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Effect of Remote Fetal Monitoring in an Inpatient Obstetrical Unit: A retrospective review

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EFFECT OF REMOTE FETAL MONITORING IN AN INPATIENT OBSTETRICAL UNIT:

A RETROSPECTIVE REVIEW

by

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Abstract

Electronic Fetal Monitoring (EFM) has been used as a tool for inpatient obstetrical care in the United States since the 1980's. The litigious nature of our society has caused much emphasis to be placed upon EFM use and interpretation; however, little evolution has occurred in monitoring techniques. The review of relevant literature found a significant gap in knowledge in regards to research of the current monitoring practice. Therefore, this study was aimed to look at the effect of remote monitoring, like the practice currently used in telemetry, on inpatient obstetrical care. The study used a retrospective review to look at three components including: reaction time of nurses, overall quality of tracing, and the Apgar score of the neonates. Study participants were selected at random from two groups, one prior to implementation of a remote monitoring protocol and one after implementation. All three components improved from the control group to the experimental group, yet only nurse reaction time was found to be statistically significant; therefore, additional research on this subject matter may be warranted. If valid, the impact of these findings is significant because they suggest the potential benefit of a new standard in care. Therefore, more research on the use of remote monitoring techniques is needed along with more data to determine the overall effectiveness in improving obstetrical care.

Keywords: fetal monitor, EFM, remote monitoring, inpatient obstetrics, intrapartum nursing, fetal heart rate

TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

EFFECT OF REMOTE FETAL MONITORING IN AN INPATIENT OBSTETRICAL UNIT

CHAPTER I: INTRODUCTION

Problem Statement

Labor and delivery is a specialized area of nursing practice that requires not only advanced nursing knowledge, but also advanced methods of monitoring and safety measures. Interpretation of the fetal heart rate (FHR) using the electronic fetal monitor (EFM) has been an area of obstetrical care that has been researched since its implementation in the 1980's. Simpson and Knox (2003) wrote about the importance of using the EFM and the implications associated with accurate interpretation. Due to the importance placed on EFM, developing an understanding of the advantages, as well as, limitations is important when looking at the practice of obstetrical nurses. Furthermore, finding methods to implement effective use of the EFM is of the upmost importance. As technology has advanced, the practice of the obstetrical nurse has evolved, and so the problem has become ensuring that practice evolves in a direction that not only supports the technology but protects the patients, both mother and her unborn child.

The problem with the current surveillance system of fetal monitors is the dependence on one single person's ability to provide continuous surveillance and the limit of one nurse's expertise. If surveillance of the fetal monitor was the nurse's sole responsibility this system would have few flaws, other than limiting the interpretation to one person's judgment. However, fetal monitoring is one of many tasks that an obstetrical nurse performs for multiple patients simultaneously. The charge placed on intrapartum nurses to not only monitor at all times, but accurately interpret the FHR is overwhelming and unrealistic because these nurses cannot simply sit at a computer and watch all of their patients without neglecting some other aspect of their care. Therefore, researching a better system that ensures constant surveillance and additional interpretive support is essential in order to ensure the safety of laboring women.

Background

The interpretation of the fetal heart rate by an electronic monitor is a huge area of litigation in obstetrical care. Since implementation of EFMs, fetal heart rate strips have been used as a tool to develop opinions about the health of a fetus prior to delivery (King & Parer, 2000). As new cases are presented the interpretation of these monitors has been used to question the delivery of care to obstetrical patients. Therefore, whenever bad outcomes are anticipated in obstetrical care, institutions often look at the EFM record and attempt to determine whether or not the care that was provided was relevant to the FHR pattern.

Unfortunately, the existence of a problem is not often known before a sentinel event occurs; however, diligent response and proactive efforts can help to create a better environment of care for the benefit of future patients. This study actually stems from a sentinel event that occurred in a level III tertiary obstetrical center. The charge of the root-cause team involved was to determine the factors that led to the sentinel event and then to implement a plan to prevent future occurrences. The root-cause team developed a plan for implementing a remote monitoring system for all patients on EFMs. However, because this system is a pilot in the field the effectiveness and benefits are not known. Therefore, a study of the pilot project is needed to measure the potential benefits, as well as, identify its potential weaknesses in order to determine if the system is an effective response to the identified areas of deficiency.

Purpose of Study

The aim of this research is to investigate the implementation of a nurse dedicated to remote monitoring of all fetal heart rate tracings, called a "Flight Control Nurse", in a level III Labor and Delivery Care Center. The goal of this study is to evaluate the effectiveness of the "Flight Control Nurse" by using quantitative measures that look at the reaction times to missing and non-reassuring fetal heart rate tracings and the Apgar scores of the neonates. The study will compare results from a

control group that were taken before the implementation of this program and from a sample group after the implementation of the "Flight Control Nurse". By comparing not only the reaction times and quality of monitoring, but by also measuring the outcomes of the neonates, the study will hopefully serve to support the need for more research and greater use of a remote monitoring system for inpatient obstetrical care.

Significance

Interpretation and integration of the EFM into practice has been the focus of all organizations involved in the care of pregnant patients including the American College of Obstetricians and Gynecologists (ACOG), the Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN), and the Society for Maternal-Fetal Medicine. All of these groups have spent extensive time and effort in researching and developing standards in regards to the use of the EFM. The 2008 National Institute of Child Health and Human Development (NICHD) workshop was organized to look specifically at the use of electronic fetal monitoring and included experts in the field with representation from all of the above mentioned organizations (Macones, et al., 2008). The group had the goal of establishing a standardized system of interpretation, as well as, identifying practice implications and areas in need of research.

With all of the major organizations behind a national move to improve the use of the EFM and to standardize the systems surrounding its integration into practice, the proposed study could serve to benefit all groups involved. Once remote telemetry was introduced to cardiac services and proved to benefit practice the use of remote telemetry technicians became the standard of care (Capuano, 1995). Therefore, using evidence to support the use of the same concept in obstetrics will hopefully lead to the same standards being created in a completely separate field. The 2008 NICHD workshop was an initial step in the right direction, now it is time to take the work another step

forward and research methods in which the EFM can be used to prevent bad events from occurring while in the hospital.

Research Questions

The proposed study will look at the following research questions:

1. Is there an improvement in the reaction times of nurses to an unintentional interruption and non-reassuring FHR tracings with the implementation of the "Flight Control Nurse"?
2. Was there an improvement in the quality of tracing available for interpretation after the implementation of the "Flight Control Nurse"?
3. Is there an improvement in neonatal outcomes based on the APGAR scores given at one and five minutes since the implementation of the "Flight Control Nurse"?

Definition of Terms

Reaction time for the purpose of this study will be used to reference the amount of time in minutes that it takes the nurse to perform the first intervention following an unintentional interruption or non-reassuring tracing.

Unintentional Interruptions refer to interruptions in the tracing due to the electronic fetal monitor being unable to trace the fetal heart rate that occur without the monitors being removed, turned off, or some other rationale for interruption being documented.

Non-reassuring tracings will be classified as those tracings that would be considered a Category II or III according to the recommendations of the NICHD fetal monitoring workshop in 2008 (Fedorka, 2010).

Flight Control Nurse (FCN) is the position being studied, where a nurse is designated on the unit to watch all of the active fetal monitor tracings. The nurse in this position must have at least two years of inpatient obstetrical experience and must pass a written test about fetal heart rate interpretation and FCN protocol prior to performing in this position. The nurse designated as the "Flight Control Nurse" is in charge of remotely monitoring at all times and is unable to leave from monitoring, unless relieved by another qualified staff member.

Quality in regards to a FHR tracing refers to the ability of the tracing to be interpreted. FHR strips must have at least ten minutes of continuous tracing in order to be accurately interpreted according to the standards established by AWHONN. For this study, quality will refer to the amount of time in minutes that the FHR is unable to be interpreted due to interruptions lasting at least 60 seconds.

Theoretical Framework

This study used The Neuman Systems Model (1995) as the theoretical framework. The Neuman Systems Model, which was contributed by Betty Neuman in 1995, fits this study because she viewed patients and patient systems as a **basic unit** and used the concepts of **environment, stressors, reaction**, and **reconstitution** to view the exchange that occurs in order to achieve **health**. Neuman also stressed the importance of **prevention** in her model referring to the different classifications including: primary, secondary, and tertiary (George, 2002).

In this study the care of the pregnant patient including the patient, fetus, and nurse will be used as the **basic unit**. This system includes all of the normal interactions that occur during the labor and delivery process. The unit includes all three elements and their relationships. The basic patient system is unique and includes all of the variables that come with individuals.

The **normal line of defense** to keep the system working correctly is represented by the use of the electronic fetal monitor because it helps to keep the system working correctly and when all things are right within the system that first line of defense is enough. However, Neuman realized when constructing her model that there are external and internal factors that sometimes cause a breakdown in the line of defense. These factors include the **environment** and **stressors**. The environment is made up of all of the factors that affect the system, including for this study: the time of day; patient acuity on the unit; number of total patients in need of care; and the state of the individual patients and their unique needs. Stressors that occur in obstetrical units include: the demands on nurses to care for multiple laboring patients; the use of medications such as Pitocin that alter the normal labor pattern; the administration of epidural analgesia; and the loss of situational awareness during long periods of bedside care. These stressors all serve as a constant strain on the basic unit or system of the laboring inpatient.

Therefore, the "Flight Control Nurse" is proposed as an added line of defense, or as Neuman describes it a flexible line of defense. The "Flight Control Nurse" is able to serve as a primary, secondary, and tertiary level of **prevention**. The nurse monitoring will be watching before any insults in the FHR tracing are noticed (primary), the nurse will also serve to get help to a patient when needed (secondary), and will continue to monitor the patient once an insult has occurred to ensure that the problem resolves or is treated appropriately (tertiary). Accordingly, with Neuman's model the flexible line of defense, or "Flight Control Nurse" can be very loose when all things are going well, or can be very tight when a patient is requiring closer supervision due to a non-reassuring pattern.

At the same time the basic unit or patient system will also be reacting to the stressors. This **reaction**, as defined by Neuman, occurs when things happen to the system. The patient reacts to stressors internally by normal defenses including sympathetic and parasympathetic

responses. The nurse also reacts to stressors by performing intrauterine resuscitation when indicated. These reactions become part of the **reconstitution** that occurs when the energy output increases in order to deal with the demands of labor and to deal with all of the stressors that are impacting the patient system. The reconstitution continues throughout the labor process and ends with the delivery of the neonate. The delivery of a healthy neonate safely would be wellness on the continuum of **health** that Neuman uses in her model.

Neuman's Systems Model will help to guide the study and provide the framework for the various components of the research. The concepts as described will be used to build the study and will be referred to when analyzing the data. Understanding the unique patient systems and the environment of Labor and Delivery is crucial in finding a better method for EFM; therefore, using these concepts to identify potential and actual threats to the study will be beneficial.

EFFECT OF REMOTE FETAL MONITORING IN AN INPATIENT OBSTETRICAL UNIT

CHAPTER II: LITERATURE REVIEW

Since its origin in the 1980's, electronic fetal monitoring has been heavily researched (Simpson & Knox, 2000). However, a significant gap in knowledge was identified in the literature review on the use of remote fetal monitoring. The term "continuous EFM" is widely used in most acute care facilities that provide obstetrical services, yet as the review of literature on this subject identified there is a lack of evidence to support that our current standards of practice meet this need. Therefore, a review of the literature was conducted to understand the current practice of electronic fetal monitoring and its implications, as well as, evidence supporting the proposed study in fields outside of inpatient obstetrics.

In an article titled, "Common areas of litigation related to care during labor and birth," Simpson and Knox (2003) explore common themes to issues of practice in obstetrics. One of the main items that they identified as a major area for litigation was, "Fetal Heart Rate pattern interpretation, communication, and documentation" (Simpson & Knox, 2003). The article explained that there were various reasons the fetal heart tracing became important in legal proceedings such as the failure to adequately assess fetal status and failure to appropriately treat a non-reassuring FHR. The article explored several other areas of obstetrical care that were areas of concern for risk management, but most revolved around the use of electronic fetal monitoring. The article continuously reinforced the importance of EFM and described various ways in which litigation could be avoided through the use of evidence-based practice, policies, and procedures that coincided with the industries recommended standards, such as those set by the American College of Obstetricians and Gynecologists (ACOG) and the Association of Women's Health, Obstetric and Neonatal Nurses (AWOHNN) (Simpson & Knox, 2003).

Most of the research reviewed identified the need to understand what the FHR means and what can be inferred from the FHR tracing. An article by King and Parer (2000), aptly titled, "The physiology of fetal heart patterns and perinatal asphyxia," looks at the reasoning behind common fetal heart patterns and explains why certain tracings require interventions. This article stressed the importance of properly identifying non-reassuring FHR tracings in order to prevent fetal hypoxia that can lead to serious brain injuries in newborns, or asphyxia. The article stated that accelerations and decelerations alone were not enough to determine the well-being of a fetus, and that the combination of these signs with the variability were necessary to adequately assess fetal oxygenation. The article also mentioned several times that external considerations such as maternal health and current treatments were important factors in interpreting the FHR tracing, all of which require human interpretation.

In addition to being able to interpret the FHR tracing, comes having an established language to describe the tracing. In an article by Macones and colleagues (2008), the recommended nomenclature for EFM interpretation was presented based on retrospective evidence of tracings that had resulted in hypoxic or asphyxiated neonates. The article which presented the recommendations of the National Institute of Child Health and Human Development Workshop (2008), established a categorical system for rating FHR tracings. There were three categories established Category I (normal, requiring no intervention), Category II (indeterminate, requiring further monitoring), and Category III (abnormal, requiring immediate intervention) (Macones et al., 2008). This system of ranking is the current recommended rating system for EFM and is supported by both ACOG and AWOHNN (Fedorka, P., 2010).

Research supporting the use and importance of using the EFM, as well as, the current recommended standards for interpretation was abundant; however, research concerning the practical, efficient, and least invasive ways to implement continuous EFM were more scarce. In an article by Clement and colleagues (1999), a qualitative study was described that was conducted to develop a

tool to evaluate a woman's perception of birth. The study wanted to establish the perception of women on common procedures one of those being EFM and interventions associated with FHR tracings (i.e. maternal positioning and Cesarean Section(C/S)). Having someone trained in EFM is important so that interventions are only used when necessary as the study showed that women's perceptions of labor can alter their self-esteem and even affect mood long after delivery (Clement et al., 1999).

Another qualitative study centered around EFM, looked at how nurses viewed various aspects of their intrapartum care (Sleutel et al., 2007). Common themes presented by Sleutel and colleagues (2007), were that nurses felt as if they were unable to labor with patients due to the "mechanization" and use of computers during the labor process. Several excerpts from nurses' questionnaires stated that due to continuous monitoring they were limited in their interactions with patients at bedside, and that it made the labor and delivery process feel more like a production line. The article addressed the importance of the labor nurse in the birthing process and explained how experienced intrapartum nurses can actually decrease the likelihood of C/S (Sleutel et al., 2007). Therefore, making continuous EFM more practical should be seen as important since it is a known to dissatisfy nurses and hinder patient care.

Another reason that the method of EFM should be researched is because use of remote monitoring by other disciplines has procured many added benefits. An article by, Capuano and colleagues (1995), discussed the piloting of a remote cardiac telemetry monitoring system. The system included monitors on an inpatient telemetry unit and satellite monitors that were set-up on various medical/surgical units throughout the hospital. By implementing the central remote monitoring system the hospital was able to save an estimated $220,000 and hours required by nursing from 9.4 to 7.7 per day (Capuano et al., 1995). The system required one person to watch all telemetry monitor that were in use so that patients could be more closely monitored on the telemetry unit, and so that stable patients could be housed on medical/surgical floors that needed monitoring that weren't

requiring cardiac interventions. Overall, the pilot study proved to make telemetry more efficient and safer in this particular facility according to Capuano and others (1995).

Furthermore, borrowing from telemetry and addressing another issue with efficiency is an article by Simpson (1999), about the use of computer generated interpretation in the field of cardiac monitoring. The article titled, "Let's Talk Telemetry," was a short informative article about the use of computer-aided interpretation. Simpson (1999) talked about the advances at this time in the ability of the computer to track and distinguish certain patterns of the heart rate, but said, "…no matter how sophisticated the system gets, no matter how blurry the lines between data and information become, no matter how standard the standards—none of it works without the knowledge of a practiced professional able to translate all the data and information into care" (p 15). Leading to the last and final area of research covered in the literature review, computer systems and their use in interpreting EFM.

New technology is being developed to interpret EFM tracings or at least to assist in the interpretation process. One such system Sonicaid FetalCare was described in an article by Pardey (2003). The system which is still being developed after its initial debut in 1989, uses a database of over 73,802 tracings to analyze the FHR tracing of a fetus. The system aims to fit a given heart rate to a baseline and determine whether or not the fetal heart rate is showing signs of fetal well-being or distress (Pardey, 2003). Significant evidence was gathered that supports the product's claim about its ability to detect variability; however the research and develop manager said, "A question that is frequently asked is whether FetalCare is better at assessing traces than a skilled human. The answer is…a skilled human can exercise clinical judgment in a way that a computer cannot" (Pardey, 2003, p. 624). Therefore, the article was reiterating the importance of having a person monitoring the FHR tracings over a computer-alone, without constant surveillance from a trained person.

Another article by Tongsong and colleagues (2005), actually presented research on the topic of computer-aided interpretation versus clinical judgment and interpretation, and found that FHR tracings when interpreted by trained professionals were done so consistently and accurately; however, the study used the computer-aided interpretation as the control, which is somewhat questionable, as pointed out by the previous article by Pardey (2003). The aim of Tongsong and others (2005), was to establish whether or not humans would consistently rate and define the FHR tracings, which there was significant findings that showed uniform interpretation did occur when subjects were given tracings to interpret. Both of these studies support the idea of having a trained professional in charge of monitoring because, not only is a human better able to understand that entire clinical picture, but they are also able to consistently identify FHR patterns, as well as the computer.

Overall, there was a wealth information available about EFM; however, the literature review identified a major gap in knowledge in regards to the use of remote monitoring in the obstetrical setting. Application of remote monitoring in telemetry has proven to be successful at not only improving patient safety, but also at making practice more efficient which is of upmost importance considering the economic constraints constantly being placed on healthcare facilities. Therefore, conducting research into to the issue of continuous EFM and ways to do so practically, non-invasively, and efficiently could serve to radically benefit the field of obstetrical nursing.

EFFECT OF REMOTE FETAL MONITORING IN AN INPATIENT OBSTETRICAL UNIT

CHAPTER III: METHODOLOGY

Overview of Design

The purpose of this research study is to evaluate the effectiveness of implementing the "Flight Control Nurse" (FCN), or remote monitoring protocol, in an inpatient obstetrical center. The study was conducted about a pilot project because there was previously no reported data available on the subject of remote electronic fetal monitoring. The concept of the "Flight Control Nurse" was borrowed from the cardiac telemetry discipline, in which monitor technicians are used to remotely watch all patients on telemetry monitoring (Capuano et al., 1995). The "Flight Control Nurse" is responsible for remotely monitoring all patients on electronic fetal monitoring within the inpatient setting and notifying nurses and physicians when there is interruption in a tracing or a non-reassuring event. The purpose of this research project was to see if any correlation existed between the implementation of the "Flight Control Nurse" position and the measured variables including: nurse reaction time, quality of tracing, and outcome of the newborn as measured by Apgar scores.

Research Design

The study was conducted using a quantitative design. The data was collected using a retrospective chart review, in order to collect the response time of nurses to electronic fetal monitoring tracings and APGAR of the neonates (Fawcett & Garity, 2009). There were two groups included in the study. The control group, or group one, included patients that were monitored before the implementation of the "Flight Control Nurse" and the experimental group, or group two, included patients that delivered after the implementation of the "Flight Control Nurse". Both groups were randomly selected from the total patient population and then adjusted to satisfy the inclusion criteria.

Context and Informed Consent

Prior to conducting the research, the researcher obtained permission from the Internal Review Board (IRB) for Gardner-Webb University and the facility in which the research was conducted. Due to the minimal risks identified for research participants an expedited approval process was used. Also, a waiver was granted for the authorization process due to the minimal risk of exposure of protected health information (PHI) and because the research project could not be conducted without such a waiver (Burns & Grove, 2009). Therefore, a plan for disguising any patient identifiers was presented along with the initial presentation to the IRB. Participant numbers were assigned to patients using a numerical identifier that could be used to validate research findings. Consent of the participants were not required because no interventions were performed outside of the routine care administered to intrapartum patients at this facility, and by taking measures to eliminate the risk of disclosing PHI there were no additional risks identified for the participants.

Sample Population

The sample population was randomly selected from the total patient population that delivered at the 961 bed tertiary care facility located in northwestern North Carolina. The control group was taken from patients that delivered up to six months prior to implementation, starting in March 1, 2009 through August 31, 2009. The experimental group was taken from the same three month period beginning six months after implementation, March 1, 2010 through August 31, 2010. The choice of using the same months is to help control any external variables such as high or low census that naturally occurs during the course of the year. These fluctuations in census and acuity are according to the statistics reported by the facility.

The sample was collected randomly by using the log of births. Patient identities were protected by using only identifying numbers and by not using the patient's name to identify the data collected. The total sample population included 200 participants, 100 in each group. The sample's

size was limited due to the capacity of the electronic system being used and time constraints of both the principal investigator and contributing members of medical team that helped in the restoration of patient medical records. Statistical significance in a group this small would indicate that future research may further strengthen the correlation of any discoveries made. After randomly, selecting 100 deliveries from the total populations of both the control participants, or group one, and study participants, or group two, the sample was measured to satisfy all of the inclusion criteria.

The inclusion criteria for this study were quite extensive. First the targeted sample population only included patients with a single gestation at term ($\geq$ 37 weeks and $\leq$ 41 weeks). Secondly, these patients had to have a documented reason for admission as one of the following: onset of labor, spontaneous rupture of membranes, or induction of labor. Patients included in the study had to have at least three hours of recorded electronic fetal monitoring. Study participants also had to have a successful vaginal delivery recorded, which excluded all C/S deliveries. Finally, participants in the study could not have had any diagnosis or reason that they would require a one to one nurse/patient ratio (i.e. high risk pregnancies, maternal conditions requiring additional nursing support, etc.).

Data Collection Methods

As mentioned, the data was collected using a retrospective chart review process. The retrospective review was necessary because the data being collected was taken from patients whom delivered before the implementation of the "Flight Control Nurse", which occurred in September of 2009. The experimental group will also came from a retrospective review to control for the Hawthorne effect, or the effect that might occur if nurses knew that their reaction times were being measured (Fawcett & Garity, 2009).

The data collection process included three steps. The first step was obtaining the sample population. As mentioned previously, 100 delivery records were selected using the random selection

technique of selecting every 5th record from March 1st until 100 records had been chosen from deliveries that occurred during the two designated time periods. Then the sample was evaluated to only include deliveries that meet the inclusion criteria. Only the records meeting the criteria set forth above had their FHR tracings reviewed, this resulted in 41 participants in group one and 44 participants in group two.

The second step required the most time from the researcher because it included reviewing of the fetal heart rate tracing. Data was only collected from the greater time period of the two: 1) when the patient is defined as being in active labor, which is classified by a dilation of greater than four (4) centimeters (Olds, London, Ladewig, & Davidson, 2004), or 2) three hours prior to delivery independent of dilation. The researcher will record the amount of time it takes from the beginning of either an interruption in the tracing or a non-reassuring event before the nurse documented her first intervention. Non-reassuring patterns for the purpose of this study were those defined as a category II or III by the NICHHD (Fedorka, 2010), including: late decelerations, new onset of variable decelerations, spontaneous decelerations, significant changes in baseline (< 110 bpm or >170 bpm), and loss of variability (<6 bpm) for greater than 20 minutes. The researcher will also collect the total time that the patient was on the monitor during the selected labor time, and the total amount of time that the tracing was unable to be assessed due to an unanticipated interruption in tracing lasting at least 60 seconds. The researcher also recorded the total number of intervention episodes noted on the electronic fetal monitor tracing. An intervention episode includes all nursing interventions performed until the issue with fetal heart rate resolves, a medical intervention is initiated, or there was a period of >5 minutes with nothing charted. After 25 minutes of monitoring time elapses after an identified need for intervention the time was cut-off to keep from skewing the data. Finally, the researcher will record the one and five minute Apgar scores given to the neonates of the mothers included in the study.

Data Analysis

After all the data was collected it was placed into a database for analysis. The total time in seconds for the nurse to document the first intervention was calculated and averaged over the total of intervention episodes, in order to establish an average reaction time to an episode for each person in the sample. The total time that the patient was off of the monitor for an unanticipated interruption was also calculated; this calculation was used to compare the amount of time that patients were not tracing in comparison to the total monitoring period. This calculation represents the percent of monitoring time that the subject was unable to be traced. Finally, the one and five minute Apgar scores will be compared for both groups. By looking at the Apgar scores and comparing the two groups the researcher evaluated any significance or correlation in the implementation of the program and the outcome of the neonates that the "Flight Control Nurse" was watching.

EFFECT OF REMOTE FETAL MONITORING IN AN INPATIENT OBSTETRICAL UNIT

CHAPTER IV: RESULTS

Sample Population

The population sizes were significantly impacted by the strict inclusion criteria, Table 1 shows the reasons for exclusion from the study. The reasons for exclusion for participation in both group one (G1) and group two (G2) were similar in a lot of ways with a higher incidence of pre-term deliveries noted in G2 , countered by a slightly higher incidence of C/S deliveries in G1. Table 1 also illustrates the large number of study participants that were excluded for reasons other than those listed including: less than 3 hours of monitoring being recorded, an excluded reason for admission, and/or the inability to retrieve a record from archive.

Table 1

Sample Population - Inclusion Criteria and Rates of Incidence for Exclusion

Group	Total	Pre-Term Delivery	Post-Term Delivery	Multiple Gestation	C/S Delivery	Other	Study Participants
G1	100	4	2	3	31	19	41
G2	100	9	2	2	27	16	44

Furthermore, when looking at descriptive statistics for the two groups, which are listed in Table 2. More similarities between the two populations can be seen, for example both G1 and G2 had mean gestational ages of 39 weeks, and similar gravida and parity rates, with G2 having on average a slightly higher incidence of gravidum. Overall, the average of total time monitored only differed by about four minutes for G1 and G2, with G2 having a little less total time on the monitor. Largely the biggest difference between G1 and G2 was in reaction time totals, on average G2 had a significantly smaller number of 1,412.43 seconds (about 23 minutes), which will be discussed further in response

to the specific research questions. Otherwise, the total time of unintentional interruptions in monitoring and total number of interventions were very similar between the two groups, which can also be seen in Table 2. By looking at these descriptive statistics the researcher was satisfied with the similarity of the two groups selected for comparison.

Table 2

Sample Population - Descriptive Averages

Group	Total	Gestational Age (Weeks)	Gravida	Parity (Admission)	Total Time Monitored – TTM (Minutes)	Total Time of Unintentional Interruptions of Monitoring – TTUIM (Minutes)	Reaction Time Total – RTT (Seconds)	Total # Intervention Episodes
G1	41	39	2	1	355.72	18.91	2338.1	3.28
G2	44	39	3	1	351.70	18.00	1412.43	3.83

Data Collected for Research Questions

1. Was there an improvement in the reaction times of nurses to an unintentional interruption and non-reassuring FHR tracings with the implementation of the "Flight Control Nurse"?

With regards to question one, the data collected showed an improvement in the overall reaction times of G2 to events in the fetal heart tracing. Table 3 shows that reaction times of nurses were improved on average by 6 minutes and 24 seconds in G2 (6 minutes), from the average reaction time in G1 of 12.4 minutes. Therefore, a positive correlation between implementation and the time it took for an intervention to be charted on the strip was shown. The level of significance, seen in Table 4, using the Independent Samples Mann-Whitney U test was .000 when looking at average reaction time and .006 when looking at reaction time totals, which shows a strong correlation between the data using the reference significance

level of .05. Figure 1 graphically displays the disparity in reaction times between the two groups, notice how G2 reaction time total (RTT) is significantly less than that of G1.

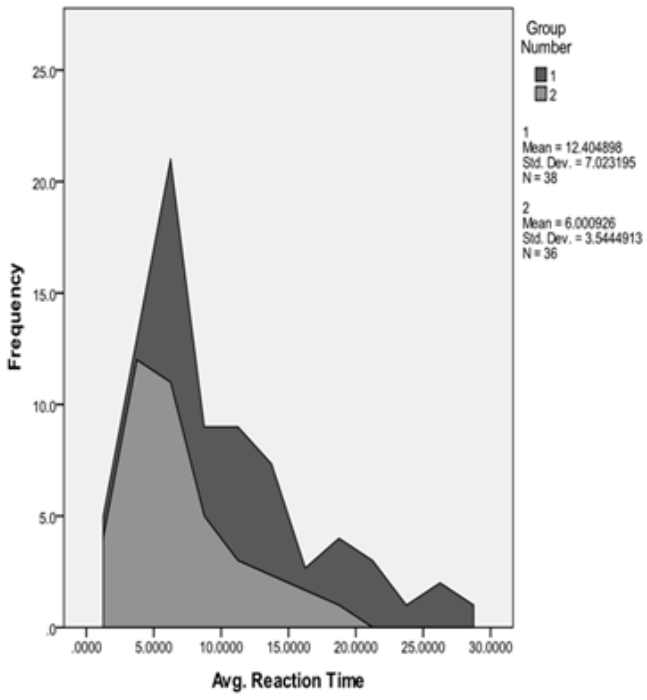
Table 3

Group Averages for Measurement Questions

Category	Group 1	Group 2
Average Reaction Time of Nurses (ART)	12.40 minutes per episode	6.00 minutes per episode
% of Non-Quality Tracing (NQT)	6.32%	5.13%
One Minute APGAR (A1)	7.43	7.85
Five Minute APGAR (A5)	8.91	8.98

Figure 1

Frequency Distribution of Average Reaction Times by Group



2. Was there an improvement in the quality of tracing available for interpretation after the implementation of the "Flight Control Nurse"?

The overall quality of tracing was measured by percentage of tracing unable to be interpreted due to unintentional interruptions of greater than 60 seconds, this variable was protected from regularly occurring events such as placement of the epidural, and use of the bedpan, by subtracting moments of documented interruptions from the total time of monitoring. In review of Table 3, it can been seen that G2 again had some improvement on G1 with a percentage of non-quality tracing being 5.13% and G1 being 6.32%; however the statistical significance of this finding was much lower showing a weaker correlation between the group assignment and percent of non-quality tracing. According to the Mann-Whitney U test of significance the level of significance for the percent of quality tracing variable was .362 (Table 4). Therefore, the finding was not significant enough to reject the null hypothesis. Therefore, further testing of this variable would be indicated to determine if implementation of the FCN would truly impact the overall quality of tracing.

3. Was there an improvement in neonatal outcomes based on the Apgar scores given at one and five minutes since the implementation of the "Flight Control Nurse"?

The Apgar scores assigned to neonates born to study participants were looked at to evaluate the impact of this program on outcomes. Surprisingly, G2 again showed some improvements from G1 in regards to Apgar scores going from 7.43 (G1) to 7.85 (G2) on average at one minute and 8.91 (G1) to 8.98 (G2) on average at five minutes. However, again by looking at the level of significance of this correlation the findings were not statistically significant enough to rule out the null hypothesis with a level of significance .163 (A1) and .264 (A5) respectively (Table 4). Therefore, further testing of this question would be necessary to determine if the implementation of the FCN was correlated with the improvement in Apgar scores, because of the small incremental difference expected a much larger sample would be

needed in order to obtain statistically significant findings. Future researchers need to conduct a power analysis of this variable to evaluate the ideal sample size to evaluate for differences in Apgar scores.

Table 4

Hypothesis Test Summary for Research Questions – Generated by SPSS Software

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Total Time of Unintentional Interruptions Minutes is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.374	Retain the null hypothesis.
2	The distribution of Reaction Time Total Seconds (RTT) is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.006	Reject the null hypothesis.
3	The distribution of % of NON-Quality Tracing is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.362	Retain the null hypothesis.
4	The distribution of Avg. Reaction Time is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.
5	The distribution of APGAR at one minute (A1) is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.163	Retain the null hypothesis.
6	The distribution of APGAR at five minutes (A5) is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.264	Retain the null hypothesis.
7	The distribution of Total of Intervention Episodes (TIE) is the same across categories of Group Number.	Independent-Samples Mann-Whitney U Test	.377	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

CHAPTER V: DISCUSSION

Summary

This study was conducted to build a foundation of knowledge in regards to the use of remote fetal monitoring for inpatient obstetrics. The literature identified a significant gap in knowledge for this particular area of nursing; therefore, this retrospective study was done to investigate the effect of a pilot remote monitoring protocol. Overall, the findings of the research supported the implementation of the FCN protocol as reaction times significantly improved after implementation, as well as, the percentage of quality tracing and APGAR scores, though those were not found to be as statistically significant. This study provides some preliminary data in regards to the use of remote monitoring for obstetrical patients, and should serve to support future research efforts in this area of nursing.

Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis of Study

Strengths. In performing a SWOT analysis of this study, many different strengths, weaknesses, opportunities, and threats were identified that could have implications for interpretation of the data collected herein , in addition to, implications for future research on this topic. The strengths that were identified include the similarity of the two sample populations even though they were collected from different periods in time. Additionally, the amount of understanding and knowledge of staff nurses about the FCN position and the roles and responsibilities of this position was an identified strength. Unlike a situation where this position may be implemented simply to test the effect, this position was implemented and staff nurses were educated thoroughly on the protocol involved. Moreover, another important strength of this study was the knowledge and background of the principal investigator, who was experienced in high-risk maternity care and is nationally certified in inpatient obstetrics.

Weaknesses. Some weaknesses identified in this study were the small sample groups used for data collection. In a hospital that averages 6,500 to 7,000 deliveries per year, a sample of 100 participants is relatively smaller than that which would be ideal for a research project of this nature. However, because there were constraints on both time and resources the smaller sample was chosen to be representative of the total population. Additionally, using patients from different periods in time was an identified weakness because variables such as experience of staff, patient acuity, and unit census could not be controlled. Researcher bias was also identified as a potential weakness because the interpretation of the fetal heart tracings was subject solely to the principal investigator; furthermore, because of the researcher's familiarity with the subjects the group assignment of study participants was known, which has the potential of creating additional bias. Finally, the data collected fails to specifically correlate the performance of nurses post-implementation with the actions of the FCN, because it would be difficult to determine if the FCN did in fact notify the nurse every time an event occurred on the fetal heart rate monitor, it would be erroneous to conclude that the FCN was the only factor impacting the improved reaction times. Other factors, such as: heightened awareness of recent sentinel events; more experienced staff; or greater expectations by supervisors for documentation may be offered as additional explanations for the decreased reaction times observed in G2. Furthermore, since documentation of interventions was the only unit available for measurement in this type of retrospective review, it is impossible for the study to determine whether or not the improvements were seen simply in documentation. Conversely, if the improvement was made in documentation because of the FCN presence, there would be the unintended, but welcome benefit to the hospital in having more accurate and detailed documentation as a result of implementation.

Opportunities. Some opportunities identified by this study would be the implications of the data collected and what that means for future researchers and others interested in the field of fetal heart rate monitoring. Some areas identified that are in need of further research include the effect on

overall tracing and the effect on the outcomes of newborns. It would also be beneficial if the reaction times of nurses were tested again in a blind study where researchers were not aware of the group assignment to see if the findings of this study were valid. Furthermore, it may be beneficial to conduct qualitative studies about the FCN protocol by gathering nurse, provider, and patient perceptions to evaluate for any perceived benefit of implementation. Finally, the potential for cost savings in the realm of liability reduction was identified in the literature review; therefore, conducting a detailed cost-benefit analysis to see if the FCN protocol was in fact cost effective for hospitals is an identified business research opportunity.

Threats. Threats that were identified in the process of this study include the lack of evidence supporting the use of electronic fetal monitors as a strong indicator of fetal well-being. While Fedorka (2010), identified certain patterns as being ominous signs such as late decelerations, the only indication in regards to the fetal heart rate tracing that was significantly linked to outcomes according to King and Parer (2000) is decreased variability. Therefore, the cost of implementing the FCN protocol may be questioned by some, if evidence is lacking to support the use of fetal heart rate interpretation as an indicator of fetal well-being. Threatening the use of this study and possible future studies is the economic constraints impacting the entire healthcare industry, including those associated with research because further research would require more time, people, and resources. In contrast, recent staffing guidelines, released by AWOHNN in 2010, could potentially cost even more for hospitals to implement than simply utilizing a FCN protocol to supplement where staffing guidelines could not be met due to budgetary constraints.

Conclusion

Overall, the evidence presented in this research study was limited by the sample size and could not directly link the implementation of the FCN with the improvements that were found; however, the findings did show significant improvements in documentation of reactions after

implementation of the remote monitoring protocol. This study does serve to increase the knowledge available about the use of remote monitoring techniques for fetal heart rate tracings, and does present the need for further research. The potential for improved outcomes and safer monitoring techniques is very relevant, and hopefully researchers will continue to build on the foundation started by this study, so that one day all obstetrical patients can benefit from the use of safe, evidence-based monitoring techniques.

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