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UNIVERSITY OF SAN DIEGO Hahn School of Nursing and Health Science DOCTOR OF PHILOSOPHY IN NURSING

CONTEXTUAL FACTORS INFLUENCING THE ACUTE CARE REGISTERED NURSE'S RESPONSE TO CLINICAL ALARMS

by

Kathleen Mary Stacy

A dissertation presented to the

FACULTY OF THE HAHN SCHOOL OF NURSING AND HEALTH SCIENCE

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requirements for the degree

DOCTOR OF PHILOSOPHY IN NURSING

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Dissertation Committee

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Abstract

Nurses are faced with a multitude of clinical alarms on a daily basis. There is an inherent expectation that upon hearing an alarm the nurse will immediately respond to assess the situation and initiate appropriate action to correct the problem. Yet this does not always occur. Issues with alarm responsiveness can pose a serious threat to patient safety.

The purpose of this qualitative study was to develop a broader understanding of the contextual factors that influenced the acute care nurse's response to clinical alarms. This study used an interpretive phenomenological methodology to study the lived experiences of the nurses who encounter alarms in the medical-surgical patient care setting.

The study was conducted in two community hospitals in southern California over a 9-week period. Four focus groups were conducted with a total of 28 participants. A tiered schedule approach was used to facilitate concurrent analysis and refinement of the interview questions. Data saturation was achieved after the last focus group. Each focus group was digitally recorded and each audio file was transcribed.

The sample consisted of 28 participants whose average age was 42.8 years, had been an RN for 10.9 years, and had been in their current position for 4.3 years. The majority of the sample was female (96%) and worked full time (75%) on the day shift (61%). Sixty four percent of the sample held an associate degree, 22% had a baccalaureate degree, and 14% had a master's degree.

Analysis of the focus group transcripts revealed the nurses used alarms tones to identify devices and alarm conditions. They used a priority setting approach to answer the alarms which was influence by a number of contextual factors. These were identified as acuity of the alarm condition (three subfactors - life-threatening physiological issues, patient safety issues, and patient comfort issues), patient satisfaction (three subfactors noise, customer service, and prior experience as a patient), experience as a nurse, unit leadership, personal motivation, availability of resources (two subfactors - time and energy), competing priorities, patient assignment, and special patient situations (two subfactors - isolation patient and effort-intensive patient and/or family). Dedication

To Every Nurse Who Has Ever Had to Answer a Clinical Alarm

To the Participants of this Study Thank you for Being Brave, Candid, and Funny and Telling Me Your Stories

To the Staff of the IMC Thank You for Endlessly Listening About My Dissertation

> To My Husband Jim And My Daughter Sherrie-Anne And My Furry "Girls" Roxy and Emma

Thank you for All Your Love, Support, and Encouragement

Preface

Faith of the Heart

It's been a long road Getting from there to here It's been a long time But my time is finally near

And I can feel the change in the wind right now Nothing's in my way And they're not gonna hold me down no more No they're not gonna hold me down

'Cause I've got faith of the heart I'm going where my heart will take me I've got faith to believe I can do anything I've got strength of the soul And no one's gonna bend or break me I can reach any star I've got faith, I've got faith, faith of the heart

It's been a long night Trying to find my way Been through the darkness Now I've finally have my day

And I will see my dream come alive at last I will touch the sky And they're not gonna hold me down no more No they're not gonna change my mind

'Cause I've got faith of the heart I'm going where my heart will take me I've got faith to believe I can do anything I've got strength of the soul And no one's gonna bend or break me I can reach any star I've got faith, faith of the heart

I've known the wind so cold, and seen the darkest days. But now the winds I feel, are only winds of change. I've been through the fire and I've been through the rain. But I'll be fine. Cause I've got faith of the heart I'm going where my heart will take me I've got faith to believe I can do anything I've got strength of the soul And no one's gonna bend or break me I can reach any star I've got faith

I've got faith of the heart. I'm going where my heart will take me. I've got strength of the soul. And no one's gonna bend or break me. I can reach any star. I've got faith, I've got faith, faith of the heart.

It's been a long road.

Diane Eve Warren

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Chapter 1

Introduction

"It may seem a strange principle to enunciate as the very first requirement in a Hospital that it should do the sick no harm." – Florence Nightingale (1859)

The concept of patient safety was thrust into the spotlight with the publication of the Institute of Medicine (IOM) report; *To Err is Human: Building a Safer Health System* (Committee on Quality of Health Care in America [CQHCA], 2000). This report highlighted the statistics that more people die each year in hospitals as a result of medical error, than die from motor vehicle accidents, breast cancer, Acquired Immune Deficiency Syndrome, and airplane crashes combined. The committee estimated that as many as 98,000 patients die each year as a result of healthcare-related mistakes, which is equivalent to the number of people who would perish if one jumbo jet crashed every day (CQHCA, 2000). This report generated a phenomenal amount of discussion and debate about the dangerous conditions within the America's healthcare organizations.

One area that has been cause for concern is patient injuries related to medical device error (Goodman, 2002). In 2002, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) issued a Sentinel Event Alert regarding ventilatorrelated deaths. Twenty-three reports of death or serious injury had been received involving patients requiring mechanical ventilation. Sixty-five percent of these events were the result of malfunctioning, misused and inadequate clinical alarms (Joint

1

Commission on Accreditation of Healthcare Organizations, 2002). After issuing the alert, JCAHO added "enhancing clinical alarm effectiveness" to the list of National Patient Safety Goals (NPSGs). It remained a goal until 2005, until such time it was integrated into the regulatory standards (Catalano, 2005).

Statement of the Problem

In today's inpatient healthcare environment clinical alarms are everywhere; cardiac monitors, intravenous infusion pumps, pneumatic compressions stockings, mechanical ventilators, etc. Almost every patient is connected to some device with an alarm (ECRI, 2002). Imhoff and Kuhls (2006) define a clinical alarm as "an automatic warning that results from a measurement or any other acquisition of descriptors of a state (here, patient state) and shall indicate a (clinically) relevant deviation from a normal (physiological) state" (p.1526). Clinical alarms are used to signal a variety of situations including a change in patient condition, an unexpected or unwarranted patient response, and actual or imminent device failure. Most alarms are auditory and rely on hearing as a primary natural warning sense (Edworthy & Hellier, 2005). Regardless of the cause, alarms warn the nurse that the patient may be in danger or at risk for harm. Any problem with an alarm poses a serious threat to patient safety.

Overview of Alarm Problems

In 2005, the American College of Clinical Engineering (ACCE) Healthcare Technology Foundation put forth an initiative "to improve patient safety by identifying issues and opportunities for enhancements in clinical alarm design, operation, response, communication, and appropriate actions to resolve alarm-related events" (p. 10). The ACCE Clinical Alarms Task Force was formed to further study alarm related problems. The task force queried the FDA MAUDE database and found 237 alarm related deaths have been reported between 2002 and 2004 (Clinical Alarms Task Force, 2007).

Problems with clinical alarms can be categorized as issues with system design, system performance, environmental influences, and operator management. System design deficiencies include recurring false alarms, device missed critical situations, and poor human factor interface. System performance deficiencies include lack of device adaptation to different patient situations and lack of standardized alarms. Environmental issues include noise and poor facility design. Operator management issues include improper alarm setup and slow or lack of response to alarms (Clark, 2005).

Lack of Response to Alarms

A slowed or failed response to a clinical alarm can lead to a catastrophic event for the patient. "In these events, the monitors and alarming mechanisms involved were judged to have worked because alarms sounded, yet in hindsight it was judged that appropriate, timely response did not occur" (Xiao, Seagull, Nieves-Khouw, Barszak, & Perkins, 2004, p. 772). Failure to respond to an alarm is thought to occur as a result of lack of vigilance, poor staff training, inadequate staffing (Clark, 2005), inappropriately set alarm limits, inability to prioritize workload, and excessive nuisance or "false" alarms (Phillips, 2006). While not hearing an alarm is one part of the issue; not heeding an alarm in another part (ECRI, 2002).

Purpose of the Study

The study of registered nurses' response to clinical alarms is in its infancy, as the concept is slowly emerging from the patient safety literature. In order to develop interventions to assist the nurse with responding quickly and efficiently to clinical alarms,

a thorough understanding of the individual, environmental, and situational factors that influence the nurse's decision to respond must be advanced. The purpose of this qualitative study was to develop a broader understanding of the contextual factors that influence the acute care registered nurse's response to clinical alarms in the medicalsurgical patient care setting.

The aims of this study were:

- to compile a rich description of the phenomenon "response to clinical alarms" with regards to:
 - the factors that influence the acute care nurse to immediately respond to a clinical alarm,
 - the factors that influence the acute care nurse to delay responding to a clinical alarm, and
 - the factors that influence the acute care nurse to not respond to a clinical alarm.
- to initiate the development of a practice theory specific to response to clinical alarms.

Background

An extensive review of the last 10 years of literature has revealed very few research studies devoted to examining the nurses response to clinical alarms. Most of the research in this area has been devoted to system design, system performance, or environmental influences (Imhoff & Kuhls, 2006). As patient safety is such a critical issue in healthcare, further research of this subject is crucial to ensuring patients are not harmed. While a few studies have highlighted the fact that nurses do not always respond to clinical alarms (Bitan, Meyer, Shinar, & Zmora, 2004; Sobieraj et al. 2006; Xiao et al., 2004), there is no clear understanding as to why this occurs.

One interesting and related study conducted by Kalisch (2006) looked at nursing care activities in medical-surgical units that were regularly missed by the nursing staff and the reasons that this occurred. This qualitative study used a grounded theory methodology with focus groups to identify nine themes of missed nursing care and seven themes related to cause. The themes related to missing nursing care were ambulation, turning, delayed or missing feedings, patient education, discharge planning, emotional support, hygiene, intake and output documentation, and surveillance. The themes related to the reasons were too few staff, time required for a nursing intervention, poor use of existing staff resources, "it's not my job syndrome", ineffective delegation, habit, and denial. This study is significant for two reasons. First it provides evidence that surveillance is an issue in the medical-surgical units. Second it highlights what is happening in the patient care units at the point of delivery. While "missed nursing care" and the "response to clinical alarms" are clearly two different concepts they are similar in nature in that the expectation exists that the activities associated with these concepts will be completed by the nursing staff. This study also underscores the contextual nature of these concepts and the need to examine them from the nurse's perspective.

According the AACN Scope and Standards for Acute and Critical Care Nursing Practice (2008) acute care nurses are responsible to "manage appropriately the interface between the patient and technology that may be threatening, invasive, and complex so that human needs for a safe, respectful, healing, humane, and caring environment are established and maintained" (p. 5). Part of managing the interface between the patient and technology is responding to alarms as they occur. As it is the staff nurse who has to respond to alarms throughout the shift, research has to be done with the staff nurse to identify the contextual factors influencing their response to clinical alarms. Until the thought process of the staff nurse who hears an alarm and makes a choice to respond or not is understood, any solution to "fix" the problem of failure to respond to clinical alarms will be inadequate.

Conceptual Underpinnings

Inherent in a healthcare system, that is supposed to heal and comfort the sick, is the philosophy of "do no harm." Patients are supposed to be safe when they enter a hospital. Thus it is not acceptable that harm come to any patient while under the supervision of the healthcare team. Keeping patients safe is an important responsibility of all disciplines involved in patient care. With the publication of the IOM report *To Err Is Human*, it became very obvious that healthcare organizations were doing a very poor job of keeping patients safe and free from harm (CQHCA, 2000). The result of this revelation was the emergence of the concept of patient safety which is defined as "freedom from accidental injury" (CQHCA, 2000, p. 211).

As frontline providers nurses are in key positions to monitor patients and intercept errors before an adverse event occurs. An *error* can be described as "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (CQHCA, 2000, p. 210), and an *adverse event* is "an injury resulting from a medical intervention" (CQHCA, 2000, p. 210). The Committee on the Work Environment for Nurses and Patient Safety (CWENPS) (2004) spoke to the role of the nurse and patient safety in the IOM report *Keeping Patients Safe*: As nurses are the largest components of the health care workforce, and are also strongly involved in the commission, detection, and prevention of errors and adverse events, they and their work environment are critical elements of stronger patient safety defenses. (p. 31)

The report categorized nursing activities into six categories; monitoring or surveillance of patients, providing physiologic therapies, assisting patients with loss of function, providing emotional support, and educating patients and families. The nurse's ability to identify, interrupt, and correct medical errors, transforming potentially negative outcomes into near miss situations, is inherent in each of these activities.

Surveillance is a critical element of patient safety. Bulechek, Butcher, and Dochterman (2008) describe surveillance as the "purposeful and ongoing collection and analysis of information about the patient and the environment for use in promoting and maintaining patient safety" (p. 699). It is a complex concept that incorporates both behavioral and cognitive components (Dougherty, 1999). Nursing actions inherent in the concept of surveillance include maintaining vigilance for potential problems (Meyer, Lavin, & Perry, 2007), developing awareness of problems as they occur, and responding to problems when they occur (Dougherty, 1999).

Responsiveness is a critical element of surveillance (Titler, 1992). Surveillance incorporates the use of technology as a means of monitoring the patient (Dougherty, 1999). Alarms are used to warn the nurse of an impending problem. The purpose of a clinical alarm is to communicate information regarding a patient situation that requires a response from the nurse (David et al., 2007). It is expected that a nurse maintains vigilance for clinical alarms and when he or she becomes aware of an alarm that the nurse will respond to the alarm. Responsiveness occurs on a continuum from a failed or no response to an immediate or appropriate response. A variety of issues can influence responsiveness including environmental, situational, and personal factors.

Research Question

What are the contextual factors that influence the acute care registered nurse's response to clinical alarms in the medical-surgical patient care setting?

Methodology

This qualitative study used an interpretive phenomenological methodology to identify the contextual factors that influenced the acute care registered nurse's response to clinical alarms in the medical-surgical patient care setting. The qualitative approach was selected because the concept of "response to clinical alarms" is not well developed in the literature as evidenced by a significant lack of previous research and a need exists to further explore and understand the phenomenon (Morse, 1991). An interpretive phenomenological approach was selected as it provides a method of arriving at a deeper understanding of the phenomena of concern through the lived experience of the participants (Creswell, 2007). Interpretative phenomenology involves the painstaking and meticulous study of participant narrative accounts of their experiences and through careful analysis an understanding or interpretation of that experience is derived (Benner, 1994). There are a number of assumptions that are inherent to this method of inquiry including the notion that participants are knowledgeable about the topic under investigation and the belief that participants are honest and do not intentionally conceal aspects of their experience (Holloway & Wheeler, 2002). Thus to further understand the concept of "response to clinical alarms" and the factors that influence this concept, it is necessary to study the lived experiences of the registered nurses who encounter this

concept.

Significance to Nursing

This study has relevance for advancing nursing science in the area of patient safety. The findings from this study will contribute to nursing research, clinical practice, and nursing education.

Nursing Research

In *Keeping Patients Safe*, the CWENPS (2004) made several recommendations for specific areas of further nursing research. These areas included patient surveillance and other nursing work processes, nursing-related errors, work space design, safe staffing, fatigue, shift work and sustained work hours, and collaborative models of care. Studies generated on these topics should focus on identifying how these areas present risk for harm to the patient. Once that is understood, studies to evaluate specific interventions to ameliorate the risk should be done.

This study will contribute to a better understanding of the concept of "surveillance" as a patient safety activity and further clarify the subconcept of "response to clinical alarms". In identifying the factors that influence the nurse's actions with regarding to responding to a clinical alarm, it will allow further research to take place to examine the extent to which these factors enhance or inhibit patient safety in the clinical setting. These factors may be developed in an instrument to allow for quantitative measurement of the phenomena and thus facilitate a broader collection of data which would allow for generalizability of the findings. Thus it is hoped that this research study will facilitate the development of the subconcept of "response to clinical alarms" into a construct for further study.

Clinical Practice

The results of this study will inform nursing leaders and those involved with the development of technology outside of the nursing domain of the factors that effect the nurse's response to clinical alarms. In order to develop interventions to assist the nurse with responding quickly and efficiently to clinical alarms, a thorough understanding of the factors that interfere with the nurse's response must be advanced. This study will help identify the issues that help or hinder these factors and allow for a broader discussion on ways to enhance clinical alarm responsiveness. Thus it is hoped that this research study will increase understanding of the issue and augment patient safety.

Nursing Education

Current education on clinical alarms is virtually nonexistent. As new technology emerges in the clinical setting it is a given that it comes with an alarm and an edict to answer the alarm immediately. The results of this study will identify the issues surrounding clinical alarm responsiveness that need to be discussed with new graduates and other nurses who are returning to the clinical setting who are faced with multiple alarms on multiple patients. Thus it is hoped that this research study will facilitate discussions regarding clinical alarms and patient safety in classrooms through out both academic and clinical settings.

Conclusion

Inherent in a healthcare system, that is supposed to heal and comfort the sick, is the philosophy of "do no harm." Patients are supposed to be safe when they enter a hospital. Thus it is not acceptable that harm come to any patient while under the supervision of the healthcare team. Keeping patients safe is an important responsibility of all disciplines involved in patient care.

Nursing work, situated as it is in the real time and space, where nurses are solicited by fellow human beings in the most profound of human experiences – birth, disease, injury, and death with all that such implies for vulnerable bodies and spirits – is work that demands nurses be responsive (Peter & Liaschenko, 2004, p. 223).

Response to clinical alarms is an important concept that needs to be further understood so

appropriate interventions can be developed to enhance responsiveness in all areas.

Chapter 2

Review of the Literature

An extensive search of the last 10 years of nursing, medical, psychology, and biomedical and clinical engineering literature has revealed very few research studies devoted to examining the nurses response to clinical alarms. Most of the research in this area has been devoted to system design, system performance, or environmental influences (Imhoff & Kuhls, 2006).

The purpose of this chapter is to provide an overview of the relevant literature related to the registered nurse's response to clinical alarms and to identify gaps in the literature to establish the need for this study. The following research studies were selected for review as they included information relevant to the concept of "response to clinical alarms." In addition, two articles addressing clinical alarm response from the quality perspective have been included in the review.

Alarm Response Studies

Study#1

The American College of Clinical Engineering Healthcare Technology Foundation Clinical Alarms Task Force (2007) conducted a survey study to assess clinical alarm issues. The survey was conducted online over a 5 month period and was completed by 1,327 participants including physicians, nurses, clinical managers, respiratory therapists, and biomedical and clinical engineers. More than one-half of the respondents were registered nurses. The survey was divided into three sections. The first section asked the participants to rate their level of agreement with 22 different statements regarding clinical alarms. The second section asked the participants to rank the level of importance (on a scale of 1 to 9) of nine different alarm issues. The third section asked the participants to comment on when they felt was needed to improve clinical alarm recognition and response. The results showed that more than 90% of the respondents agreed with the purpose of clinical alarms, the need for differentiated (based on source) and prioritized (based on urgency) alarm signals, and that nuisance alarms occur frequently, disrupt patient care, and decrease confidence in the alarm. In addition, 42% of the participants ranked false alarms and inadequate clinical alarm response as the two most important alarm issues.

The researchers failed to provide all the data so it was difficult to assess if there were any problems with the data analysis. The survey was included in the article and it would have been of interest to see how the participants responded to all the statements. The comments solicited from the participants in section three were also not discussed. To facilitate the dissemination of the results of the study, it was published in both the clinical engineering literature (Clinical Alarms Task Force, 2007) and the nursing literature (Kornewicz, Clark, & Yadin, 2008).

Study #2

Bitan, Meyer, Shinar, and Zmora (2004) conducted an observational study to assess nurses' reactions to clinical alarms in a neonatal intensive care unit. The researchers collected data over 47 different time periods for a total of 30 hours and 42 minutes of observation time. Two nurses were observed at a time with a total of 17 different nurses being observed by the end of the study. Data analysis consisted of two parts. First, they analyzed the frequency, duration and cause of the alarm. Second, they analyzed the nurses' reactions to the alarms. The researchers reported that the most common cause of a clinical alarm was decreased oxygen saturation and that the alarms went off an average of 16.74 times an hour for an average duration of 15 seconds. Next, the researchers calculated the probability of the nurse answering the alarm within one minute. For alarms that lasted 5 seconds or less, the probability that the nurse responded to them within 15 seconds was 5.3%, within 30 seconds was 6.7% and within 60 seconds was 9.8%. For alarms that lasted longer the probability of being responded to increased. It is important to note that in this study the alarms would silence themselves if the parameter being monitored went back into a normal range. From this data the researchers concluded that nurses rarely respond to clinical alarms but did acknowledge that the nurses' might be filtering out the false alarms and thus responding to only the clinical alarms they think are important.

The results of this study are problematic because the observers (who were not nurses) never solicited any input from the nurses they were observing as to their decision making regarding when to respond and when not to respond. The researchers also did not explain what type of response they were observing for. For instance, an alarm sounds while the nurse is tending to the baby in the next bed, the nurse looks up and sees the alarm on the monitor, looks at the baby, and judges everything to be fine, the alarms silences itself. It's unclear if the researchers judged that to be a response or a nonresponse. The statistical analysis of the nurses' response time was confusing. Instead of measuring the probability of a response, the more meaningful data would have been the actual response time. In addition, it was unclear from the data analysis which clinical alarm events were silenced by the nurse and which were silenced by the parameter returning to baseline. Clinically if the parameter being monitored returns to baseline and the alarm silences itself, a response from the nurse may not be necessary. The researchers on the other hand were still expecting a response from the nurse and this may have skewed the data.

Study #3

Xiao, Seagull, Nieves-Khouw, Barcrak, and Perkins (2004) conducted a qualitative study to examine the phenomena of failure to respond to clinical alarms. The researchers took four case reports from the organization in which the patient had suffered an adverse event related to failure to respond to clinical alarms. A variety of questions were developed to elicit responses regarding why there was a failure to respond to the clinical alarms in a timely fashion. Ten interviews were done with a variety of individuals including clinical staff nurse, nurse manager, biomedical technician, risk managers, physicians, and respiratory therapists. The researchers, using an organizational systems approach, identified several themes that emerged from the interviews. These included mission-shifting, acuity-creep, off-floor activities, increased logistical burden, overprescription of monitored beds, use of supplemental staff, monitor set-up, and many different types of alarms.

Mission-shifting was the term used for the phenomena of altering a unit in the hospital to care for a different type of patient than was originally intended. In this case the area was designed for caring for unmonitored patients and now housed monitored

patients. This created auditory issues for the nursing staff. The idea of *acuity-creep* referred to the increasing acuity of the patient with the increasing need for more medical devices with alarms. Off-floor activities depicted the frequent need of a nurse to have to monitor another nurse's patients because the nurse was off the floor. The concept of *increased logical burden* referred to the constant movement of patients and the distractions it caused the nurse. Over-prescription of monitored beds referred to the increased placement of patients into monitored beds by the physicians and the resultant increase in alarms. Use of supplemental staff referred to the increased use of non-regular staff on the unit. The supplemental staff was thought not to be as familiar with the equipment as the regular staff and thus increased the incident of operator errors. Monitor set up referred to the defaulting of alarm parameters every time the monitor was powered off and on. This lead to an increase in nuisance alarms if the staff did not take the time to personalize the alarm parameters to the individual patient. Lastly, the concept of many different types of alarms was used to describe the wide variety of clinical alarms that that could be heard within the unit. Not only did each piece of equipment have a different alarm; some pieces of equipment had a variety of alarms signaling different problems.

This study took an organizational viewpoint to examine the issued of failed alarm response. The researchers failed to report the demographics of the study group and thus no correlation what done regarding what nursing thought the issues were versus another discipline. Several themes emerged that would warrant further research.

Study #4

Evans et al. (2005) conducted a pilot study to examine the effects of an enhancement audio and visual ventilator alarm system on response time. The researchers developed a computer program that integrated ventilator alarms into the existing computer system. When a critical ventilator alarm was initiated, the system displayed a visual alarm on all the unit bedside computers and sounded a "submarine dive horn" audio alert. A six-month pilot study was conducted in four different intensive care units within one hospital. Response time was determined by alarm duration time which was calculated from the time the alarm sounded to the time it was silenced or the problem was corrected. During the 6-month study period a total of 237 critical ventilator events occurred with an average response time of 20.5 seconds.

The biggest problem with this study was that the researchers failed to gather any baseline data. Thus they could not draw any conclusions regarding the effectiveness of the enhanced notification system. While they did analyze the types of critical ventilator alarms that occurred they failed to present any description of the types of patients, any discussion of the severity of illness, or provide the length of duration of mechanical ventilation. Thus the number of events is meaningless data. This study was based on the assumption that when a clinical alarm is heard, someone will respond to it immediately. The researchers failed to identify any intervening variables that might affect the ability of the responder to respond immediately.

Study #5

Osinaike, Amanor-Boadu, Oyebamiji, Tanimowo, and Dairo (2006) conducted a descriptive study to investigate the effects of audible alarms in the operating room and intensive care unit. Subjects included 35 anesthesiologists, 7 surgeons, 2 nurse anesthetists and 20 intensive care unit nurses. A close-ended questionnaire was used to assess the effects of clinical alarms on attention, workload, and working memory. The researchers found that the majority of the subjects felt that clinical alarms were useful in getting their attention, did not increase their workload, and did not affect their memory. The researchers concluded however, that clinical alarms increase distractions, increase workload, and increase memory impairment.

Overall this study was fraught with methodological issues. The researchers did not provide operational definitions for the three variables. It was difficult to assess the appropriateness of the methodology as the instrument as was not included nor were any sample questions provided. It was unclear if the researchers were using a standardized instrument or developed their own; either way reliability or validity of the instrument was not reported. In addition, only a small sample of nurses was surveyed and probably most importantly, the results did not support the conclusions.

Study #6

Sobieraj et al. (2006) conducted a quantitative study to investigate the audibility of clinical alarms in a medical-surgical setting. The researchers examined the distance at which the nursing staff could hear an intravenous infusion pump alarm. Once the alarm sounded, the nurse had 3 minutes to respond to the alarm. When a member of the nursing staff arrived to silence the alarm, they were asked to identify where they were when they heard the alarm sound. That distance was measured. In addition, the staff member was asked to rate how well the alarm was heard on a Likert scale. Data was collected over an 8-week period during the day from various rooms within the unit, with the patient room doors open and closed. The researchers concluded that in this setting, the alarms were audible within 95 feet with the patient room doors open. When the patient room doors were closed however, audibility was significantly decreased.

This was a well done study. The research methodology took into account a variety of intervening variables, such as the hearing acuity of the staff, environmental background noise and the acoustical properties of the unit. Data analysis was sound and appropriate for the study. The researchers identified that the study was based on the assumption that if the nurse heard the clinical alarm, the nurse would respond to the clinical alarm. However, during the study this did not always happen. Several reasons were identified for the lack of response including simultaneous activation of several clinical alarms, the nurse's perception that the clinical alarm was "false" alarm, the nurse's perception that the clinical alarm was not urgent, and finally just ignoring it all together (Sobieraj et al, 2006). The biggest limitation to the study is it's generalizability to other facilities as patient units are architecturally different from facility to facility.

Study #7

Cook (2008) studied the ability of telemetry nurses to discern critical and noncritical electrocardiographic (ECG) alarms. Twenty-nine nurses listened to ten prerecorded alarms in a quiet room and were asked to identify each alarm. The results showed that only 60% of the nurses could correctly identify the alarms. The most common mistake was that the "leads off" alarm was mistakenly identified as the "low battery" alarm.

While this is a small study it does have some interesting implications. Many nurses feel that noncritical alarms are unimportant and do not respond to them. The "leads off" alarm is a critical alarm and ignoring it can have significant repercussions for the patient. When a patient has an ECG lead off their rhythm may no longer be transmitted to the monitor and if the patient experiences life-threatening dysrhythmias it will not be detected. While many registered nurses believe that they are able to correctly tell the difference between different alarm tones this study illustrates that this is not always the case.

Appropriate Clinical Alarm Limit Studies

Study #8

Solsona et al. (2001) conducted a study designed at testing an intervention to get the nurses to set appropriate auditory clinical alarm limits in a 12-bed intensive care unit. The study was executed in three phases. In the first phase, the researchers monitored the minimum and maximum alarm settings of selected patient variables (respiratory rate, heart rate, expired minute volume, airway pressure, oxygen saturation, and arterial blood pressure) three times a day to obtain baseline data. Data was collected on 60 patients over a 3-month period. In the second phase, the researchers had the staff document the minimum and maximum alarm settings for the selected patient variables every 4 hours in the medical record for 12 months. The researchers postulated that having the nurses' document the limits frequently would encourage them to adjust them to a more appropriate range. In the third phase, the researchers repeated the first phase to obtain post-intervention data. Data was collected on 40 patients over a 3-month period. Based on the data analysis the researchers concluded that the intervention was effective.

There were several problems with this study. The researchers failed to provide an operational definition of what "appropriate alarm limits" are, such as heart rate alarms set within 10% of baseline heart rate. In addition, the data analysis did not make any sense with regards to the research question. The researchers analyzed the data by patient and averaged data over time versus looking at it by shift or by nurse. The patient may have had shift or two when the alarm limits were not set correctly but when averaged together to get one set of post-intervention data per patient, this information was lost. Instead of looking if the alarm limits were set appropriately or not, they looked at how far off the alarm limits were set from the actual parameter being monitored. They concluded their intervention worked because the variation in the alarm limits from the actual parameter being measured was statistically significantly closer to the actual parameter after the intervention than before the intervention. Clinically this does not make sense because even though the alarm limits might have been set closer to the parameter being monitored, they still might not be close enough to be considered within an appropriate range. The study also lacks generalizability due to the single site setting and the small sample.

Quality Improvement Projects

Project #1

Hyman and Johnson (2008) performed a fault tree analysis to evaluate alarm related harm to a patient. A fault tree analysis is process often used by engineers to analyze an adverse event and to identify the contributing factors. In this analysis the authors (two clinical engineers) identified five main contributing factors to alarm related harm and then a number of secondary contributing factors. The first main contributing factor was "patient condition triggers an alarm but not responded to in a timely manner" (p. 88). The other main contributing factors related to equipment issues and are not relevant for this discussion. The authors then identified secondary contributing factors to untimely alarm response. These factors were staff does not hear the alarm, staff is too busy, staff deliberately ignores the alarm due to a history of false alarms, staff is confused about which alarm is sounding, and staff is unaware of the criticality of the alarm. Additional issues related to the staff being too busy included competing demands on the staff and understaffing.

The authors presented an extensive analysis of alarm related harm to the patient and identified a number of areas for further consideration. The biggest limitation to this project however, was the lack of involvement of nurses; who are the end users of the equipment. The authors also did not identify how they came to the conclusion that these were the only secondary contributing factors nor did they speculate that there might possibly be additional ones.

Project #2

Semple and Dalessio (2004) performed a failure mode and effects analysis (FMEA) to evaluate current practice in a telemetry unit with regards to recognizing and responding to noncritical telemetry alarms. In this unit the telemetry monitoring system identified the "leads off" alarm as a noncritical alarm and sent out a different alarm tone when this problem occurred. The average response time to noncritical alarms was 12 minutes. Since the patient could have a critical dysrhythmia during this time and it would not be noted on the monitor, this situation presented a significant threat to patient safety.

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A team was assembled that consisted of five nurses from the telemetry unit (including the two authors), the nurse manager, and the director of clinical engineering. Using the 10-step FMEA process the team was able to identify a number of critical failure modes and developed a number of interventions to correct them. While a number of the failure modes centered on the equipment and the nurses not hearing the alarm, failure to respond to the noncritical alarm was also mentioned. The team identified that this occurred as a result of the nurse not recognizing the critical nature of the alarm and decided it was more of an issue with staff competency. Interventions to fix the problem included educating the staff to the need to answer noncritical alarms promptly and emphasizing the liability associated with a delayed or failed response. Following the implementation of all the interventions outlined in the FEMA, the response time to noncritical alarms decreased to 1.57 minutes.

This FEMA is an excellent example of how to use the process to make significant changes in clinical practice and improve patient safety. It is readily apparent that interventions that the team implemented had a significant initial impact on the identified problem. One issue with this project though, is that the team failed to consider any other failure modes for the lack of response by the nurses to the noncritical alarms. As the data presented was collected at the end of the project it would be interesting to see if they were able to maintain the gains the low response time.

Conclusion

The research on nurses' response to clinical alarms is very limited. Bitan et al. (2004) showed that nurses do not always appropriately respond to clinical alarms. Sobieraj et al. (2006) discovered that nurses did not always respond to a clinical alarm

even if they heard it. The Clinical Alarms Task Force (2007) survey respondents identified failure to respond to alarms as an important issue. Xioa et al. (2004) provided the most insight into reasons for poor clinical alarm response and these warrant further exploration and validation.

As patient safety is such a critical issue in healthcare, further research of this subject is crucial to ensuring patients are not harmed. While a few studies have highlighted the fact that nurses do not always respond to clinical alarms, there is no clear understanding as to why this occurs. As it is the registered nurse at the bedside who has to respond to clinical alarms throughout the shift, research has to be done with this group to identify those issues that impact their response. Until a thorough understanding of the situational, environment, and individual factors that affect the registered nurse's response is obtained, any solution to "fix" the problem of failed or slowed response to clinical alarms will be incomplete.

Chapter 3

Methodology

The purpose of this qualitative study was to develop a broader understanding of the contextual factors that influence the acute care registered nurse's response to clinical alarms in the medical-surgical patient care setting. In this chapter the study methodology is discussed along with procedures for sample selection, data collection, and data analysis. Rigor and ethical considerations are also presented.

Research Design

This qualitative study used an interpretive phenomenological methodology to gain insight into the environmental, situational, and personal factors that influence the acute care registered nurse's response to clinical alarms. The qualitative approach was selected because a need existed to further explore and understand the concept of "response to clinical alarms". This concept is not well developed in the literature as evidenced by a significant lack of previous research (Morse, 1991). An interpretive phenomenological approach was selected as it provided a method of arriving at a deeper understanding of the phenomena of concern through the lived experience of the participants (Creswell, 2007).

Interpretative phenomenology involves the painstaking and meticulous study of participant narrative accounts of their experiences and through careful analysis an understanding or interpretation of that experience is derived (Benner, 1994). This method

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seeks to divulge the lived experience of individuals experiencing a certain phenomenon, while acknowledging the researcher's personal beliefs, and embraces the view that understanding requires interpretation. It aims to offer insights into how a given person, in a given context, makes sense of a given phenomenon. Based on the work of Heidegger, interpretative phenomenology involves examining how a phenomenon appears and analyzing it to make sense of it. Examining the concept of "response to clinical alarms" through the lived experience of the participants provides rich data for analysis and interpretation, which reveals not only how they respond but the contextual factors that influence their response (Smith, Flowers, & Larkin, 2009).

van Manen (1990) outlined six activities that comprise the methodological structure of an interpretative phenomenological research study:

(1) turning to a phenomenon which seriously interests us and commits us to the world;

(2) investigating experience as we live it rather than as we conceptualize it;

(3) reflecting on the essential themes which characterize the phenomenon;

(4) describing the phenomenon through the art of writing and rewriting;

(5) maintaining a strong and oriented pedagogical relation to the phenomenon;

(6) balancing the research context by considering parts and whole. (p. 30-31) These six steps form the procedural blueprint for this study.

There are a number of assumptions that are inherent to this method of inquiry including the notion that participants are knowledgeable about the topic under investigation and the belief that participants are honest and do not intentionally conceal aspects of their experience (Holloway & Wheeler, 2002). Thus to further understand the

concept of "response to clinical alarms" and the factors that influence this concept, it was necessary to study the lived experiences of the registered nurses who encountered this concept.

Sample

Research Site

The setting for this research study was two not-for-profit hospitals located in southern California. One is a 350-bed community hospital and the other is a 120-bed community hospital. They are both members of the same healthcare system and they share some of the same staff. This site was chosen based on the researcher's affiliation with the healthcare system.

Sample Selection

An initial purposive sample of 20 participants was sought, from the population of acute care registered nurses employed in the medical-surgical patient care setting, with final sample of 28 participants having been obtained. The final sample size was determined based on data saturation. For the purpose of this study the participants were required to meet the following inclusion criteria: 1) must be a registered nurse working in a medical-surgical unit in the stated research setting, and 2) must have at least one year of full time experience in the clinical setting. The experience criterion was established to ensure that the participants had enough exposure to the phenomena of concern in order to have experiences upon which to reflect. Limiting the area to medical-surgical nursing units ensures homogeneity within the participant group.

Sample Access

To obtain access to the participants the researcher met with the nursing leadership

of the medical-surgical units and explained the purpose of the study. Once their permission was obtained and approval was obtained from the hospital institutional review committee (Appendix A) and the USD institutional review board (Appendix B), the researcher posted flyers (Appendix C) in the different units soliciting participation in the study. The researcher also attended the unit practice councils in the target areas to solicit support for the study directly from the nursing staff. The participants for the first focus group where solicited through the unit practice councils. The other three focus groups were solicited using the flyer; hence there is only three dates on the flyer. An email using the information on the flyer was sent to all the nurses in the targeted units as well. Prospective participants were asked to contact the researcher via telephone or email using the contact information listed on the flyer to discuss the study or ask any questions.

Data Collection

The registered nurse's response to alarms was explored using a focus group technique. A focus group uses moderator-lead semistructured group sessions to solicit opinions, beliefs, and attitudes about the phenomena of interest (Kruger, 2000). Four focus groups were conducted with each group containing anywhere from four to nine participants. The focus groups were conducted on a "tiered schedule" to facilitate concurrent analysis and refinement of the interview questions. The first focus group was held the middle of March 2009 and the last focus group was held in June 2009. There was three weeks between each group. The final number of focus groups was determined by data saturation. After the fourth focus group the researcher believed that data saturation had been reached. Each session was held in a secure conference room within the hospital but away from patient care activities which provided a comfortable atmosphere for participation. Three of the sessions were held at the bigger hospital and one session was held at the smaller hospital. All of the focus groups were conducted by the researcher and were recorded with two small, digital recorders. The researcher also took notes in the event the recorders failed and to capture field notes. This method of data collection was selected as it allows the researcher to gather data in a variety of ways including interviewing the individual participants, group interaction, and participant observation (Plummer-D'Amato, 2008a). Focus groups allow the participants to talk with each other, instead of to the researcher, which enhances their responses as it triggers memories and allows for discourse and clarification of the phenomena under discussion (Benner, 1994).

Participant Management

Prospective participants were asked to call or email the researcher using the contact information on the flyer to sign up for one of the focus group sessions. At that time the participant was asked to leave either a telephone number or email address. To confirm their participation in the study the researcher contacted the participants about one week prior to their scheduled focus group and then again the day before their scheduled session. Each participant received a \$25.00 gift card to thank them for their participation. All participants were guaranteed a gift card regardless of whether they stayed for the entire focus group or decided to withdraw from the study. All the participants stayed for the entire focus group and no participants withdrew from the study.

Session Management

At the beginning of each session, the researcher informed the participants that the

session would be digitally recorded. Next the researcher explained the purpose of the study as well as the risks and benefits of the study. The participants were also informed that at any time they could withdraw from the study, ask questions about the study, or refuse to answer any questions posed by the researcher. The researcher then asked the participants to read and sign the Consent Form (Appendix D). A copy of the Consent Form was given to each participant. The researcher then asked the participants to reach participant. The researcher then asked the participants to reach participant. The researcher then asked the participants to reach participant. The researcher then asked the participants to reach participant. The researcher then asked the participants to complete a Demographic Information Form consisting of eight questions regarding participant's demographic characteristics (Appendix E).

The participants were asked to introduce themselves, using their first name only. They were advised that there were no right or wrong answers and that the goal of the discussion was to identify their opinions, beliefs, and knowledge related to the factors that influence their response to clinical alarms in the patient care setting. Rules of communication were also discussed with an emphasis on encouraging all members to participate and the importance of not criticizing the responses of others. The researcher then turned on the digital recorder.

Using the interview guide (Appendix F), the researcher then asked a series of questions to solicit each of the participant's experiences with responding to clinical alarms. The interview began with nonthreatening questions to facilitate group comfort in voicing individual viewpoints and engaging in discourse. At the completion of the session, participants were instructed not to share the discussion or individual responses. Field notes were documented at the end of each focus group session. Depending on the size of the focus group, the entire session took from 60 to 70 minutes.

Data Management

Once a focus group was completed the digital recordings were uploaded and sent to GMR Transcription Service (Tustin, California). They were transcribed verbatim within three to five days after each focus group by a trained transcriptionist. A confidentially agreement is on file with GMR Transcription. The researcher reviewed the written transcripts against the digital recordings to ensure accurate transcription of the interviews. The digital recordings were erased once accuracy of the transcript had been confirmed by the researcher.

Each transcript was annotated with factuals, field notes, methodological notes, analytic notes, and personal notes to provide a complete narrative transcript of the focus group session. Any specific contextual details, in either the audio file transcripts or field notes, which could reveal the identity of the participants, were changed or omitted as appropriate. Demographic information responses were aggregated. All participant information, consent forms, and annotated transcripts are kept in a locked cabinet in the researcher's home office. These items will be maintained for five years.

Data Analysis

In interpretative phenomenology data analysis occurs concurrently with data collection. According to Crist and Tanner (2003) this occurs in five nondiscrete nonlinear iterative phases. In the first phase the initial narrative transcript of the focus group was analyzed for emerging lines of inquiry for future focus group sessions. The researcher's interview techniques were also evaluated to identify areas of improvement (Crist & Tanner, 2003). In this study the interview guide grew from five questions to eleven

questions from the first focus group to the last. The researcher's interview style also evolved from one focus group to the next.

In the second phase the transcripts were analyzed through multiple readings to identify central concerns or important themes, exemplars or significant excerpts, and a paradigm case (Crist & Tanner, 2003). Paradigm cases are vivid examples of particular ways of being, of concerns, or of practices (Benner, 1994). In the third phase shared meanings of phenomena were identified by comparing and contrasting the narratives (Crist & Tanner, 2003).

In the fourth phase final in-depth interpretations were formed and shared with some of the participants as a method of confirming and validating the analysis (Crist & Tanner, 2003). The researcher selected two participants from each focus group and made contact with them, either in person or via a telephone call, for clarification and validation of identified themes. These follow-up discussions lasted no more than 10 minutes. In the fifth and final phase the manuscript of the interpretation was finalized and disseminated (Crist & Tanner, 2003).

Rigor

Rigor was achieved through the establishment of trustworthiness by demonstrating dependability (reliability), credibility (internal validity), transferability (external validity), and confirmability (objectivity) (Plummer-D'Amato, 2008b).

Dependability was confirmed via a dependability audit which involved the maintenance of an audit trail that would allow another researcher to follow the same processes (Plummer-D'Amato, 2008b). In this case all data was carefully maintained and documented to ensure an accurate accounting of the processes used in the study. A

process was developed for referencing all statements and subsequent themes to the original narratives from which they were drawn.

Credibility was established by member checking which entailed the review of the transcript analysis with members of the original focus groups (Plummer-D'Amato, 2008b). In this case at least two members of the each focus group were contacted and asked to concur with the final analysis of the discussion.

Transferability was confirmed via rich descriptions of the data (Plummer-D'Amato, 2008b). The focus group interview format used in this study involved asking general, open-ended questions about the participants' experiences with clinical alarms. This allowed the participants to speak freely of their experiences and produced rich, detailed descriptions of those experiences.

Confirmability was established via reflexivity which entails reflecting on one's own biases (Plummer-D'Amato, 2008b). This was achieved through self-reflection and disclosure of the researcher's background and personal feelings regarding the subject of study. Thus the reader should be able to establish if bias existed in the analysis of the narrative accounts.

Ethical Considerations

This study was approved by the University of San Diego Institutional Review Board and the Intuitional Review Committee of the target hospitals prior to the commencement of participant recruitment. Participants' names were deleted from the audio file transcripts and field notes. In addition, any specific contextual details that could reveal the identity of the participant were changed. All demographic responses were aggregated. Audio files were destroyed once the transcripts were verified for accuracy by the researcher. All participant information, consent forms, and annotated transcripts are kept in a locked cabinet in the researcher's home office. These items will be maintained for five years.

Ethical considerations raised by this study are concerned with obtaining informed consent and maintaining participant confidentiality (Holloway & Wheeler, 2002). At the beginning of each focus group the researcher outlined the purpose of the study and the possible risks and benefits to the participants. The risk to the participants was that they may become tired during the focus group. There was no direct benefit to the participants except they will be helping nurses and other healthcare personnel learn about the process of responding to clinical alarms.

To ensure adequate disclosure, each participant was given a copy of the Consent Form which outlines the purpose of the study and contact numbers for further information. To ensure voluntariness the researcher informed the participants that they could withdraw from the study at any time and that they could refuse to answer any of the questions posed by the researcher. To ensure comprehension, each participant was given an opportunity to ask questions about the study at any time. There were no existing power relations between the researcher and the participants that could have been perceived as coercion.

The Researcher's Reflections on the Phenomenon

Prior to conducting an interpretive phenomenological study it is important that the researcher reflect on his or her experience with the phenomenon under study. These reflections should assist with identifying any bias the researcher might have toward the

phenomenon at the time of analysis (van Manen, 1990). The following statements were this researcher's initial reflections on the subject.

I am a Critical Care Clinical Nurse Specialist who currently works on an intermediate care unit. Everyday I observe a variety of different nurses respond to a variety of different clinical alarms in this unit. Many of the alarms in this unit are the same alarms that are found in the medical-surgical nursing units. Sometimes the nurses answer the clinical alarms right away and sometimes it takes several minutes for a nurse to respond to an alarm. I have observed a variety of nursing behaviors including walking right by a patient's room with an alarm ringing, sitting at the desk charting in front of a patient's room with an alarm ringing, and going into a patient's room and looking at the equipment and leaving without silencing or correcting the alarm. As I refuse to believe the nurses do not care about alarms and I know them to be kind, caring and compassionate individuals, there must be other factors that are influencing their response to clinical alarms. While I could speculate about those factors, I have chosen not to because it would be just speculation. I have not worked as a staff nurse for a long time and thus my current experience with responding to alarms is very different from the staff nurses' experience. It is my intent to set aside my experience and to attempt to capture their experiences through their stories to discern those factors influencing their response to clinical alarms.

Chapter 4

Results

The purpose of this qualitative study was to develop a broader understanding of the contextual factors that influenced the acute care registered nurse's response to clinical alarms in the medical-surgical patient care setting. This study used a series of focus groups to gain insight into the environmental, situational, and personal factors that influence the nurse's response to clinical alarms. An interpretive phenomenological methodology, as described in the previous chapter, was used identify noteworthy themes that are representative of these contextual factors.

In this chapter the description of the participants and the contextual factors influencing the response to alarms is presented. The types of devices found in the patient care setting and the implications of alarms tones are also discussed.

Description of Participants

The sample consisted of 28 participants whose average age was 42.8 years, had been an RN for 10.9 years, and had been in their current position for 4.3 years. The majority of the sample was female (96%) and worked full time (75%) on the day shift (61%). Sixty four percent of the sample held an associate degree, 22% had a baccalaureate degree, and 14% had a master's degree. Table 1 provides a complete overview of the participant data.

Table 1

Participant Profile

Characteristics	N	%	Μ	Range
Gender				
Male	01	04		
Female	27	96		
Employment				
Full Time	21	75		
Part Time	07	25		
Per Diem	00	00		
Shift Worked				
Days (0700-1930)	17	61		
Nights (1900-0730)	11	39		
Basic Nursing Program				
Licensed Vocational Nurse	02	07		
Diploma	00	00		
Associate Degree	19	68		
Baccalaureate Degree	07	25		
Master's Degree	00	00		
Highest Nursing Degree				
Associate Degree	18	64		
Baccalaureate Degree	06	22		
Master's Degree	04	14		
Doctoral Degree	00	00		
g				
Age	28		42.8	28.0-63.0
# Voorg og og DNI	20		10.0	01 0 27 0
# i ears as an KIN	28		10.9	01.0-27.0
# Years in Present Position	28		04.3	00.5-12.0

It is important to note that this study was conducted in California where the nurse patient ratios are regulated by law. The sample in this study was drawn from a variety of different units that had a number of different staffing models. Thus the nurses who participated in these focus groups may have had anywhere from three to five patients. The units varied in size from 20 beds to 33 beds.

Types of Devices

At the beginning of each focus group the participants were asked to identify the various types of devices with a clinical alarm that were used in the different units that they worked. All four focus groups identified the same pieces of equipment. The participants also identified that several devices had multiple alarms tones signaling different types of alarm conditions. Table 2 lists all the equipment with a clinical alarm as identified by the participants and those with multiple alarm tones. While a patient never has all this equipment attached to them at one time, many patients do have five or six different devices attached them at any given time.

Alarm Tones

During the focus groups it became very apparent that the participants used the alarm tones to identify the different pieces of equipment and in some cases the different alarm conditions. Some of the participants were even able to mimic the alarm tones of the different devices. This created a great deal of laughter in each group! One participant said, "And it's interesting with each beep, you know which pump, what pump is going off." Another participant said:

But I think with the IV machine you hear it go off so often that we tend to kind of tune that out a bit, whereas when the PCA goes off you know it's a definite sound. The tube feeding is a definite sound, and the bed alarm is shrill, very shrill. And then the vital machine will drive you crazy, so that's a real loud one.

Table 2

List of Devices with Alarms in Medical-Surgical Units

Device	Alarm Tone		
Intravenous (IV) Pump	Multiple Tones		
	Keep Vein Open (KVO)		
	Occluded		
	Battery Failure		
Patient-controlled analgesia (PCA) Pump	Single Tone		
Pneumatic Compression Stocking (PAS) Pump	Single Tone		
Feeding Pump	Single Tone		
Hospital Bed with built in Bed Exit Alarm	Single Tone		
Tab Alarm (aka Bed Buddy)	Single Tone		
Vital Sign Machine	Multiple Tone		
	Vital Sign Alteration		
	Battery Failure		
BiPap® Machine	Multiple Tone		
	High Priority Alarms		
	Medium Priority Alarms		
	Low Priority Alarms		
Constant Positive Airway Pressure (CPAP)			
Machine (2 different types of devices)			
Hospital owned	Single Tone		
Patient owned	Single Tone		
Hoana LifeBed Coverlet	Single Tone for All Alarm		
Bed Exit Alarm	Conditions		
Heart Rate Alteration			
Respiratory Rate Alteration			
vacuum-assisted closure (VAC) Device	Single I one		
Air-Fluidized Beds	Single Tone		
Barlatric Beds	Single Tone		
Specially Bed Overlays	Single Tone		
Low Air Loga Mettroga	Single Tone		
LOW AIT LOSS MATTRESS	Single Tone		

Another participant speculated on how the ability to recognize the different alarms

occurs:

It's also when you start nursing and you're orientated, it's not like somebody said, okay, this alarm is for this or this alarm is for that. It's when you're working on the floor, and then through as you hear the alarm you go, oh, that's that, oh, that's that. And eventually you hear them enough that you can recognize what they are. And if it's a new one, then you go hunt for it.

When the initial focus group was asked, "Can you tell the difference in the different alarms?" One participate said, "Uh huh. Yes. Yeah. Very distinctive." and all the other participants nodded their heads in agreement. The participants in the other focuses groups also responded the same way to that question. One participant said, "Yeah, if you're sitting at the nurses' station, you hear [an alarm], you're like oh, somebody's PCA." Another participant added to this comment and said, "Right. I think its subconscious. I think you just get, you know, subconscious what you know by the different tones." When asked to elaborate about alarms in general one participant said:

Like everyone said, I don't like alarms but you deal with it. But it's good that they're so distinctive so that you kind of know, "Oh, should I run, or should I just walk there?" Or, "Let me save my stuff [referring to charting on the computer], then I'll go." That's all.

Another participant followed up this comment with "Well, I like the distinction of the alarms because it sets your priorities".

When asked about responding to an IV pump alarm one participant said, "Kind of depends on which alarm is going off because you can tell by the tone. You can tell by the tone on the IV what it is." When asked to elaborate on the different alarm tones the participant responded, "Well there's – there's a different tone for occlusion. There's a different tone for air and a different tone for KVO. And they're very slight but you can, after a while, tell." The participant further added, "Oh, battery failure – or like the battery – oh, yes. That has a different tone also. Yeah." Another participant discussing the IV pump also said:

Like there's a difference with the Baxter when it's KVO, when it's occluded I'm more likely to go in and check on it right away when it's occluded then if it's doing the intermittent beep, beep then when it's beep, b

Thus it became clear that the participants used their ability to differentiate the alarm tones to not only identify the device from which it is emanating but they could also identify the alarm condition that was creating the alarm.

Factors Influencing the Response to Clinical Alarms

Analysis of the focus group transcripts revealed a number of contextual factors that influenced the acute care registered nurse's response to alarms in the medicalsurgical patient care setting. These factors are acuity of the alarm condition, patient satisfaction, experience as a nurse, unit leadership, personal motivation, availability of resources, competing priorities, patient assignment, and special patient situations. The acuity of the alarm condition was broken down into three subfactors; life-threatening physiological issues, patient safety issues, and patient comfort issues. Patient satisfaction was broken down into three subfactors; noise, customer service, and prior experience as a patient. Availability or resources was broken down into two subfactors; time and energy. Special patient situations was broken down into two subfactors; isolation patient and effort-intensive patient and/or family.

Acuity of the Alarm Condition

One factor that influenced the acute care nurse's response to clinical alarms was acuity of the alarm condition. It became apparent in each focus group that when an alarm was heard that the participant would identify the alarm (usually by tone) and make a decision as how to respond to the alarm. One of the major influences to the nurse's response was the perceived importance of that alarm to the nurse; thus the more important the alarm the faster the response. When asked "Do you think all clinical alarms are equally important?" in all four focus groups the participants unanimously said "No". While the participants felt alarms in general were important, they also felt that some were more important than others. One participant said:

I think they are [all important] because there is a specific reason behind them. There is something that needs to be addressed. Some may have a greater weight, but it is an alarm to indicate that there is something that needs to be addressed.

One participant stated "So a tab alarm would be something I would respond to quicker than, say, a PAS." In this case the nurse is referring to the fact that he or she would respond faster to an alarm signaling that the patient is getting out of bed (a tab alarm) then to an alarm signaling malfunctioning pneumatic compression stockings. Another participated stated:

But it's important to know too like because of the differences in alarms it allows that nurse to prioritize the importance that we all talked about. It's important to know if a patient's about ready to fall out of bed; when you hear that terrible shrill from a patient alarm we're running because we know someone might take a spill on the floor, and that can't wait. Whereas you know if the beeping on the secondary IV line has a soft little beep, that can hold for just a little bit because that's just switched over to TKO.

Another participant summarized the issues as "It's a matter of running or walking."

Each focus group was asked to identify which clinical alarms were more

important than others and each group came up with essentially the same triage schema.

The participants identified the most important clinical alarms that warranted an

immediate response by the nurse were the BiPap and CPAP alarms, vital sign machine

alarms, IV pump alarms (depending one what is being administered), bed exit or tab

alarms, and PCA pump alarms. One participant stated:

A lot of times you'll be charting, you'll be doing things, you'll say, "What is that noise in the back of my head?" And all of a sudden, you realize, "Oh, it's an IV, somebody's IV." And then you'll – you know, it's like an irritation. But if it's something – you know, the more shrill ones like the PCA or the bed alarm one, then you know I think we react.

Another participant said:

Whereas if it's an IV - or a PAS - you have a minute - you can wait a minute - if you're in the middle of something, before you get there. It's just not a bigger priority as if somebody's about to fall - to me.

Even among the more important alarms the participants made distinctions as to which alarm was more critical. One participant said:

Some can wait for the moment; you're getting too many alarms at the same time. Like if your patient is crawling out of bed, like, the exit alarm versus the PCA, I would go to the bed exit alarm first.

Thus what emerged from the focus group discussions was that not all alarms warrant an immediate response and that the importance placed on the alarm was based on the acuity of the alarm condition. The acuity of the alarm condition was influenced by three subfactors as evidenced by whether the alarm heralded life-threatening physiological issues, patient safety issues, or patient comfort issues. One participant summed it up and said, "And everything else just is secondary." Another participant, when asked to describe a low priority alarm, stated, "Or a PAS alarm because those do go off all the time and they're not – they're not a high priority in the patient care per se. They're not going to impact how they feel."

Life-threatening physiological issues. The participants all agreed that the any alarm that signaled that the patient was experiencing a life-threatening physiological issue warranted an immediate response. These alarms included the CPAP and BiPAP machines, the vital sign machines, and the IV pumps when they are delivering continuous medication drips such as insulin, heparin, or antidysrhythmics. As one participant said, "You're almost going by - in a way your ABCs [airway, breathing, and circulation]." One participant discussed ongoing alarm issue with a BiPAP machine:

Sometimes too if they're on BiPAP or CPAP you kind of know, "Oh, they had an air leak all day," you know. They keep [alarming] over and over – you've had to

call Respiratory several times because they've had an air leak. We keep trying to adjust the mask to fit just right. We've put gauze [around the mask to facilitate a seal], we've tried to, you know adjust the mask. So sometimes, we know there's been an issue all day. You go in and check anyway, even though we know there's been an issue.

Another participant elaborated on an incident regarding a vital sign machine alarm:

We were helping to clean a lady in a Bed 2, and Bed 1's vital sign machine was beeping because her blood pressure had just dropped down on the next cycling. So we had to quickly put the lady back in Bed 2 down and go respond to the Bed 1 and stayed with her. She continued to drop, so that was distressful for the patient, so we didn't silence it, of course, but continued to watch it and we got her to the appropriate unit.

Another participant discusses her response to the alarm on the vital sign machine:

Well, for me on the post – you know, we get a lot of post-ops here on the third floor. And so if I know that it's a post-op patient, or even if it's not a post-op patient, certainly I would go in because we may be monitoring saturations or you know, a blood pressure series.

While all IV pump alarms did not merit an immediate response time, it did matter

if a medication drip what being administered that would alter the patient's physiological

response. As one participant said, "It depends on what's hanging." Another participant

discussed responding to an IV pump alarm while on the way to give medications. "But if

it's just a regular fluid, then that can wait a little. I'll give the meds. But if your drip is

running then I go check my drip first." One participant discussed their response to

hearing an alarm in a patient room and said "It depends if that's the drip alarming, too.

Then you'd better go over your Cardizem drip." Another participant stated:

If they had – they're on insulin drip, you know they're on insulin drip and you heard it beeping you have to go and check it right away. That depends on what type of medication they're – versus, you know, if it's only a KVO IV, then it can wait a little bit.

When asked how they would respond if the medication hanging of the IV pump was heparin, one focus group replied in unison, "We'd be there faster."

Patient safety issues. The participants also discussed the urgency of responding to an alarm that indicates the patient's safety is at risk. Any alarm that heralded the impending fall of a patient warranted an immediate response. One participant said "Safety is so important." In this study this type of alarm took three different forms: a tab alarm (also referred to as a Bed Buddy alarm), bed exit alarm, and a Hoana life bed alarm. As one participant stated it "If you're in the middle of something and you hear that Bed Buddy, the bed alarm go off, you know you need to get there right away." Another participant said "That Bed Buddy goes off, you go to that room." To put it in perspective with other alarms a participant said

Whereas if it's an IV - or a PAS - you have a minute - you can wait a minute - if you're in the middle of something, before you get there. It's just not a bigger priority as if somebody's about to fall - to me.

Another participant stated

We had someone – I think it was in [room] 43 or [room] 44 – that was on one of those Bed Buddies. And I heard it go off because I'm right in front of [room] 40, so I start running that direction – you should see, four or five people. I'm like, "Oh, I guess they don't need me because four or five people run in that direction at the same time." That's a pretty good response.

Patient comfort issues. Patient comfort was also a big issue for the participants.

They felt that patients receiving pain medication via a PCA pump warranted an immediate response when the alarm went off. As one participant stated it "Well, because first thing the patient will say 'hey', they know what's the PCA's for. So when it's alarming, that means I'm not getting anything. That's first thing they say." Another participant put it another way "So, I mean, the PCA effects the patient's life." Another participant explained their thoughts "When it's empty, which is important to your patient, too, is, I mean, it's still important to the patient and to you. You want to maintain pain control. So you move on that one a little faster." When asked about hearing a PCA alarm on a patient that was not assigned to the participant, one participant replied "I want to always call the patient's nurse because their pain is very – is a priority."

Patient Satisfaction

Another factor that influenced the acute care nurse's response to clinical alarms was patient satisfaction. The desire to improve patient satisfaction enhanced the nurses' alarm responsiveness as there are a number of negative consequences associated with alarms. One participant pointed out the effects of the alarms on a patient with hearing aids, "Or the ones with hearing aids, their hearing aids will actually buzz when the alarm goes off" and another participant then added, "and that's painful for them." Three subfactors of patient satisfaction were identified; noise, customer service, and prior experience as a patient.

Noise. Alarms create noise which is irrigating or annoying to a patient. Patient satisfaction is negatively impacted by noise and thus the desire to keep the noise to minimum enhanced the nurses' responsiveness to clinical alarms. One participant illustrated the point:

Well, you can peek, and also, we have a lot of elderly people. And if somebody is just snoring and sleeping, you can come back, if it's KVO. But if it's somebody young and really irritated with the sound, you want to reprogram, add a little bit more volume.

Another participant talking about the patient's response to a vital sign machine alarm said, "Yes, because it's so loud. It's very annoying and the patient is just 'Get this thing out of here'."

Each focus group identified that clinical alarms are annoying and they would prefer the patient not to have to listen to them. As one participant said, "I went right in,

took care of it because I can't stand – I don't want my patients to hear that because it's annoying." Another participant stated, "I know it's annoying them and the family so I went in and took care of it." Another participant discussed answering a tube feeding pump alarm:

So no flow and it happened like two more times that I had to change the tubing, but that was it. I went right in, took care of it because I can't stand - I don't want my patients to hear that because it's annoying.

One participant said, "Every time I go into a patient's room I say, 'Let's take care of that beep. That must be driving you nuts.' And they're like, 'Yes'." Another participant, discussing the effects of alarms on a patient, said:

They're just bothersome. And the first thing I think of, if it's bugging me I really think of my patient; they shouldn't be hearing this right now. So I really try to get in there as soon as I can and to stop it and do whatever I have to do because I don't like them. So they don't either, so I'm really good about it.

In particular the battery failure alarm on the vital sign machine and IV pump are

very loud and as one participant put it "shrill." Given the loudness and harshness of these

two alarms the participants felt these two alarms in particular warranted a fast response. As one participant put it, "If they're [batteries] failing, I would definitely go into any room." Another participant concurred and stated, "I put the vital sign machine unplugged as pretty high [priority] because the alarm is very high so that's piercing to the patient." Another participant pointed out, "Not just that it's shrill and you know it could be a problem with patient, but you know that this is also annoying to the patient." Another participant highlighted the same issue, "It's like piercing sound that's going to wake everybody up or – or annoy people, then you definitely need to get to – to that alarm as soon as possible." Another participant said, "The shrill alarm from the low batteries in the vital machine or the IV pump are equally shrill. And the patient gets startled with that shrieking noise." Another participant was a little blunter about the sound and said, "And your patient would go crazy if you don't silence it. You've heard it?"

The issue of patient awareness is particularly evident on the night shift because it is quieter at night and the alarms are more easily heard. As one participant stated:

My other comment is the alarm at nighttime versus daytime – you would probably respond to any alarm faster at nighttime because of the magnitude [of the sound] on the unit. It just sounds so much louder. You can hear a beep-beep from an IV secondary line so clear you know what room it's coming out of, versus the day when the volume of the unit is much louder.

Another participant concurred and said during the day shift, "You can't hear the alarms because it's too noisy." One participant said during the night shift, "The patients are sleeping, and they're [the alarms] very loud." Another participant said, "Especially at night - they [the alarms] wake them [the patients] up. You have to go and silence them [the alarms]." Another participant, discussing the night shifts response to an alarm, said, "So the first thing that makes a sound, we're right out there that second." Lastly another participant provided their observation:

Right. It [the alarm] will not only wakeup the patient that it's on, it will wake them up two or three doors down also. So you, at night especially, I think we move a lot quicker. Well, I shouldn't say that. We – we try to move quicker and respond to the alarms really fast or send someone else in because of the disturbance that they have actually to the entire floor at night. It's just the sound reverberates.

Customer service. Aside from the noise factor the nurses also wanted to increase the perception of the patient and family on the attentiveness of the nurse and keeping the patient happy and secure. Customer service is an important component of patient satisfaction and thus the desire to improve customer service enhanced alarm responsiveness. One participant talked about the patient's using the call system to get someone to respond to an alarm. The participant elaborated on answering the call bell at the desk and hearing the patient say, "I'm calling from Bed 2 – there's a beeping going on over there [referring to bed 1]." In one focus group the participants identified that the issue of unanswered alarms had come up on a customer service survey. One participant offered this insight, "And that's, I think, honestly probably the most common complaint from patients."

Thus to enhance customer service and decrease patient complaints the participants placed a focus on responding to alarms. One participant said, "I let the patient know that I'm not ignoring it. That I'm prioritizing it." Another participant discussed why she answered other nurses' alarms:

You know the other thing that I thought of is if a patient has family members in there, well, the patient or the family members or visitors don't know that that's not your patient sometimes. So if you walk by and you ignore what is real obvious, they kind of – they're probably thinking, why is she ignoring this alarm. They don't know to call the desk, that sort of thing. So that influences me. If I see that there is someone there.

Another participant said, "I at least put my head in and say, I will let your nurse know that that's alarm, and it's okay for a couple of minutes, or however I want to say that." Another participant observed, "Even a patient alone, if they're alone and they're alert, that makes a difference." Another participant offered this insight, "Don't ignore it [the alarm] because they know you're ignoring it." While another participant observed, "Right, you keep walking by, and they're thinking you're not paying attention to this [the alarm]." One participant elaborated, "So it's patient satisfaction and safety; well, being, feeling secure and all that kind of stuff, and family too. So that's a big reason why I stop." Another participant said, "Or if you know from before that the family has a lot of complaints, just get in there every time the alarm rings." Lastly one participant summed up the issue nicely, "Because the happier they are, the easier it is to take care of them." *Prior experience as a patient.* Prior experience as a patient heightens the nurses understanding of the patient experience and hopefully the desire to improve the patient satisfaction. In this study prior experience as a patient was positive influence alarm responsiveness. As one participant pointed out, "I think the response to call bells and alarms and whistles might have to do with your own experience with being a potential or possible patient." When asked if they agreed with this statement the majority of focus group participants who had prior experience as a patient said, "Yes." Another participant elaborated on their experience:

For me, I've been a patient several times before. And so I always think about myself when I'm lying in that bed and what would I want for myself, and you bring a whole different perspective because you know all of the things that can go wrong as a result of that bell or that alarm not being answered. And so that's another driving force for my getting up. And you feel helpless in that bed. And so when I'm thinking about a geriatric population or even a group of people in my same age bracket, you're out of your comfort zone and you're already feeling extremely vulnerable. And so a helping hand at that moment, to shut that alarm off or to let you know that you're okay, and that things are going right.

Another participant concurred:

I mean if you've never been a patient in a bed listening to beep-beep going off at your bedside then you might not think it's so important. But if you have been in that stressful situation – when they're sick, to them that little beeping could just drive them absolutely crazy. So it probably adds experience as a patient compared to nursing experience.

Experience as a Nurse

Another factor that influenced the acute care nurse's response to clinical alarms

was experience as a nurse. In all four focus groups the discussion came up about new

graduate nurses and their response to alarms. There was an overwhelming sentiment that

new graduate nurses responded to their own alarms quickly but did not respond to other

nurses' alarms. The participant comments were based on their own observations and there was a lot of speculation as to the reasons that this occurs. One participant said:

It's interesting how I remember -I so clearly remember that in my first year you don't really hear that [device alarms]. You're so focused into whatever you're doing when you're a new grad. But it's weird, now that -I don't know"

This was followed by another participant's comment, "Yeah, a little – a little more

seasoned. And then you just hear those [device alarms] and you stop what you're doing."

The focus group participants believed that the new graduate nurses readily

answered their own alarms. As one participant said, "I think that they would respond to

an alarm much more quickly than we would, only because they wouldn't know what it

was." The participants also stated that they thought that new graduate nurses responded to

all their alarms in the same way as they were unable to prioritize their alarms. One

participant gave this example:

I had a fourth semester student, almost done, a preceptee, and she – there was an [IV] alarm. Like it was occluded because I think they were bending their arm. And we were doing other stuff, but she kept going to that, you know, where I was going let's just not worry about it right now. You know, that kind of a thing, too. I've seen that before where you go – where I would go, I have to start a new IV but that's not going to happen right now; I'm going to go do this, and she kept going to it. I was like; just don't worry about that right now. But that kind of a thing, too, where they just don't really know.

Another participant said, "I think being a novice nurse, being fresh from school, I think

they're still in the problem of prioritizing which ones to do first, and the task that they are

for the day." Another participant pointed out:

Well, some of them [new graduate nurses] don't know how to prioritize yet, the alarms. They think it's just like, hey, this is simple alarm. They don't realize the severity of that yet because they have not been exposed to those kinds [of alarms] probably before.

Another participant emphasized, "As they get [more experience], and they learn what the

alarms are, then they'll start prioritizing like us."

The focus group participants also thought that new graduate nurses did not answer other nurses' alarms. When asked if they thought that nurses answered each others alarms, one participant said, "I think not the new grads, just because they're so focused." Another participant said, "I think they don't answer other people's alarms because they don't even know what to do with their own."

There was a lot of speculation as to why this occurred. Some of the participants felt that new graduate nurses were not aware of what was going on around them. One participant said, "They still have their blinders on." Another participant elaborated further and said, "I think it's because they're task oriented and in their own little world that they can't see the outside of what's going on. So they're more focused on their particular load." While other participant offered this opinion, "I think they have so much going on in their heads that they shut out everything, they have tunnel vision." Another participant agreed with this and said, "Yeah, tunneled." Another participant had a slightly different thought, "I think some of the new grads don't want to intrude on other people's patients, whereas we've been here and it's like we just want it [the alarm] to stop." One participant offered a more theoretical perspective, "They're in their – in their space of nursing."

Two other notions as to why new graduate nurses did not answer other nurses' alarms were that they were not sure what do about any problem they might find and they are intimidated. When asked, one participant said, "If they see air in a line, they're like – they don't even know how to figure out their own line. They're not going to try to figure out yours." One participant had a slighted different view, "They don't want to mess it up." While another participant said, "They don't want to make it worse." Another

participant offered, "Also maybe a little intimidated, afraid they might not do the right

thing." One participant related a previous experience:

So certainly I could see them being a little less apt to answer them because they've got so much. And I remember this one thing. When I went from the floor to ICU, and I remember all of those tubings and everything, it was like all I could do was focus on what was in my room. And I'd go, oh, my God. So I can imagine. I can imagine how a new grad would feel, going into someone else's room. They feel so insecure.

While another participant said, "And they don't want to judge another experienced nurse.

I don't think they have the guts to say hey, your pump is almost empty. Do you know

what I mean?" One participant summed it by saying, "At first, you're scared to go touch

other people's [equipment]."

Unit Leadership

Another factor that influenced the acute care nurse's response to clinical alarms

was unit leadership. Units with actively engaged charge nurses who role modeled the

behavior positively influenced alarm response behaviors in the nurses. One participant

who works in the float pool offered this observation:

I have an interesting perspective because I do, do the STAT pool and I go around everywhere and it is a floor-by-floor experience. It depends. It really depends on the floor that I'm on. Some – some floors, the nurses work a little more cohesively and do respond more efficiently to alarms and stuff, and others I have seen just sit, you know, and I'm running down the hallway to answer all alarms. So it's – it's been a mixed experience.

When asked if he or she agreed with the preceding comments another participant who

also works in the float pool said, "Yes, I do. There's just a different - different floors

have different dynamics to them and I guess days and nights do work differently too."

Another participant offered this observation:

I don't think we addressed this either. The size of the floor can affect whether or not you're apt to. I've worked upstairs on the fourth floor, and versus being downstairs, it's a small unit. Even the secretary, she's answering lights. She's going in there. So you develop a nice culture, and everyone is helping out everyone.

When asked what influences alarm responsiveness another participant answered, "The type of nurse they are, how they feel about the floor and the people they work with. I think all of those factors."

Many of the participants attributed the differences in the unit to unit leadership. On units were leadership set an example and routinely answered alarms the staff were more apt to respond to alarms quicker. Thus strong unit leadership enhanced alarm responsiveness. One participant remarked:

You know what, I work here per diem, and I also work full time at a different hospital. And I noticed, not so much here, but at the other place. We have different charge nurses. And some of them do not do anything when they hear an alarm. They walk by. And some of them go in and take care of the alarm.

Another participant said, "When I see I have a charge nurse that jumps in, it kind of – the whole atmosphere of the floor is very different." Another participant stated, "Yes, if they show the group that they do it, answer the alarm right away then, you know, like we are in on that stuff. Say, hey, we better be on the ball." Another participant said, "And then like you said, the charge nurse, that's a biggie right there because that's the leadership. That's the model." One participant felt leadership could help get the nurses to answer each others alarms more frequently through voicing their concerns. The participant said. "Or if they have like a little morning meeting and saying, you know, guys, I really want us to help each other." Another said "Or just verbalize it instead of just not addressing it. Be like, I want people to answer these alarms, and kind of enforce it."

Personal Motivation

Another factor that influenced the acute care nurse's response to clinical alarms was the personal motivation of the individual nurse. It became clear from the dialogue in the focus groups that some nurses choose not to respond to their alarms in a timely fashion while some nurses always answered them quickly. Thus depending on their personal motivation a nurse may be inclined or disinclined to respond to an alarm. The participants felt the difference between the two situations was related to the personality of the individual nurse. The participants provided several examples. As one participant articulated it:

Well, I think I came in to nursing, I came in late, and I came in thinking that maybe nurse – I always admired nurses so much. Maybe they were different in that they wore white hats and all that kind of stuff. I realized that it's just like every other – there are those that care and those that don't care, just like in any other walk of life. I always call it the "who takes the last piece of paper out of the Xerox machine syndrome." I am always putting – if I had the last piece of paper, I always put one in. But does that make me OCD? I don't know. I just think I don't want the next person – and I always try – my life, I try to think, well, what would I want done.

One participant discusses a colleague who is ignoring a clinical alarm:

Yeah, it just bothers me. I hate alarms, but it really frustrates me when I see a nurse sitting in front of a room that's been alarming for 30 minutes, and I'm going, "Now, didn't you hear the alarm, you're sitting there?" So I'll go and say something; like they just totally ignore it, and it really, you know, bothers me if they're just like – they're sitting right in front and they're hearing this alarm, but they just totally ignore it. It's just like you just need to go in – you know, it's KVO, you just need to put more volume, and you're done in one minute.

Another participant reiterates another example:

Because I went up and I was like – because I fixed the tube feed, and then I went to find the nurse and I said, "Is there a reason your tube feed stops?" And she's like, "No." And I said, "Because I don't want to start it again if you've got it on pause for a reason, but it's [the alarm] been going off for like 15 minutes." She goes, "I'm sorry. I think I just forgot to fix it."

Another participant describes another example:

Mine was the wound VAC and I was a resource on that day and the nurse just totally ignored it for like about four hours. And it was like, "Well, it's because he's sleeping and we're going to go and change it when we give him a bath." So finally, I went in there and checked – "Did you troubleshoot?" "Not at all." So I went in there; it was just the canister wasn't pushed in all the way; I tried to troubleshoot it and it stopped beeping. So it was like, "You need to go and really check what's going on before saying it's leaking and we have to change the whole wound VAC" rather than saying you have to go and check what's wrong with the alarm.

Another participant illustrates another example:

I think, too, that when alarm goes off continuously, like a patient is always bending their arm - you go in a lot to begin with, and then later on you just tell the nurse, you know, I've gone in so many times, you know, you've got to look into your IV or something.

There was a lot of speculation in the focus groups as to why certain nurses choose

not to answer the alarms. One participant said, "They're just one way. It's like they're

busy, and they have their thing to do, and they're not interested in what's going on

around them." Another participant speculated, "They just don't care." While another

participant stated, "Some people don't want to bother." Another participant commenting

on the subject said, "I really think people just don't want to take on more work than they

have to do." Another participant pointed out, "I think personality has a lot to do with it."

While another participant said "I think it also gets back to the personality. There - in the

world, there are people that stop to help people and people that don't stop to help people."

One participant offered an example of how they handle this situation:

And I try to basically answer any alarm I hear if I, you know, have the time to do it. And then I base that decision on what's the priority of the alarm. But I try to take some action on - first I wait to see if it's going to be answered. And then if it appears it's not going to be answered, then it probably has something to do with my personality, but you know, that's how I do it.

Lastly one participant made this observation about nurses who answer alarms quickly:

They have a decreased of tolerance for noise. Some people just can't stand that alarm. Some people are the first – they answer the phone when it rings the first time, it's those people who go to the alarms really quickly.

Availability of Resources

Another factor that influenced the acute care nurse's response to clinical alarms was the availability of resources. In this situation the resources are time and energy.

Time. Time is major resource that influences the acute care nurses' response to clinical alarms. Time plays a critical part in the nurses' decision to answer those alarms that they consider less important. In other words all the other alarms that are not associated with life-threatening physiological issues, patient safety issues, or patient comfort issues. It was clear from all the focus group discussions that time was an issue for the participants with relation to alarm responsiveness. As one participant put it when asked about answering alarms, "Yeah, it depends how busy you are." One participant was very candid about the issue:

If I've got 15 things I need to do, or I'm going to replace my PCA because it was ringing, I'm not stopping. Maybe I'm not going back, or maybe I'm calling the nurse as I'm walking down the hall. I'm not stopping for every single alarm. I don't have time.

One participant elaborated on their thoughts regarding why nurses do not answer some alarms:

Or they know what the task entails but it's going to be like time consuming either changing it or trying to figure out what it is, and so they don't even want to deal with that. So they're like, "Okay, we'll just leave it alone for now."

Another participant said, "It's going to take you two seconds. I have enough time to stop for two seconds and make the sound stop." Another participant declared, "If I've got the time, then I think I'm more likely to go in [the room and answer the alarm]." One participant related their response to how busy they were during the day. The participant said, "In the morning time when I'm more busy, I usually don't. But in the, later on in the day if things are slower, I'll go ahead and answer." One participant discussed their feelings on the subject:

And for me, I find it really interesting because I'm just new again back into the hospital after being out in home health. And so while I was out there, definitely I tended to sit with the patients and to talk with them, and to address whatever needs. And I find myself doing that here too, but I've got to come back in to balance in terms of – as much as I enjoy spending time with them, I've got to pull back. I have to pull back going into other people's rooms addressing those alarms and things. Then I'm behind, meeting the expectations.

The type of alarm response also varied with the availability of time. While the

nurse might respond to the alarm if it took to long fix the problem they would not stay

and take care of the problem. One participant said, "The point was you answered the

alarm, you were trying to fix the problem but you'll only stay so long to fix it." Another

participant stated:

It's extensive and a Wound Vac is its own little complicated dressing and equipment and everything else, so I would just silence it and to let the nurse know you might have a leak or something else going on here.

Another participant further elaborated:

With alarms, the less time you have to be in the room, the more apt I am to respond to it. If it's just a beeping IV with a KVO, I'll silence it and just, I'll be back or your nurse will be in to take care of this. If it's going to be quick, I don't mind doing it.

Another participant said, "I'll try to fix it, and if it continues to beep and it's taking too

long, I'll call the nurse who is taking care of the patient." One participant summed up the

issue, "You make sure the patient is alright but if it's not your patient you don't have time

to take care of all the routine stuff."
Energy. Another factor that influenced the acute care nurses' response to clinical alarms was energy or the lack thereof. The nurses in this study all worked 12 hour shifts in busy units. Toward the end of the shift the nurses are more tired and less inclined to respond to alarms particularly if they have had a very busy shift. One participant said:

If you were at the end of your 12 hours and you're just down and you've had the most horrible day and you just hear an IV beeping, maybe because it's occluded. You're not going to be quite as eager to jump up and take care of that as opposed to when you were first starting at 9:00. Do you know what I mean?

Another participant summed it up by saying, "Yeah, because I know, and I hate to say it, but if I had the most horrific day, by the end of the shift I'm just like done with this." Another participant commented, "You know. And as much as I might want to care, I just don't." Another participant followed that comment up with "I agree with you. You have to really push yourself sometimes." Another participant said, "Yeah, when 12 hours gone, you're like done." One participant spoke to what contributed to the fatigue, "You may have one patient in the back, and you've got another patient on the front. And so people are tired because they don't strategically plant the assignment." Another participant reiterated, "I feel like I'm going in the first part of the day, and so I'm willing to just – but then at the end of the day, it's kind of winding down and so I'm kind of winding down." One participant felt differently about responding to alarms at the end of the shift. The participant said, "I think I'm more at the end of the shift because at that time, there's that sense of relief that I'm leaving, so then you're more willing to do more because you're leaving."

Competing Priorities

Another factor that influenced the acute care nurse's response to clinical alarms was competing priorities. This factor was important in influencing the response to those alarms deemed as not important such as the IV pump alarms and those not discussed earlier in the chapter. Often the nurse is busy or in the middle of something and a decision has to be made as to which is more important -- the alarm or the task at hand. One participant said:

It would also depend on if I was walking by, and I was already focused on doing a task. Let's say I was doing a dressing change and I forgot one thing, if it alarmed and I was walking by, an IV or something, I would probably ignore it because I have a patient waiting for me to do something immediately. If I was walking by just to do my rounds, absolutely I'd go and silence it, maybe even change the bag if I needed to. It would all depend on what was happening at that moment.

Another participant said, "It's different if you are not doing anything." When asked if

they would respond to an alarm another participant said, "Depending on where I am and

what I am doing." Another participant reiterated:

Yeah. Other than that - if I had to leave a patient in a precarious situation to go answer an alarm then I - like if I was walking somebody from the bathroom, I wouldn't just leave them if they needed assistance.

Another participant followed up the previous comment with "Mine [response] would be

the same thing. If I were already doing patient care, which I cannot leave, then I would at

least call for them through the call light, or yell out, or something." Another participant

shared a recent experience:

The day I was resource in [room] 45 we were up to our elbows doing a dressing change and someone's tube feeding was going off and off and off and off, and we're like eew! You want to go fix it but you can't, you can't leave, and finally –

Another participant stated, "If you're charting and then you hear it, then you go." While

another said, "Yeah, if you're in the middle of a clean up you might wait a second."

Lastly, another participant replied, "If you're all gowned up in an isolation room, then

you can't leave."

Patient Assignment

Another factor that influenced the acute care nurse's response to clinical alarms was the patient assignment for the nurse. While the nurses did answer alarms for all the patients they felt more in tuned with what was going on with their own patients and thus more inclined to answer their own alarms quicker. As one participant put it, "You're so in tune to your patient, too, and you've got your ear out for that area." Another participant stated, "You're just like, 'Oh, that's my tube feeding,' because you know you have a tube feeding running, or you know your formula's about to run out." Another participant pointed out, "Yeah, sometimes you're expecting the alarm." One participant explained it this way:

As nurse, we take ownership of our patients. So I - we do take priority of our ownas opposed to others on the floor, and not that that's a good thing or a bad thing,but I do notice that, that we do like to keep our own more attentive than others,you know. Like if other family members from other patients are like, okay, we'llcall. But if it's our family for our patient, we tend to be a little bit more quick torespond. I don't know if that's a good thing or not. I do notice that.

Special Patient Situations

Another factor that influenced the acute care nurse's response to alarms was special patient situations. Two different patient situations were identified during this study. They were the patient in isolation and the effort-intensive patient and/or family. In both of these scenarios the nurses (particularly those not assigned to care for these patients) were disinclined to respond to the clinical alarms except the for the lifethreatening or patient safety alarms identified earlier in the chapter.

Isolation Patient. Caring for a patient in isolation requires that you don a variety of personal protective equipment prior to entering the room. This was perceived to be a lot of extra work and generally disagreeable by the nursing staff. While this had minimal

influence on the nurse caring for the patient, it did negatively influence the other nurses

on the unit. These nurses are disinclined to answer the alarms of a patient in isolation.

One participant related a recent incident:

I just had, actually, an incident yesterday where I had a PCA and -I'm sorry -IV, but the patient was in isolation, and so the nurse was reluctant to not go in there. So but - she had called me like twice, but that was in the beginning of shift so I was still getting report and everything, and I was just like, "Well, I can't do anything right now. I can't," you know, "I'm doing report because the off shift has to leave," but she just let it beep, beep, beep.

Another participant stated:

Sometimes people in isolation where you have to gown up with so much junk on that it's just like, you know what? It's like, "I'll just call the nurse because it's easier that way," and stuff even though it's like a simple task. So I'm guilty of that too.

Another participant stated:

Why not - it seems silly to make two trips. If the nurse is going in, in the next 10, 15 minutes, I mean she needs to - she can go there first. She's got to gown up anyway to go in and do whatever she's doing. I'm not going to gown up, and then she's gowned up and going in.

Another participant stated they would at least check out the situation:

But the one thing about the isolation, I was thinking about what do I do. I always look in the window to see what's going on in there, and usually determine if they're trying to get out of bed or -

While another participant offered another point of view "Yeah, I try to look in the

window and then determine what's the priority of it. If I have time, I'll go try to do it.

Otherwise, I'll call." Another participant stated, "If I heard the alarm and she's running

around like a chicken with her head cut off, and I'm just charting, I'd go ahead and go in."

When asked what would happen if the patient was trying to get out of bed or it was a life-

threatening emergency, one participant said, "And I don't think any of us would stand

there and put all the garb on. You'd just run in." This sentiment was reiterated in all the focus groups.

Effort-intensive patient and/or family. In this situation the patient and/or family

was perceived to be needy, demanding, aggressive, or unpleasant to deal with. The nurses

were disinclined to answer the alarms of this type of patient particularly if the patient was

not assigned to them. As one participant explained it:

If it's a particular kind of patient in a room that you know is difficult or needy -I know that some people will not respond to the alarm because of that particular patient. It's almost as if the alarm doesn't exist. So the type of patient might change your attitude as well as the volume or kind of alarm that there is as well. I've noticed that a lot.

Another participant explained it this way:

Or we have aggressive patients, or patients that are just outwardly mean to you, and you know you don't want any piece of that. And some nurses just don't want to deal with it, so they avoid it at all costs.

When asked about it one participant said:

It does. It really does impact because if you – okay, yeah. Particularly if you know what's going on or how they've been and it would depend on what alarm is going off. But yeah, definitely. If it's a – if it's a non-urgent alarm going off I – I would think twice or I would – or I would definitely not do my – "Is there anything else I can do for you?"

Another participant was being very candid about answering the alarm in patient room

with a known effort-intensive family and said, "I'm not going in there; the family's there;

forget it." Another participant who was caring for an effort-intensive patient offered this

insight in how they deal with this situation, "Sometimes I tend, with patients like that, I

go in there, and I - I think to myself 'Please be polite.' I tell someone to call me in a

couple minutes so I can get out." Another participant explained, "And a lot of times I find

myself going in and they'll be like thinking; oh, you're another nurse, can I ask you about

this? And you're going, 'I've got to go'." Another participant summed up the issue and

said:

I think that's one of the major barriers for nurses not wanting to go in there or do something for another nurse. It's not that they don't like the nurse, it's just they don't want to get sucked into a whole other situation.

Conclusion

The nine major contextual factors identified in this study that influenced the acute

care nurse's response to clinical alarms in the medical-surgical patient care setting are:

- Acuity of the Alarm Condition
 - o Life-Threatening Physiological Issues
 - o Patient Safety
 - o Patient Comfort
- Patient Satisfaction
 - o Awareness of the Alarm Tone
 - o Customer Service
 - Experience as a Patient
- Experience as a Nurse
- Unit Leadership
- Personal Motivation
- Availability of Resources
 - o Time
 - o Energy
- Competing Priorities
- Patient Assignment
- Special Patient Situations
 - o Isolation Patient
 - o Effort-Intensive Patient and/or Family

Chapter 5

Discussion

The purpose of this qualitative study was to develop a broader understanding of the contextual factors that influenced the acute care registered nurse's response to clinical alarms in the medical-surgical patient care setting. Analysis of the focus group transcripts revealed a number of contextual factors; acuity of the alarm condition, patient satisfaction, experience as a nurse, unit leadership, personal motivation, availability of resources, competing priorities, patient assignment, and special patient situations. Acuity of the alarm condition contained three subfactors; life-threatening physiological issues, patient safety issues, and patient comfort issues. Patient satisfaction contained three subfactors; noise, customer service, and prior experience as a patient. Availability of resources contained two subfactors; time and energy. Special patient situations contained two subfactors; isolation patient and effort-intensive patient and/or family.

In this chapter the findings of this study are discussed with relationship to current literature. The response patterns to clinical alarms are examined and a definition of "response to clinical alarms" is proposed. The limitations of the study and the implications of the study for nursing are also presented.

Response to Clinical Alarms

A number of different alarm response patterns emerged from the focus group transcripts. While the researcher did not specify any particular type of response to an

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alarm when interviewing the participants, it was extremely informative to the researcher to hear how they responded to various alarm situations. Response behaviors included:

- Participant would answer alarm immediately and fix the problem.
- Participant would silence the alarm and call another RN or the certified nursing assistant (CNA) (if appropriate) to fix the problem.
- Participant would place machine on standby and call another RN or CNA (if appropriate) to fix the problem.
- Participant would turn off the machine if unable fix the problem or silence the alarm and call another RN or CNA (if appropriate) to fix the problem.
- Participant would finish what he or she is doing and then answer the alarm.
- Participant would call another RN to answer the alarm.
- Participant would call nursing unit secretary to call another RN or a CNA to answer the alarm.

Thus the concept of "response to clinical alarms" could be defined as the initiation of some form of action on the part of the nurse to alleviate the alarm condition. The action could be direct or indirect as long as the intent to alleviate the alarm condition is present. All of the previously listed activities would constitute some form of response to an alarm. Taking no action once an alarm was heard would constitute "failure to respond to a clinical alarm". The appropriateness of the alarm response can only be evaluated within the context of the patient's situation. Currently there is no theoretical definition found in the literature for this concept. While the purpose of this study was to explore the factors that influence the nurse's response to clinical alarms, this study also provided an opportunity to view the concept through the lived experience of those who

come in contact with it everyday. It is important to take note of these experiences at this time as evidence of the complexity of the concept.

Discussion of the Findings

The nursing role in responding to alarms is essential for patient safety in the medical-surgical environment. Given the increased acuity and complexity of the patients in a typical medical-surgical unit, many patients often have five to six pieces of equipment attached them at one time. It is not uncommon to see a patient with an IV pump, a PCA pump, a PAS pump, a bed exit alarm, a mattress overlay, and vital sign machine attached to them. In addition, each nurse may have five or more patients depending on where they work. It is important to understand the work environment in which these nurses "live", as any discussion of the factors that influence their response to alarms has to be framed within the context of that environment.

Complexity of Work in Acute Care

Ebright, Patterson, Chalko, and Render (2003) studied nurses in the acute care environment in order to develop a better understanding of the complexity of their work. A research team composed of two nurses, one physician safety expert, and one human performance expert used a combination of observation and interviews to study eight expert nurses from a variety of acute care settings. The study addressed three areas; issues affecting nurse work, cognitive factors driving nurse performance and decision making, and strategies used to manage work successfully.

Analysis of the data revealed twenty-two different themes or patterns that reflected work complexity, cognitive issues driving work performance and decision making, and strategies for care management. Patterns reflecting work complexity included disjointed supply sources, missing equipment or supplies, repetitive travel, multiple interruptions, waiting for systems or processes, difficulty accessing resources to continue or complete care, inconsistencies in care communication across care providers and/or patient, and breakdown in communication process/communication medium. Patterns reflecting the cognitive issues directing the nurses' activities were divided into goal patterns and knowledge patterns. Goal patterns included maintaining patient safety, preventing from getting behind, avoid increasing the complexity of situation, appearing competent and efficient to coworkers, and maintaining patient/family satisfaction. Knowledge patterns included knowing individual patient information, knowing typical patient profiles, and knowing unit routines and workflow. Patterns reflecting care management strategies included stacking of activities, anticipating or forward thinking, proactively monitoring patient status, making strategic delegation and hand-off decisions, and stabilizing and moving on.

Some of the findings from the study done by Ebright et al. (2003) provide insight into some of the factors that influenced the nurse's response to clinical alarms identified in this study. Clinical alarms are a form of interruption and as such add to the complexity of the work environment. Four of the cognitive goal patterns driving nurse performance and decision making from the Ebright et al. study may inform the findings of this study. These are maintaining patient safety, preventing from getting behind, appearing competent and efficient to coworkers, and maintaining patient/family satisfaction.

The goal of maintaining patient safety provides insight into the enhanced alarm responsiveness associated with the factor "acuity of the alarm condition". The goal of maintaining patient satisfaction provides insight into the positive influence of the factor

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"patient satisfaction" on alarm responsiveness. The goal of preventing from getting behind provides insight into the inhibited alarm responsiveness associated with the factor "availability of resources" particularly as it relates to the subfactor "time" and the factor "competing priorities". In addition, some of the new graduate nurse behaviors presented as part of the factor "experience of the nurse" may be related to the goal of appearing competent and efficient to coworkers. In other words new graduate nurses may avoid answering alarms that they are uncomfortable with troubleshooting for fear of appearing incompetent to coworkers.

Cognitive Work of Nursing

Potter et al. (2007) expanded upon the study done by Ebright et al. (2003) and examined nurses in the acute care environment in order to develop a better understanding of the cognitive work of nursing. They used a combination of observation and interviews to study clinical decision making in seven nurses from different units. The study focused on how the nurses used cognitive sequencing to implement the nursing process and how they cognitively managed interruptions.

The findings of the study demonstrated that nursing work is multifaceted and nonlinear. Nurses engage in numerous planned and unplanned cognitive shifts throughout the shift. A cognitive shift is a change in focus such as from one patient to another patient or one task to another task. Cognitive shifts can result in loss of attention to patient's needs and omissions in care. Interruptions cause unplanned cognitive shifts. As stated earlier, clinical alarms are a form of interruption and thus cause cognitive shifts. In the Potter et al. (2007) study dealing with interruptions made up about 7% of the nurses' work time. On average the nurse experienced seven cognitive shifts an hour. The results of Potter et al. (2005) study may also provide insight into some of the factors that influence the nurse's response to clinical alarms. Clinical alarms cause unplanned cognitive shifts. It is not clear at this time what effect unplanned cognitive shifts have on responding to clinical situations. Some nurses may to unable to cope with or unwilling to deal with unplanned cognitive shifts particularly if they are numerous or the nurse is tired. The idea of unplanned cognitive shifts may provide insight into the factor "availability of resources" particularly as it relates to "fatigue." Towards the end of the shift several of the nurses reported being tired and not as readily willing to continue to answer alarms (particularly if the clinical alarm concerned a patient not assigned to them). This could be the result of not being able to cope with any more unplanned cognitive shifts and the desire to finish their own work and go home. The factor "personal motivation" may also be influenced by the concept of unplanned cognitive shifts particularly as it relates to decreased alarm responsiveness. Perhaps the process of cognitive shifting is more difficult for some nurses and they avoid it and outwardly appear unwilling to answer clinical alarms.

Interruptions

Clinical alarms are interruptions and the factors that influence the nurse's response to alarms may be related to how nurses cope with interruptions. Brixey et al. (2007) conducted a concept analysis of the phenomenon "interruption" and developed a definition derived from the literature and a model highlighting the process. Both of which are relevant for this study. Brixey et al. defined an interruption as:

A break in the performance of a human activity initiated by a source internal or external to the recipient, with occurrence situated within the context of a setting or location. This break results in the suspension of the initial task by the initiating the performance of an unplanned task with the assumption that the initial task will be resumed. (p. E38)

A clinical alarm fits this definition. Brixey et al. also developed a theoretical model called The Brixey Model of Interruption (See Figure 1).



Figure 1. The Brixey Model of Interruption. *Note.* From "A concept analysis of the phenomenon interruption," by J. J. Brixey, D. J. Robinson, C. W. Johnson, T. R. Johnson, J. P. Turley, and J. Zhang, 2007, *Advances in Nursing Science*, 30(1), p. E39. Copyright 2007 by Wolters Kluwer Health/Lippincott Williams & Wilkens. Reprinted with permission.

Using this model the response to a clinical alarm can be examined. In the preinterruption phase the nurse is going about completing some form of task. When the nurse hears an alarm (an interruption) the nurse stops (the interruption lag) what he or she is doing (primary task) and the nurse has to make a decision whether to accept or reject the interruption. If the nurse chooses not to answer the alarm then he or she continues on with the primary task. This would be considered "failure to respond to a clinical alarm".

If the nurse accepts the interruption then there are four methods of handling the situation. The first method is answering the alarm immediately. The second method is negotiating to handle the alarm at a better time. In this case the nurse may finish what she is doing before answering the alarm. The third method is to mediating or delegating the response to someone else. In this case the nurse may call another nurse to fix the problem or get a CNA to fix the problem. The fourth method is to schedule the interruption for a specified time and this would not apply to the clinical alarm scenario (Brixey et al., 2007). What the model does not explain is how the nurse decides whether to accept or reject an interruption. It is helpful however in explaining the mechanics of handling a clinical alarm.

Priority Setting

It was clear from the data in this study and the literature that nurses some form of clinical decision making process to decide whether to answer a clinical alarm. The findings from this study suggest the nurses use priority setting for answering alarms. They use the alarm tones to determine which device is alarming and in some instances what alarm condition is occurring. Once they establish what device is alarming they determine the importance of the alarm and then determine the immediacy of the response. Hendry and Walker (2004) did an extensive review of the literature concerning priority setting. "Priority setting by nurses in clinical practice involves the ordering of nursing problems using notions of urgency and/or importance, in order to establish a preferential order for nursing actions (Hendry & Walker, 2004, p. 430). Dealing with interruptions such as clinical alarms as a component of a nursing problem would be included in this definition.

Hendry and Walker (2004) identified a number of variables in the literature that would have an impact on priority setting. These included the expertise of the nurse, the patient's acuity, the availability of resources, ward organization, philosophies and models of care, the nurse-patient relationship, and the cognitive strategy used by the nurse to set priorities. They developed a model of priority setting illustrating the process of planning care for a patient (see Figure 2). The nursing activities involved in planning patient care are listed inside of the circle while the variables that impact the priority setting are on the outside of the circle. Hendry and Walker (2004) also noted that very little research has been conducted in this area.



Figure 2. Model of priority setting for planning patient care. *Note*. From "Priority setting in clinical nursing practice: Literature review," by C. Hendry and A. Walker, 2004, *Journal of Advanced Nursing*, 47, p. 432. Copyright 2004 by Blackwell Publishing Ltd. Reprinted with permission.

This model also provides an excellent explanation of the factors identified in this study. The same factors that appear to influence the planning of care also impact interruptions in that care. In this study nine contextual factors were identified as influencing the nurse's response to clinical alarms in the acute care setting. Differences in the name of the aside, these factors are essential the same as the ones illustrated here in the priority setting model.

"Acuity of the alarm condition" corresponds to acuity of the patient. "Patient satisfaction" and "personal motivation" correspond with philosophies and models of care. In today's hospital environment patient satisfaction is an important component of most models of care if not from a nursing perspective then an administrative perspective. Hendry and Walker (2004) used the term *philosophies* to include both professional and personal values and beliefs thus the factor of "personal motivation" fit within this category. "Experience as a nurse" corresponds with experience/expertise of nurse. "Unit leadership" corresponds with ward organization. "Availability of resources" corresponds with availability of resources. "Patient assignment" corresponds with nursing-patient relationship. "Competing priorities" corresponds with priority setting strategies and frameworks. In this factor the nurses demonstrated that they used priority setting strategies to deal with the competing priorities. "Special patient situations" would correspond with other influencing factors. Thus it would appear that this research study has validated Hendry and Walker's priority setting model as it relates to responding to clinical alarms.

Alarms Tones

There is very little research available that examines the use of alarm tones to different devices and alarm conditions. One study done in the intensive care unit and operating room found that nurses accurately identified the alarm only 39% of the time (Momtahan, Tanslet, & Heru, 1993). This research was done with older equipment and in an area with multiple alarms and it not generalizable to the acute care setting. There has been no research done in the medical-surgical patient care setting.

In this research study the nurses relied on the alarm tones to assist them with determining the priority of an alarm. In each focus group the participants were able to mimic the alarm tones of the different devices such that the researcher was able to identify the devices. The concept is not farfetched and the idea of the nurses developing this skill is not unheard of either. Alarm designer designers have identified the characteristics of an ideal alarm and are working on improving devices all the time. These characteristics include easy to locate, resistant to masking by other sounds, allow communication, easy to learn and retain and easy to distinguish from other alarms. By making an alarm resistant to masking by other sounds it will make the alarm more easily heard and harder to be missed. By allowing communication the alarm will be less irritating to the patient and allow discussion between healthcare staff particularly at critical times (Edworthy & Hellier, 2006). Obviously more research is needed in this area.

Summary

Acute care nurses work in a complex work environment. Interruptions caused by clinical alarms increase the complexity of the environment and result in unplanned

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cognitive shifts for the nurse. It is not clear at this time what effect unplanned cognitive shifts have on responding to clinical situations. When the nurse hears a clinical alarm a decision must be made as to answer or not answer the alarm. The nurse uses a priority setting model to make that decision. The contextual factors that influence the nurse's response to alarms are acuity of the alarm condition, patient satisfaction, experience as a nurse, unit leadership, personal motivation, availability of resources, competing priorities, patient assignment, and special patient situations. Each of these variables can be supported by the priority setting model developed by Hendry and Walker (2004). Figure 3 is a model for depicting the nurse's response to clinical alarms.



Figure 3. Contextual factors influencing the acute care nurses response to clinical alarms in the medical-surgical patient care setting.

Limitations of the Study

There are number of limitations associated with this study:

- The study findings may not be generalizable to all acute care nurses. The participants were a self-selected sample of nurses from a single site who were willing to talk about their alarm response practices. The results may only represent the lived experiences of the participants.
- The focus groups lacked anonymity as many of the participants knew each other as well as the researcher. This may have precluded the participants from being completely candid in their responses. The participants may have limited their responses to only professionally acceptable information. The presence of a digital recorder may have also inhibited some participant responses.
- The participants may have hidden certain aspects of their experience and thus the ensuing transcript may not have represented their entire experience.
- The participants described their alarm response patterns. There is always the possibility that their reported behavior may differ from their actual behavior. However, the cost of observing the nursing staff in the patient care setting is prohibitive and the observer effect could influence their actions anyway.
- The focus groups were semi-structured, using pre-determined questions, so that responses also were structured, to some degree, by the researcher. While most of the questions were open-ended, some aspects of the experience of responding to clinical alarms may not have been revealed.

Implications

This study has relevance for advancing nursing science in the area of patient safety. The importance of this study is that is was done with front line staff who are at the point of delivery. The results of this study highlight that there are a number of contributing factors that either enhance or inhibit the nurse's response to an alarm. Thus there is no simple solution to address the issue of failure to respond to alarm. The findings from this study have several implications for clinical practice, nursing administration, and nursing education.

Clinical Practice

The findings from this study have several implications for the clinical practice setting. It is very important that all appropriate nursing staff be able identify critical alarms and non-critical alarms. This will allow the nurses to prioritize their responses to the alarms and enhance patient safety. In addition the nursing staff should be familiar with the purpose of all clinical device alarms and know how to troubleshoot the equipment. This should increase their confidence level with handling alarm situations. It is also important that clinicians work with biomedical equipment manufacturers to ensure that different devices have distinctive alarm tones for different alarm conditions and unique to the device. This will further enhance the nursing staff's ability to identify and prioritize alarm situations. The nursing staff should be taught strategies to minimize "false" alarms. This will decrease the number of device alarms. Lastly, it is imperative that all appropriate nursing staff receive thorough inservice education for all new clinical devices with an emphasis on the alarm conditions and alarm management.

Nursing Administration

The findings from this study have several implications for nursing administration. This study highlighted the issue that patient satisfaction is a consideration in responding to alarms. Thus action plans for enhancing patient satisfaction should incorporate interventions to decreasing alarms response times. In addition each unit should address alarm response as part of their performance improvement plans. A plan for monitoring response times should be developed to ensure that critical alarms are being answered in a timely fashion. The plan should also include strategies for answering alarms when the nurse assigned to the patient is not available to respond and when the patient is in isolation. Lastly, nursing administrators need to promote a unit culture of responding to alarms regardless of who is assigned to the patient. This study highlighted the fact that unit culture is an important factor in influencing the nurse's response to alarms. Consideration should be given to adoption standards for the promotion of an environment of professional caring such as those outlined in the AACN Healthy Work Environment Standards (American Association of Critical-Care Nurses, 2005) or the ANCC Magnet Recognition Program (American Nurses Credentialing Center, 2008).

Nursing Education

The findings from this study have several implications for nursing education. While in nursing school it is important that nursing students be educated about surveillance activities and the importance of device alarms. During their clinical rotations nursing students should be taught the purpose of each piece of medical equipment involved in the care of the patient and how to use the equipment properly including alarm management. The alarms tones of the different devices and different alarm conditions should be demonstrated to the students when in the clinical setting. In addition, the students should be coached on how to prioritize different alarms and alarm conditions. An emphasis should be placed on the implications of a slowed or failed response to the device alarm.

Recommendations for Future Nursing Research

The concept of "response to alarms" is an important surveillance activity with significant implications for patient safety and it warrants future study. The initial dimensions of the study should be expanded through replication of the study in other medical-surgical settings with a larger more diverse sample to increase the generalizability of the findings. In addition, the study should be replicated with new graduate nurses to confirm the observations and speculations of the participants in this study. As the nurse uses alarms tones for the identification of the different devices and alarm conditions, a new study should be designed to evaluate the accuracy of the nurse's ability to differentiate alarm tones. Lastly, it is hoped with further study that an instrument could be developed to allow for quantitative measurement of the "response to clinical alarms".

Conclusion

This study of the nurse's response to clinical alarms was undertaken to discover the hidden within the phenomena and draw it out so others would understand. When a clinical alarm sounds and appears to go immediately unanswered, assumptions are sometimes made by those observing. As this study demonstrates the decision to respond to an alarm is a complex one that is influenced by personal, environmental and situational factors. Each situation is unique and grounded in the lived experience of the nurse in the

context of a specific moment in time and place in other words "being-there".

Nursing is an art: and if it is to be made an art, it requires an exclusive devotion as hard a preparation, as any painter's or sculptor's work; for what is the having to do with dead canvas or dead marble, compared with having to do with the living body, the temple of God's spirit? It is one of the Fine Arts: I had almost said, the finest of Fine Arts. ~Florence Nightingale

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Appendix C

Advertising Flyer

RESEARCH PARTICIPANTS WANTED!!!
Acute Care RNs with more than 1 years experience
I am conducting a research study to gather information regarding the factors that influence your ability to respond to patient alarms!!! I am interested in hearing about your experiences!! Takes about 1 hour!
Join one of the following Focus Groups!! Share your story!!
Group #1 – 3/31/09 at 0800 in IMC Conference Room (PMC) Group #2 – 4/21/09 at 0800 in Meeting Room D (POM) Group #3 – 5/12/09 at 0800 in IMC Conference Room (PMC)
All responses will be kept strictly confidential
Refreshments provided. \$25.00 Gift Card to thank you for your time!
Questions? Need more information? Interested in participating!! Reserve your space!
Contact: Kate Stacy PhD(c), RN, CNS – Intermediate Care Unit (PMC) Ext. 3794 (office) or 760-753-1959 (home) <u>kathleen.stacy@pph.org</u> or <u>kmstacy@att.net</u>

APPENDIX D

Consent Form

Contextual Factors Influencing the Acute Care Nurse's Response to Clinical Alarms

You are being asked to participate in a research study. This research study is being conducted by Kathleen (Kate) Stacy RN, a registered nurse, as part of her doctoral dissertation at the University of San Diego, Hahn School of Nursing. You are being asked to take part in a group discussion, called a focus group. The purpose of this focus group is to find out how nurses respond when clinical alarms go off.

This study is NOT being sponsored by Palomar Pomerado Healthcare. You do <u>not</u> have to participate if you don't want to. Nothing about your job status, or your family's access to social services or health care will change if you decide not to do this.

What you are being asked to do in this focus group:

• You will attend a small discussion group called a "focus group" that will be held in the meeting room here at this facility. It will last about an hour. About 4-8 registered nurses who work on the medical surgical units at Palomar or Pomerado Hospital will be in this group. Kathleen (Kate) Stacy, a registered nurse, will lead the discussion. If, after reading this Consent Form, you decide to do this, you will sign two copies of it and keep a copy for yourself. Then Kate will give you a brief information form to fill out. The form asks things such as your age, employment status, and your nursing education and experience. Then, Kate will begin the group discussion with you. This discussion part will be audio-taped, but you will never be identified by your name. Kate will use numbers for each participant, and remind everybody to just use the numbers if they speak to each other. Kate will ask the participants questions about clinical alarms, such as what kind of alarms you work with. She will also ask you to give a specific example of a time you answered an alarm, and if you answer alarms for other nurses.

- You can stop anytime you want to, or decide you just don't want to do this. If you decide not to do this, no one will embarrass you. It is not impolite to decide you don't want to do this. Just raise your hand and let Kate know you'd like to be excused. It will be no problem.
- There is a restroom just outside this room, and you can go to the restroom at any time. The entire activity will last about an hour.

Your participation in this study is:

Voluntary. You do not have to do any of this. Nothing about your employment status at Palomar or Pomerado Hospital, or access to health or social services will change if you decide not to do this. You can decide to quit at any time.

Confidential. No names will be recorded on audiotape or attached to the survey form. All consent forms will be stored separately from data. Only code numbers will be used while recording the discussion. What you say in the discussion will be transcribed (written into a document). A transcriptionist (a person who types your words while listening to your audio recordings) will sign a pledge of confidentiality before doing this work. All data, including audiotapes, will be kept in a locked file cabinet and only the researcher will have access. She will keep all the completed data at least 5 years before destroying them. The results will be reported on a group basis, and your identity will never be identified in reporting the results. The results of the research project may be made public and information quoted in professional journals or meetings, but your real name will never be used. We are encouraging everyone in the group to keep what is said in the group confidential and within the group. But we can't guarantee that someone won't tell someone else what you said here, and you need to know that this might happen.

Potential Risks. If you become tired while filling out the form or participating in the focus group, you can take a break and rest. Sometimes when nurses are asked to reflect on their professional performance, they feel emotions like anxiety. If you would like to discuss these feelings, you can call the **San Diego County Mental Health Hotline (1-800-479-3339), anytime, 24 hours a day.**

Benefits. The benefit to participating will be in knowing that you helped nurses and other healthcare providers know more about the things that impact how nurses respond to alarms. You will receive a \$25 gift card of your choice for participating. Kate will give you the \$25 gift card even if you start the session and decide not to finish it, or decide to withdraw from the study completely.

Participant Costs. The only cost to you is the time you spend traveling to and participating in the focus group.

Further Information. If you would like to know more about this research study before, during, or after your participation in it—you can call Kathleen Stacy at (760) 753-1959 or e-mail her at KMStacy@att.net.

You can also call her research advisor, Dr. Jane Georges, Associate Professor in the School of Nursing at the University of San Diego, at 619-260-4566 or e-mail her at jgeorges@sandiego.edu.

I have read and understand this form, and consent to the research it describes to me. I have received a copy of this consent form for my records.

Signature of Participant

Date

(Printed name of Participant)

Signature of Investigator

Date

Appendix E

Demographic Information Form

Instructions: Please fill in or circle the most appropriate response.

- 1. Age: _____
- 2. Gender:
 - a. Male
 - b. Female
- 3. Number of years as an RN _____
- 4. Basic nursing program:
 - a. Licensed Vocational Nurse
 - b. Diploma Hospital School of Nursing
 - c. Associate Degree
 - d. Baccalaureate Degree
 - e. Master's Degree
- 5. Highest nursing degree:
 - a. Associate Degree
 - b. Baccalaureate Degree
 - c. Master's Degree
 - d. Doctoral Degree
- 6. Current employment status:
 - a. Full time
 - b. Part time
 - c. Per diem
- 7. Number of years in present position _____
- 8. Shift worked:
 - a. Days (0700-1930)
 - b. Nights (1900-0730)

PLEASE DO NOT PLACE YOUR NAME ON THE FORM

Appendix F

Interview Guide

- Please describe the types of clinical alarms that you normally deal with on a daily basis.
 - a. Anyone work with the Hoana bed coverlet?
- 2. Do you think all clinical alarms are equally important?
 - a. Do some clinical alarms have a higher priority than other alarms?
 - b. What makes an alarm have a higher priority than another alarm?
 - c. How do you prioritize your alarms?
 - If you were passing medications and you heard the alarm go off what would you do?
 - 2) Why? What influences you to go one over the other?
 - d. Does the alarm tone matter to you? Can you tell them apart?
- 3. Think about the last time you were working on the unit and you heard an alarm go off.
 - a. Where were you?
 - b. Was it your patient?
 - c. What type of alarm was it?
 - d. What did you do?
- 4. Do you routinely answer the alarms of patients other than your own?
 - a. What if you are in the middle of doing something for one of your patients?
- 5. Do you think other nurses routinely answer alarms? Their own? How about other than their own?

- In the first group I did they felt that new grads did not routinely answer alarms – do you agree with that or not? What has that been your experience?
- b. Why do you think that some people do not answer alarms?
- 6. What enhances your response to a clinical alarm?
- 7. What inhibits your response to a clinical alarm?
- 8. NIGHT RNS: Do you think alarm response varies on night shift versus day shift?
- 9. STAT RNS: Do you think alarm response varies from unit to unit?
- 10. Is there anything else about clinical alarms that you would like to share?
- 11. For participants who work with the Hoana bed coverlet:
 - a. Has the Hoana bed every alerted you to a patient's deteriorating condition?
 - b. Has the Hoana bed every alerted you to a patient's impending fall?
 - c. Any other comments regarding the Hoana bed you would like to share?

Version #4
98

Appendix G

Copyright Permission for Figure 1



Lippincott Williams & Wilkins 351 W. Camden Street Baltimore, MD 21201 410 528 4000 tel www.LWW.com

DATE: 8/31/09

Kathleen Stacy 7885 Paseo Almendro Carlsbad, CA 92009

Fee: \$0.00

Re: Advances in Nursing Science Spec Mat: ANS, 2007; 30(1):E39, Fig. 4 PhD Dissertation / Non-commercial use

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Appendix H

Copyright Permission for Figure 2

Dear Kathleen Stacy,

Thank you for your email request. Permission is granted for you to use the material below for your thesis/dissertation subject to the usual acknowledgements and on the understanding that you will reapply for permission if you wish to distribute or publish your thesis/dissertation commercially.

Best wishes,

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To Whom It May Concern:

I am interested in obtaining permission to use a figure from one of your articles in my PhD dissertation.

Article: Hendry, C., & Walker, A. (2004). Priority setting in clinical

nursing practice: Literature review. Journal of Advanced Nursing, 47,

427-436.

Figure: Figure 1 p. 432.

Please let me know the cost and how to go about it.

Thanks,

Kathleen Stacy