Diagnosing Alarm Fatigue in a Children's Hospital

Christopher Fry

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Honors Advisor

Abstract

Background: Alarm safety is one of the most prominent and high profile problems in hospitals. When alarms sound constantly throughout the day nurses may experience sensory overload. This desensitizes nurses to alarms, which can create an unsafe, and in some events even fatal environment for the patients. **Methods:** Central monitoring data was collected on 4 units throughout the Children's Hospital. Researchers observed central monitor and nurses' verbal and nonverbal reactions to those alarms. Nurses were also preliminarily surveyed to address their perceptions of alarms on the unit. **Results:** The average number of alarms per bed, 35 an hour, was extremely high. Nurses also stated in the survey they were desensitized to alarms and the majority believed their coworkers did not handle alarms appropriately. Observations of the nurses revealed that only 22% of nurse responses to alarms were positive. **Conclusion:** The results of this study indicate that alarm fatigue is present in the hospital setting. By identifying the nurses' response to the alarms (verbal and non-verbal) as well as the frequency of alarms on the unit, a better understanding of alarm fatigue was achieved. The results of this study indicate a great need for interventions developed to address alarm frequency and the nurses' responses to alarms.

Background

Every year over 6 million children are hospitalized. This makes up 17 percent of all hospitalized individuals (HCUP Home, 2015). These children find themselves staying in Pediatric Units, which are special floors in hospitals reserved for children. Their reasons for being admitted can vary greatly from mechanical injury to autoimmune disorder to infections. One element that links all of these children, however, is the fact that they need continuous monitoring and frequent assessments by the nurses and providers. Physicians, nurses, and staff must create a delicate balance between providing interventions around the clock while also giving the patients time to rest. According to the NIH, a lack of sleep may cause an array of problems including focus issues, mood alterations, and slower response times. In addition, chronic lack of sleep increases an individual's risk of obesity, cardiovascular disease, and infection (2011). Because sleep is also linked to immune functioning and overall healing in patients, it is essential for nurses to allow patients, especially children, to get the best quality sleep they can. There are many reasons for the lack of sleep children experience in the hospital, but one study found that there were three major categories. These categories included noises, worries/discomfort, and hospital specific variables like pain and vital sign checks. They found that alarms on medical equipment bothered 42% of children and 66% of parents. The researchers discovered that alarms were one of the largest, modifiable, disruptors of sleep (Meltzer, Davis, & Mindell, 2012).

Alarms not only make maintaining sleep difficult, but can also be challenging for the nurses to manage. One of the essential ways to provide continuous care is the appropriate use of central monitors. Central monitors are commonly used on acute care units throughout the hospital. They display vital, real-time patient information such as heart rate, blood pressure,

oxygen saturation, and cardiac wave forms. However, every time a patient's vital signs exceed or fall short of their preset parameters an alarm will sound. According to the Joint Commission statement on the issue of alarms in hospitals, the number of alarm signals per patient per day can reach several hundred depending on the unit (Joint Commission, 2013). Accompanied by these auditory alarms are a barrage of different colored flashing lights and signals, highlighting the cause of the alarm. This onslaught of beeps, buzzes, and chimes, which were initially intended to help patients and alert caregivers, may actually be doing just the opposite. When a nurse is overwhelmed with too many alarms, they may tend to trivialize and possibly even ignore alarms. This sensory overload that desensitizes nurses to alarms, which can create an unsafe, and in some events even fatal environment for the patients, is known as alarm fatigue (Cvach, 2012).

The goal of this research is to understand alarm fatigue in a Children's Hospital by evaluating central monitors and the reactions of the nurses to those monitors. Clinical alarms have been atop the ECRI Institute's list of "Top 10 Health Technology Hazards" ever since the list was first created in 2007. Over the past 3 years "Alarm Hazards" have been listed as the number one health device technology hazard. A review of the FDA's Manufacturer and User Facility Device Experience database revealed 566 deaths between 2005 and 2008 that directly mention alarms as a possible contributor to the death of the patients (Cvach, 2012). Furthermore, in April of 2013 the Joint Commission issued a Sentinel Event Alert due to 98 alarm related incidents between January 2009 and June 2012. Of these 98 events, 80 resulted in the death of the patient. The Joint Commission believes that these 98 alarm-related incidents represent less than 10% of the actual alarm related harms that occurred in the hospital (Mitka, 2013).

Perpetuating the problem of alarm fatigue is the ever-increasing number of monitoring devices attached to the patients. Medical devices have been designed and honed to be as sensitive

as possible to ensure any true sentinel event is not missed. However, this has resulted in extremely sensitive alarms that predict a large number of false positives. In fact, research has shown that 72-99% of hospital alarms are false (Graham & Cvach, 2010). In addition, further research has shown that 85-99% of alarm signals do not require intervention (Sendelbach & Funk, 2013). These are often referred to as nuisance alarms, or alarms that typically do not result in adverse or potential adverse patient conditions. This may occur due to the fact that parameters are too narrow, default settings on central monitors are not adjusted, electrocardiogram electrodes are no longer adequately sticking, or sensors being misplaced (Graham & Cvach, 2010). A study monitoring alarms on Medical/Surgical floors in a community hospital found that the average patient's alarms were triggered 95.6 times per day. They found that only 34% of critical alarms, such as extreme tachycardia, bradycardia, or desaturation were found to be true. After an analysis of their alarm history, they were able to reduce the number of heart rate alarms by over 50% with a small adjustment of a max HR from 120 to 130 bpm. In addition, they saw a 36% decrease in desaturation alarms when the parameter was lowered from 90% to 85%. It was concluded that alarm limits are often too sensitive for their patients, and the number of alarm triggers could be greatly reduced by creating patient specific parameters on central monitors (Gross, Dahl, & Nielsen, 2011).

Another instance of widening alarm parameters occurred at Dartmouth-Hitchock Medical Center. They began implementing surveillance monitoring, which is the continuous collection of routine vital signs to help recognize trends in patient deterioration. For 11 months they collected data on rescue events, such as Rapid Responses, as well as transfers to intensive care units. Through this research they found that an oxygen saturation of less than 80%, rather than the typical 90-93% should be implemented before an alarm sounds. This number represents an event

significant enough to require intervention, without overburdening the nurses. In addition, a 15 second delay was installed. This meant that a patient's oxygen saturation would have to drop below 80% for over 15 seconds before the alarm would sound. This helped eliminate nearly all false positive readings. The results showed a decrease in rescue events from 3.5 per 1,000 patients to 1.2 per 1,000. ICU transfers also decreased from 5.6 per 1,000 to 2.9 per 1,000. This saved patients a total of about 150 days spent in an ICU. Finally, using this new parameter, patients averaged only 4 alarm notifications per 24 hours (Taenzer, Avery, Karon, & McGrath, 2013). The ability to widen parameters and delay alarms signals also had a direct impact on nursing response to the alarms. Once nurses became aware that the incidence of false alarms had been reduced, they were less likely to ignore the alarms, resulting in faster response to the patient, and a reduction in adverse events.

Aside from changing alarm parameters, decreasing monitor alarms through the use of team-based standardized care and processes has also proven to be successful. Research on a 24-bed pediatric unit showed that using 4 components of standardized care helped to drop the median number of alarms per patient per day from 180 to 40; an 80% decrease. These components included age-appropriate parameter standards, daily replacement of electrodes, daily assessment of cardiac monitor parameters, and using a reliable method for appropriate discontinuation of the monitors. Nurse compliance with these standards increased from 38% pre-study to 98% post-study. The median number of false alarms on the floor dropped from 95% to 50%. The biggest finding from this study was that families reported an increase in nursing response time (from 87% to 95%) (Dandroy et al, 2014).

An additional approach to managing clinical alarms came in the form of how the alarm was presented. Boston Medical Center was able to reduce alarms by 89%, as well as improve

patient and staff satisfaction scores, by setting 'crisis alarms.' Rather than use a typical alarm for patients who experienced extreme bradycardia (< 45 bpm) or extreme tachycardia (> 130 bmp), they used "crisis" alarms. These new alarms required the nursing staff to act on the alarm, rather than simply turn it off. This intervention eliminated the alarms' abilities to self-reset, which would have otherwise allowed them to sound on and off multiple times. This intervention reduced alarm alerts in one week from 62,793 to 3,970 (Whalen, Covelle, Piepenbrink, Villanova, Cuneo, & Awtry, 2014).

Nurses have also been surveyed to assess their perception of alarm setting and management. One study found that 93% of nurses interviewed felt that alarm fatigue results in alarm desensitization and disabling of alarms, while 81% felt that the key factors associated with alarm fatigue were false-positive alarms and inappropriately set alarms (Christensen, Dodds, Sauer, Watts, 2014).

Although there is a myriad of research explaining and helping to resolve alarm fatigue, little has been done to address the problem directly with the nurses. Nurses have been given questionnaires about their feelings and attitude towards alarms, but they have not been observed to see how they behaviorally and clinically react to the alarms. This gap in observations of nurse responses to alarms, including the amount of time it takes them to respond, presents a major problem in our ability to combat alarm fatigue. Additionally, few studies have assessed nurses' perception of alarms or their self-assessment of alarm fatigue. Therefore, the purpose of this study is to understand alarm fatigue in a Children's Hospital by evaluating central monitors and the reactions of the nurses to those monitors. Research questions to address this purpose include:

1) What is the incidence of alarms during an observed experience in 4 pediatric units?
2) What are nurses' verbal and nonverbal reactions to central monitors?

3) Is there a correlation between nurses' verbal and nonverbal reactions and alarm data?
4) Based on this data, what unit recommendations are needed to better standardize and improve their alarm management?

Methods

Procedures

In order to examine alarm fatigue in nurses, a mixed-method study was conducted across four pediatric units at University of North Carolina Hospital in Chapel Hill, NC. Trained observers from the research team selected four different observation times (0500-0700, 0800-1000, 1700-1900, and 2000-2200) and observed 4 pediatric units over three separate days. This totaled 12 2-hour observations on each of the 4 units. During the 2-hour observations, the central monitor and nurses on the unit were observed. Each time a central monitor alarmed, it was coded as either a red alarm (emergent), or yellow alarm (warning). Observers then recorded if the nurses responded to a central station or not. Finally, any verbal or nonverbal comments made by the nursing staff were written down and distinguished as positive, negative, or neutral. Information from the central monitors was downloaded after observations were complete. This data included the number of total alarms sounded and why these alarms occurred.

Study Setting: Four acute care units in the Children's Hospital at the University of North Carolina Hospital in Chapel Hill, NC participated in this study. The Children's Hospital at UNC Hospital is an academic medical center that admits approximately 6700 pediatric patients per year and treats children from all 100 counties in North Carolina and from 45 states across the country (N.C. Children's Hospital, 2015). The researches observed central monitors on four different Pediatric Units in the hospital (7 Children's, 6 Children's, 5 Children's, and the Children's Intermediate Cardiac Care Unit (CICC)).

7 Children's is a 24-bed unit dedicated to the care of pediatric surgery and trauma patients. Its patient population varies from general pediatric surgery, ear/nose/throat, neurosurgery, burns, transplant cases, and many others. 6 Children's is also a 24-bed unit specialized for medicine patients. 5 Children's is a 16-bed unit dedicated to the care of pediatric hematology/oncology, bone marrow transplant, and pulmonary patients. The CICC is an 8-bed unit that focuses on pediatric cardiac patients (unchealthcare.org, 2015).

Sample: Nurses on all four pediatric units participated in this study. A total of 200 nurses are employed across the 4 units. Nurses were observed in their regular work routines and no identifying information was collected during observation. All nurses were anonymously administered a survey to assess their current perceptions of unit alarms.

Measures:

Central Monitors: Each time a central monitor alarmed, it was coded as either a red alarm (emergent), or yellow alarm (warning). Total alarms generated were recorded from each central monitor in the unit over the observation period. Observers noted if the nurses responded at the central nursing station or not. Additionally, nurses' verbal and nonverbal responses to the central monitors were recorded.

Alarm Fatigue Survey: A 16-item survey was developed by the research team to assess the nurse's current practice involving alarm management and perception of its effectiveness (Appendix 1). The survey was administered anonymously online prior to the observation of the nurses in the unit.

Observation of Nurses: Verbal and non-verbal responses by the nurses to the alarms were recorded by trained members of the research team over three days (four times a day, at two hour intervals). Inter-rater reliability was achieved by having the observers record alongside the

PI of the study over a 30-minute period, using a standardized observation tool (Appendix 2). Observations were then compared to those of the PI, and members of the team received feedback if discrepancies between the PI occurred. Once the reliability training was complete, each member of the research team assigned themselves to one of the four pediatric units. Once assigned to a specific time timeframe, the same observer did the second and third observations in the same timeframe. The rationale for this approach was to ensure consistency on each unit. Members of the research team recorded how frequently the alarms were triggered, and the verbal and non-verbal reactions of the nurses to the alarms. Verbal and non-verbal reactions were subsequently broken down into positive, negative, or neutral responses. A positive reaction was described as any comment positive in nature which led to nurses checking on patients or making changes to alarm limits. Positive nonverbal reactions included prompt responses to alarm and engaging with the central monitors. Neutral responses were any comments or behaviors related to silencing the alarm, and taking note of the current alarm sounding. Negative responses were and comments or body language displaying frustration or annoyance towards alarms or the duties that needed to be performed because of those alarms.

Data Collection and Analysis: Data was collected over a three-month period (November 2014 – February 2015) from three sources: the central monitoring system, observer data, and the nursing survey. Central monitoring data included frequencies of alarms and alarm types such as heart rate or respiration rate. It also gathered information for each patient like how many times a particular patient's alarms sounded. Descriptive statistics (mean scores, and frequencies, ranges, and patient parameters) were used to analyze the central monitors, non-verbal and verbal observations, and the nursing survey.

Results

Central Alarms:

A total of 8,552 alarms were generated from 123 beds in the four units. This yields an average of 35 alarms per bed per hour. If this number were representative of a typical hour, there would be an average of 835 alarms per bed per day throughout the Children's Hospital. The total number of alarms, separated by type of alarm generated, over a 3-day period, is presented in Table 1-4 below. In tables 1-4, the top three producers of alarms, in order, were heart rate (3,051), respiratory rate (2,809), and pulse oxygenation (1,263).

Total alarms generated ranged (from least to greatest) 795 in the CICC, 1,228 on 5 Children's, 2,793 on 6 Children's, and 3,736 on 7 Children's. Across all observations, there were 14 central monitors observed in the CICC, 37 observed on 5 Children's, 53 on 6 Children's, and 56 on 7 Children's.

Table 1: Total Alarm Numbers for 5 Children's Unit

5 Children's				
Date	**11/19/14**	**11/24/14**	**12/4/14**	**Grand Total**
Alarm Type				
HR	**133**	**54**	**305**	**492**
SpO2	**99**	**81**	**65**	**245**
Desat	60	35	38	133
RR	**51**	**75**	**52**	**178**
Pulse	49	8	13	70
Brady	17	4	29	50
NBP	13	7	8	28
Asystole	12		1	13
Tachy	9		2	11
Vent Fib/Tach	2		4	6
Apnea			2	2
Grand Total	**445**	**264**	**519**	**1228**

Table 2: Total Alarm Numbers for 6 Children's Unit

6 Children's Date	11/17/14	11/24/14	12/2/14	Grand Total
Alarm Type				
Apnea	16	5	1	22
Asystole	13	4	3	20
Brady	6	28	5	39
Desat	32	57	48	137
HR	**370**	**139**	**321**	**830**
NBP	21	14	4	39
Nurse Call		3		3
Pulse	1		34	35
RR	**453**	**517**	**205**	**1175**
SpO2	**220**	**108**	**121**	**449**
Tachy	15	4	12	31
Vent Fib/Tach	7	6		13
Grand Total	**1154**	**885**	**754**	**2793**

Table 3: Total Alarm Numbers for 7 Children's Unit

7 Children's Date	11/29/14	12/14/14	12/17/14	Grand Total
Alarm Type				
RR	**402**	**602**	**408**	**1412**
HR	**181**	**297**	**853**	**1331**
SpO2	**118**	**218**	**173**	**509**
Desat	104	107	83	294
NBP	15	3	18	36
Tachy	12	31	28	71
Apnea	6	19	3	28
Brady	6	9	11	26
Missed Beat	3			3
Pause	2			2
Vent Fib/Tach	1	2	1	4
Asystole		12	8	20
Grand Total	**850**	**1300**	**1586**	**3736**

Table 4: Total Alarm Numbers for CICC Unit

CICC Date	11/19/14	11/24/14	12/4/14	Grand Total
Alarm Type				
HR	**110**	**83**	**205**	**398**
PVCs/min	54	4	43	101
SpO2	**19**	**1**	**40**	**60**
RR	**15**	**4**	**25**	**44**
Pair PVCs	14		22	36
NBP	8	2	13	23
Non-Sustain VT	7		6	13
VTach	7		5	12
Desat	6		17	23
Run PVCs	5	1	8	14
Tachy	4	2	2	8
Missed Beat	4		6	10
Pause	4			4
Brady	3		30	33
Pulse	3		3	6
Asystole	2		4	6
Vent Fib/Tach			2	2
Multiform PVCs			2	2
Grand Total	**265**	**97**	**433**	**795**

Alarm Incidence per Monitor

When data from each monitor is taken individually, it is clear there are some large disparities in the number of alarms generated between each patient. On 5 Children's, one monitor produced 317 of the possible 519 alarms, or 61% of total alarms observed that day. These trends continued throughout the observations. Nearly every observation had at least one bed that at least tripled what the average alarms generated should have been. Tables 5-8 below represent the number of alarms generated per bed during each observation.

Table 5: Total Alarms per Bed on 5 Children's Unit

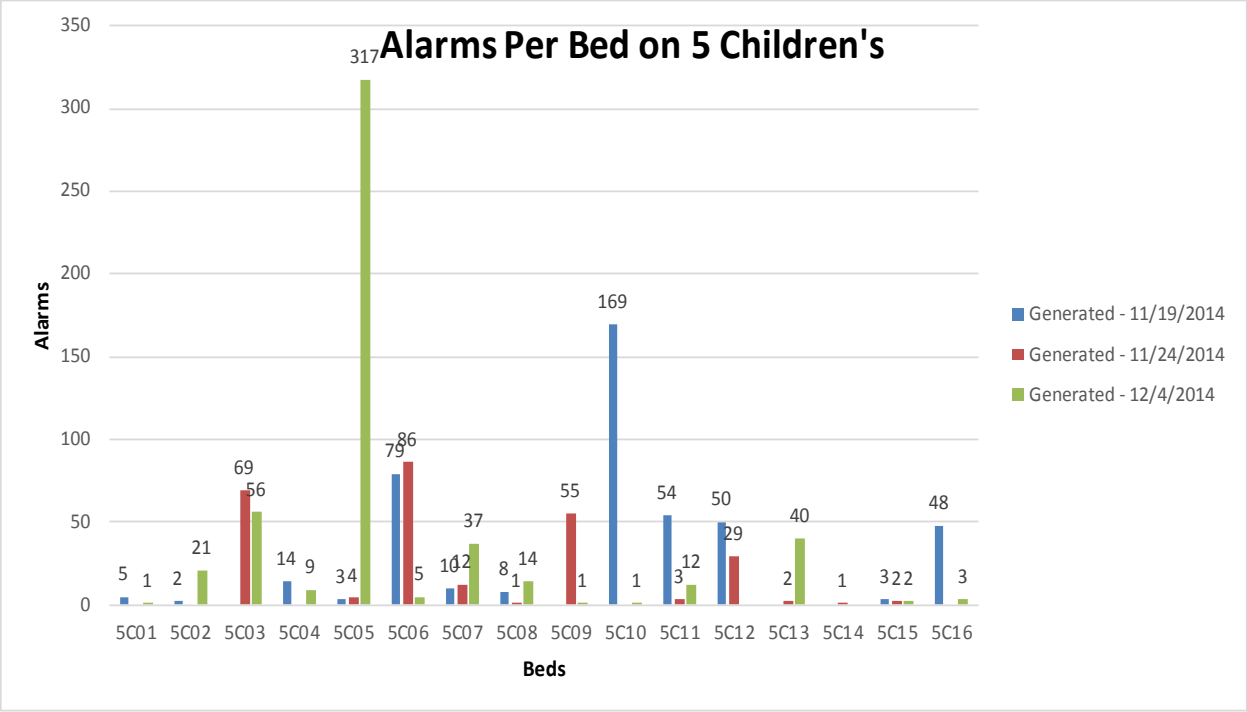


Table 6: Total Alarms per Bed on 6 Children's Unit

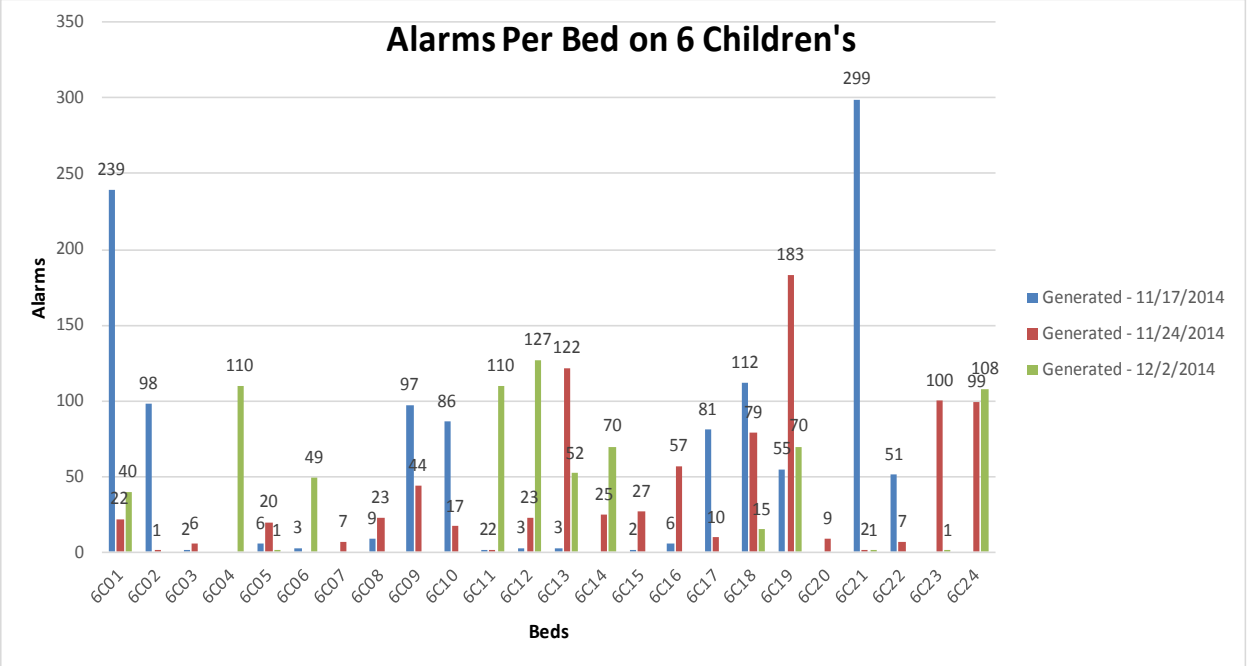


Table 7: Total Alarms per Bed on 7 Children's Unit

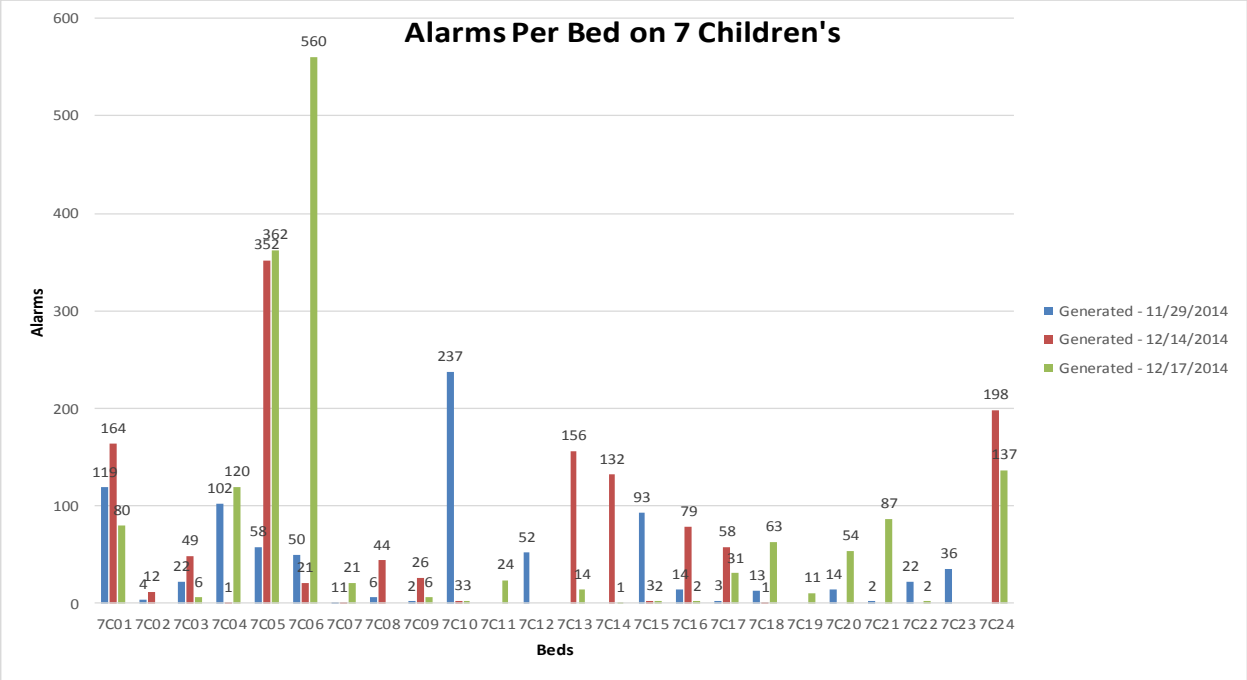
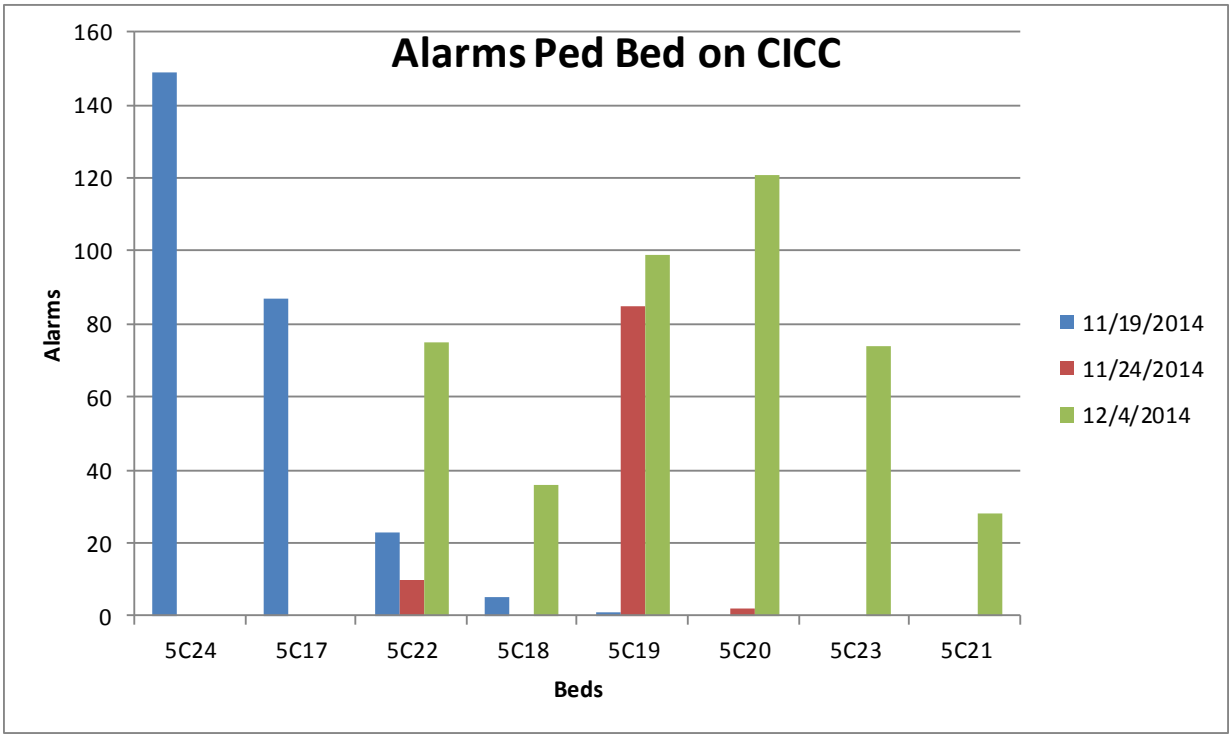


Table 8: Total Alarms per Bed on CICC Unit



Survey of Nurses

Of the 200 nurses that were administered the survey, 55 nurses responded, with a response rate of 27.5%. Of the 16 questions, 4 questions revealed the most about nurses and their alarm habits. The majority of nurses surveyed (89%) indicated that alarms were perceived as background noise. Of the respondents, 78% of nurses indicated that they *did not* check on their patient when the alarm sounded. The survey revealed that less than half of nurses (47%) believed their colleagues handled alarms appropriately. Finally, when directly asked on the survey if they feel they have been desensitized to alarms, 69% stated they were. The full survey with results is presented as Appendix 1.

Nurse Responses to Alarms

Over the course of all the observations, nurses responded a total of 50 times at the central monitoring station. Of these responses, 46% (n = 23) were coded by the observers as negative; 32% (n = 16) were coded as neutral; and 22% (n = 11) were coded as positive. A copy of the standardized observation tool is available under Appendix 2.

Discussion

The aim of this study was to collect central monitor alarm data and to observe nurses' verbal and nonverbal reactions to those alarms. The majority of research conducted on alarm fatigue has focused on the number of alarms per unit, and how to decrease them. Only a few studies have observed the nurses to see what their reactions actually are when an alarm sounds. This study worked to identify alarm fatigue by observing nurses' reactions to the central monitors, and by preliminarily surveying them on their approaches and beliefs towards alarms.

The results of this study indicate that there is much work to be done on the issue of alarm management in the Children's Hospital. The majority of alarms triggered came from three

sources; heart rate, respiration rate, and oxygen saturation. These three sources of alarms, along with all of the other alarms, combined to create 8,552 alarms generated throughout the study. If the number of alarms observed was representative of a typical hour, each patient monitored would have alarmed 35 alarms every hour. This equates to an average of 835 alarms for every child on a central monitor throughout the Children's Hospital. This number is vastly greater than even the Joint Commission's statement of several hundred per day (2013), and is highly indicative of the institution being at risk for alarm fatigue. Interventions to address this exceedingly dangerous number of alarms must be identified and implemented to reduce nursing desensitizing and alarm fatigue.

One intervention to reduce the incidence of alarms would be to identify which alarms are truly necessary, and to set parameters to help reduce false alarms. Researchers at Dartmouth-Hitchcock found that oxygen saturation parameters should be set at 80%, which they found to be sensitive enough to find adverse event, but not overly burdensome to the nurses. In addition, occasional and brief desaturations from a multitude of factors including mild sleep apnea, a patient clenching their first or even just lifting their hand, are of little importance to the nurses (Taenzer, et al., 2013). Furthermore, researchers found that while observing false alarms in an intensive care unit at John Hopkins, the biggest contributor to the number of false alarms was the pulse oximetry alarm (Cvach, 2010). Because oxygen saturation was in the top 3 reasons for alarms produced in our study, it must be speculated that these desaturations may be creating a large number of false positives.

Another finding of this study was that the majority of alarms produced on any given unit typically emerged from one or two beds. This is best exemplified by an observation on 5 Children's when 14 monitors were observed. One monitor produced 317 of the possible 519

alarms, or 61% of total alarms observed that day. These trends continued throughout the observations. Nearly every observation had at least one bed that at least tripled what the average alarms generated should have been. To help curb this problem, a unit coordinator or nurse manager should be assigned to check the number of alarms generated from each bed could help distinguish the outliers. This would allow the nurses to determine if the high number of alarms was out of necessity, or if something should be changed to diminish those alarms in the future.

The preliminary survey distributed to the nurses was the first signal that there was the potential for alarm fatigue on every floor observed. The vast majority of nurses believed that the alarms became background noise, and did not check on their patients after every alarm. This then begs the question; if the nurses are not checking on their patients after every alarm, why are these alarms evening being used? If the nurses know they will not pay attention to an alarm because it is not serious enough of an adverse event, or they believe it to be a false positive, there is no reason for these alarms to be sounding. They are contributing to the overall number of alarms, and adding to further alarm fatigue. In fact, when asked directly if they felt they were becoming desensitized to alarms, 69% of nurses stated they were. Before the data collection or observations even began, the nurses were already admitting they were experiencing alarm fatigue.

The verbal and nonverbal responses observed in the nurses correlated with the preliminary survey and alarm data. This evidence brings to light two major concerns. The first is that throughout the entire series of observations, nurses only responded at the central monitor 50 times. That is less than 1% of the times the alarms sounded. The second finding was that nearly half of all observable nurse responses to alarms were negative. This is another indication that alarm fatigue is ever present. The use of an alarm fatigue committee could help to diminish these negative responses. A committee would have the power, authority, and responsibility to monitor

the number of alarms sounded to check for outliers, and to also hold nurses accountable for their reactions to alarms.

Limitations of the study

One limitation of this study was the inability to distinguish a generated alarm that resulted in an intervention versus an alarm that did not require intervention. The alarms captured from the central monitors provided an excellent representation of the overall alarm situation on all of the pediatric units, but were quite indistinguishable in terms of nurse intervention. The validity of the study would improve if it were known exactly to which alarms the nurses responded, and to see which ones they ignored. Future work could be aimed at linking alarm sounds and actual nursing intervention. Efficacy of these alarm sensitivity changes and their effect on patient outcomes are also warranted.

Implications for Practice

The results of this study show that a significant number of nurses fall victim to alarm fatigue. These finding have direct implications for novice as well as experienced nurses. Nurses should be more acutely aware of alarm parameters for their patients' monitors, and must be cognizant of the alarms around them. Nurses should be advocates for themselves, as well as for their patients, and address concerns regarding alarm fatigue with management and other leaders in order to make unit changes that would reduce the incidence of fatigue.

Conclusion

Although alarms are life-saving and a necessary part of hospital monitoring, they can compromise patients' safety if they are dismissed. The results of this study indicate that alarm fatigue is present in the hospital setting. By identifying the nurses' response to the alarms (verbal and non-verbal) as well as the frequency of alarms on the unit, a better understanding of alarm

fatigue was achieved. The results of this study indicate a great need for interventions developed to address alarm frequency and the nurses' responses to the alarms. Future work should be aimed at identifying and testing interventions to reduce alarm fatigue and its impact on work environment and patient outcomes.

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Appendix 1: Survey of Nursing Perception of Alarms

7 Children's

Survey Questions	Yes	No	No Answer
Do you notice every time an alarm goes off?	8	8	
Do the alarms become background noise?	16		
Do you check your orders for call parameters?	12	4	
Do you change your monitors according to ordered call parameters?	10	6	
Have you adjusted the parameters in the monitor on your patient without contacting the patient's physician?	12	4	
Do you use the correct leads and pulse oximeter for the patient's age and size?	14	2	
Do you change the monitors according to the patient's age (Neonatal,, Pediatric, or Adult)?	10	6	
Do you replace leads and pulse oximeters with the appropriate equipment when you suspect they are not in working order?	16		
Do you always check on your patient when the alarm goes off?	2	14	
Do you tend to silence the alarms and not check on the patient if you do not think the reading is accurate?	13	3	
Do you silence alarms from patients that are not yours?	13	3	
DO you check on patients after an alarm goes off if the patient is not yours?	11	4	1
Do you feel that the monitors can be customized to your patients' needs?	13	3	
Do you feel you have been desensitized to the alarms?	12	3	1
Do other nurses respond to their alarms appropriately?	6	7	3
Do you ask physicians to discontinue monitors when they are not clinically necessary?	11	5	
Do you initiate cardiorespiratory monitors without orders from the physician?	11	5	

6 Children's

Survey Questions	Yes	No	No Answer
Do you notice every time an alarm goes off?	11	6	
Do the alarms become background noise?	14	3	
Do you check your orders for call parameters?	15		2
Do you change your monitors according to ordered call parameters?	13	3	1
Have you adjusted the parameters in the monitor on your patient without contacting the patient's physician?	11	6	
Do you use the correct leads and pulse oximeter for the patient's age and size?	16	1	
Do you change the monitors according to the patient's age (Neonatal,, Pediatric, or Adult)?	7	10	
Do you replace leads and pulse oximeters with the appropriate equipment when you suspect they are not in working order?	17		
Do you always check on your patient when the alarm goes off?	3	14	
Do you tend to silence the alarms and not check on the patient if you do not think the reading is accurate?	15	2	
Do you silence alarms from patients that are not yours?	11	6	
DO you check on patients after an alarm goes off if the patient is not yours?	13	3	1
Do you feel that the monitors can be customized to your patients' needs?	13	4	
Do you feel you have been desensitized to the alarms?	11	4	2
Do other nurses respond to their alarms appropriately?	6	10	1
Do you ask physicians to discontinue monitors when they are not clinically necessary?	17		
Do you initiate cardiorespiratory monitors without orders from the physician?	9	7	1

5 Children's

Survey Questions	Yes	No	No Answer
Do you notice every time an alarm goes off?	5	3	
Do the alarms become background noise?	6	2	
Do you check your orders for call parameters?	7	1	
Do you change your monitors according to ordered call parameters?	6	2	
Have you adjusted the parameters in the monitor on your patient without contacting the patient's physician?	7	1	
Do you use the correct leads and pulse oximeter for the patient's age and size?	7	1	
Do you change the monitors according to the patient's age (Neonatal,, Pediatric, or Adult)?	5	3	
Do you replace leads and pulse oximeters with the appropriate equipment when you suspect they are not in working order?	8		
Do you always check on your patient when the alarm goes off?	3	5	
Do you tend to silence the alarms and not check on the patient if you do not think the reading is accurate?	8		
Do you silence alarms from patients that are not yours?	7	1	
DO you check on patients after an alarm goes off if the patient is not yours?	8		
Do you feel that the monitors can be customized to your patients' needs?	6	2	
Do you feel you have been desensitized to the alarms?	6	2	
Do other nurses respond to their alarms appropriately?	2	6	
Do you ask physicians to discontinue monitors when they are not clinically necessary?	7	1	
Do you initiate cardiorespiratory monitors without orders from the physician?	7	1	

CICC

Survey Questions	Yes	No	No Answer
Do you notice every time an alarm goes off?	7	7	
Do the alarms become background noise?	10	4	
Do you check your orders for call parameters?	14		
Do you change your monitors according to ordered call parameters?	12	2	
Have you adjusted the parameters in the monitor on your patient without contacting the patient's physician?	7	7	
Do you use the correct leads and pulse oximeter for the patient's age and size?	13	1	
Do you change the monitors according to the patient's age (Neonatal,, Pediatric, or Adult)?	10	4	
Do you replace leads and pulse oximeters with the appropriate equipment when you suspect they are not in working order?	14		
Do you always check on your patient when the alarm goes off?	2	10	
Do you tend to silence the alarms and not check on the patient if you do not think the reading is accurate?	9	5	
Do you silence alarms from patients that are not yours?	10	4	
DO you check on patients after an alarm goes off if the patient is not yours?	14		
Do you feel that the monitors can be customized to your patients' needs?	13	1	
Do you feel you have been desensitized to the alarms?	9	5	
Do other nurses respond to their alarms appropriately?	10	4	
Do you ask physicians to discontinue monitors when they are not clinically necessary?	10	4	
Do you initiate cardiorespiratory monitors without orders from the physician?	7	7	

Diagnosing Alarm Fatigue in a Children's Hospital

Appendix 2: Observation of staff RN response to monitors

Date/Time	**RED Alarm (Emergent. Does not stop unless physically silenced)**	**Yellow Alarm (Warning, stops if patient resolves condition within 10 seconds)**	**Responded to at Central Station (Yes or No)**	**Verbal Comment made about alarm (Positive response by RN or Negative response/body language/nonverbal by RN at the Central Monitor; Place word(s)/phrase that signaled positive or negative response in box)**	**Observer responses noted (please note anything important related to alarms that you may have noticed during your observation period)**
			Yes No	Positive Negative Neutral	
			Yes No	Positive Negative Neutral	
			Yes No	Positive Negative Neutral	