit's overall noise level as lower after the intervention.

Because an institutional standard for alarm response was lacking, the preintervention survey also requested information on how staff responded when an alarm was heard. Responses by staff to this question were to check the patient, verify the alarm, troubleshoot the leads/electrodes, and notify the house officer.

The survey tool was used to check nurses' perceived compliance with alarm management. The results of the survey may not be representative of the average nurse employed on the unit because completion of the survey was not mandatory.

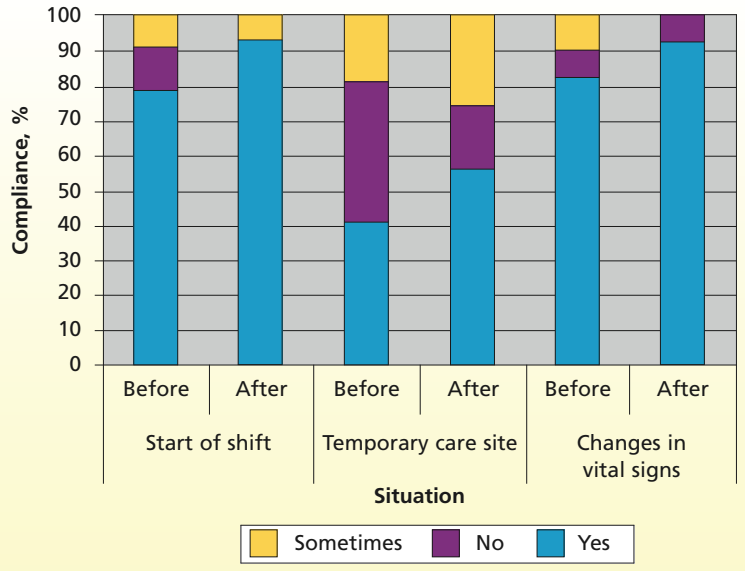

Figure Results of nurse survey before (n = 23) and after (n = 16) intervention: nurses' compliance with changing parameters.

Discussion

Although alarms are important and sometimes lifesaving, they can compromise patient safety if they are often false-positive. The problem of excessive alarms has been recognized and studied extensively in the past 20 years in various settings, particularly in the intensive care unit.[2,4,5,7,9,10] Nuisance alarms are annoying alarms that may interfere with patient care and typically do not result from a patient having an adverse condition. Alarms that are viewed as false-positive and/or nuisance alarms may cause a delay in reaction time or reduce the probability of nurses responding.

The approach in this quality improvement initiative was to perform small tests of change, which included ensuring proper training of staff about monitoring systems, regular assessment and individualization of alarm parameters, ensuring audibility and accountability of alarms, revision of monitor alarm defaults, and software modification to provide a remote auto view of alarms at the patient's bedside. As a result of the positive effects of retraining, a skills checklist for alarm management competency (Appendix 2, www.ajcconline.org) is now used on the unit to educate all new nurses about the monitor system and to ensure that they are knowledgeable about monitors and alarm management. This checklist includes information on electrode preparation and placement, monitor skills, and troubleshooting that supplements the practical points of the hospitalwide interdisciplinary policy on monitors.

This initiative resulted in a 43% reduction in critical physiologic monitor alarms.

This unit-based initiative was beneficial as a starting point for revamping alarm management throughout the institution. Overall, the CUSP team found that modifying alarm parameter defaults and educating nurses about the importance of individualizing monitor alarm parameters helped decrease excessive monitor alarms. The CUSP team also learned that even with proper tailoring of alarms, crisis alarms such as asystole, ventricular tachycardia, and ventricular fibrillation can occur falsely. Some of the main reasons for this undesired effect are poor skin preparation or electrode interface, movement of the patient, and lack of adherence of electrodes. When false crisis

alarms occur, these "nuisance" alarms can result in nurse desensitization, which may lead to delayed action by the nurse the next time the monitor alarms.[2,4,9]

Other valuable lessons learned include the following: (1) unit staff should analyze their alarm parameters and alarm levels to determine if they are appropriately set and avoid duplicative alarms; (2) alarm parameters should be set to actionable levels to decrease the number of false or "nuisance" alarms occurring and increase the likelihood of the alarm being an actionable alarm so it will not be ignored; (3) nurses must be trained to individualize alarm parameters and levels so alarms that occur are meaningful and actionable; and (4) institutions would do well to establish an institutionwide standard for management of physiological monitor alarms. These lessons were brought back to the Alarm Management Task Force for discussion and consideration by other monitored units.

Alarms that are viewed as false-positive or nuisance alarms may delay a nurse's response.

The results of these small tests of change on a single unit provided the basis for applied learning to other adult and pediatric units in the institution. The test unit has continued its quest for quality by partnering with the Clinical Engineering Department to pilot a new middleware system that enables physiological monitor alarms to be communicated through a variety of systems such as pagers, cell phones, and LED marquee signs. This system will broaden the ability to receive alarm notification through multiple channels versus just one-way pagers.

This unit-based initiative was a starting point for revamping alarm management in the institution.

Although this quality improvement initiative led to standardization of monitor education and implementation of a hospitalwide monitor protocol, additional benefits included increasing nurses' knowledge of monitors and decreasing the number of nuisance alarms. Complete buy-in from coworkers or staff was essential to achieving a true culture change in alarm management. Manipulation of monitor defaults and staff training are not sufficient to sustain change unless the unit is held accountable for maintaining a zero-tolerance for nuisance alarms and troubleshooting these alarms as soon as they occur.

ACKNOWLEDGMENTS
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FINANCIAL DISCLOSURES
None reported.

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REFERENCES

1. Drew BJ, Califf RM, Funk M, et al. Practice standards for electrocardiographic monitoring in hospital settings. *Circulation.* 2004;110(17):2721-2746.
2. Clark T, David Y. Impact of clinical alarms on patient safety. American College of Clinical Engineering Healthcare Technology Foundation Web site. http://www.acce-htf.org/publications.asp. Published 2006. Accessed October 2, 2009.
3. Phillips J, Barnsteiner JH. Clinical alarms: improving efficiency and effectiveness. *Crit Care Nurs Q.* 2005;28(4):317-323.
4. Atzema C, Schull MJ, Borgundvaag B, Slaughter GRD, Lee CK. Alarmed: adverse events in low-risk patients with chest pain receiving continuous electrocardiographic monitoring in the emergency department: a pilot study. *J Emerg Med.* 2006;24:62-67.
5. Sobieraj J, Ortega C, West I, Voepel L, Battle S, Robinson D. Audibility of patient clinical alarms to hospital nursing personnel. *Military Med.* 2006;171:306-310.
6. Mondor TA, Finley GA. The perceived urgency of auditory warning alarms used in the hospital operating room is inappropriate. *Can J Anesth.* 2003;50:221-228.
7. Bliss J, Fallon CK, Nica N. The role of alarm signal duration as a cure for alarm validity. *Appl Ergonom.* 2007;38(2):191-199.
8. Freudenthal A, Melles M, Pijl V, Bouwman A, Stappers PJ. In: de Waard D, Brookhuis KA, eds. *Human Factors in Design, Safety, and Management.* Maastricht, the Netherlands: Shaker Publishing; 2005:219-233.
9. Biton Y, Meyer J, Shinar D, Zmora E. Nurses' reactions to alarms in a neonatal intensive care unit. *J Cognitive Technol Work.* 2004;6:239-246.
10. Tsien CL, Fackler JC. Poor prognosis for existing monitors in the intensive care unit. *Crit Care Med.* 1997;25(4):614-619.
11. The hazards of alarm overload: keeping excessive physiological monitoring alarms from impeding care. *Health Devices.* 2007;March:73-83.
12. GE Medical Systems Information Technologies. *Solar 8000M V4 Basic Bedside Monitor Applications Class Workbook.* Waukesha, WI: GE Medical Systems; 2003.
13. American Association of Critical-Care Nurses. *ST-Segment Monitoring* [practice alert]. Aliso Viejo, CA: American Association of Critical-Care Nurses; 2008. (See Appendix 2, www.ajcconline.org).

CE Test

Test ID A1019012: Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms.

Learning objectives: 1. Describe causes of increased nuisance and false-positive alarms and appropriate nursing interventions to decrease their occurrence. 2. Identify the effects of frequent false-positive physiological monitor alarms and their relationship to the potential for compromised patient safety. 3. Discuss ways nurses can appropriately tailor parameters for monitoring system alarms to meet the specific needs of each patient.

1. According to researchers' findings, frequent false-positive alarms resulted in a change in the management of the patient what percentage of the time?
a. Less than 1%
b. 1% to 5%
c. 5% to10%
d. Greater than 10%

2. The 2006 survey of health care professionals by the American College of Clinical Engineering showed that a large percentage of respondents believed which of the following?
a. Nuisance alarms occur infrequently and are disruptive to patient care.
b. Nuisance alarms occur frequently and do not disrupt patient care.
c. Nuisance alarms occur infrequently and are not disruptive to patient care.
d. Nuisance alarms occur frequently and disrupt patient care.

3. Nurses in intensive care units report that the primary contributor to the number of false alarms in their units is which of the following?
a. The cardiac rate/rhythm alarm
b. The blood pressure alarm
c. The pulse oximetry alarm
d. The respiratory rate alarm

4. Cardiac monitoring algorithms are set for high sensitivity at the expense of which of the following?
a. Accuracy
b. Specificity
c. Electronic documentation of cardiac dysrhythmias
d. Appropriate visual assessment of patients by nurse

5. What are "smart alarms"?
a. Alarms that continuously reset themselves based on automatic averaging of the patient parameters
b. Alarms that convey a sense of urgency by using a variety of alarm tones (sounds)
c. Alarms that analyze multiple parameter changes in the patient's condition
d. Alarms that allow physiological monitor information to be communicated to pagers, cell phones, or similar devices

6. Which of the following terms did the authors use to describe the risk to clinicians when physiologic monitor alarm frequency is high?
a. Alarm abandonment
b. Alarm monotony
c. Alarm duplication
d. Alarm desensitization

7. The initial baseline alarm data for this study were collected during which of the following periods of time?
a. 21 days
b. 18 days
c. 14 days
d. 10 days

8. Which of the following types of patient status alarms were *not* included in this study, but will be addressed in a future project?
a. Advisory alarms
b. Warning alarms
c. Crisis alarms
d. Message alarms

9. Changes to default settings, including parameter limits and levels, were made to achieve which of the following?
a. Limited variation from the manufacturer's recommended default settings
b. Creation of a consistent, standard alarm response time for the nurses in the unit
c. Reduction in the amount of time nurses spent troubleshooting common physiological monitor problems
d. Occurrence of alarms that were actionable and clinically significant

10. Which of the following alarm parameter changes did the unit-based task force specifically intend to trigger the nurse to evaluate for electrolyte disturbances?
a. Oxygen saturation default limit
b. Premature ventricular contraction limit
c. High heart rate limit
d. Low heart rate limit

11. Which of the following alarms were increased from advisory level to warning level as part of this project?
a. Bradycardia and tachycardia alarms
b. Heart rate high and low alarms
c. Lead failure and arrhythmia suspend alarms
d. Irregular couplet and premature ventricular contractions alarms

12. In addition to manipulation of monitor defaults, what do the authors suggest in order to sustain changes in monitor management?
a. Establishing unit-specific monitoring protocols rather than hospitalwide protocols
b. Setting of parameters so there are duplicative alarms for asystole, ventricular tachycardia, and ventricular fibrillation
c. Creation of a Comprehensive Unit-Based Safety Program in each monitoring unit
d. Maintaining zero tolerance for nuisance alarms and troubleshooting them as soon as they occur

13. This study included tests of changes made to monitor management in which of the following areas?
a. Revision of default settings for the unit's monitor alarms, implementation of a retraining program for all nurses in the unit, and addition of new software for the physiological monitoring system
b. Revision of default settings for the unit's monitor alarms and addition of new software for the physiological monitoring system
c. Revision of default settings for the unit's monitor alarms and implementation of a retraining program for all nurses in the unit
d. Implementation of a retraining program for all nurses in the unit and addition of new software for the physiological monitoring system

14. By what percentage did the total number of critical physiological alarms decrease between the measurement at the beginning of the study and at the end of the study?
a. 23%
b. 33%
c. 43%
d. 53%

Test ID: A1019012 Contact hours: 1.0 Form expires: January 1, 2012. **Test Answers:** Mark only one box for your answer to each question. You may photocopy this form.

1. ❑**a**	**2.** ❑**a**	**3.** ❑**a**	**4.** ❑**a**	**5.** ❑**a**	**6.** ❑**a**	**7.** ❑**a**	**8.** ❑**a**	**9.** ❑**a**	**10.** ❑**a**	**11.** ❑**a**	**12.** ❑**a**	**13.** ❑**a**	**14.** ❑**a**
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EBR Evidence-Based Review

Evidence-Based Review and Discussion Points

By Ruth Kleinpell, RN, PhD

Evidence-Based Review (EBR) is the journal club feature in the *American Journal of Critical Care*. In a journal club, attendees review and critique published research articles: an important first step toward integrating evidence-based practice into patient care. General and specific questions such as those outlined in the "Discussion Points" box aid journal club participants in probing the quality of the research study, the appropriateness of the study design and methods, the validity of the conclusions, and the implications of the article for clinical practice. When critically appraising this issue's EBR article, found on pp 28-35, consider the questions and discussion points outlined in the "Discussion Points" box. Visit **www.ajcconline.org** to discuss the article online.

This quality improvement initiative assessed the impact of management interventions and education to reduce the number of cardiac monitor alarms on a medical progressive care unit. An evaluation of the types and frequency of monitor alarms was conducted and an interdisciplinary alarm management taskforce was formed.

A hospitalwide cardiac monitoring protocol was then developed and tested during a year-long process. Recommendations for alarm management that were implemented included nursing staff interventions to individualize alarm parameter limits and levels. Results from the initiative showed that implementation of an interdisciplinary monitor policy and education focusing on optimal cardiac monitor alarm limits and levels resulted in a 43% reduction in critical monitor alarms.

Investigator Spotlight

This feature briefly describes the personal journey and background story of the EBR article's lead investigators, discussing the circumstances that led them to undertake the line of inquiry represented in the research article featured in this issue.

Maria Cvach

Because she had been involved in other safety initiatives, including a Fall Safety program, coauthor Maria Cvach was familiar with many of the safety concerns related to monitor alarms.

She said working with an interdisciplinary team was a very positive experience. The team included engineers, the unit's nursing manager, and even vendors. She noted: "We even had a monitor vendor who eagerly attended meetings, assisted us in understanding the monitor, and brought in experts from the vendor's company when needed." She was also pleased that participants on the interdisciplinary committee participated in writing the hospitalwide policy.

Coauthor Kelly Creighton Graham was the clinical nurse representative from the medical progressive care unit (MPCU) on the alarm committee. She played an active role in implementing change on the MPCU as a senior nurse and later as the unit's patient coordinator. Cvach said, "Since Kelly worked on the MPCU, it was not difficult for her to recruit participants from the unit. The culture of the unit is to promote patient safety."

Information From the Authors

Coauthor Maria Cvach, RN, MSN, CCRN, said the idea for a quality improvement project on cardiac monitor alarms was the result of patient safety concerns and risk managment issues. She cited the Joint Commission's 2004 National Patient Safety Goal No. 6 to improve the effectiveness of clinical alarm systems as the specific motivation for the project.

Cvach explained how the interdisciplinary alarm management taskforce was formed: "We started with a focus group for the medical progressive care unit (MPCU) for 9 months. The initial group consisted of nurses, clinical engineers, and physicians in the MPCU. We expanded our membership 9 months into the project and brought in nursing staff from other non-MPCU areas including intensive care and telemetry units, human factors engineering, risk management, and operations integration."

Quality monitoring activities were then implemented. She explained: "Clinical engineering connected a tracking device to the unit's physiologic monitors that was able to quantify the number of alarms coming from the monitor at each bedside. This information was downloaded into an Excel spreadsheet and we were able to document the number of alarms and the types of alarms that were occurring on the unit for a period of 18 days."

The timeline for the study was established after the team determined the required components. Cvach said the initiative began in January 2006. "It took us 4 months to study the problem and gather alarm data for objective assessment of excessive alarms. Once we were able to quantify the

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number, we were able to determine interventions that may be helpful in reducing the number of alarms." The team reviewed the unit's default parameters for physiologic monitor alarms and made recommendations to decrease duplicate alarms. They also lowered threshold parameters to actionable levels and changed alarm levels from advisory to warning where appropriate.

To reduce excessive noise, the intervention team programmed benign alarms to display messages. They also developed a hospitalwide monitor protocol that included alarm management, and assessed the unit staff's knowledge of physiologic monitors and alarm management. An education plan for the staff also was developed.

Cvach said, "All of this was done using a plan-do-study-act approach so that lessons learned could be shared with other units if they were successful."

The team led a small test of change that focused on targeting alarm parameters. Cvach explained, "Performing 'small tests of change' means to make one change and to test it. For instance, if an alarm parameter was changed for heart rate from an upper limit of 120/min to 150/min, or premature ventricular contractions changed from 6/min to 10/min, the change was made and then the effect on the alarms was studied to see the significance on the reduction of alarms and to determine if the change resulted in any kind of patient safety issue."

Implications for Practice

The results of the study show a significant decrease in the number of alarms due to the initiative. This finding has direct implications for critical care nurses. Cvach believes that critical care nurses who do not have a unit-based or centralized monitor watch would benefit from examining their monitor alarms, parameter thresholds, and levels. Alarms should be set to actionable levels so as not to desensitize staff. She noted, "Critical care nurses should know their equipment and be familiar with troubleshooting nuisance alarms. It is important that alarms be individualized for the patient so when an alarm occurs it is meaningful and handled expeditiously."

In conclusion, Cvach advised nurses to ensure that their hospital has a policy for alarm management that covers alarm audibility, alarm escalation, and troubleshooting alarms. She said, "Educate staff via monitor competency checklists. Study your unit to determine if alarm desensitization is occurring and how it can be reduced."

About the Author
Ruth Kleinpell is contributing editor of the Evidence-Based Review section. She is a professor in the Rush University College of Nursing, a teacher-practitioner at the Rush University Medical Center, and a nurse practitioner with Our Lady of the Resurrection Medical Center, Chicago, Illinois.

eLetters
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Discussion Points

A. Description of the Study
- ❑ What was the purpose of the project?
- ❑ Why is the problem significant to practice?

B. Literature Evaluation
- ❑ What does the literature indicate with respect to alarm rates and false alarms?
- ❑ Why is the concept of alarm fatigue important to patient care?

C. Sample
- ❑ What were the characteristics of the test unit for the project?

D. Methods and Design
- ❑ How were cardiac alarm and system status alarm data collected?
- ❑ What were the specific tests of change that were implemented during the program?

E. Results
- ❑ What was the decrease in total number of alarms that occurred due to the initiative?
- ❑ How did the alarm data compare to the average census of the unit?

F. Clinical Significance
- ❑ What are implications of the study for clinical practice?
- ❑ How does the study extend the evidence base on the impact of interventions targeting proper tailoring of alarms?

Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms

Kelly Creighton Graham and Maria Cvach

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