ALARM MANAGEMENT: A QUALITY IMPROVEMENT PROJECT TO DECREASED NON-ACTIONABLE CARDIAC TELEMETRY ALARMS.

by

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ABSTRACT

A high number of non-actionable cardiac alarms compromise patient safety. Up to 99% of telemetry alarms are false or non-actionable, leaving nurses to guess which 1% of alarms are real. This alarm fatigue phenomenon leaves patients vulnerable and nurses guessing. The incorporation of evidence-based guidelines into a policy and guidelines, followed by education, is insufficient to reduce the number of alarms and alarm fatigue. Key stakeholders must make concretive efforts to effect change.

INTRODUCTION

Everyday, caregivers/nurses are bombarded by a myriad of alarms. These beeps, chimes, bells, and horns become white noise to nurses, resulting in slow or non-existent responses. Many nurses have become desensitized to these alarms due to the large number of false or non-actionable alarms.[1,2] Studies have shown that approximately 72–99% of alarms are false or non-actionable.[3,4] This "crying wolf" phenomenon furthers alarm fatigue and compromises patient safety. The Joint Commission (TJC), Food and Drug Administration (FDA), the American Association of Critical-Care Nurses (AACN), and the Emergency Care Research Institute (ECRI) have all recognized this potentially life-threatening issue. Since 2013, as part of the 2014 National Patient Safety Goals, TJC has required hospitals to address physiologic alarms.[3–8] The purpose of this paper is to review how a written policy and guidelines on cardiac monitoring and alarm management, followed by six weeks of education, affected the number of non-actionable cardiac alarms on four medical telemetry unit.

Background

Alarm fatigue is defined as sensory overload or desensitization due to an excessive number of alarms, especially when alarms are non-actionable.[1,3,8–10] High numbers of alarms, due to a high number of non-actionable, are compromise patient safety by forcing the provider to decide if an alarm is real and actionable. Understandably, the ECRI rated "alarm systems" as the number-one health technology hazard in 2012, 2013, and 2014. The FDA reported 566 monitor alarm-related deaths in 2005–2006, and TJC sent out a sentinel alert on alarm-related events, reporting that, from 2009–2012, 98 clinical alarm-related events occurred. Of those 98 reported events, 80 patients died, 13 patients experienced permanent loss of function, and five patients had added hospital stays and unexpected injury.[1,3,4,11–13] Alarm fatigue is the most common contributor to these kinds of alarm-related events and is a significant factor in patient safety.

Alarm fatigue is a significant problem for healthcare consumers, nurses, and organizations. Patients and family members are being cared for in increasingly noisy units. Patients who are exposed to these noisier units are experiencing anxiety, sleep deprivation, and delirium.[14] Not only are these noisy units not conducive to rest and healing, but they also cause distraction during care and delayed responses. Alarms are not the only noise the nurse have to contend with: overhead messages, carts being wheeled down halls, personal pagers and phones, and conversations all contribute to the elevation of noise levels on a unit.[15] With nurses being bombarded with various alarms and other noises, they are unable to discern between noises that need responses and those that do not.[1,15] Honan et al.[14] evaluated perceptions of clinical alarms and found that many caregivers describe the noise on their unit as "noxious," "unnerving," and "ominous." Nurses also report that this "noise pollution" facilitates distrust in alarms, contributing to slowed responses or nurses ignoring the alarms altogether.

Caregivers may disable alarms, turn them off, or change parameters on monitors without evaluating the patient's condition, consulting a provider, or notifying the next nurse.[2,8,11] Lukasewicz and Andersson Mattox[16] relay a case study of a nurse who had been watching a monitor all evening on a patient who continued to have numerous non-actionable alarms; by the morning, while the nurse was trying to concentrate, she became frustrated and suspended the alarms. However, this time the alarm signaling was actionable. The patient became hypoxic and needed assistance. Monitors are placed on patients to alert the bedside caregiver to any deterioration in a patient's condition. If these alarms are disabled, turned off, or ignored, the patient could die or be harmed.[1,3,8,17,18]

Quality improvement

The focus of this project was to reduce the number of non-actionable cardiac alarms. The organization, in adherence with TJC requirements, gathered an interprofessional team together to evaluate the multiple physiological alarms within the facility. In conjunction with recommendations from the AACN and TJC, the team determined to focus their initial efforts on cardiac telemetry alarms. The team's primary goal was to develop a policy, guidelines, and an educational plan for cardiac alarm management to reduce the number of non-actionable cardiac alarms.[4,13]

Project question

The PICOT question for this project was: In telemetry nurses, how does a cardiac/telemetry alarm management policy, guidelines and education, compared to current state, affect the reduction of false or non-actionable alarms, within six weeks?

METHOD

This quality improvement project utilized Kurt Lewin's change theory and the action research model as a framework for implementation. Lewin's change theory has three basic concepts: driving forces, restraining forces, and equilibrium. Driving forces propel change or cause change to occur. Restraining forces push or oppose the change. Equilibrium is where no change occurs; the driving forces are equal to the restraining forces.[19] Lewin's change theory also has three stages: unfreezing, change, and refreezing.[20] The first stage is the unfreezing of current processes or behaviors and preparing for change. The challenge of this stage is to help individuals overcome their resistance to change. This is accomplished by increasing driving forces and decreasing restraining forces. The second stage is the moving or changing phase. This stage involves movement toward change and encouraging adaptation to change. The final phase, refreezing, is where the change is reinforced and sustained. It is important to make sure that the change is sustained or old practices will return.[21,19,20] This project was submitted to both the hospital and college institutional review boards, and it was determined that it did not meet the criteria for human subject research.

Action research follows the nursing process: assessing, planning, implementing, evaluation, and replanning. Nurses prefer to use action research for its success in system improvement and ease of use.[22] Action research is based on the assumption that the researcher is best able to understand, assess, plan, and evaluate the issue. The goal of action research is to improve a system process and to generate knowledge. Performance indicators are measured before and after intervention to determine whether the action research goals were reached. Reflection is an important step in this process; it allows researchers to evaluate the new progress and determine if further interventions are needed or if change was effective.

Setting

This quality improvement project took place in a Magnet-recognized, 390-bed, not-for-profit hospital in the Pacific Northwest. The four centralized cardiac monitoring units/care areas and their nurses were included in this project. A centralized cardiac monitoring unit was defined as any unit with the capability of continuously monitoring the cardiac status of their patients in a centralized area on the same unit to which the patient is assigned, and has trained telemetry technicians assigned to perform monitoring tasks. The four care areas with centralized cardiac monitoring at this organization are the intermediate care unit (IMCU), progressive care unit (PCU), acute neuroscience unit, and the acute medical telemetry unit. The IMCU is a 29-bed unit that is a critical care step-down unit. This unit primarily cares for post-cardiac surgery patients, averaging 26 telemetry patients a day. The PCU is a 29-bed unit that takes cardiac intervention patients. The PCU averages 23 telemetry patients a day; it is also responsible for monitoring the majority of the remote telemetry patients. The acute neuroscience unit, a primary stroke center, cares for all the neurological and stroke patients, and is a 25-bed unit that averages nine telemetry patients a day. The acute medical telemetry unit, a 25-bed unit, is a medical surgical unit that has on average seven telemetry patients a day, and cares for a variety of dual diagnosis patients.

Intervention

The plan included using evidence-based practice (EBP) recommendations to reduce alarm fatigue through the development of a policy, guidelines and education.

Policy and guidelines

TJC, as part of the 2014 National Patient Safety Goal,[6] requires each organization to establish policies and procedures around clinical alarms. The AACN and TJC have recommended cardiac monitoring as one of the initial physiological monitors for organizations to focus on. Each organization’s policy should include information on who can set alarms, who has the authority to disable alarms, who can change parameters, who can set alarm signals, who can turn off monitoring, who will respond to alarms, and who verifies that equipment is operating appropriately.[4–6] Additionally, Cvach[1] and the AACN[17] made several EBP recommendations related to cardiac monitoring: education on monitoring equipment, suspending alarms during direct patient care, adjusting alarm parameters based on the clinical picture of the patient, documenting alarm parameters within the electronic medical record (EMR), preparing the skin prior to placing electrodes, and placing electrodes properly.[13,16,23] The interprofessional team reviewed and integrated TJC requirements, elements of former cardiac monitoring policies, and workflows of each care area into a new cardiac monitoring and alarm management policy and guidelines.

Education

Education revolved around the integration of EBP recommendations to reducing non-actionable cardiac alarms. Education was distributed to nurses, telemetry health unit coordinators/telemetry technicians (THUC), who provide the continuous monitoring of cardiac patients, and certified nursing assistants (CNA). Prior to initiating education, each floor’s unit based council (UBC), a group that assists in self-governing their care area, was contacted and consulted. Only three of the UBCs participated; the fourth, the acute medical telemetry UBC, did not have an active UBC at the time. The UBCs were informed of new policy and guidelines, after which they collaborated and developed an individualized education plan, and identified key staff to assist with the education.

Education occurred in two phases. Phase one included a one-page information sheet that reviewed the significance of alarm fatigue. Phase two included strategies for reducing non-actionable alarms, comprising the “Reduce the NOISE” campaign. The acronym NOISE was used to help staff remember strategies: N = new electrodes every 24 hours; O = optimized alarm parameters; I = indication for cardiac monitoring; S = suspend during direct patient care; E = electrode placement and proper skin preparation.

Phase two: education

N = new electrodes every 24 hours

Prior to the cardiac alarm management policy, there were no guidelines on how often electrodes were to be changed. The staff were taught to follow the EBP recommended strategies, and change electrodes every twenty hours.[1,5,9,13,23] Each UBC determined who was responsible for changing the electrodes, and when they wanted the changes to occur. Most units elected to have electrodes changed between 7 a.m. and 2 p.m. nurses were responsible for making sure electrodes were changed, but CNAs could change them if time permitted. To validate electrode changes, the UBC was encouraged to use an audit tool, completed by the nurses or CNA, to verify task completion.

O = optimize alarm parameters

Default settings were reviewed with the nurse and THUC. Nurses were responsible for reviewing the set parameters on their monitored patients, and were taught to set parameters based on the clinical picture of the patient. THUCs were encouraged to collaborate with the nurse and give recommendations on parameter changes and when parameters needed to be reviewed. Nurses were also asked to collaborate with providers on parameter changes.[1,4,5,16,23]

I = indication for cardiac monitoring

An introduction on the American College of Cardiology (ACC) and American Heart Association (AHA) guidelines for managing non-intensive care unit (ICU) patients requiring cardiac monitoring was given to the caregivers. This guideline was used to determine which patients needed cardiac monitoring and the length of time for which monitoring was necessary.[5,24,25] Nurses were encouraged to collaborate with their provider partners on justifying continued use of cardiac monitoring. Later in 2016, in an effort to continue decreasing alarm fatigue, the EMR will signal nurses and providers to justify continued use of cardiac monitoring outside the ICU.

S = suspend alarms during direct patient care

Many alarms were initiated because patients were removed from monitoring for self-care or testing purposes. Nurses and CNAs were encouraged to notify the THUC to have the patient placed in suspend mode until the activities were completed.[1,5,23]

E = electrode placement and proper skin preparation

In addition to changing electrodes, nurses and CNAs were given instruction on proper skin preparation and placement of electrodes. All caregivers and CNAs were taught to use soap and water to clean the skin, to avoid use of alcohol swabs, and to use a washcloth or gauze to dry skin prior to electrode placement, as this helps to roughen the skin. The nurses and CNAs were taught to stay away from implanted devices, scar tissue, irritated skin, and bony surfaces. Staff were given the AACN's diagram for proper lead placement.[1,5,23,26]

Analysis

Two measures were used to gauge the effectiveness of a cardiac monitoring policy, guidelines, and education. First, the number of alarms in each care area per patient per day was gathered from the centralized cardiac monitoring equipment. This data was gathered both pre- and post-intervention to determine whether the number of alarms was affected. The second measurement was completed using a survey. This survey was used to calculate the nurses' perception of alarms and the effectiveness of policy both pre- and post-intervention.

Survey on the perception of alarms

A survey was used to analyze the nurses' perception of alarms and the usefulness of the policy and guidelines. This ten-question survey used questions similar to a national survey on physiological alarms to determine the attitudes and practices related to clinical alarms.[12,14,27] The survey included five demographic questions and five questions related to perception of alarms, sensitivity to alarms, and effectiveness of alarm management policy and guidelines. A five-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) was used to analyze the perception of alarms.

Cardiac monitoring alarm data

The cardiac monitoring equipment was used to collect data on the number of alarms for an eight-day period (Monday through Monday) in four care areas: the IMCU, PCU, acute neuroscience unit, and the acute medical telemetry units. A census of the total number of telemetry patients per month per care area was collected from the revenue and usage report, and an average number of patients per day per care unit was calculated. The alarm data was compared by both the care area and the classification of alarm: arrhythmia, parameter, and technical.

RESULTS

This quality improvement project implemented a new alarm management policy and education as a means to reduce the number of non-actionable cardiac alarms.

Perception of alarms

The perception of cardiac alarms was collected both pre- and post-implementation through a survey. The perceptions of 146 telemetry nurses were gathered; 78 surveys were completed pre-intervention and 68 post-intervention. In this survey, 88% of participants were female, and 48% of participants had less than five years of nursing experience. The demographics for the two populations, pre- and post-intervention, were homogeneous (all p-values > 0.05) and should not have interfered with the impact of perceptions (Table 1).

The results for the five questions on the perception on alarms are summarized in Table 2. The last question, "Clinical policy and guidelines regarding alarm management are effectively used in my facility?" shows a significant difference between pre- and post-intervention responses. The percentage of disagreement on "Clinical policies and guidelines are effectively used?" reduced after intervention ($p < 0.018$).

Cardiac monitoring data

When all the care areas were combined into the three alarm classifications, arrhythmia events increased from 36% to 54% after intervention, parameter events decreased from 42% to 34%, and technical events decreased from 21% to 12% post-intervention (Table 3). There was significant variation among care areas, so the t-test was run by care area. A total of 6,282 alarms were compared: 2,454 pre-intervention and 3,828 post-intervention. PCU showed a significant decrease in both parameter and technical alarms ($p < 0.001$); IMCU had a significant decrease in technical alarms ($p < 0.001$); and the acute neuroscience unit had a significant decrease in parameter alarms ($p < 0.001$). The acute medical telemetry unit did not show any significant changes (Table 4).

Relationships to other evidence

The result of this project further supports that the implementation of key strategies such as changing electrodes every 24 hours, proper skin preparation and placement, customizing alarm parameters, suspending alarms during direct patient care, and the appropriate use of cardiac monitoring can reduce the number of cardiac alarms, thereby reducing alarm fatigue.

Sendelbach, Wahl, Anthony, and Shotts[23] were able to reduce cardiac alarm by 88.5% in a one-year period. Over that year, they released four phases that focused on different alarm management strategies. Phase one consisted of daily electrode changes and standardization of skin preparation. They reported a reduction of alarms from 28.50 at baseline to 18.52 on their pilot. They targeted one ICU, whereas this project was implemented in four non-ICU units. Another study by Walsh-Irwin and Jurgens,[26] with a sample size of 15 patients, used a prospective descriptive design to determine whether proper skin preparation and electrode placement would reduce the number of alarms. The study counted the number of alarms pre-intervention and post-intervention and showed a 44% reduction in alarms by utilizing proper skin preparation and appropriate placement.

DISCUSSION

This quality improvement project is in its initial stages. At six weeks post-implementation, three of the four care units started to show a reduction in cardiac alarms. Several problem areas have been identified and recommendations have been offered to further reduce nuisance alarms. The first problem that has been identified is that nurses are not comfortable customizing the alarm parameters on the cardiac monitoring equipment. Some nurses understood the importance of customizing parameters, but did not feel comfortable adjusting the monitoring equipment. It was recommended that representatives from the monitoring equipment company come in and teach a group of stakeholders, nurses and THUCs how to properly customize the monitoring equipment parameters. This stakeholder group would then train other nurses and THUCs on how to adjust parameters utilizing the “train the trainer” model and provide education. Additionally, it was found that education on the importance of customizing alarm parameters needs to be reinforced on units that have a high number of new graduate nurses and high turnover such as the acute medical telemetry care area.

Elimination of duplicate alarms was identified as another opportunity for improvement. Sendelbach, Wahl, Anthony, and Shotts [23] recommended the elimination of duplicate alarms. Currently, the monitoring equipment has two sets of duplicate alarms; tachycardia and high heart rate, and bradycardia and low heart rate. A recommendations, following suit with Sendelbach, Wahl, Anthony, and Shotts [23], is to eliminate high and low heart rate from the monitoring equipment to avoid redundant alarms.

The final opportunity discovered was to increase support. The three care areas that showed improvement had UBC involvement. The acute medical telemetry unit did not have an active UBC; therefore, there was limited support for this initiative. The acute medical telemetry unit also had a high turnover and more new graduate nurses, which warranted additional reinforcement of education. Additional support is needed from the managers, educators, and director. Although there was an audit system in place, there was no follow-through on task completion or the ability to reeducate in the moment. The recommendation is to have the director, managers, educators, and the UBC review the current audit tool and develop a plan to increase compliance and offer additional education and support for this initiative.

Summary

Large numbers of false or non-actionable cardiac alarm are compromising patient safety. TJC has required hospitals to write a policy on alarm management, on their chosen physiologically monitoring device, in hopes of reducing this “crying wolf” phenomenon promoting patient safety. A quality improvement effort was made to determine if a cardiac monitoring and alarm management policy, guidelines and education would reduce the number of non-actionable cardiac alarm on four telemetry units. A policy and guidelines were written and education disbursed in two phases. Six weeks post-implementation three of the four units showed a significant reduction in cardiac alarms. The development of a policy and guidelines was found to be a foundation to build on. Additional interventions and supports will be needed to help further reduce non-actionable cardiac alarms.

Limitations

This was a quality improvement project, and, therefore, the results cannot be generalized. Direct cause-and-effect relationships cannot be established, either. It could not be determined that the policy and guidelines directly affected the quality of healthcare on the unit. However, it could be determined that a reduction in the number of alarms caused a reduction in alarm fatigue. Because monitor tracing (the monitor screen output of the electrophysiology of the heart) was not assessed, it could not be determined for sure that the alarms that signaled were clinically significant. Only the total number of alarms could be calculated. Furthermore, the determination of perception of alarms could not be directly linked to cardiac alarms as there were many different types of monitors on the units and the survey did not specify cardiac alarms exclusively. It would also have been difficult to single out just cardiac alarms from all the other noises on a unit.

Conclusion

This project demonstrated that the publication of a cardiac alarm policy and education can set a foundation for improvement in the reduction of non-actionable alarms. However, publication of a policy and guideline is not adequate to move change into sustainability or a refreeze state. Currently, this organization is still in the moving stage of implementation. Although there are driving forces that are propelling this project, there are several restraining forces that prohibit full implementation of recommended alarm management strategies. The driving forces, such as changing electrodes every 24 hours and proper placement and skin preparation, are being utilized and sustained through continued education in patient care orientation, required yearly CNA training, and reinforcement of the UBC. However, the restraining forces, such as setting parameters, leadership and education support, and elimination of duplicate alarms, are pushing against a refreeze stage.

The recommendations fall in line with the elimination of the restraining forces, and aligning the restraining forces with the driving forces to create a balanced state effecting change. This would include education to staff on how to customize the parameters on cardiac monitors, diminish the nurses' resistance to making change, and increase their understanding on how to work with the monitoring equipment. Eliminating duplicate alarms would reduce repetitive alarms from the same cause. Finally, and most important, is to increase support. The managers, educators, UBC, and director need to come together in a joint effort to drive the alarm management strategies forward to create a safer patient environment. However, it should be kept in mind that at only six weeks post-publication of the policy and education, three of the four care areas did show significant reduction in one or more classification of alarms. This leads us to believe that through reinforcement of alarm management strategies the organization can push past the restraining forces and see significant change in all care areas and in all classifications of alarms.

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Table 1
Demographic Summary

		Pre-Intervention		Post-Intervention		
		Frequency	%	Frequency	%	*p* - value*
N		78		68		
Gender	Female	69	88	59	87	0.756
	Male	9	12	9	13	
Age	18-29	22	29	21	31	0.855
	30-39	23	30	25	37	
	40-49	14	18	10	15	
	50-59	13	17	11	16	
	60	5	6	1	1	
Highest Nursing Degree	ADN	28	36	27	40	0.855
	BSN	49	63	40	60	
	MSN	1	1	0	0	
Care Area	IMCU	13	17	19	28	0.139
	Medical Telemetry	30	39	15	22	
	Neurological	18	24	20	29	
	PCU	15	20	13	19	
	Other	0	0	1	1	
RN Experience	0-5 Years	36	46	34	50	0.491
	11-15 Years	2	3	5	7	
	16+ Years	14	18	9	13	
	6-10 Years	26	33	20	29	

Table 2

Summary of Nurses' Perception of Alarms

		Pre-Intervention Frequency	%	Post-Intervention Frequency	%	*p* -value*
Q7_1 Is the noise level on your unit acceptable?	Strongly Disagree	2	3	2	3	0.429
	Disagree	28	36	20	29	
	Neutral	23	29	20	29	
	Agree	22	28	26	38	
	Strongly Agree	3	4	0	0	
Q7_2 Nuisance alarms occur frequently?	Strongly Disagree	1	1	0	0	0.544
	Disagree	13	17	9	13	
	Neutral	15	20	17	25	
	Agree	37	49	37	54	
	Strongly Agree	10	13	5	7	
Q7_3 Nuisance alarms disrupt patient care?	Strongly Disagree	3	4	0	0	0.238
	Disagree	12	15	7	10	
	Neutral	16	21	16	24	
	Agree	33	42	37	54	
	Strongly Agree	14	18	8	12	
Q7_4 Clinical staff are sensitive to alarms and respond quickly?	Strongly Disagree	1	1	2	3	0.547
	Disagree	13	17	9	13	
	Neutral	14	18	14	21	
	Agree	30	38	32	47	
	Strongly Agree	20	26	11	16	
Q7_5 Clinical policies and guidelines regarding alarm management are effectively used in my facility?	Strongly Disagree	0	0	0	0	0.018
	Disagree	16	21	4	6	
	Neutral	25	32	23	34	
	Agree	26	34	36	53	
	Strongly Agree	10	13	5	7.35	

Table 3
Overall Alarm Rates by Classification

Classification	Pre-Intervention		Post-Intervention		Total		
	Frequency*[1]	%	Frequency	%	Frequency	%	*p* -value*[3]
Arrhythmia	893	36	2065	54	2959	47	<.001
Parameter	1038	42	1318	34	2356	37	<.001
Technical	523	21	445	12	968	15	<.001
Total N	2454		3828		6282		

Table 4

Alarm Rates for each Classification and Care Area

Care Area	Classification	Pre-Intervention Frequency*[1]	%	Post-Intervention Frequency	%	Total Frequency	%	*p*-value*[3]
IMCU	Arrhythmia	285	44	975	54	1260	51	<.001
	Parameter	320	49	795	44	1115	45	0.026
	Technical	49	8	46	3	95	4	<.001
Medical Telemetry	Arrhythmia	114	41	97	38	211	40	0.399
	Parameter	107	39	109	42	216	40	0.509
	Technical	54	20	53	20	107	20	0.911
Neurological	Arrhythmia	166	37	178	52	344	43	<.001
	Parameter	152	33	44	13	196	25	<.001
	Technical	137	30	118	35	255	32	0.188
PCU	Arrhythmia	328	31	815	58	1143	46	<.001
	Parameter	459	43	370	26	829	33	<.001
	Technical	283	26	228	16	511	21	<.001