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## Perceptions of Infusion Pump Alarms among Experienced Nurses versus Novice Nurses

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# Perceptions of Infusion Pump Alarms among Experienced Nurses versus Novice Nurses

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Graduation Year: 2020

## Abstract

In nursing, infusion pumps are used daily to provide critical medications, fluids, and nutrition to patients. The alarm signals on these pumps can alert nurses to potential issues with the infusion, but some of these alarms are not clinically significant. In this study, the student researcher determined whether there was a statistically significant difference in the perceptions of infusion pump alarms among experienced and novice nurses. The student researcher hypothesized the novice nurses would have a higher perception of infusion pump alarms. The student researcher had the education department at a rural hospital in the southeastern United States distribute an infusion pump alarm survey to both experienced and novice nurses during mandatory training. The student researcher received 50 total survey responses after 17 were discarded for not meeting criteria. After the data was collected, a *t*-test was performed resulting in a *p* value of 0.208 causing the student researcher to fail to reject the null hypothesis showing no statistically significant difference among experienced and novice nurses. In future studies, the student researcher recommends sampling more nurses from a variety of hospitals and ensuring nurses properly fill out the survey. Regarding nursing practice, the student researcher recommends teaching proper pump use to improve staff response to alarms.

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## Chapter I

### Origin of the Problem

Health care facilities utilize alarm equipped medical devices in different units to monitor the conditions of patients and to accelerate the delivery of patient-centered care. These alarms detect a change in a patient's established baselines and stimulate health care personnel's attention. Nurses spend most of their time taking care of patients and are more in contact than any other health care provider. It is important for nurses to perceive these alarms and carry necessary interventions to optimize the delivery of safe and quality care. However, the increase in the frequency of alarms has generated an increase in alarm fatigue. Sincox and Nault stated that "alarm fatigue occurs when hospital staff becomes desensitized to alarm alerts causing missed alarms or delayed responses" (2014, p. 1). With the increase in the occurrence of several types of alarms, nurses' perceptions of alarms decrease over time, which compromises the safety of patients. Adverse events related to improper alarm management significantly increased in 2016 in comparison with 2005 and 2011 events (Ruppel et al., 2018).

There are increased chances for experienced nurses to develop desensitization of alarms over novice nurses because of increased exposure to alarms over the years of experience. Since nurses play a significant role in patient care, it is important to evaluate appropriate strategies to decrease alarm fatigue and increase perceptions of clinical alarms. The Joint Commission published the National Patient Safety Goals for 2019 which stated one goal is to "make improvements to ensure that alarms on medical equipment are heard and responded to on-time" (2018, p. 1). It is also imperative for hospitals to adapt necessary initiatives to decrease the frequency of false alarms and individualize alarm settings according to the needs of the unit (Cosper et al., 2017). Reducing alarm fatigue and increasing the perceptions of infusion pump alarms are important in order to improve the quality of patient care in health care facilities.

### Clinical Observations that Precipitated Interest in Problem

Throughout the student researcher's time in hospital clinical settings, she has observed many instances of alarm fatigue in the nurses, precipitating her interest in the subject. The student nurse noticed the nurses in the critical care unit regularly stopped or ignored the continuing alarms. Most nurses did not even hear the alarms while some nurses paused or stopped the alarms and started working on other things. Most of the alarms were primarily because of vital sign changes from the patient's expected baseline. However, most of the patients in the unit often had a variable baseline rather than established normal baselines. The nurses working in the unit were aware of the modified baseline of the patient, so they did not perceive it as an important situation to which to respond. Also, nurses were more attentive towards the Intravenous (IV) pump alarms especially if lifesaving medicines such as vasopressors were running in the line. Vasopressors are medications utilized to increase a patient's blood pressure. While caring for an extremely critical patient whose blood pressures were extremely low, the bedside nurses of the patients were more alert toward the infusion pump alarms. In contrast, in care of less critical patients, nurses were not as prompt in responding to infusion pump alarms. Besides these, most of the nurses working in the unit could easily differentiate the monitor alarms from infusion pump alarms but the student nurse could not differentiate the distinctness of the ongoing alarms. The student nurse analyzed the impact of experience in being able to differentiate the nuances of several continuing alarms. Therefore, the student nurse believed that the perceptions of the alarms in the hospital setting depended on the

condition of the patient, an unexpected change in the baseline of the patient, or the nuances of the continuing alarms.

### **Theory**

The student researcher used Albert Bandura's Self-Efficacy Theory to support her research hypothesis. Self-efficacy establishes a direct relationship between the individual's attitudes and beliefs and the individual's control over the events that occur in his or her life. Perceptions vary in each individual; therefore, one's thought process complements one's decision-making process. Bandura's Self-Efficacy Theory describes the effects of "motivational, cognitive and affective intervening processes" on the individual's activities (Schwarzer, 2014, p. 3). Bandura's Self-Efficacy Theory supports the student's research study as both novice nurses and experienced nurses' individual perceptions affect the perceptions of infusion pumps. It depends on whether the nurse perceives an ongoing alarm as an actionable alarm or as a non-actionable alarm. The actionable alarms require immediate interventions by nurses while non-actionable alarms do not require immediate interventions and have lower clinical significance. Experienced nurses who have been working on a unit for a long time may easily differentiate an actionable alarm from a non-actionable alarm. Their attitudes on infusion pump alarms change over years of experience, affecting their actions on those alarms. However, novice nurses who have been working on a unit for a brief time may have a problem differentiating an actionable alarm with a non-actionable alarm. So, their attitudes on those infusion pump alarms may directly affect their actions on those alarms.

### **Significance of the Problem**

The primary purpose of the monitor alarms and infusion pump alarms is to draw the attention of nurses toward the change in patients' conditions. However, most of these alarms are either false or non-actionable alarms. The presence of numerous alarms in the unit distracts and disrupts the nurses working on the unit and leads to alarm fatigue. The desensitization of these alarms may prompt nurses to miss actionable alarms or may lead to delayed interventions to these alarms (Sincox & Nault, 2014).

There are many causes that contribute to alarm fatigue. The study by Funk, Clark, Bauld, and Coss (2014) identified frequent false alarms as the main factor and difficulty in identifying the source of an alarm as the second most crucial factor for alarm fatigue among the nurses. Frequent false alarms often include alarms due to poor placement of electrodes, lack of or irregular change of electrodes, broken lead wires, insecure sensor placement, disconnected or damaged sensor, and patient's condition like pigmentation of skin, presence of nail polish, and state of low perfusion (Cospers et al., 2017). Thus, these frequent false alarms desensitize the perceptions of alarms among nurses leading to missed or delayed interventions for actionable alarms. According to the Joint Commission (2013), there were 98 alarm-related sentinel events from January 2009 to June 2012. A sentinel event is defined as an unexpected incidence compromising patient safety or leading to injury or death. Of those reported events, "80 resulted in death, 13 in permanent loss of function, and five unexpended additional care or extended stay" (The Joint Commission, 2013, p. 1). Alarm fatigue may provoke a delay in inpatient treatment, an error in ventilator uses and medication administration, or an injury from falls. The Emergency Care Research Institute (ECRI) has published a Top 10 Healthcare Technology Hazard List, which has placed clinical alarms near or at the top of the list for many years (The Joint Commission, 2013, p. 2). Thus, it is important to reduce alarm fatigue among nurses as it

compromises patient safety and quality of patient care. The frequency of alarm fatigue would significantly decrease if health-care facilities and nurses adopt necessary alarm management strategies to reduce the occurrence of false or non-actionable alarms.

### **Statements**

**Problem Statement.** Is there a difference in the perceptions of infusion pump alarms among experienced nurses as compared to novice nurses?

**Purpose Statement.** The purpose of this study is to evaluate whether there is a difference in perceptions of alarms among experienced nurses as compared to novice nurses.

**Operational Null Hypothesis.** There will be no statistically significant difference in perceptions of infusion pump alarms among experienced nurses and novice nurses.

**Research Hypothesis.** Novice nurses will have increased perceptions of infusion pump alarms than experienced nurses.

### **Definitions**

For the purpose of this study, the following terms are defined:

**Experienced Nurse.** A registered nurse with 5 or more years of experience.

**Novice Nurse.** A registered nurse with less than 5 years of experience.

**Infusion Pump Alarms.** An infusion pump is a device responsible for delivering medication, fluids, or nutrients to a patient. An infusion pump alarm signals when the infusion pump has encountered a problem requiring attention.

**Perception.** The participant's way of understanding or interpreting sensory information regarding infusion pump alarms, which is assessed through the scores obtained from the Infusion Pump Alarm Survey provided to the participants.

### **Assumptions**

For the purpose of this study, the student researcher made the following assumptions:

1. Experienced nurses and novice nurses are aware of the importance of response to infusion pump alarms.
2. Participants correctly identified themselves as experienced nurses or novice nurses based on the provided questionnaire.
3. Participants answered the questionnaire truthfully, without the use of outside resources.
4. The questionnaire accurately measured the perceptions of experienced and novice nurses.
5. The data collected were consistent and appropriate.
6. Experienced nurses and novice nurses are without sensory impairments.

## Chapter II

### Review of Literature

The alarms in hospital settings monitor the conditions of patients and facilitate nurses to intervene and take control of situations. Nurses play a significant role in assessing alarms as they spend more time with patients than any other health care personnel. However, the increase in the number of alarms in the hospital settings has caused desensitization among nurses leading to missed or delayed action. Thus, alarm fatigue is a major concern in nurses as it compromises the quality of patient care. Alarm management is important in delivering safe patient care and optimizing quality of care. The student researcher collected evidence of alarm fatigue among nurses. She collected articles examining alarm fatigue and measuring alarm accuracy as well as clinical relevance of alarms. The collected research was peer-reviewed, from the United States, and conducted within the last five years. This research focused on the concerns about alarm fatigue reflecting its causes and effects and helped identify necessary approaches for reducing alarm fatigue.

The student researcher classified the review of literature into two categories based on each study's objective. The first category included four research studies focusing on general alarm fatigue. The second category included four research studies focusing on alarm accuracy and clinical relevance.

### Alarm Fatigue

The student researcher reviewed four articles centered on alarm fatigue. Allan's (2018) study examined the effects of alarm fatigue. Cameron and Little's (2018) study evaluated nurses' perceptions of alarm fatigue. The study by Ruppel et al. (2018) determined change in alarms identification and perceptions among the clinicians while the study by Honan et al. (2015) explored nurses' experience with clinical alarms. All four articles assessed the perception of alarm fatigue among nurses for the purpose of recognizing and planning appropriate alarm management interventions.

Allan's (2018) study addressed the problem of alarm fatigue and its consequences on the quality of patient care. A group of interdisciplinary professionals launched a quality improvement (QI) project examining the effects of alarm fatigue and exploring the strategies for reducing the number of non-actionable alarms. The interdisciplinary team conducted a literature review to disclose educational interventions and strategies for increasing the awareness of alarm fatigue and improving alarm management. The team utilized the National Clinical Alarm Survey developed by the Healthcare Technology Foundation (HTF) to assess the baseline perception and awareness of the nurses about alarm fatigue working in the intensive care unit (ICU). Then the nurses who took the survey participated in eight weeks of intense education sessions. The sessions focused on educating nurses about alarm fatigue and establishing strategies to manage alarms to reduce alarm fatigue. The research team later discovered inadequate knowledge of alarm customization in nurses to accurately describe or define alarm fatigue.

The researchers compared pre and post-education surveys to evaluate the improvement in staff compliance and confidence with customization of alarm settings. The goal was to achieve a 20% improvement in survey results after education sessions. The results were calculated by evaluating the mean of the surveys of pre and post-education. The component used in Allan's research study (2018) revealed a pre-intervention group mean of 2.25 and a post-intervention group mean of 1.79, which resulted in a 20.44% improvement score. Furthermore, several other

survey questions from this study revealed an overall increase in the group of critical care nurses' knowledge of alarm fatigue.

In addition to Allan's (2018) study, Cameron and Little's (2018) research also conducted an educational session to evaluate the perceptions of nurses and practices of alarm management in an acute care hospital setting. The researchers studied a group of nurses working in an acute care setting in hospitals in the southeastern United States. The educational session was a mandatory alarm management education program. The researchers conducted a pre-test survey among nurses to evaluate baseline perceptions and practices related to alarm fatigue and management. Then the researchers conducted a mandatory education session that focused on strategies for effective alarm management. Four hundred seventeen nurses participated in the pre-test survey and 215 nurses participated in the post educational session survey. The overall result displayed a substantial increase in alarm perceptions and the identification of effective alarm management strategies to reduce alarm fatigue. The participating nurses identified measures like improved staffing and updated equipment as applicable strategies to improve the management of alarms in the ICU as well as the quality of patient care (Allan, 2018).

Since alarm management is important in reducing alarm fatigue and maintaining patient safety, the Healthcare Technology Foundation (HTF) launched a clinical alarms improvement program, which surveyed professionals working in healthcare facilities for assessment of the perceptions. Ruppel et al. (2018) utilized the results of the HTF survey in 2016 and compared it with all the findings collected in 2006 and 2011. The researchers studied the change in identification of alarms in the hospitals and alarm perceptions among the clinicians since 2006 to evaluate the alarm management. Ruppel et al. collected data using a nationwide distributed online survey. The researchers utilized  $\chi^2$  and Kruskal-Wallis analysis methods to compare the obtained results with the results of 2006 and 2011. The researchers acknowledged the substantial differences among three of the surveys. The respondents of the 2016 survey reported agreeing on the increase in the frequency of nuisance alarms, which disrupted patient care and delayed quick response to clinical alarms. Nuisance alarms are unnecessary alarms without clinical significance. The adverse events related to improper alarm management had also significantly increased in 2016 in comparison with 2005 and 2011. However, most of the hospitals did adopt initiatives to improve alarm management in 2016, more than in 2006 and 2011. Likewise, the study recognized the increment in harmful effects of alarm fatigue and encouraged the implementation of education sessions to develop effective alarm management strategies.

In addition to these studies, the objective of the study by Honan et al. (2015) was to qualitatively investigate nurses' experience with clinical alarms. The research utilized the survey of the HTF. The primary focus of the survey was to evaluate the alarm perceptions of nurses and clinical management. This survey consisted of four demographic questions related to work. These questions were further classified into 20 general statements regarding clinical alarms that allowed the participants to answer a series of questions using a 1 to 5 scale. A score of one indicated that a nurse strongly agreed, a score of three indicated a nurse had a neutral feeling toward the question, and a score of five indicated that a nurse strongly disagreed. Another section consisted of four questions that measured nurses' perceptions of the occurrence of adverse effects, utilization of monitor watchers, and initiatives and new technological solutions to improve alarm management. The last segment of the survey included nine issues constraining proper management of clinical alarms.

The researchers utilized the Krippendorff method for content analysis to evaluate the comments provided by nurses who participated in the nationwide survey conducted by HTF during 2011. The data collected were from 406 nurses who participated in the survey. The study recognized six themes after analyzing the survey, including Dissonance and Desensitization; Pollution, Panic, and Pathology; Calling for Accountability; Calling for Authority of Nurses; Clinical Alarm Management is Crucial but Not a Panacea; and Hope for Future. All the themes were interrelated with each other. Dissonance and Desensitization as well as Pollution, Panic, and Pathology described tendencies of nurses to ignore alarms that were perceived as annoying, frequent, or unnecessary. Meanwhile, Calling for Accountability encouraged nurses to take responsibility for their own patients' alarms as well as help other nurses respond to their patient's alarms for reducing the overall noise pollution and alarm fatigue. Calling for Authority of Nurses pointed out nurses' increased authority over pumps and their ability to change alarm settings. This was effective in reducing the chance of non-actionable or nuisance alarms. Furthermore, the remaining themes, Clinical Alarm Management is Crucial but Not a Panacea and Hope for Future discussed the future of clinical alarms. These themes emphasized the importance of appropriate training related to response to various alarms in order to decrease the occurrence of sentinel or other adverse events. Honan et al. (2015) reviewed the role of nurses in reducing the noise pollution and established nurses' concerns about alarm fatigue.

### **Alarm accuracy and clinical relevance**

The student researcher reviewed four articles that emphasized alarm accuracy and their clinical relevance. A study by Cospers et al. (2017) identified non-actionable clinical alarms and their consequences in healthcare facilities, while a study by Funk, Clark, Bauld, and Coss (2014) determined changes in nurses' attitudes and perceptions of clinical alarms since 2005. In addition to these studies, Ruppel, Funk, and Whittemore's (2018) research used an integrative review method to examine approaches measuring alarm accuracy and the relevance of these alarms in the ICU. Whereas, Vitoux, Lehr, Dekker, and Schuster's (2017) study assessed the frequency of infusion pump alarms and their clinical relevance in the ICU environment.

A study by Cospers et al. (2017) categorized the problems accountable for non-actionable clinical alarms and collected the data to recognize the most prominent non-actionable alarm in healthcare facilities. The purpose of this study was to determine and address the cause of false and non-actionable alarms, to separate true alarms from false alarms, and to optimize the delivery of safe patient care. Cospers et al. (2017) used a sample from the monitors with built-in alarms of a hospital. The data were collected with the assistance of the hospital's information technology department to pull up the monitors' alarm. The collected sample assisted the researchers to identify the false alarms signals and clinically irrelevant alarms. These false alarms were activated because of poor placement of electrodes, lack of or irregular change of electrodes, broken lead wires, insecure sensor placement, and disconnected or damaged sensors. Besides false alarms, the hospitals lacked individualized default alarm settings and used manufacture alarm settings in all the units. The nurses lacked the control to customize the alarm settings accordingly, which was responsible for increasing alarm fatigue among the nurses. The researchers emphasized the importance of health care facilities to monitor and reduce the occurrence of false and clinically irrelevant alarms to decrease alarm fatigue. The researchers also concluded that these facilities need to customize individual default settings based on the needs of a unit and to empower the nurses to customize the monitor alarms according to patient needs.

While Cospers et al. (2017) explored the cause of false and non-actionable alarms, Vitoux et al. (2017) studied the frequency of infusion pump alarms and their clinical relevance in the ICU environment. In this study the researchers classified alarms based on type of alarms, infusions, frequency, and duration. The understanding of infusion pump alarm trends helped the researchers to comprise techniques effective in minimizing non-actionable alarms and enhancing response to actionable alarms. The researchers collected data from 29 hospitals from May 2013 to April 2016. This research helped in obtaining results that were effective in reducing non-actionable alarms and increasing the response to actionable alarms. The research identified adjusting pump configurations, reinforcing practices for avoiding preventable alarms, assessing weekend staffing, and resource support as effective techniques in reducing the unnecessary alarms.

Ruppel, Funk, and Whittemore's (2018) research used an integrative review method to examine approaches measuring alarm accuracy and the relevance of these alarms in the ICU. The study also helped in comparing the inaccurate proportions and irrelevant clinical alarms that were reported in the study. Alarm fatigue compromised patient safety as it delayed the alarm response by health care providers. The delay in alarm interventions could also risk patient safety. So, the assessment of the alarm accuracy and its relevance was important to evaluate the thoroughness of alarm interventions done in critical care units. The data for this research were collected using inclusion criteria. The inclusion criteria utilized five databases: Ovid MEDLINE, PubMed, CINAHL, Scopus, and Embase, while removing all duplicates. This data was further classified into full-text articles relating to the ICU that calculated proportions of accurate or irrelevant alarms and used integrative methods to examine the approaches. Twelve studies met the inclusion criteria for this research. Among these studies, four articles comprised of a pediatric population, seven comprised of the adult population, and one comprised both children and adults. The research utilized real-time annotation and retrospective annotation to measure alarm accuracy and its relevance. Real-time annotation incorporated the alarms that were established on the clinician's response. It included unit nurses or staff and on-unit observers from the research team. Meanwhile retrospective annotation incorporated video recordings of the patient's room essential in monitoring the physiological parameter waveforms and in storing the gathered alarm data. Thus, these waveforms provided better validity and reliability than the clinician's response (Ruppel, Funk, & Whittemore, 2018).

The proportions of accuracy and relevance of the clinical alarms varied extensively in the studies based on the clinician's response. The studies that included real-time annotation, 68% of alarms were labeled as false alarms and 27% of alarms were labeled as ones that needed a healthcare provider response. The annotation of alarms based on the clinician's response reflected unresponsiveness in 72% to 77% of alarms. However, the unresponsiveness did not reflect the accuracy and clinical relevance of the alarms. While the alarms annotated based on researcher observation, 86% of alarms were inaccurate and only 6% were clinically irrelevant. In the studies utilizing retrospective annotation methods, the alarming accuracy was better and clearer than the ones utilizing retrospective annotation. There were 55% to 89% of alarms that were labeled as inaccurate alarms. The proportions obtained in the retrospective annotation labeled 87% as non-actionable, 46% as not alarm relevant, and 61% as irrelevant. The research combined the data obtained from both real-time annotation and retrospective annotation and concluded that there were higher proportions of clinically irrelevant alarms in the ICU (Ruppel, Funk, & Whittemore, 2018).

In addition to these research studies conducted, Funk, Clark, Bauld, and Coss's (2014) study investigated the change in attitudes and practices of clinical alarms since 2005. This study also utilized the survey of the HTF for evaluating the purpose of their study. The researchers analyzed the survey results conducted in 2005 and 2011. The researchers also supplemented four additional questions in the 2011 survey to investigate initial survey issues. These questions assessed the presence of adverse patient events from the problems of clinical alarms, use of monitor watchers, development of alarm improvement strategies, and new technological solutions in the working institution of the participating nurses. Funk et al. (2014) obtained 1327 responses from 2005 and 4278 responses from 2011. Among the respondents, about 80% comprised of registered nurses (RN). The comparison of the survey revealed trivial difference in the results of two surveys. The research also helped in identifying a total of nine different alarm issues provoking alarm fatigue in nurses. The study recognized frequent false alarms as the main factor and difficulty in identifying the source of an alarm as the second most crucial factor for alarm fatigue among the nurses. Furthermore, Funk et al. (2014) emphasized the importance of individual hospitals to adapt systematic and interdisciplinary approaches to decrease the alarm fatigue.

## **Conclusion**

The studies evaluating alarm fatigue all focused on the perceptions of alarm fatigue of nurses and glanced into the strategies of effective alarm management. Allan (2018) as well as Cameron and Little (2018) conducted a pre and post-education session survey to explore the difference in perceptions of alarm fatigue. However, the study by Allan (2018) utilized the National Clinical Alarm survey developed by the HTF to assess the baseline perception and awareness of the nurses about alarm fatigue working in the ICU. While, Cameron and Little (2018) conducted a pre-test survey among nurses working in an acute care setting of a hospital to evaluate the baseline perceptions and practices related to alarm fatigue and management. Furthermore, both Ruppel et al. (2018) and Honan et al. (2015) utilized the HTF survey to determine nurses' perceptions of alarm fatigue. Ruppel et al. (2018) used the findings of 2005 and 2011 and compared them with the survey conducted in 2016 using the  $\chi^2$  and Kruskal-Wallis analyses method to compare obtained results. Meanwhile, Honan et al. (2015) utilized the survey results from 2011 using the Krippendorff method for content analysis to evaluate the comments provided by the participating nurses.

The studies evaluating alarm accuracy and clinical relevance all acknowledged the necessity to determine alarm accuracy and explore the clinical relevance of alarms. The study by Cosper et al. (2017) as well as Vitoux et al. (2017) recognized the appropriate interventions in reducing frequency of non-actionable alarms. However, each study had different interventions. Cosper et al. (2017) recognized the need of health care facilities to customize individual default settings based on the needs of a unit. It also highlighted the need to empower the nurses to customize the alarms monitor according to patient needs. Vitoux et al. (2017) identified adjustment of pump configurations, reinforcement of practices to avoid preventable alarms, assessment of weekend staffing, and supporting the resources as effective techniques in reducing these unnecessary alarms. Furthermore, studies by Ruppel, Funk, and Whittemore (2018) Funk et al. (2014) assessed the presence of alarm inaccuracy in hospitals. However, Ruppel and Whittemore (2018) utilized an inclusion criterion to collect the data for the research while Funk et al. (2014) utilized the results of the HTF survey to collect the data for the research.

Hospitals utilize alarms to enhance the safety of patient care. However, increase in the occurrence of alarms causes desensitization to these alarms. Alarm fatigue affects both experienced and novice nurses. Therefore, it is important to assess the prevalence of alarm fatigue and launch appropriate strategies to reduce the occurrence of false and clinically irrelevant alarms in units.

## Chapter III

### Research Design

The student researcher used a non-experimental comparative design method for the research. The non-experimental comparative design method did not manipulate the independent or dependent variable. The design was based on a one through five Likert scale that assessed perceptions of infusion pump alarms (Nieswiadomy & Bailey, 2018). The student researcher collected data without using any external variables for her research. This method helped the student researcher to collect and differentiate data regarding the perceptions of infusion pump alarms among the experienced nurses and the novice nurses. The samples collected using this design helped the student researcher to collect an adequate sample for her research hypothesis.

### Variables

The independent variable in the study was the experience of the nurses. The nurses were classified as either experienced nurses or as novice nurses based on their number of years as registered nurses. The dependent variable of the study was the perceptions among the nurses regarding the infusion pump alarms. The student researcher controlled the survey used in the study. The survey was available to all participants for the same amount of time and the same survey was used for every participant. However, there were some extraneous variables that could not be controlled for the purpose of the research study. The student researcher could not determine if the participants were honest while answering the questions in the survey. Some other extraneous variables included the amount of time spent in the clinical setting and past experiences impacting the results. The student researcher also assumed that participants understood the questions and only looked at the current working environment of the participants.

### Selection of Subjects and Settings

The setting in which the study took place was a 315-bed rural hospital in the southeastern United States. The target population within this study was licensed RNs who were categorized as experienced or novice nurses. The accessible population included RNs currently employed at a rural hospital in the southeastern United States working in medical-surgical (med-surge) and the ICU. The student researcher utilized convenience sampling where the accessible population lacked representation of complete sample of the target population. Non-probability sampling methods like convenience sampling suited the student researcher best considering the accessible population and time restraints (Nieswiadomy & Bailey, 2018). The student researcher gathered data from 60 to 100 participants. The student researcher determined the accessible population was not representative of the target population. The accessible population were the RNs who worked at a small, rural hospital in the southeastern United States. However, they did not fully represent the target population, which consisted of all registered nurses across the United States.

### Data Collection

The data collection tool used by the student researcher included the Infusion Pump Alarm Survey (see Appendix A) to test perceptions of experienced and novice nurses. The survey was composed of 22 total questions. Seven of the questions were demographic questions assessing the participants' gender, age, years in nursing, hours worked, type of unit, job title, and

frequency of infusion pump use. There were 15 subsequent questions that assessed the participants' perceptions of infusion pump alarms. Ten of the questions measured perceptions on a scale from "strongly agree" to "strongly disagree," and the remaining five questions measured perceptions on a scale of "most" to "least." The survey measured the nurses' perceptions of infusion pump alarms by asking specific questions of the participants. The participants answered confidentially making it the most appropriate tool to measure the critical variables. The survey used had established reliability and validity as it had been previously used in the research study *Perceptions of infusion pump alarms: Insight gained from critical care nurses* by Vitoux, Schuster, and Glover (2018). The survey was reviewed by a panel of experts when utilized in this prior study. The survey was brief and comprehensive, which helped the student nurse to gather the necessary data to accurately measure her hypothesis. The student researcher received consent to utilize the survey from the prior researcher (see Appendix B). The student researcher received permission from the Institutional Review Board (IRB). Following IRB approval, a consent letter was obtained from the healthcare setting (see Appendix C).

The data collection instrument utilized by the student researcher was a survey provided by the student researcher that provided confidentiality to participants. The student researcher passed out paper copies of the survey on six different floors of the research facility over a three-week period on both day and night shifts. The student researcher remained consistent by approaching each participant in the same manner, providing each of them with the same survey, and giving each the same instructions. The student researcher informed the participants that the survey provided was designed to measure their perception of infusion pump alarms. The participants were informed that anonymity would be maintained, and participation was completely voluntary. Participants were asked to answer the questions honestly and informed that it would take approximately 10 minutes to complete the survey. By submission of the survey, participants were granting consent to be a part of the study. Participants were informed that participating in this study would have no impact in their employment status. Participants were informed that they could withdraw from the study at any time prior to the submission of the survey. At the end of the three-week period, the collected data was compiled into a spreadsheet for analysis, which was stored on a password protected computer. After analysis was completed, data and the answer copies were destroyed to protect the participants' confidentiality.

### **Statistical Analysis**

The student researcher used a *t*-test to interpret the data collected. The student researcher selected the *t*-test method to examine the directional research hypothesis, where novice nurses would have increased perceptions of infusion pump alarms. The *t*-test was adequate for this research study because it examined the difference between the mean values of a variable in two groups (Nieswiadomy & Bailey, 2018). In this study, the student researcher compared mean values of the perception level of novice nurses and experienced nurses.

### **Limitations**

Several limitations to the study were recognized by the student researcher. First, there was no way to know if the participants answered each question within the survey honestly. Environmental limitations were a factor with the student researcher. Convenience sampling was utilized for the study due to the limited time frame for data collection; therefore, the population of participants only included licensed RNs within a small rural hospital within the Southeastern United States (Nieswiadomy & Bailey, 2018).

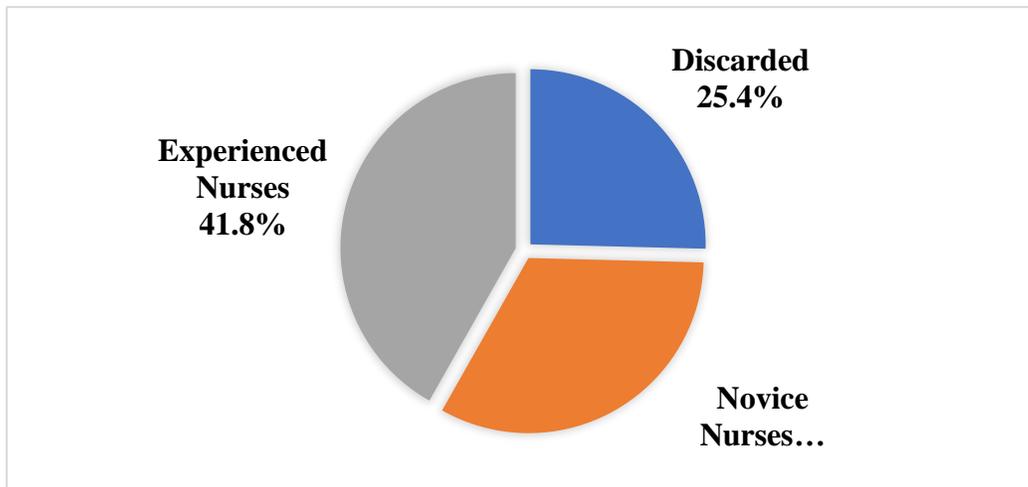
## Chapter IV

### Results of the Study in Terms of the Original Hypothesis

The purpose of this study was to determine whether there was a difference in the perceptions of alarms among experienced nurses as compared to novice nurses. The student researcher hypothesized novice nurses would have increased perceptions of infusion pump alarms over experienced nurses. A survey entitled Infusion Pump Alarm Survey by Vitoux, Schusler, and Glover (2018) was provided to the sample population during a required training event held by the participating facility. During the training event, nurses voluntarily answered the questions and returned them to the facility's education department to be picked up by the student researcher at the end of the one-week period. The surveys were placed in a secure location until data analysis was completed.

There were 67 surveys returned from the education department; however, the student researcher removed 17 surveys from the total collected due to incompleteness, inapplicable participants, and noncompliance with survey instructions. Some surveys were also missing demographic data needed to properly classify experienced and novice nurses and were discarded. Data were analyzed from 22 novice nurses' responses and 28 experienced nurses' responses to the survey. Among the total surveys collected, 25.4% were discarded, 32.8% were classified as novice nurses' responses, and 41.8% were classified as experienced nurses' responses (see Figure 1).

**Figure 1**  
*Surveys Collected*

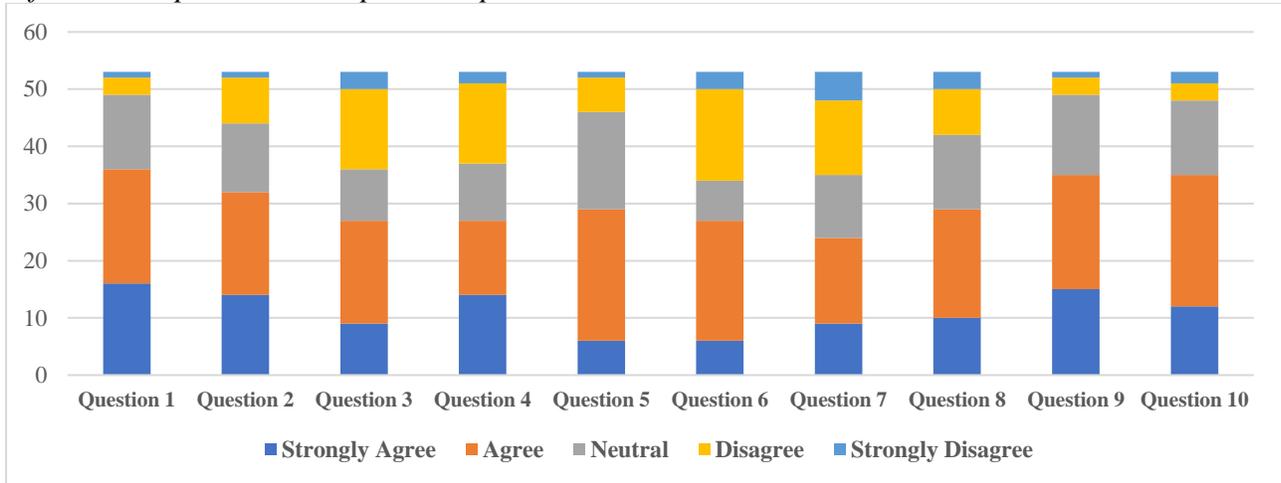


The student researcher calculated the average survey score for the experienced and novice nurses after analyzing the participants' responses. The scores reflected whether nurses perceived an ideal situation on their unit regarding nuisance alarms and responses to them or a not ideal situation. The data was then compared between the two groups. The average survey score for the experienced nurses was 19.037 out of 40 questions (47.5%), and the average survey score for the novice nurses was 21 out of 40 questions (52.5%).

Based on these results, the student researcher could not say with any certainty whether there was an overall positive or negative perception of infusion pumps in a clinical setting. The total number of responses for each question, however, aided the student researcher to determine

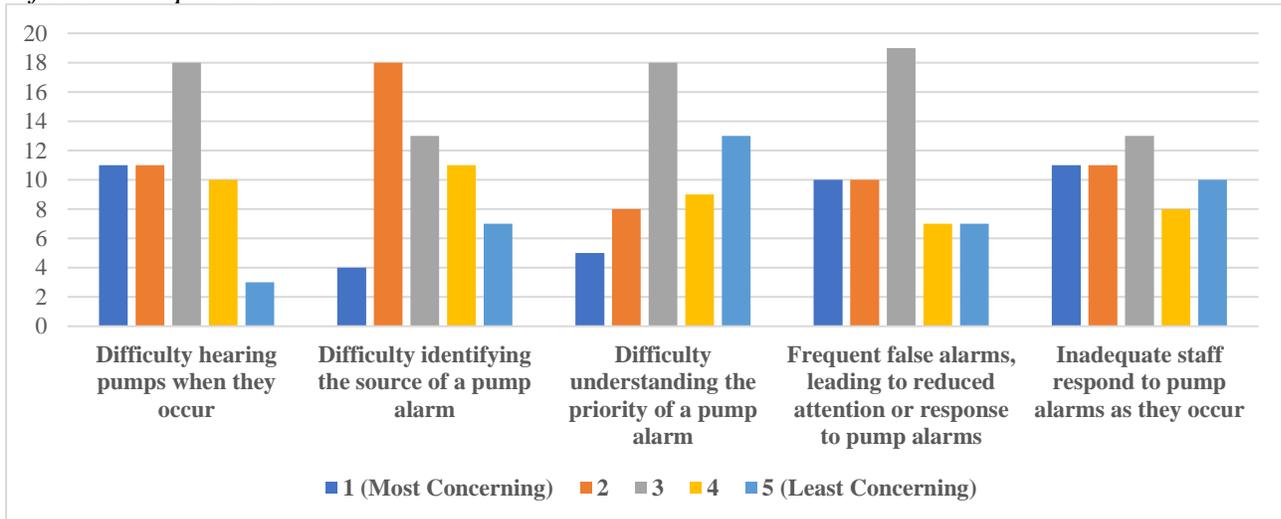
the overall perceptions for each issue related to infusion pump alarms evaluated. Figure 2 shows the frequency with which participants responded strongly agree to strongly disagree for each question. Questions one through 10 may be found in Appendix A on the Infusion Pump Alarm Survey. As a whole, participants had similar perceptions for each question, which was supported by the student researcher’s data analysis. At the end of the survey, the participants were asked to rank five issues concerning infusion pump alarms from most concerning (1) to least concerning (5).

**Figure 2**  
*Infusion Pump Alarm Perception Responses*



Not all participants appropriately answered this section according to the directions, but the student researcher was still able to observe which issues the participants found most concerning regarding infusion pumps compared to the others (see Figure 3). The participants seemed to agree that difficulty hearing and identifying the source of a pump alarm and inadequate staff response to alarms were the top issues regarding infusion pump alarms.

**Figure 3**  
*Infusion Pump Issues*



### **Data Analysis**

The student researcher evaluated the data collected and utilized the results from the survey to determine the significance of the study. The  $t$  test analysis revealed  $t = 1.276$ ,  $p = 0.208$ ,  $df = 48$ . The  $t$  test was used to determine if there was a significant difference in the perceptions of infusion pump alarms among experienced and novice nurses. With the  $p$  value greater than 0.05 and  $t$  test less than 2, the student researcher failed to reject the null hypothesis that there will be no statistically significant difference between the perceptions of infusion pump alarms among experienced and novice nurses.

### **Findings from Similar Research Studies**

The student researcher reviewed several studies focused on perceptions of infusion pump alarms. Two separate studies conducted by Cosper et al. (2017) and Cameron and Little (2018) were reviewed regarding alarm fatigue and its accuracy. Cosper et al. (2017) concluded that many alarms were false or nonactionable, and with simple changes and additional education, there could be fewer alarms to decrease alarm fatigue in nurses and nursing assistive personnel. According to the student researcher's findings, many participants strongly agreed or agreed that pump alarms occurred frequently and disrupted patient care. Honan et al. (2015) concluded that as alarm technology continues to advance, alarms can be honed and developed to decrease nurses' fatigue and increase timely response to alarms. Their findings related to the student researcher's study as over half of the participants in the student researcher's study agreed that new technologies would improve alarm management and recognition.

Vitoux, Schuster, and Glover (2018) utilized the same survey as the student researcher. They found that nurses believed infusion pump alarms occur frequently and disrupt patient care. The student researcher's data reflected similar findings with 68% of nurses agreeing or strongly agreeing that nuisance alarms occurred frequently and 60% agreeing or strongly agreeing that nuisance alarms disrupted patient care. Eighty Five Percent of nurses surveyed by Vitoux, Schuster, and Glover (2018) agreed that unit monitors and other advanced alarm technology would help improve alarm management. The student researcher had similar findings with 64-66% of participants agreeing or strongly agreeing with that sentiment on questions nine and ten.

### **Limitations of the Study and the Effects of Intervening Variables**

The student researcher observed the following limitations while conducting the research survey:

1. Not all participants completed all the questions on the survey; therefore some surveys were not usable and there was a small sample size of only 50 applicable surveys out of 67 responses.
2. The student researcher collected data utilizing convenience sampling from one location.
3. It was unknown if any participants used outside resources because the student researcher did not proctor or observe completion of the survey.
4. Some participants were administrators and directors, not bedside nurses, so the surveys they completed were not applicable.
5. The researcher was not able to control instructions given to participants because she was not there when they were given. The instructions given could have affected the participants' understanding of certain questions.

6. The time frame the participants had in which to complete the survey was another limitation. The survey was only available during the participants' required training time at the facility. The student researcher could not ensure all participants were given the same time frame since she was not there to administer.

The student researcher was only able to use a small sample from the approved location, and some surveys could not be included because they were not representative of the population being studied or were not completely filled out. Furthermore, many participants did not understand the last section of the survey where participants were asked to rank five issues concerning pump alarms in order from least concerning to most concerning. Many participants did not put them in an order, but rather gave each a score by itself, which skewed how the student researcher could interpret their data. If the student researcher could have given the surveys, the expectations for the survey could have been better explained and misunderstanding avoided.

### **Alterations from Proposal**

The student researcher had alterations from the proposal of the research survey while collecting data. The student researcher did not pass out the paper copies of the surveys in the research facility. Instead, the participating facility's educational department delivered surveys to each nurse attending required training sessions at the hospital. The student researcher did not physically hand out the surveys over a three-week period, but rather allowed other trusted individuals to disperse, collect, and hold the surveys until the student collected them. Therefore, the student researcher could not ensure that all of the participants had the same amount of time to complete each survey. The student researcher also could not control the units that the surveys were dispersed to because they were distributed to nurses attending required training sessions at the hospital. The student researcher also could not control the instructions given to participants, which could have affected their understanding of certain questions. Additionally, the student researcher could not be sure that participants did not speak to each other or ask other participants' opinions on different items while answering the survey. After the completion of the surveys, the surveys were returned to the educational department supervisor before later being collected by the student researcher. Lastly, there were only 50 applicable surveys collected, which did not meet the student researcher's goal of 60-100 applicable surveys.

## Chapter V

### Conclusion

The purpose of this study was to determine if there was a significant difference in the perceptions of infusion pump alarms among experienced and novice nurses. The research hypothesis stated that novice nurses would have increased perceptions of infusion pump alarms compared to experienced nurses. The null hypothesis stated there will be no statistically significant difference in perceptions of infusion pump alarms among experienced nurses and novice nurses.

Data was collected from a total of 67 licensed RNs from a 315-bed rural hospital in the southeastern United States. However, there were 5 participants who failed to complete the survey and these were not included in the study results. An additional 12 participants were discarded as the student researcher utilized only bedside nurses. There were 22 novice nurse participants and 28 experienced nurse participants. The nurses voluntarily completed the student researcher's survey entitled Infusion Pump Alarm Survey (Appendix A). The participants voluntarily completed the student researcher's survey. The survey was available to participants during each nurse's mandatory training session provided by the rural hospital's education department. The survey contained 22 items that assessed the participant's gender, current work unit, years of experience as a licensed RN, employment status, occupation title, frequency of infusion pump use, and perception of infusion pump alarms. Participants only had access to the survey during their training session. The student researcher collected surveys from the facility, gathered the data, and utilized an independent *t*-test to analyze the perception differences among experienced and novice nurses.

The student researcher analyzed the participants' responses and compared the average survey scores among experienced and novice nurses. The average score for novice nurses was 21 (52.5%) and the average score for experienced nurses was 19.03 (47.5%). Even though the novice nurses had a slightly higher score compared to the experienced nurses, the student researcher concluded from the *p* value that there was no statistically significant difference in the perceptions of infusion pump alarms among experienced and novice nurses. The data resulted in a *p* value of 0.208. Since the *p* value was greater than 0.05, the student researcher failed to reject the null hypothesis.

### Implications

The student researcher was able to provide many implications for future research studies on the perceptions of infusion pump alarms. The results of the study established the continued need for training and education on nurses' perceptions with infusion pump alarms. The average score for novice nurses was 21 (47.5%) and the average score for experienced nurses was 19.03 (52.5%). The results from the study suggested there was no difference in the perceptions of infusion pump alarms when comparing experienced and novice nurses. Years of experience did not have a major influence on the perceptions of infusion pump alarms. Healthcare organizations should provide additional education and training to experienced and novice nurses to resolve any potential problematic unit issues that would interfere with the perception of infusion pump alarms. As technology advances within healthcare, additional research is needed to detect patterns of change in the nurses' perceptions based on varying models technology such as infusion pumps. The nursing profession must collaborate with the healthcare technology

industry in order to create solutions to increase the perception of infusion pump alarms, which could subsequently reduce the amount of time it takes to respond to the alarms.

Healthcare organizations will continually need to monitor new evidence-based practice with the use of rapidly evolving medical technological equipment to ensure nurses are educated and trained on the updated infusion pumps and alarms in order to protect the safety of patients. However, future studies could be limited with the varying models of infusion pumps and alarms within different healthcare organizations.

### **Recommendations**

The student researcher proposed the following recommendations to improve future research on this subject.

1. Collect data from a larger sample size in the hospital.
2. Collect data from multiple hospitals in a larger geographical area.
3. Proctor the survey in order to prevent the potential use of outside materials.
4. Alter questionnaire instructions to limit completion by bedside nurses rather than nurse administrators or directors.

### **Theoretical Application**

The nursing theory best supporting the exploration of the research problem is Albert Bandura's Self-efficacy Theory. This theory was representative of the intentions and behaviors of individuals. The Self-efficacy Theory was supportive of the student researcher's study on the perceptions of infusion pump alarms among experienced and novice nurses because it focused on human activities and how they are influenced by individuals' attitudes and abilities when making decisive actions. Bandura's theory "influences the effort one puts forth to change risk behavior and the persistence to continue striving despite barriers and setbacks that may undermine motivation" (Schwarzer, 2014, p. 1). It focuses on the individual and the influence the environment has on his or her perceptions. The student researcher recognized that both experienced and novice nurses rely on their own capabilities and individual thought processes to determine which course of action would be the most effective in response to infusion pump alarms. The Self-efficacy Theory supported the student researcher's belief that the nurses' perceptions of the infusion pump alarms were related to effectiveness of patient care. The principles of the theory were the basis for self-beliefs, which influence how individuals feel, think, and act (Schwarzer, 2014, p. 3). The basis for nurses' actions directly relate to patient care in determining through their perception if an infusion pump alarm is clinically significant or insignificant. The clinical significance of the alarm can influence the response time of the nurse when responding to an infusion pump alarm. Overall, the perceptions could influence the rate of infusion pump errors within the hospital setting.

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## Appendix A

This questionnaire is designed to measure your perceptions of infusion pump alarms. There will be demographic data such as gender, age, and job title collected. No identifying data will be collected or used in this study and you will remain anonymous. Participation in this study and answers provided will not affect your employment in any way. By filling out and returning this form, you are consenting to be a part of research study. You may withdraw from this study at any time before completing and returning the questionnaire. please answer each question as honestly as you can. You will have about ten minutes to complete the questionnaire. Thank you for your participation.

*The purpose of this survey is to assess clinicians' perceptions about pump alarms. Please complete this survey by filling in the circle with your selection like this: ●*

1. Gender	<input type="radio"/> Female <input type="radio"/> Male	2. Age	__ __ yrs	3. Years in nursing	__ __ yrs	4. Hours worked	<input type="radio"/> Full-time <input type="radio"/> Part-time
5. Type of unit	<input type="radio"/> ICU <input type="radio"/> PICU <input type="radio"/> NICU <input type="radio"/> ER <input type="radio"/> OR <input type="radio"/> Tele <input type="radio"/> Med/Surg <input type="radio"/> Other: _____						
6. Job title	<input type="radio"/> Staff Nurse <input type="radio"/> CNS/Educator <input type="radio"/> Manager <input type="radio"/> Other: _____						
7. Pump use	<input type="radio"/> Every Workday <input type="radio"/> Occasionally ( <i>few times a week</i> ) <input type="radio"/> Rarely ( <i>few times a month or less</i> )						

***Based on your experience using pumps in your unit, please respond to the following statements.***

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Pump nuisance alarms occur frequently.	<input type="radio"/>				
2. Pump nuisance alarms disrupt patient care.	<input type="radio"/>				
3. Pump nuisance alarms reduce trust in alarms and cause staff to inappropriately silence alarms at times other than set up or procedural events.	<input type="radio"/>				
4. There have been frequent instances when pump alarms could not be heard and were missed.	<input type="radio"/>				
5. Staff are sensitive to pump alarms and respond quickly.	<input type="radio"/>				
6. When a number of pumps are used on a patient, it can be confusing to determine which is alarming.	<input type="radio"/>				
7. Unit noise (phones, pages, other device sounds) interferes with pump alarm recognition.	<input type="radio"/>				
8. Unit size or layout interferes with pump alarm recognition and management.	<input type="radio"/>				
9. Unit monitors with visual display of pump alarms (infusion, type of alarm, location) would be useful for improving alarm recognition and management.	<input type="radio"/>				
10. Alarm integration with communication systems (pagers, cell phones, other) would be useful for improving alarm recognition and management.	<input type="radio"/>				

***Based on your experience, please rank the following issues concerning pump alarms in order from 1 (most important) to 5 (least important). \*\*Use only one number per issue.***

	MOST 1	2	3	4	LEAST 5
1. Difficulty hearing pump alarms when they occur.	①	②	③	④	⑤
2. Difficulty identifying the source of a pump alarm.	①	②	③	④	⑤
3. Difficulty understanding the priority of a pump alarm.	①	②	③	④	⑤
4. Frequent false alarms, leading to reduced attention or response to pump alarms.	①	②	③	④	⑤
5. Inadequate staff to respond to pump alarms as they occur.	①	②	③	④	⑤

Abbreviations: CNS, clinical nurse specialist; ER, emergency room; ICU, intensive care unit; med/surg, medical/surgical; NICU, neonatal intensive care unit; OR, operating room; PICU, pediatric intensive care unit; Tele, telemetry.

## Appendix B

**From:** Rachel Vitoux [mailto:[rachel.vitoux@bbraunusa.com](mailto:rachel.vitoux@bbraunusa.com)]  
**Sent:** Sunday, August 25, 2019 5:40 PM  
**To:** Tara Sullivan <[tsullivan@muw.edu](mailto:tsullivan@muw.edu)>  
**Subject:** Re: Permission to utilize the Infusion Pump Survey

Tara,

Thank you for your interest in this topic! Yes, you may use the survey as long as you reference the source and please let me know the outcome of your research. Good luck!

Thank you,  
Rachel

Rachel R. Vitoux, MBA, MSN, RN, CPHIMS | Director, Clinical Consulting & Services |  
B. Braun Medical Inc.  
Cell [317.407.2490](tel:317.407.2490) | [rachel.vitoux@bbraunusa.com](mailto:rachel.vitoux@bbraunusa.com)  
Pump Software Technical Support: [aistechsupport.us@bbraunusa.com](mailto:aistechsupport.us@bbraunusa.com) | [1.800.627.7867](tel:1.800.627.7867)

On Aug 25, 2019, at 12:04 PM, Tara Sullivan <[tsullivan@muw.edu](mailto:tsullivan@muw.edu)> wrote:  
Ms. Vitoux,

Hello, my name is Tara Sullivan and I am a nursing faculty at Mississippi University for Women in Columbus, MS. I am writing to request permission to utilize the Infusion Pump Survey utilized in your research study titled: Perceptions of Infusion Pump Alarms. I help my students with undergraduate BSN research and my group is very interested in this topic. Thanks so much for your time and please let me know if you have questions.

Tara Sullivan, MSN, RN  
Mississippi University for Women  
Nursing Faculty  
Bachelor of Science in Nursing Program  
[tsullivan@muw.edu](mailto:tsullivan@muw.edu)  
662-329-7310 (Office)  
205-712-3314 (Cell)  
662-329-7310 (Office)

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**Appendix C**  
**IRB Approval**



December 18, 2019

Ms. Tara Sullivan  
Mississippi University for Women  
College of Nursing and Health Sciences  
1100 College Street, MUW-910  
Columbus, MS 39701

Dear Ms. Sullivan:

I am pleased to inform you that the members of the Institutional Review Board (IRB) have reviewed the following proposed research and have approved it as submitted:

<b>Name of Study:</b>	Perception of Infusion Pump Alarms among Experiences Nurses versus Novice Nurses
<b>Research Faculty/Advisor:</b>	Tara Sullivan
<b>Investigators:</b>	Priyanka Panta

I wish you much success in your research.

Sincerely,

Scott Tollison, Ph.D.  
Provost and Vice President for Academic Affairs

ST/ tc

pc: Irene Pintado, Institutional Review Board Chairman

**Appendix D**

Approval from the Facility

January 8, 2020  
Ms. Mary Ellen Sumrall  
Chief Nursing Officer  
Baptist Memorial Hospital-Golden Triangle  
2520 N 5<sup>th</sup> Street  
Columbus, MS 39705

Yes, I give my permission for the student researchers to conduct this questionnaire.

No, I do not give my permission for the student researchers to conduct this questionnaire.

Mary Ellen Sumrall  
Chief Nursing Officer

Printed Name and Title

1/13/20 Mary Ellen Sumrall

Date Signature