

University of Alabama in Huntsville

**LOUIS**

---

Doctor of Nursing Practice (DNP)

UAH Electronic Theses and Dissertations

---

2013

## **Promoting a safe clinical environment through the use of an evidence-based protocol to reduce alarm fatigue**

Richard C. Meeks

Follow this and additional works at: <https://louis.uah.edu/uah-dnp>

---

### **Recommended Citation**

Meeks, Richard C., "Promoting a safe clinical environment through the use of an evidence-based protocol to reduce alarm fatigue" (2013). *Doctor of Nursing Practice (DNP)*. 3.  
<https://louis.uah.edu/uah-dnp/3>

This Doctor of Nursing Practice (DNP) is brought to you for free and open access by the UAH Electronic Theses and Dissertations at LOUIS. It has been accepted for inclusion in Doctor of Nursing Practice (DNP) by an authorized administrator of LOUIS.

**PROMOTING A SAFE CLINICAL ENVIRONMENT THROUGH THE USE OF  
AN EVIDENCE-BASED PROTOCOL TO REDUCE ALARM FATIGUE**

by

**RICHARD C. MEEKS**

**A SCHOLARLY PROJECT**

**Submitted in partial fulfillment of the requirements for the  
Degree of Doctor of Nursing Practice  
in  
The Joint Doctor of Nursing Practice Program  
of  
The University of Alabama in Huntsville  
The University of Alabama at Birmingham  
The University of Alabama  
to  
The School of Graduate Studies  
of  
The University of Alabama in Huntsville**

**HUNTSVILLE, ALABAMA  
2013**

In presenting this scholarly project in partial fulfillment of the requirements for a doctoral degree from The University of Alabama in Huntsville, I agree that the Library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by my advisor or, in his/her absence, by the Director of the Program or the Dean of the School of Graduate Studies. It is also understood that due recognition shall be given to me and to The University of Alabama in Huntsville in any scholarly use which may be made of any material in this dissertation.

Phillip C. Meeks      3-1-13

Student Signature

Date

## SCHOLARLY PROJECT APPROVAL FORM

Submitted by Richard C. Meeks in partial fulfillment of the requirements for the degree of Doctor of Nursing Practice and accepted on behalf of the Faculty of the School of Graduate Studies by the scholarly project committee.

We, the undersigned members of the Graduate Faculty of The University of Alabama in Huntsville, certify that we have advised and/or supervised the candidate on the work described in this scholarly project. We further certify that we have reviewed the scholarly project manuscript and approve it in partial fulfillment of the requirements for the degree of Doctor of Nursing Practice.

3-1-13 Joy Anderson Committee Chair  
(Date)

Gary L. Hays

Cynthia R. Hansen

\_\_\_\_\_

\_\_\_\_\_

Joy Anderson Program Director

Jay Raines College Dean

Thonda Kay Stede 3/7/13 Graduate Dean

## **ABSTRACT**

The School of Graduate Studies  
The University of Alabama in Huntsville

Degree: Doctor of Nursing Practice College: Nursing

Name of Candidate: Richard C. Meeks

Title: Promoting a Safe Clinical Environment Through the Use of an Evidence-Based Protocol to Reduce Alarm Fatigue

**Background** Alarm related deaths are increasing. As complexity in the clinical environment increases, patient notifications are sent to clinicians as an approach to prevent adverse events. Each notification must be analyzed for action. This increase in stimulation can lead to clinician desensitization and an unsafe environment.

**Purpose** To promote a safe patient environment through the implementation of an evidence-based project to increase awareness and to reduce potential adverse effects of clinical alarm fatigue.

**Implementation** A series of focus groups and observational assessments were conducted in an acute care hospital. Focus group participants, n=10, reported themes of constant interruption of central station alarms, telephone calls and the increase of clinical interactions due to patient volumes. Participants also expressed need for a clear, concise alarm management policy. There were 829 interactions within a 36 hour period, 276 interactions per shift, or one interaction every three minutes. Of those interactions, the top three categories were physiologic monitor 30.88%; clinical interactions 25.94%, and equipment alarms from a portable ventilator machine 13.99%. Of these, approximately 70% required action. The clinical alarms totaled 256 or 85 alarms per shift, seven alarms per hour. Of the three types of alarms, urgent alarms represented 78% of all physiologic

alarms, with 87% of those alarms required action. As a result of these findings, a proposed policy and staff educational plan was developed.

**Discussion** Although alarms are significant warning signs in the clinical environment, overuse can lead to clinician desensitization. This evidence-based project identified patient safety issues and evidence-based solutions to decrease excess alarms and increase action of caregivers in response to alarms.

Key words: Alarm, fatigue, monitoring, technology, nursing, nuisance alarms

Abstract Approval:

Committee Chair

*Faye Anderson*

Program Director

*Faye Anderson*

Graduate Dean

*Thonda Kay Haede 3/7/13*

## **ACKNOWLEDGEMENTS**

The work described in this scholarly project would not have been possible without the assistance of a number of people who deserve special attention. First, I would like to thank Dr. Faye Anderson for her support, guidance and mentoring throughout all stages of the work. Second, Dr. M. Peggy Hays for many years of mentoring and encouragement. Third, a special thanks to Lisa Gann, Chief Nursing Officer, Cynthia Hansen, RN and the staff at the project facility for their clinical guidance, and professional friendship over the years.

Last, I would like to thank my partner, Preston Rowland and many family and friends who encouraged me to finish this degree.

## **Promoting a Safe Clinical Environment Through the Use of an Evidence- Based Protocol to Reduce Alarm Fatigue**

The intensive care environment is complex. Adding to the complexity is technology transmitting an array of patient status notifications to health care personnel. As a result, personnel are inundated with bells, beepers, buzzers, and flashing lights (Phillips & Barnsteiner, 2005). Each notification must be analyzed, and a determination must be made whether it is significant (true positive) or has no clinical significance (false positive) (Phillips & Barnsteiner). The increase in cognitive stimulation can create confusion, increase the potential for clinician desensitization, and lead to an unsafe environment for patients (Graham & Cvach, 2010; J. Keller, 2006).

Alarm-related deaths have become a national concern (Freeman, 2010; Jo & Paul, 2012; Kowalczyk, 2011). The Joint Commission (TJC) integrated the awareness and preventive testing of alarms into its Environment of Care (EOC) standards (Jo & Paul; Korniewicz, Clark, & David, 2008). The standards require regular audibility testing, appropriate use, and customization. The Emergency Care Research Institute (ECRI) rated alarm hazards as number one on its 2012 list of priorities and identified problems with monitor alarms as attributable factors in 216 deaths from 2005-2010 (Kowalczyk, 2011).

Clinical alarm integration complexity may contribute to the frequency of alarm-related adverse events (Korniewicz et al., 2008). Alarm integration systems combine communications from various sources and deliver messages to clinicians via end devices such as phones, pagers, nurse call systems and other tactile devices (Clark, 2005).

Integration of clinical alarms into a master facility communication system is



accomplished by software within the facility computer network structure. Often called a clinical orchestrator, this software acts as a conductor of communication to devices carried by the clinician. Receiving signals from any device that is wired into the network, the clinical orchestrator has the ability to relay alarm violations as well as other types of communication to many devices simultaneously.

In a 2008 study, 54 % of respondents saw utility in the integration of alarm and communication systems (Korniewicz et al., 2008). While this relay is helpful in many situations, attachment of clinical alarms to other communication devices, different from the original device, adds a layer of complexity to the alarm chain, potentially lengthening clinical response time (Bell, 2010). This complexity causes a slower alarm response, decreases alarm sensitivity, and increases the potential ignoring of alarms because of multiple notifications.

Alarm fatigue is the term applied to any situation in which clinicians are exposed to environments with excessive noise or disruption (Harris, Manavizadeh, McPherson, & Smith, 2011). The probability of responding to alarms decreases when cognitive stimulation is high (Jo & Paul, 2012). Many factors contribute to this increased stimulation, but perhaps one of the most significant is false or nuisance alarms. Jo and Paul (2012) found nuisance alarm ratings as high as 85% in intensive care and variable acuity environments. Forty three percent of these alarms were redundant alarms created by the same violation traveling through different devices. Graham and Cvach (2010) also found that 85% of false-positive alarms were produced by physiologic monitors, and those alarms produced a change in the management of the patient less than 1% of the time.

Safe and effective management of clinical alarms is a regulatory expectation (Korniewicz et al., 2008). This management is impacted by the hospital's mix of technology, patient care models, population, physical layout, staffing and culture( Keller, Diefes, Graham, Meyers, & Pelczarski, 2011;Yoder & Phillips, 2010). The integration of technology must be purposeful and must consider nursing practice in order to prevent patient harm.

### **Identification of the Problem**

To promote a safe patient environment, a clinical alarm fatigue project was implemented in a community hospital. The facility was a 110- bed community hospital located in southeastern United States. The primary service lines are Medical/Surgical, Emergency, Critical Care Services, Obstetrics and Surgical Services. The patient population was predominantly adult, with a small percentage of pediatrics. This topic was important to the facility because of an incident that occurred in August 2008 resulting in patient death, placing the facility in immediate jeopardy with the state and The Joint Commission. Investigation of this incident indicated a delay in response after an alarm notification of asystole. The patient was observed alive at 10:10am. The patient's physician noted asystole on the central monitor, entered the room at approximately 11:15am and initiated lifesaving protocols. The patient was coded approximately 20 minutes but was unable to be resuscitated. There was no documentation that an alarm had alerted the clinicians and resulted in a response. While this incident did not occur on the project unit, the unit was chosen because of its patient acuity and frequent interaction with multiple alarms.

The Intensive Care Unit (ICU), a 10-bed unit was selected for the project implementation. Staff ratios are determined by acuity, usually 2 patients for each nurse. A 6-lead electrocardiography (EKG) hard-wired monitoring system is standard, utilizing a bedside flat panel display. Alarm volume is defaulted at 40%. Standard rhythm analysis occurs via leads II and IV. Other standard parameters include heart rate, blood pressure, pulse oximetry and respiratory rate. Additional parameters are added as needed according to patient condition. Each device is cleared after patient discharge, restoring settings back to default. Although central monitors are located at the station, clinicians are responsible for monitoring and interpreting alarms. Other necessary equipment is transported into the room according to patient condition. Common patient conditions are coronary artery disease (CAD), chronic respiratory illness, renal disease, gastrointestinal disease and medical sepsis. The patients are monitored for physiological changes such as arrhythmias, hypotension, hypertension and low blood oxygen saturation. Physicians are on-call rather than located in the unit; therefore nurses must be skilled in customizing and responding to clinical alarms. While this skill is an expectation, there is no annual clinical alarm education that is required at this time.

### **Purpose and Objectives**

The purpose of the project was to increase awareness and promote changes in practice to reduce the potential adverse effects of clinical alarm fatigue. The specific objectives were:

1. To increase awareness among hospital leaders and clinicians of the adverse effects of clinical alarm fatigue.

2. To develop an evidence-based clinical alarm policy to reduce clinical alarm fatigue.

### **Review of Evidence**

A literature search was conducted utilizing the University of Alabama in Huntsville (UAH), Middle Tennessee State University (MTSU) and the University of Alabama in Birmingham (UAB) library online database tools as well as the Cumulative Index to Nursing and Allied Health (CINAHL) search engine. Key words included The Joint Commission, alarm, clinical alarm fatigue, alarm fatigue, nuisance alarms, clinical alarms, fatigue in pilots, alarm overload, technology overload, physiological alarms, ICU alarm, telemetry alarm, telemetry alarm fatigue, patient safety, sentinel events and monitoring and telemetry. Limitations placed on the search were English language and a timeframe between 1995 to present. Online database resources provided the majority of literature.

Alarm fatigue occurs when large numbers of notification alarms overwhelm and desensitize providers (Talley et al., 2011). In a quantitative study in a large progressive care unit located in the United States, over an 18 day period with an average daily census of 12, the total number of alarms were 16,953, or 942 alarms per day with a different alarm occurring every 90 seconds (Talley et al.). Harris and others (2011) found false and technical alarms are the most significant sources of excessive alarms in the clinical environment. In 2006, the American College of Clinical Engineers (ACCE) found that 77% of critical care nurses report that nuisance alarms interrupt patient care, reduce trust in alarms, and are disabled by the caregiver (Jo & Paul, 2012).

In another quantitative study conducted in a major teaching hospital in the United States, Joe & Paul (2012) found 83% of alarms were false. Nuisance alarms are a significant source of alarms in the clinical environment (Korniewicz et al., 2008). Nuisance alarms, triggered inappropriately when a clinically significant event does not exist, include both critical and low level priorities. The number of nuisance alarms or false positive alarms is a significant factor in response time (Jo & Paul). Some nuisance alarms are inevitable, but clinicians are more likely to ignore a significant alarm when there is a high rate of nuisance alarms (J. Keller, 2006). Nuisance alarms create a ‘boy that cried wolf’ environment and sidetrack providers from performing routine tasks or lead them to inappropriately silence alarms (Talley et al., 2011). Nuisance alarms also contribute to desensitization, so alarms for clinically significant events go unnoticed and are less likely to elicit a response from clinicians (Korniewicz et al., 2008).

In addition to nuisance alarms, factors contributing to alarm fatigue include complex monitoring systems, tension in the clinical environment, patient assignments and improper training on alarm protocols (Harris et al., 2011). Strategies to manage these factors vary and should be individualized by type of unit and patient population. Reduction of nuisance alarms requires a clinician to fine tune alarm sources (Piepenbrink, 2011). Changes must be based on patient condition, type of monitoring system, and the alarm in excess. Other research indicates consideration should also be given to changes in practice, increased clinician expectations via policy, and staff education (Harris et al., 2011).

Alarm management is the most consistent method to decrease alarm fatigue (Shah 2011). In a unit-based descriptive study, Gram and Cvach (2010) determined an

institutional policy standardizes the use of clinical alarms. Goals of alarm management are to increase actionable alarms alerting staff to clinically significant alarms (Keller et al., 2011). Alarm management protocols are expected by regulatory bodies and should provide clear, evidence-based guidance to clinicians (Mooney, 2003). Alarm management protocols should include key items to decrease nuisance alarms. Components of this protocol are priority of patient and alarm, proper application and use, customizable alarm parameters, methods to decrease nuisance alarms, and critical alarms escalation pathways (Phillips & Barnsteiner, 2005; Weil, 2009).

An alarm schematic should also be incorporated into policy (Shah, 2011). This schematic should include responder notification, response time, and priority of alarms (Ferenc, 2012; Phillips & Barnsteiner, 2005). Consideration should be given to incorporating a brief delay in secondary alarm notification for patient alarms that resolve quickly (Shah).

Ongoing staff education regarding the alarm management protocol is necessary to provide clinicians with alarm management skills and expectations to decrease nuisance alarms and potential patient harm (Harris et al., 2011; Phillips & Barnsteiner, 2005; Richardson, 2004; Weil, 2009). Based on findings from a descriptive study evaluating effectiveness of clinical alarms sponsored by ACCE, Korniewicz and others (2008) recommended a system-wide educational plan be instituted in order to standardize appropriate responses to alarms. Alarm management training should be provided upon initial employment, and annually (Korniewicz et al., 2008; Richardson, 2004). In addition, alarm drills should be arbitrarily completed to observe response times after an

alarm is triggered. As understanding and customization of alarms increases, alarm noise will decrease (Phillips & Barnsteiner, 2005; Weil, 2009; Shah, 2011).

In summary, alarm fatigue has contributed to patient injuries and deaths (Ferenc, 2012). Patient harm is attributed to slowed or absent response to alarms. Multiple nuisance alarms create an environment of desensitization and a “culture of ignoring alarms” because the assumption is the alarms are false (Graham & Cvach, 2010). Alarm fatigue had multiple contributory factors including nuisance alarms, improper training, tension in the clinical environment, and complex monitoring systems (Jo & Paul, 2012). Phillips and Barnsteiner (2005) indicate the management of alarm fatigue should consider changes in practice patterns, expectation setting via policy as well as ongoing staff education. An overview of the research details the need for an alarm management strategy, including ongoing education and guidance policy (Bell, 2010; Catalano, 2005; Clark, 2005; Ferenc; Freeman, 2010; Graham & Cvach; Harris et al., 2011; Jo & Paul; Keller et al., 2011; Korniewicz et al., 2008; Kowalczyk 2011; Mooney, 2003; Piepenbrink, 2011; Phillips & Barnsteiner; Richardson, 2004; Shah, 2011; Talley et al., 2011; Weil, 2009).

### **Guiding Theory**

The organizing framework for this project is derived from Bertalanffy’s general systems theory. Bertalanffy (1968), a biologist, proposed a single framework to account for the similarities found in many disciplines. A system is defined as a set of strong interactions or complexities within an organization, scientific endeavor or social interaction. Many aspects of a system are non-linear providing a strong network or bond

to other concepts. This non-linear relationship is important because of complexity of the clinical environment, and the need for bi-directional communication during practice changes.

Bertalanffy (1968) described the theory as the science of wholeness. Wholeness, is the dynamics of integrated parts that may not be well understood by the study of one aspect in isolation (Bertalanffy). The concept of wholeness is interwoven, acting as glue to bond concepts together. The natural tendencies of a system may be open or closed, generated because of the need to be isolated or 'separated' from other environmental factors. Rapoport and Horvath (1968) described the theory's necessity because of the increasing complexity of future environments including many non-scientific interactions. Bertalanffy's system theory was selected to guide the project because of the aspect of joining unrelated, non-linear concepts from different disciplines into a common body of knowledge (Kast & Rosenzweig, 1972). The theory was also chosen because of its accuracy and complexity to study and alter environments that are not conducive to experimentation (Badcock, 2012).

Unity of science in the systems theory is the translation of the theory into physical events (Bertalanffy, 1968). These physical events are realistic aspects of encounters, observable events, and organization at all levels of a system. Translated into aspects particular to this project, Bertalanffy's aspects of realism, observable events, and organization contribute to the success and failures of a clinical protocol, and the clinician's ability to incorporate alarm management strategies into practice. For example, hospital protocols for alarm management must provide clear guidelines for clinicians, including order of response, timeframe and patient need. Failure to respond appropriately



leads to an increasing number of nuisance alarms, increased clinician stress and anxiety, and adverse patient events such as death (Harris et al., 2011). Development of a standard policy regarding alarm management is supported by Bertalanffy's thoughts on the unity of science as patient interactions are realistic events, and policy provides a level of development or organization to a practice.

Bertalanffy (1968) incorporated aspects of education or an educational generalist into the theory, providing for a more integrative educational approach to scientific problems. Balance is necessary in a complex system. Problems arise when ideas are inserted into a complex system, and balance is altered (Badcock, 2012). For example, integration of bedside monitoring devices into the communication structure of an organization can lead to duplication of alarms, missed alarms, and a slow response time. These events occur as a result of a concept inserted into an environment, altering its balance.

To be viable, a system must be goal-directed, feedback driven, and adaptable to change (Bertalanffy, 1968). The conceptual model (Appendix A) visually describes this relationship and the use of feedback as a driver of sustainability. An integral part of this model is the feedback loop. This loop is interwoven into each aspect of the model and drives the shared outcome.

Each of the framework components has an impact on the overall success and sustainability of the clinical environment. While this project is focused on alarm fatigue, each aspect of the conceptual framework is an integral part of the environment, providing constant feedback, to achieve the shared outcome, quality patient care. The concept of

alarm fatigue is an aspect of the environment, and interacts with all components within the framework.

### **Project Design**

Hospitals proposing improvement in alarm management should conduct an observational assessment. This assessment is a systematic, critical analysis of how alarms are used on a particular unit (Keller et al., 2011). Historical data such as root cause analysis (RCA) data, failure mode effects and criticality analysis (FMECA) and negative outcomes data are also used to identify alarm notification, response and customization strategies (Keller et al.). Assessment, intervention, and education are the cornerstones for decreasing environmental hazards in the clinical environment (Talley et al., 2011).

In this project, focus groups of clinical staff were used to review use of clinical alarms and existing policies regarding alarm management. A focus group approach was an effective interview tool in this case because participants share similar characteristics, experiences and backgrounds (Rodriguez, Schwartz, Lahman, & Geist, 2011). Also, it provided an avenue for participants to share attitudes, beliefs and opinions (Papastavrou & Andreou, 2012). Perceptions of the clinical staff regarding alarm-related concerns and observations of how alarms are used in a particular care area provided baseline information regarding the unit's culture of alarms and alarm strategies.

### **Implementation Strategies**

This quality improvement project began with the UAH Institutional Review Board approval in November 2012. A presentation of the project to facility executive and unit leaders occurred in November 2012. A total of 14 leaders were present, representing

all major service areas, including the project unit. Leaders were provided information on the literature review, the guiding theory, the project design, implementation strategies, and projected timeline. Discussion occurred regarding barriers to the project including potential clinician anxiety during the observational periods. The strategies used to decrease these barriers included providing participants an overview of the project and answering any questions prior to observation.

Focus groups were organized in November 2012; 40% of full and part time staff members (n=10) participated in the groups. Purposive sampling was utilized in order to gain all skill levels of clinicians that interact with monitoring equipment. Groups were limited to a maximum of 5 participants each in order to encourage participation (Papastavrou & Andreou, 2012). Both groups differed in terms of educational level, skill mix, and number of years on the job as well as accountability for interacting with alarms. Unit leaders were not included because of the possibility that these members could dominate the conversation and decrease discussion due to the potential power distinction between participants.

An interview guide (Appendix D) was developed according to the strategies of engagement, exploration and exit (Rodriguez, et al., 2011). Both focus groups were conducted by the investigator, acting as the moderator. The interviews lasted approximately 60 minutes and took place in the ICU break room between December 2012 and January 2013. Each group began with participant and moderator introductions. To start the interview process, participants were asked to think back on a typical busy day in the ICU with adequate staff. A 2 minute period of silence was given in order for participants to engage in that experience and remember particular situations (Rodriguez,

et al.). Questions were asked in order and open ended responses were documented. Finally, an additional 2 minute period of silence was used after reading the exit question (Rodriguez et al.). The exit question was structured as open-ended in order to encourage dialogue, summarize points and clarify any outstanding issues by participants (Papastavrou & Andreou, 2012). Data analysis occurred after each focus group session and was not shared with participants. Data were read, highlighting key thoughts, impressions or concepts. The researcher compared findings with existing literature to determine further analysis and areas of focus.

An observational assessment was used to review the occurrences of interactions on a particular unit. An observational approach was effective in this case because it provided a systematic review of alarm management, and how interruptions affected patient care (Keller et al., 2011). The investigator observed a total of three 12 hour shifts (7 am to 7 pm) in the project unit. Shifts were randomized during the months of December 2012 through January 2013 in order to experience patient volume fluctuations and changes in staff. The day shift was observed because it is busiest with the most interactions including call bells, alarms, physician interactions and other disruptions. The investigator was assigned to observe particular patients by the charge nurse in order to minimize any perception that the observer was a threat or making judgments regarding practice that would be reported to nursing leadership. No clinicians or patients were observed more than once. Clinician educational level, skill mix and number of years on the job did not factor into observational assignments. Clinicians to be observed were provided with an informed consent and were given the opportunity to decline participation prior to the start of the observational assessment. No clinicians declined.

An interaction was defined in this project as any exchange between clinicians and equipment while providing patient care. Interactions did not include any interactions during time that care was not being provided. Clinical interactions were defined in this project as clinician to clinician interactions necessary for delivering patient care; those included discussing status of patients, asking for assistance, or consulting others regarding patient status.

Data analysis occurred after each observational shift and was not shared with participants or nurse leaders. Descriptive statistics were used for the study data. Inferences were also drawn regarding peak times, alarm volume and response times. Initial data collected included the number of interruptions for the total time period of monitoring. The following calculations were made:

- a. Average number of interactions per shift (Total number of interactions/ total observation time).
- b. Average number of clinical alarms per shift (Total number of clinical alarms/total observation time).
- c. Average number of actionable alarms per shift
- d. Average number of equipment interactions per shift (Total number of equipment interactions/total observation time).
- e. Average number of clinical interactions per shift (Total number of clinical interactions/total observation time)

Utilizing findings from the observational assessment, a draft hospital policy was created entitled “Preventable Strategies to Reduce Alarm Fatigue” (Appendix F).

Incorporating aspects of two hospital wide policies already in existence, the proposed policy included the following:

- a. Relevant literature review and references
- b. Alarm prioritization strategy and proposed expected response times
- c. Strategies for alarm standardization and review
- d. Strategies to reduce alarm fatigue
- e. Strategies for alarm management in the clinical environment
- f. Goals for clinicians regarding alarm response, customization and silencing parameters.
- g. Alarm audibility standardization
- h. Annual educational requirements
- i. Equipment testing, repair, maintenance and purchase requirements
- j. Nursing and leadership considerations.

A facility alarm policy is in existence. This policy was approved in February 2006 and reviewed bi-annually. The last review of this policy was November 2011. The policy did not meet the scope of this project because it is limited in detail and has no defined base of clinical evidence. Also, the current policy does not address alarm standardization, response time expectations or educational requirements. When approved, the proposed policy will provide clinicians with a comprehensive alarm management policy including aspects of relevant literature, alarm reduction strategies, clinician education and competency requirements.

An educational plan (Appendix G) was also developed utilizing project findings. This plan included an in-depth literature review, evidence based actions as well as a comprehensive list of references and resources. This educational plan is designed to provide the basis for initial education as well as an annual update for clinicians.

Post implementation informational sessions were provided in February 2013 in two separate sessions; one to unit clinicians and one to hospital-wide nurse leaders. Informational sessions included findings from the literature review, project overview and unit observational results. Groups also discussed alarm management strategies and recommendations for practice. Each informational session was followed by a project evaluation.

Participants completed a project evaluation (Appendix B). One question scored on a 6 point likert-type scale from 1 (not at all) to 6 (entirely) asking participants to rate application of this project to current practice. Other questions were open ended, requesting participants to identify two alarm reducing strategies, and two additional areas participants could adjust their practice as a result of this project. Participants were asked to describe any potential barriers to practice changes as well as any general comments regarding clinical alarms.

### **Evaluation**

A total of 10 clinicians participated in two focus groups (group A n=5, group B n=5). Fifty percent of participants stated alarms were an issue on the unit, with repeating themes regarding alarm management. An increase in alarms relative to patient volume, and the lack of control over alarms in rooms were among those most noted by

participants. All participants denied that alarm-related events have occurred on the unit. All participants concluded the number one disturbance that interrupts patient care was telephone calls. Participants could not differentiate calls from the wireless unit phone or another source as all calls route through a central location. When asked what alarm occurs most often, 70% of participants referenced the central station, while other specifically described heart rate alarms or artifact. Half of the participants stated there was not an alarm management policy in place on the unit, while 30% were unsure. When participants were asked how they prioritize alarms, 90% said they prioritize based on alarm severity. Participants stated customization (personalization of alarm parameters according to patient condition) occurred often in the shift, including customization of alarms after a baseline protocol was gathered. Coincidentally, 70% of participants stated a standard configuration of alarms existed, while 20% stated alarms did not reset when patient discharge occurs. Ninety percent of participants recognized feeling overwhelmed with many interruptions per shift. When participants were asked to estimate the number of interruptions per shift, 70% stated greater than 100. When asked the exit question, clinician's interaction with the central station was identified as a common theme. Participants noted constant sounding of alarms, and 30% of participants reported that the central station was constantly printing unwanted strips, potentially wasting paper.

Common themes evolved from focus groups. These were the constant interruptions of central station alarms, telephone calls and the increase of clinical interactions relative to patient volume. Participants underscored the need for an alarm management policy and protocol to guide practice on this unit.



During the 36 hour observational period, the total number of interactions was 829 with 276 interactions per shift or one interaction every three minutes (Figure 1).

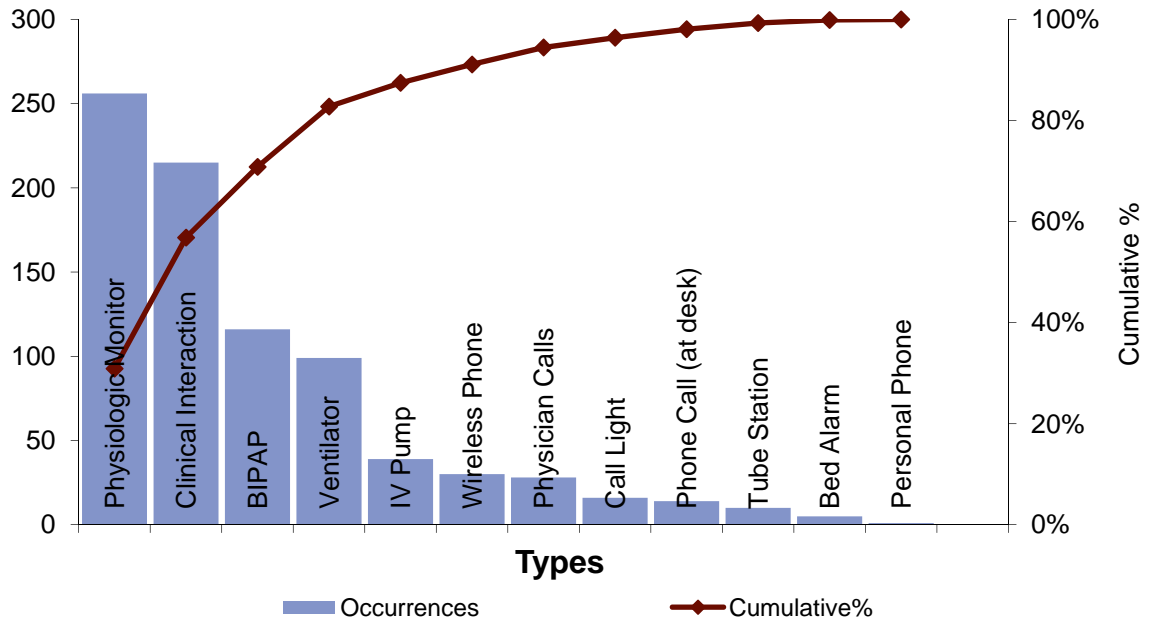


Figure 1 Total interactions by category

Peak interaction times were 7 am to 9 am and 11 am to 12 noon. The top three interactions were physiologic monitor 30.88%; clinical interactions 25.94% and equipment alarms from a bi-level positive airway pressure (BIPAP) machine 13.99%. Of these interactions, 70% required action.

For the same period, clinical alarms totaled 256 or 85 alarms per shift, seven alarms per hour. Of the three types of alarms, urgent alarms represented 78% of all physiologic alarms, 87% of those alarms did not require action (Figure 2). While only 1.5% of all alarms were critical, 100% required action and were answered by a clinician immediately. Technical alarms were 21% of all alarms. Room alarm volume ranged

from 10% to 50% per room. Central station volumes were consistently set at 80% audibility. Customization of physiologic alarms was not observed.

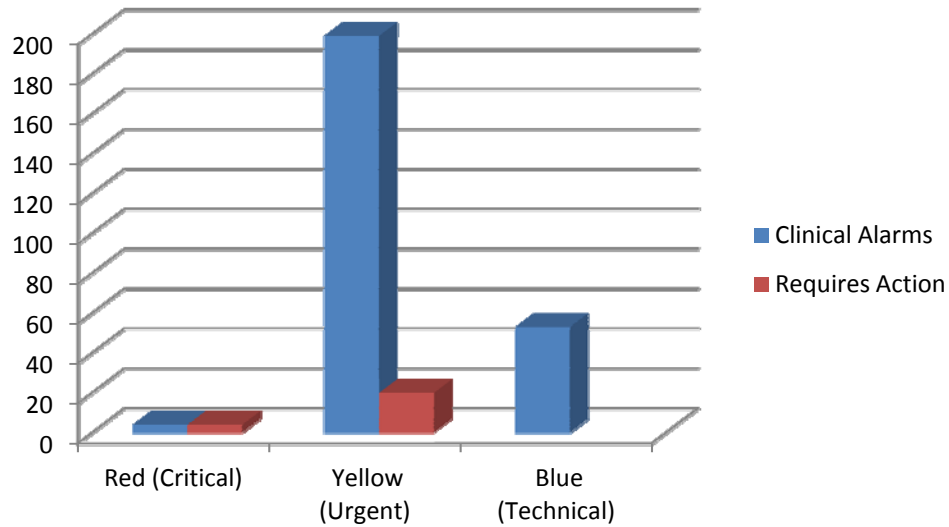


Figure 2 Clinical alarms categorized by type and action

Clinical interactions totaled 215 or 72 per shift or 6 interactions per hour. During the observational period, unnecessary interactions were minimal (less than 1/shift). One clinician indicated other staff members were avoiding the subject clinician because of observer presence.

Equipment interruptions totaled 534 or 178 per shift or five interactions per hour. The top three types of equipment interactions were physiologic monitor 30.88%; BIPAP machine 13.99% and a ventilator 11.94%. Of these interactions, 42% required action (Figure 3).

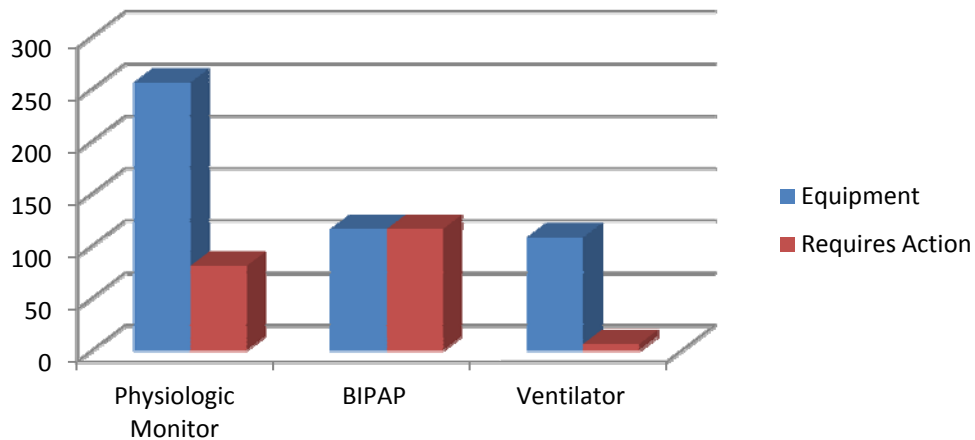


Figure 3 Equipment alarms categorized by type and action

Twenty eight post informational outcomes survey forms were completed after two informational sessions. Most were completed by unit clinicians (n= 20) representing 80% of all full and part time employees. Of the completed surveys, 29% (n=8) were completed by nurse leaders. The requirement for completing an outcomes survey was attendance at the informational session.

The item rating overall application to practice received high scores with the 95% rated as “entirely”. When participants were asked to identify alarm reducing strategies, suggestions included alarm audibility, alarm customization, silencing of alarms and early response to patient condition. Additionally, participants identified common themes when asked to identify two strategies to reduce clinical alarms. These themes included appropriate activation of alarms, alarm standardization, alarm customization and re-evaluation of current alarms per shift. Participants stated barriers to practice changes included method of shift assignment as well as current integration of monitoring equipment with wireless phones.

## **Discussion**

The researcher compared findings with existing literature to determine further analysis and areas of focus. Unit results were comparable to other studies within the literature. As expressed in focus group sessions, there is a direct correlation between patient volume and clinical alarms (Burgess, Herdman, Berg, Feaster, & Hebsur, 2009). Ninety percent of the clinicians stated that alarms were customized according to patient condition. This finding compared to that reported by Graham & Cvach (2010) in a large quantitative study in which 94% of clinicians stated alarm customization occurred. Of interest, observed alarm customization did not correlate as actual alarm customizations did not occur during the observational assessments. Nuisance or non-actionable alarms also coincided with other studies (Graham & Cvach). Urgent alarms represented 78% of all physiologic alarms; 87% of those alarms were non-actionable. Clinician interactions were not identified in the literature.

## **Application to Practice**

Although clinical alarms are necessary interactions when providing care, the mishandling of alarms can also put patients at risk. The approach to this project was to collect objective and subjective data in order to gain an understanding of how clinical alarms were used on the project unit. This approach was beneficial as a starting point for adjusting the units alarm management practices and to make recommendations regarding future practice changes. Recommendations included adjustments in alarm audibility, standardization and customization.

Adequate alarm audibility is a longstanding regulatory requirement (Sobieraj, et al., 2006). Regulatory bodies expect alarms to be audible and have a particular sound that is independent from other sounds on the unit (Catalano, 2005). In-room alarm volumes ranged from 20% to 40% on the project unit. Default alarm volume limits ranged from 100% to 10%. Alarm volumes set at 20% were not audible at the bedside. Central station alarm volumes were defaulted at 80%. The central station had no range for volume adjustment.

Focus group participants identified central station alarms occurring most frequently. During project implementation, central station alarms were observed to be a constant interruption to staff. Upon further investigation, patient rooms with active central station alarms had in-room alarm volumes set at 30% or lower. Clinicians assigned to those rooms did not hear room alarms. Since alarms were not silenced in patient rooms, those alarms continued to sound at the central station. Practice recommendations regarding alarm volume included a reprogramming of alarm volume in all rooms to a pre-set range. Recommended in-room volume ranges to include maximum 80% and minimum 40%. Audibility of alarms in rooms could potentiate decreasing central station alarm volume to 50%.

Alarm standardization and customization are tools that are used to decrease alarm occurrences (Graham & Cvach, 2010). Standard alarm parameters are typically present in devices and assist clinicians by providing baseline parameters in order to initiate care. Aspects of standard parameters include high and low settings for all parameters according to hospital policy and unit protocol (Keller et al., 2011). Customization of alarms gives the clinician an opportunity to ‘fine tune’ alarms to promote actionability. Once patient

discharge has occurred, clinicians can complete a discharge from the physiologic monitor and reset all alarm parameters to default; thus resetting the monitor for the next patient.

Although focus group participants stated alarm customization occurred often, there was no evidence of alarm customization during the observational assessments. Also, observation of monitors in empty rooms at the central station did not appear to be reset to default. Upon further inspection of a sample of empty rooms (n=2), physiologic monitors were not cleared of previous patient data, thus all customization of parameters were still intact. Admission of a patient onto these monitors would potentially mix patient data, measure patient data by parameters customized for a previous patient, and increase risk for alarm related events. Practice recommendations regarding alarm standardization and customization include the following (Graham & Cvach, 2010):

- a. Standard parameters are adopted by the project unit and reviewed quarterly.
- b. Customized alarm parameters are reported each shift to oncoming providers
- c. Bedside monitors are cleared after each patient discharge in order to reset standard parameters.

Finally, an unexpected change in practice occurred during project implementation. Each central station alarm that occurred produced a recorded strip. Clinicians would tear strips and immediately place in trash container. If not pulled from the recorder, strips would run and eventually spill over into the floor around the bank of monitors. Often times, a plastic trash bag would be placed under the monitors to catch the unwanted printed strips. Strip paper was purchased in bulk, costing approximately \$700 in 2012. Recommendations for practice change included a software programming

adjustment so that all alarms, excluding critical alarms, were stored into memory, not printed. This practice change is expected to save \$250 per year.

### **Conclusion**

Alarm fatigue continues to be an opportunity to overwhelm clinicians. On the basis of findings, clinical staff on the project unit are more aware of alarm fatigue and its consequences. Unit staff and leadership are more aware of basic strategies to decrease nuisance alarms and increase patient safety efforts. Immediate actions being taken by unit leadership include adjustment of bedside alarm volumes to 40% while other aspects of the policy and educational plan await final adoption. The adoption process includes policy presentation at the hospital Medical Executive Committee, then final approval by the Board of Trustees. Adoption is expected within the second quarter 2013. After policy adoption is complete, the educational plan will be incorporate into hospital and unit based orientation activities. Expected implementation of the educational offerings is third quarter 2013. The continued evaluation of this project will be completed by the facility.

During implementation, this project gained publicity by the corporate owner of the facility. Discussions are ongoing with the Chief Nursing Officer and corporate risk management regarding the hospitals ability to gain premium credit, or an additional decrease in insurance premiums, for the work completed during this project. Also, the investigator has received an invitation to present project findings and recommendations to the corporate risk management team post implementation.

At completion of this project, investigators goals are project publication and ongoing education. While in the stages of project development and implementation, there seemed to be more questions regarding aspects of alarms that developed. Clearly, publication of this project would benefit other critical care providers nationwide. Few research studies regarding this topic exist in the literature. Future research could prove beneficial to discover new methods to decrease alarm fatigue and increase safety of patients in the clinical environment.



## REFERENCES

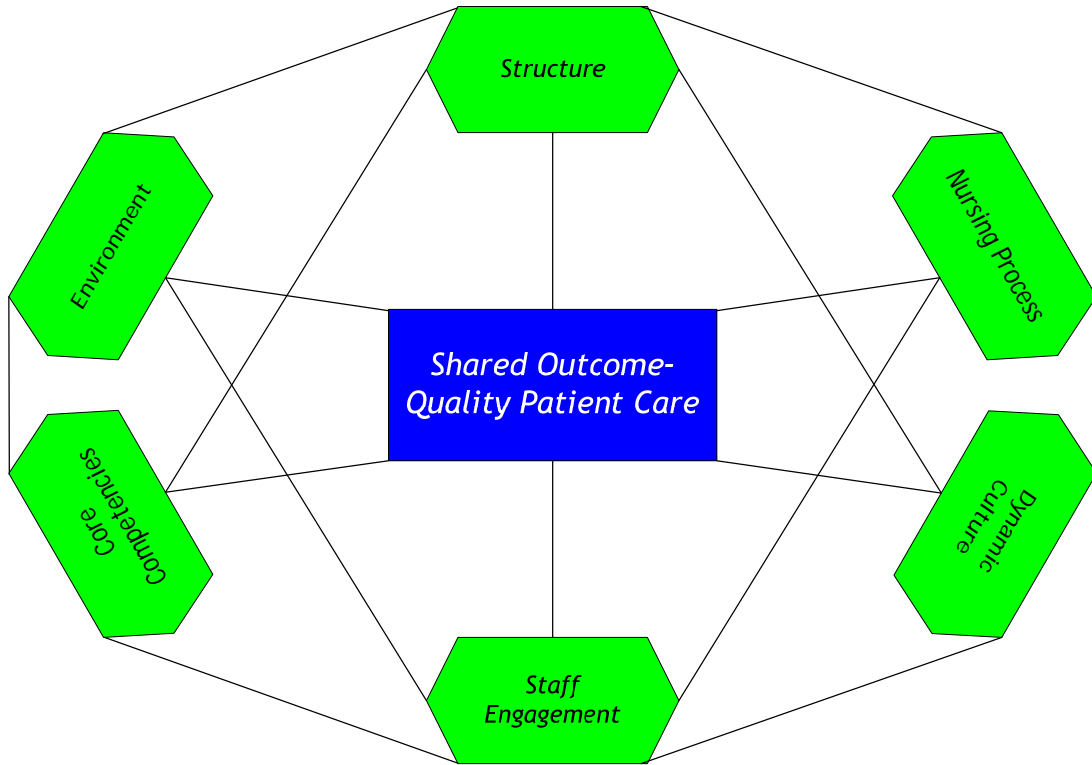
- Badcock, P. B. (2012). Evolutionary systems theory: A unifying meta-theory of psychological science. *Review of General Psychology, 16*(1), 10-23. doi: 10.1037/a0026381
- Bell, L. (2010). Monitor alarm fatigue. *American Journal of Critical Care, 19*(1), 38-38. doi: 10.4037/ajcc2010641
- Bertalanffy, L. V. (1968). *General System Theory Foundations, Development, Applications*. New York: George Braziller.
- Burgess, L. P. A., Herdman, T. H., Berg, B. W., Feaster, W. W., & Hebsur, S. (2009). Alarm limit settings for early warning systems to identify at-risk patients. *Journal of Advanced Nursing, 65*(9), 1844-1852. doi: 10.1111/j.1365-2648.2009.05048.x
- Catalano, K. (2005). Clinical alarms management and the JCAHO standards. *Biomedical Instrumentation & Technology, 11*.
- Clark, T. (2005). JCAHO news & views. Clinical alarms remain an area for patient safety improvement. *Biomedical Instrumentation & Technology, 39*(5), 357-358.
- Ferenc, I. (2012). Alarm fatigue to get heightened attention. *H&HN: Hospitals & Health Networks, 86*(5), 18.
- Freeman, G. (2010). Clinical alert fatigue threatens patient safety. *Healthcare Risk Management, 32*(9), 101-103.
- Freeman, G. (2010). Take these steps to reduce alert fatigue. *Healthcare Risk Management, 32*(9), 103-103.

- Graham, K. C., & Cvach, M. (2010). Monitor alarm fatigue: Standardizing use of physiological monitors and decreasing nuisance alarms. *American Journal of Critical Care, 19*(1), 28-35. doi: 10.4037/ajcc2010651
- Harris, R. M., Manavizadeh, J., McPherson, D. J., & Smith, L. (2011). Do you hear bells? The increasing problem of alarm fatigue. *Pennsylvania Nurse, 66*(1), 10-13.
- Jo, M. S., & Paul, R. B. (2012). Managing alarm fatigue in cardiac care. *Progress in Pediatric Cardiology, 33*, 85-90. doi: 10.1016/j.ppedcard.2011.12.014
- Kast, F. E., & Rosenzweig, J. E. (1972). General System Theory: Applications for Organization and Management. *Academy of Management Journal, 15*(4), 447-465. doi: 10.2307/255141
- Keller, J. (2006). Clinical engineering's role in managing clinical alarm risk. *Biomedical Instrumentation & Technology, 40*(1), 64-66.
- Keller, J. P., Diefes, R., Graham, K., Meyers, M., & Pelczarski, K. (2011). Why clinical alarms are a "top ten" hazard: How you can help reduce the risk. *Biomedical Instrumentation & Technology, 45*, 17-23. doi: 10.2345/0899-8205-45.s1.17
- Korniewicz, D. M., Clark, T., & David, Y. (2008). A national online survey on the effectiveness of clinical alarms. *American Journal of Critical Care, 17*(1), 36-41.
- Kowalczyk, L. (2011). Patient alarms often unheard, unheeded. *The Boston Globe*.
- Mooney, M. C. (2003). JCAHO solutions. Get a handle on National Patient Safety Goals, part 2. *Nursing Management, 34*(9), 16.
- Papastavrou, E., & Andreou, P. (2012). Exploring sensitive nursing issues through focus group approaches. *Health Science Journal, 6*(2), 185-200.

- Phillips, J., & Barnsteiner, J. H. (2005). Clinical alarms: Improving efficiency and effectiveness. *Critical Care Nursing Quarterly*, 28(4), 317-323.
- Piepenbrink, J. (2011). Taking alarm standardization to the floors with a telemetry training system. *Biomedical Instrumentation & Technology*, 45, 24-28. doi: 10.2345/0899-8205-45.s1.24
- Rapoport, A., & Horvath, W. (1968). *Thoughts on organization theory*. Chicago: Aldine.
- Richardson, W. (2004). Home study program. Clinical alarm systems testing -- a program assessment model. *AORN Journal*, 80(2), 279. doi: 10.1016/s0001-2092(06)60565-6
- Rodriguez, K. L., Schwartz, J. L., Lahman, M. K. E., & Geist, M. R. (2011). Culturally responsive focus groups: Reframing the research experience to focus on participants. *International Journal of Qualitative Methods*, 10(4), 400-417.
- Shah, R. (2011). On alert! Maximizing performance of hospital clinical alarms. *Health Facilities Management*, 24(11), 23-27.
- Sobieraj, J., Ortega, C., West, I., Voepel, L., Battle, S., & Robinson, D. (2006). Audibility of patient clinical alarms to hospital nursing personnel. *Military Medicine*, 171(4), 306-310.
- Talley, L. B., Hooper, J., Jacobs, B., Guzzetta, C., McCarter, R., Sill, A., Wilson, S. L. (2011). Cardiopulmonary monitors and clinically significant events in critically ill children. *Biomedical Instrumentation & Technology*, 45, 38-45. doi: 10.2345/0899-8205-45.s1.38
- Weil, K. M. (2009). Alarming Monitor Problems. *Nursing 2009* (September).

Yoder, V. J., & Phillips, A. (2010). Patient safety focus. Alarm management: Clinical perspective. *Biomedical Instrumentation & Technology*, 44(2), 152-153.

APPENDIX A  
Conceptual Framework



APPENDIX B

Educational Outcomes Survey

**Clinical Alarm Fatigue-Educational Outcomes Survey**

**Directions: Please rate the degree to which you will be able to implement aspects of the training into practice using the following key:**

1	2	3	4	5	6
<b>Not at all</b>		<b>Inconsistently/partly</b>			<b>Entirely</b>

**As a result of this training, I can identify 2 alarm reducing strategies:**

1. \_\_\_\_\_
2. \_\_\_\_\_

**As a result of this training, I will be able to change my practice to reduce clinical alarms by:**

1. \_\_\_\_\_
2. \_\_\_\_\_

**Please describe any barriers to practice changes:**

---

---

**General comments regarding clinical alarms:**

---

---

## APPENDIX C

### Consent

Consent Form:

**Scholarly Project Title:** Promoting a Safe Clinical Environment Through the Use of an Evidence-Based Protocol to Reduce Alarm Fatigue.

You are invited to participate in a scholarly project regarding clinician behaviors as they interact with clinical alarms, notifications and interruptions on the clinical unit. The project is designed to help us understand the number of alarms, notifications and interruptions that clinician's experience.

The primary investigator is Richard C. Meeks, a student at the University of Alabama in Huntsville. Mr. Meeks contact information is as follows: Phone: 615-573-4431 or email [rmeeks36@gmail.com](mailto:rmeeks36@gmail.com)

**PROCEDURE TO BE FOLLOWED IN THE STUDY:** Once written consent is given, you will be asked to participate in one of 2 focus groups. Members of the focus group will participate for approximately two (2) hours, during a time that is mutually agreeable by the focus group and investigator. Three (3) clinicians will also participate in an observational assessment, interacting with the investigator for approximately 12 hours. The observations are conducted only to identify numbers and types of clinical alarms, notifications and interruptions.

**DISCOMFORTS AND RISKS FROM PARTICIPATING IN THIS STUDY:** There are no expected risks associated with your participation.

**EXPECTED BENEFITS:** There are no personal benefits as a result of participation in this project

**CONFIDENTIALITY OF RESULTS:** Participant numbers will be used to record your data, and these numbers will be made available only to the researcher directly involved with this project, thereby ensuring strict confidentiality. This consent form will be destroyed within 12 months. The data from your session will only be released to those individuals who are directly involved in the project and only using your participant number.

**FREEDOM TO WITHDRAW:** You are free to withdraw from the project at any time. You will not be penalized because of withdrawal in any form. Investigators reserve the right to remove any participant from the session without regard to the participant's consent

**CONTACT INFORMATION:** If any questions should arise about this project or your rights as a participant, you may contact the Principal Investigator at any point in the research process. You may contact Richard C. Meeks at 615-573-4431 or at [rmeeks36@gmail.com](mailto:rmeeks36@gmail.com), Dr. Faye Anderson, Project Chair at 256-824-2437 or [faye.anderson@uah.edu](mailto:faye.anderson@uah.edu), or Dr. Nicholas Jones, IRB Chair, in Morton Hall 332, at [irb@uah.edu](mailto:irb@uah.edu) or at 256-824-2338.

If you agree to participate in our research please sign and date below. If you are under the age of 19, please provide your parent or legal guardian's signature indicating consent.

This study was approved by the Institutional Review Board at UAH and will expire one year from November 5, 2012.

\_\_\_\_\_  
Name (Please Print)

\_\_\_\_\_  
Signature                      Date

\_\_\_\_\_  
Parent/Guardian Signature (if younger than 19)

## APPENDIX D

### Focus Group Questionnaire

#### **Engagement:**

1. Is alarm management a problem in this unit?
2. Have there been any alarm related events in this unit? (death or otherwise)
  - a. If yes, explain the event
3. What is the number one disturbance when providing patient care?
4. What alarm occurs most often?

#### **Exploration:**

1. Does an alarm management policy exist at the present time?
2. When an alarm occurs, do you prioritize?
  - a. If yes, how does prioritization occur?
3. Is there, in writing, a protocol that outlines the response times for alarms according to priority?
4. Do you customize alarms per patient?
  - a. If no, why not?
5. Is there a standard configuration of alarms for this unit?
6. How often are you interrupted per shift?
7. Do you feel overwhelmed when multiple alarms or stimuli interrupt you?

#### **Exit:**

1. Is there anything else you would like to say about alarms in this unit?



## APPENDIX E

### Clinical Observation Tool

<b>Date:</b>	<b>Nurse:</b>											
<b>Alarm Type</b>	<b>7A-8A</b>	<b>8A-9A</b>	<b>9A-10A</b>	<b>10A-11A</b>	<b>11A-12N</b>	<b>12N-1P</b>	<b>1P-2P</b>	<b>2P-3P</b>	<b>3P-4P</b>	<b>4P-5P</b>	<b>5P-6P</b>	<b>6P-7P</b>
Critical (red)												
Urgent (yellow)												
Technical (Blue)												
<b>Device Type</b>	<b>7A-8A</b>	<b>8A-9A</b>	<b>9A-10A</b>	<b>10A-11A</b>	<b>11A-12N</b>	<b>12N-1P</b>	<b>1P-2P</b>	<b>2P-3P</b>	<b>3P-4P</b>	<b>4P-5P</b>	<b>5P-6P</b>	<b>6P-7P</b>
Physiologic Monitor												
IV Pump												
Ventilator												
Other												
<b>Other Stimulations</b>	<b>7A-8A</b>	<b>8A-9A</b>	<b>9A-10A</b>	<b>10A-11A</b>	<b>11A-12N</b>	<b>12N-1P</b>	<b>1P-2P</b>	<b>2P-3P</b>	<b>3P-4P</b>	<b>4P-5P</b>	<b>5P-6P</b>	<b>6P-7P</b>
Personal Phone												
Call Light												
Phone call (at desk)												
Physician calls												

## APPENDIX F

### Proposed Policy

**TITLE:**        **Preventable Strategies to Reduce Alarm Fatigue**

**PURPOSE:** To improve patient safety through validation, verification and customization of clinical alarms to assure alarms are activated appropriately, individualized by patient, audible and receive appropriate response.

**DEFINITIONS: (ATTACHMENT A)**

**LITERATURE REVIEW: (ATTACHMENT B)**

**POLICY:**     Clinical alarms are to be acknowledged and acted upon in a manner identified by the facility in order of alarm priority.

#### **PRIORITY OF ALARMS**

1. An alarm priority strategy will be used to prioritize alarms. Alarms will be answered in order of priority
  - a. High priority
  - b. Medium priority
  - c. Low priority

❖ **Leads off will be considered a high priority alarm and responded to as such**

2. Alarm response can be **active** or **passive**. Expected response times include:
  - a. High priority alarms- **Immediately**
  - b. Medium priority alarms- **1-3 minutes**
  - c. Low priority alarms- **3-5 minutes**
  - d. Leads off alarm- **Immediately**
3. Tiers of coverage include:
  - a. Primary Provider
  - b. Secondary Provider
  - c. Charge Nurse

**NURSING CONSIDERATIONS:**

- When clinical alarms are annunciated, staff will personally check the patient and evaluate reasons for the alarm before resetting it
- Alarms may be muted or suspended for the brief period of time only when a clinician is monitoring, evaluating and treating the patient
- Tiers of coverage should be assigned via a clinical leader and indicate a contact number for each provider
- Alarms must be reactivated prior to leaving the room
- Proper skin care should be observed and electrodes changed on the following schedule:
  - When electrodes are dry/damaged or removed from skin
  - Every 24 hours
- Patients should be discharged from monitors upon transfer or discharge from the bed, unit, or facility
- Ensure all patient alarms are appropriately activated (not suspended) , including all dysrhythmia detection features and alarm volume
- Perform quarterly reviews of standard alarm configurations in order to ensure clinical relevance
- Perform equipment checks to ensure activation of features including volume prior to the following:
  - Assuming care of the patient
  - After shift change (during first encounter with patient)
  - Post transfer of patient

## **ALARM STANDARDIZATION**

1. All alarms must be:
  - Activated whenever a medical device is in use
  - Verified at the start of each shift
  - Verified if the patient is transported between clinical areas including procedural areas
  - Communicated to the next provider of care
  - Alarms are re-evaluated in the following situations:
    - Change of shift
    - Change of caregiver
    - Change in patient condition
2. With a physician order, alarm limits appropriate to the equipment may be adjusted to patient driven parameters
3. Alarm limits must be set within acceptable ranges based upon the patient's condition so that any change in patient condition will trigger an alarm

4. Alarms are not to be disabled or inactivated at any time
5. Alarms are not to be set to such extremes as to fail to detect significant changes in patient condition, or an operational condition of equipment
6. Alarms must be customized to each individual on the basis of alarm events and clinical presentation
7. For consistent communication among clinicians and monitor technicians, a label noting the parameter changes will be attached to the appropriate monitor

**\*\* Perform the Discharge function at the bedside after every patient discharge in order reset default alarm limits\*\***

### **ALARM AUDIBILITY**

1. Standardized alarm volumes will be set at maximum 50%, minimum 40%.
2. Volume levels of clinical alarms must be sufficiently audible with respect to distances and competing noise to be heard by the responsible clinicians
  - a. Alarms may be adjusted upward at certain times of the day based on noise level and activity in the patient care area
  - b. Patient room and location may need to be moved in order to improve audibility of the alarm
3. In circumstances where the patient room door must be closed, care providers will maintain regular assessments of the room to evaluate alarm status
4. In circumstances where a stand-alone monitor is in use, care providers will check volume:
  - a. Upon initial use of equipment
  - b. Change in caregiver
  - c. Change of shift
  - d. Change in patient condition
5. Monthly alarm audibility observations must be completed including:
  - a. Audibility of alarms by staff members
  - b. Volume level of alarm
  - c. Level of prompting needed to gain response of alarm

### **NURSING CONSIDERATIONS**

- Alarm volume is checked to ensure it is audible within the range of the clinician
- Clinicians should instruct patient and or family to alert the staff if an alarm sounds from equipment

## **EDUCATION**

1. Education regarding the use of clinical alarms is provided at the following times:
  - a. Initial employment
  - b. Prior to equipment use
  - c. Annually
2. Competency regarding operation of clinical alarms, including activation, appropriate alarm limits and patient condition will be conducted:
  - a. Initial employment
  - b. Annually
3. Education should include:
  - a. Monitoring functionality and facility policy
  - b. Alarm volume default settings
  - c. Unit default settings
  - d. Clinical alarm protocols
  - e. Alarm customization requirements
  - f. Alarm customization communication per shift
  - g. Incident reporting requirements

## **EQUIPMENT TESTING/REPAIR/MAINTENANCE/PURCHASE**

1. Biomedical services test equipment prior to being placed into service. This testing includes:
  - a. Alarms are tested and are functioning as intended by the manufacturer
  - b. Alarm trip points are tested for accuracy and activation with every scheduled Planned Maintenance (PM), repair, or when a specific problem is identified
  - c. Alarms are tested to ensure they are not temporarily or permanently disabled
2. All alarm systems incorporated into medical equipment, associated with patient monitoring must be activated while in use
3. An inventory of the various types of clinical alarms will be maintained by biomedical services
  - a. Staff must notify biomedical services when new clinical alarms are placed into services, or changes in physical environment of the area, which might affect audibility of alarms
4. Default alarm settings must be reviewed quarterly and adjusted for clinical relevance

## **NURSING CONSIDERATIONS**

- Immediately report any device malfunctions or concerns to the biomedical department. Remove the device from operation according to the hospital policy until it has been evaluated
- If an alarm is unable to be set properly, or is not audible to the degree necessary, the clinician will tag the equipment, remove from service and notify the biomedical department
- Ensure knowledge of the facility alarm backup plan if monitors become dysfunctional and make sure the plan is readily accessible in case of an emergency

## **LEADERSHIP CONSIDERATIONS**

- Carefully evaluate devices being considered for purchase and include clinical users into the decision making process
- Evaluate alarm configurations. Is it configured appropriately for the clinical environment
- Encourage a culture in which deviation is not accepted and alert fatigue is openly acknowledged as a potential problem
- Don't be afraid to ask if alarms are actionable. If not, request permission to disable

## **LITERATURE SOURCES: (ATTACHMENT C)**

## ATTACHMENT A

### DEFINITIONS:

**Alarm Fatigue** is a term applied to any situation in which clinicians are exposed to environments with excessive noise or disruption

**Alarm Management** occurs when standardization of clinical alarms decreases nuisance alarms, and produces actionable alarms that alert for significant events

**Alarm Schematic** is defined as a diagram of clinical response to alarms including responder notification, response time and priority of alarms

**Active Alarm Response** is the action of physically assessing the patient and resolving the triggered alarm

**Clinical Alarms** are defined as any alarms that are intended to protect a patient receiving care or alert staff that a patient is at increased risk, needing immediate assistance

**High Priority Alarm** is an alarm condition that is acted upon immediately. These alarms include equipment that poses threat, injury or death. Examples include ventilators, and 'red' alarms on physiologic monitors

**Initial Response** is the act of physically assessing the patient after an active alarm has sounded. This does not include resolution of the alarm trigger

**A lead off Alarm** is an alarm condition that is acted upon immediately. This alarm indicates that all patient leads are off and monitoring is not occurring

**Low Priority Alarm** is an alarm condition that is acted upon within 3-5 minutes and poses minimal threat to patients. These alarms include feeding tube alarms, inoperable or technical alarms (blue) on physiologic monitors, such as SPO<sub>2</sub> probe removal

**Medium Priority Alarm** is an alarm condition that is acted upon within 1-3 minutes. These alarms include equipment that would pose minimal adverse effects. Examples include limit violations on physiologic monitors (yellow)

**Notification Alarm** is any clinical alarm intended to alert the caregiver if a specific condition occurs. Notification alarm status can be critical, urgent or non-life threatening

**Nuisance Alarm** is a clinical alarm that is triggered inappropriately when a clinical significant event does not exist

**Passive Alarm Response** occurs when a caregiver is alerted regarding a triggered alarm from a non -licensed person



## ATTACHMENT B

### LITERATURE REVIEW

A comprehensive literature review was performed utilizing three university libraries as well as the Cumulative Index to Nursing and Allied Health (CINAHL) search engine.

Key words included: The Joint Commission, alarm, clinical alarm fatigue, alarm fatigue, nuisance alarms, clinical alarms, fatigue in pilots, alarm overload, technology overload, physiological alarms, ICU alarm, telemetry alarm fatigue, patient safety, sentinel events and monitoring and telemetry.

Limitations placed on this search were English language and a timeframe between 1995 to present.

- Alarm fatigue occurs when large numbers of notification alarms overwhelm and desensitize providers
- 942 alarms per day (one alarm occurring every 90 seconds) was observed in a large intensive care unit, average daily census 12
- Nuisance (false) alarms are the most significant source of excessive alarms in the clinical environment
- Eighty-three percent of notification alarms are false. Nuisance alarms, triggered inappropriately when a clinical significant event does not exist, include both critical and low level priorities
- The number of nuisance alarms is a significant factor in response time
- Some nuisance alarms are inevitable, but clinicians are more likely to ignore a significant alarm when there is a high rate of nuisance alarms
- Nuisance alarms also contribute to desensitization to devices, such that alarms for clinically significant events go unnoticed and are less likely to gain a response from clinicians
- Factors contributing to alarm fatigue include complex monitoring systems, tension in the clinical environment, patient assignments and improper training on alarm protocols
- Reduction of nuisance alarms requires a clinician to fine-tune alarm sources
- Research indicates consideration should also be given to changes in practice, increased clinician expectations via policy, and staff education
- Alarm management is the most consistent method to decrease alarm fatigue
- The use of institutional policy standardizes the use of clinical alarms
- Components of the alarm management protocol should include priority of patient and alarm, proper application and use, customizable alarm parameters, methods to decrease nuisance alarms, and critical alarm escalation pathways

- Ongoing staff education regarding the alarm management protocol is necessary to provide clinicians with alarm management skills and expectations to decrease nuisance alarms and potential patient harm
- Improper customization can lead to excessive non-actionable alarms

A system-wide educational plan should be instituted to standardize appropriate responses to alarms

- Alarm management training should be provided upon initial employment, and annually thereafter
- As understanding and customization of alarms increases, alarm noise will decrease

## ATTACHMENT C

### LITERATURE SOURCES

- Brown, J. C., & Anglin-Regal, P. (2008). Clinical alarm management: A team effort. *Biomedical Instrumentation & Technology*, 142-144.
- Burgess, L. P. A., Herdman, T. H., Berg, B. W., Feaster, W. W., & Hebsur, S. (2009). Alarm limit settings for early warning systems to identify at-risk patients. *Journal of Advanced Nursing*, 65(9), 1844-1852. doi: 10.1111/j.1365-2648.2009.05048.x
- Graham, K. C., & Cvach, M. (2010). Monitor alarm fatigue: Standardizing use of physiological monitors and decreasing nuisance alarms. *American Journal of Critical Care*, 19(1), 28-35. doi: 10.4037/ajcc2010651
- Harris, R. M., Manavizadeh, J., McPherson, D. J., & Smith, L. (2011). Do you hear bells? The increasing problem of alarm fatigue. *Pennsylvania Nurse*, 66(1), 10-13.
- Jo, M. S., & Paul, R. B. (2012). Managing alarm fatigue in cardiac care. *Progress in Pediatric Cardiology*, 33, 85-90. doi: 10.1016/j.ppedcard.2011.12.014
- Keller, J. (2006). Clinical engineering's role in managing clinical alarm risk. *Biomedical Instrumentation & Technology*, 40(1), 64-66.
- Korniewicz, D. M., Clark, T., & David, Y. (2008). A national online survey on the effectiveness of clinical alarms. *American Journal of Critical Care*, 17(1), 36-41.
- Phillips, J., & Barnsteiner, J. H. (2005). Clinical alarms: Improving efficiency and effectiveness. *Critical Care Nursing Quarterly*, 28(4), 317-323.
- Piepenbrink, J. (2011). Taking alarm standardization to the floors with a telemetry training system. *Biomedical Instrumentation & Technology*, 45, 24-28. doi: 10.2345/0899-8205-45.s1.24
- Talley, L. B., Hooper, J., Jacobs, B., Guzzetta, C., McCarter, R., Sill, A., Wilson, S. L. (2011). Cardiopulmonary monitors and clinically significant events in critically ill children. *Biomedical Instrumentation & Technology*, 45, 38-45. doi: 10.2345/0899-8205-45.s1.38

## APPENDIX G

### Educational Plan

#### **Clinical Alarm Fatigue**

**Goal:** To promote a safe patient environment through the implementation of an evidence-based education to increase awareness and to reduce potential adverse effects of clinical alarm fatigue.

**Method:**

1. Delivery of education regarding clinical alarm fatigue include one of the following methods:
  - a. Live presentation via power point
  - b. Educational Portal (HealthStream)
2. Education regarding clinical alarm fatigue will be delivered at the following intervals
  - a. During the initial 30 days of employment
  - b. Prior to equipment use
  - c. Annually
3. Education may be delivered as a part of hospital-wide orientation or competency (unit) based orientation.

**Content:**

1. Content to be included in presentations regarding clinical alarm fatigue includes:
  - a. Areas where monitoring occurs within facility
  - b. Regulatory requirements
  - c. Relevant literature review
  - d. Facility policy
  - e. Alarm volume importance
  - f. Default settings (specific to unit)
  - g. Clinical alarm protocols (specific to unit)
  - h. Alarm customization requirements
  - i. Alarm communication requirements
  - j. Incident reporting requirements
  - k. Equipment malfunction and out of service protocol

**Evaluation:**

1. An educational evaluation will be completed by the participants after each educational session (Attachment A).

2. Educational evaluations include:
  - a. Participant usability
  - b. Identification of two alarm reducing strategies
  - c. Identification of two practice changes to decrease clinical alarms

**Competency:**

1. Competency will be validated by unit preceptor at the following intervals (Attachment B)
  - a. Initial competency
  - b. Annual competency

Attachment A  
Educational Outcomes Survey

<b>Clinical Alarm Fatigue- Educational Outcomes Survey</b>
--

Directions: Please rate the degree to which you will be able to implement aspects of the training into practice using the following key:

1	2	3	4	5	6
<b>Not at all</b>		<b>Inconsistently/partly</b>			<b>Entirely</b>

As a result of this training, I can identify 2 alarm reducing strategies:

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_

As a result of this training, I will be able to change my practice to reduce clinical alarms by:

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_

**General comments regarding clinical alarms:**

---

---

Attachment B

**Alarm Management Competency**

Name \_\_\_\_\_

Unit \_\_\_\_\_

**Initial Competency**       **Annual Competency**      **Verified**  
by \_\_\_\_\_

	Yes	No	N/A
1. Responds to clinical alarms according to hospital policy.			
2. Acknowledges use of alarm response times and appropriately responds to alarms. a. High Priority - <b>Immediate Response</b> b. Medium Priority- <b>1-3 minutes</b> c. Low Priority- <b>3-5 Minutes</b> d. Leads Off – <b>Immediate Response</b>			
3. Establishes tiers of coverage each shift by the Charge Nurse including contact number for each provider. a. Primary Provider b. Secondary Provider c. Charge Nurse			
4. With activation of a clinical alarm, staff will check patient first and evaluate reasons for alarm.			
5. Suspends alarms when clinician is in room and are reactivates prior to leaving room.			
6. Demonstrates ability to silence in-room alarms.			
7. Demonstrates ability to customize alarms per parameter			
8. Acknowledges re-evaluation of the need for alarm customizations in the following situations. a. Change of shift b. Change of caregiver c. Change in patient condition			
9. Demonstrates ability to adjust in-room alarm volume.			
10. Acknowledges alarm volume standards and the need for in-room alarm volume			
11. Demonstrates volume check when using stand-alone monitors including: a. Upon initial use of equipment b. Change in caregiver c. Change of shift d. Change in patient condition			

<b>12.</b> Demonstrates ability to perform discharge on monitor and at central station			
<b>13.</b> Demonstrates protocol when reporting device malfunction, tag equipment, removes from service and notify biomedical engineering for repair.			