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Effects of a Blended Basic Telemetry Course on the Telemetry Reading Proficiency of Newly Licensed Registered Nurses

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Walden University

College of Health Sciences

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Joan Yankalunas

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Walden University
2020

Abstract

Effects of a Blended Basic Telemetry Course on the Telemetry Reading Proficiency of Newly Licensed Registered Nurses

By

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BSN, Misericordia University, 2005

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Dissertation Submitted in Partial Proposal

of the Requirements for the Degree of

Doctor of Philosophy

Nursing Education

Walden University

November 2020

Abstract

Telemetry interpretation is a common skill required by registered nurses (RNs) to take care of patients in an acute care setting. Telemetry education guidelines are needed because there are no established standards for the amount, type, or scope of education needed for RNs who take care of patients on continuous telemetry monitoring. The purpose of this retrospective analysis design study, guided by Benner's skill acquisition model and Kirkpatrick's learning outcomes measurement theory, was to (a) determine the effect of a blended telemetry course, which is a combination of eLearning and an instructor-led class, on the telemetry reading proficiency of RNs in an acute care setting over time, and (b) to compare the difference in charting of telemetry interpretation and treatments actions taken based on ECG results over time after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical, acute care settings. Data on 98 records were analyzed using a repeated measures ANOVA to determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs acute care setting over time. No differences were revealed. MANOVA was used to compare the difference in RN charting of interpretation and action based on ECG results over time of those who work in critical care, progressive care, and medical-surgical acute care settings. No difference was revealed. Recommendations for future research are to establish competencies and educational standards for nurses for continuous telemetry monitoring practices and to determine an effective way to deliver the information to meet competencies and standards which would affect positive social change through improved patient care outcomes.

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Dedication

I would like to dedicate my dissertation to God and thank Him for his love and support through my dissertation journey and every day; without him I am nothing. I would also like to dedicate this work to my husband Joe, whose unwavering belief in my abilities kept me going with his simple words of "You can do it!" when I would get tired and begin to doubt my work. To my parents Mary McGuire Yankalunas and William Yankalunas, they instilled in me the importance of education and hard work to accomplish my dreams and to care for others. I know if they were still with us, they would be proud. This work is also dedicated my grandmother Mary Yankalunas, who was not allowed to attend high school simply because she was a woman. She instilled in me that I could accomplish whatever I set out to do regardless of my gender. Of course, I must mention my cats who faithfully contributed to my work by keeping me company.

Credit also goes to my family and friends who supported my when the journey became long. My sister Mary Daley and Aunt Ursula McGuire were always proud of me and encouraged my work and required regular updates. My friend and fellow nurse Betsy Roe bragged about my accomplishments to others and listened to my frustrations when the process got difficult. I would also like to give credit to my friend and coworker Edith Gray, who was always ready to help me figure out the next steps and help me find the answers I needed to succeed. Thank you everyone who offered kind words and encouragement!

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Chapter 1: Introduction to the Study

Introduction

Continuous electrocardiographic (ECG) monitoring is common in the care of patients admitted with cardiovascular health issues (Sampson, 2018). Today's healthcare delivery requires structure and processes that lead to positive patient outcomes (Kronick et al., 2015). The structure of healthcare delivery includes people, education, equipment, and data collection (Kronick et al., 2015). Healthcare delivery processes include policies, protocols, and procedures (Kronick et al., 2015). ECG monitoring requires several resources from both structure and process such as people, education, equipment, policies, and procedures to effectively take care of a telemetry patient. Nurses are responsible for the initiation of telemetry for the patients who need continuous ECG monitoring, the monitoring of patients, and forming decisions based on the results (Sampson, 2018).

According to the American Heart Association (AHA), ECG monitoring has evolved from a simple heart rate and basic rhythm monitoring to include detection of complex arrhythmias, myocardial ischemia, and prolonged QT issues. For nurses to use continuous ECG monitoring or telemetry effectively, it is imperative that they receive adequate ECG education (Sandau et al., 2017). The latest AHA Practice Standards for ECG Monitoring in acute care found that there are no established standards for the amount, type, or scope of education needed for nurses who take care of patients on continuous ECG monitoring (Sandau et al., 2017).

In this study, I examine learning outcomes from a blended basic telemetry course and explore what nurses use in practice after completing the course. Understanding what a nurse needs to know to care for a telemetry patient can lead to understanding how best to deliver the educational content needed to use continuous ECG monitoring safely and effectively. Continuous ECG monitoring, when done effectively, can lead to positive social change through better patient outcomes because of faster identification of changes in ECG rhythms and treatment of cardiovascular issues (Sandau et al., 2017).

In chapter 1, I discuss the following topics: background, problem statement, purpose, this research question and theory, definitions, assumptions, scope, delimitations, limitations, and significance.

Background

Continuous ECG monitoring or telemetry is a common intervention used for patients admitted to the hospital for various diagnoses, especially if a cardiovascular problem has been diagnosed (Sampson, 2018). Even though the use is common, knowledge of continuous telemetry requires both expertise and skilled clinical judgment (Sampson, 2018). Registered nurses (RNs) who work with patients on telemetry must learn how to read and interpret ECGs before practicing in this specialized clinical area. Telemetry education is necessary for RNs and can be required of other healthcare workers based on the healthcare setting and who is taking care of the patient.

The American Association of Critical-Care Nurses (AACN) and the AHA recommend that telemetry education include electrode placement, correct interpretation of the telemetry reading, goals of monitoring, alarm management, and response to interpretation. Yet neither organization gives recommendations on how to best deliver the educational content (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017).

There are multiple ways to teach ECG monitoring or cardiac telemetry: instructor-led, web-based, unit-based activities, unit preceptorship, competency validation, self-directed learning, simulation, and hybrid or combinations of methods (Crimlisk et al., 2015; Schultz, 2011, Spiva et al., 2012; Sumner, Chang, Jones, Burke, & McAdams, 2012). The AHA found that both eLearning and instructor-led education or a blended approach of both are effective, based on the prior telemetry knowledge and experience of the students. However, it recommended further research to determine if face-to-face education is effective for the nurse with no telemetry knowledge and if eLearning is effective to build on the prior knowledge of nurses with telemetry experience (Sandau et al., 2017). Exploring learning outcomes from a blended basic telemetry course may help to formulate an understanding of what information nurses use when caring for ECG-monitored patients. Knowing what information nurses apply in caring for telemetry patients and the effectiveness of that information can then be used to formulate a more efficient and effective, blended, basic telemetry course curriculum.

Problem Statement

In healthcare, employers' goals are to hire RNs with the knowledge required to provide high-quality patient care. However, due to the ever-changing nature of healthcare that requires a commitment to lifelong learning, education requirements do not stop with a nursing degree (Garafalo, 2016). Continuing education is designed to enhance a nurse's ability to provide complete patient care through education on current nursing practice and to provide the opportunity to learn about new knowledge, skills, and practice in nursing (Zupanc, 2016). The telemetry education examined in this research is considered continuing education and it goes beyond basic nursing skills learned in a nursing curriculum.

After RNs are hired to work in a telemetry unit, they require proof of telemetry competency or are given the education needed to care for telemetry patients RNs need to interpret ECGs accurately and then provide the correct care to maximize positive patient outcomes (Funk et al., 2017; Sandau et al., 2017). Continuing education, in this case, telemetry education, is required so that nurses can keep up with technological requirements and perform effective nursing care for telemetry patients (Grohmann, Beller, & Kauffeld, 2014; Grohmann & Kauffeld, 2013). The course used for this research, a blended learning telemetry course, teaches nurses how to read, interpret, and correctly act upon the telemetry monitoring. Blended learning includes both online and face-to-face learning activities (Deschacht & Goeman, 2015). The blended learning telemetry course includes both eLearning modules and an instructor-led workshop. Ultimately, what is learned in job training or job-related education should transfer from the classroom to job performance (Tonhauser & Buker, 2016). The efficacy of nurses reading telemetry strips during patient care should be the learning outcome of a telemetry course. At the end of a blended basic telemetry course, learning outcomes can be measured by a survey of student satisfaction (Kirkpatrick & Kirkpatrick, 2016) and posttest to show competence (Crimlisk, Johnstone, & Winter, 2015; Kirkpatrick & Kirkpatrick, 2016). The next level of evaluation is the application of education to on-the-job performance or the behavior changes related to education. This requires investigation beyond a survey or test, for example, audits, direct observation, or supervisory reports (Kirkpatrick & Kirkpatrick, 2016; Saks & Burke, 2012).

Learning outcomes should be examined beyond the survey or posttest, progressing to the evaluation of actual applications of knowledge (Estes Kennedy, Young, Chyung, Winiecki, & Brinkerhoff, 2013). A framework for learning outcomes measurement is Kirkpatrick's model of training evaluation, which has four levels of evaluation: Level 1 involves the participant's reaction to the learning; Level 2 is posttesting; Level 3 involves behavior changes; and Level 4 is workflow changes (Kirkpatrick Partners, 2017). Sumner et al. (2012) found that less than 20% of organizations conduct learning outcomes measurements beyond the Level 2 evaluations of posttesting. Level 2 evaluations, or testing after an educational program, can show the immediate response to learning through a formal test (Kirkpatrick Partners, 2017), but cannot show what was learned and will be applied in the nursing care of patients, which is the intent of nursing continuing education.

The problem with the lack of measuring learning outcomes at Level 3 (behavior change) is that there is limited information to show if learning outcomes are applied to practice. Accurately reading and interpreting the ECG is crucial in providing patient care (Brooks, Kanyok, O'Rouke, & Albert, 2016). In nursing practice, observing and monitoring learning outcomes at the levels of behavior change and workflow may enhance the knowledge required to develop more effective ways to teach telemetry or other patient care skills to nursing staff.

Purpose of the Study

The purpose of this retrospective analysis study was twofold: (a) to determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at 3 months, 6 months, and 12 months posttraining, from 2016 to 2019, as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time; (b) compare the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or physician extender for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings. Documentation includes assessing the measurements of the telemetry complexes and heart rates, lead selection, follow-up if there is an abnormality, a response for stable dysrhythmias, and an emergency response for life-threatening dysrhythmias as correct or incorrect (AACN Clinical Resources Task Force, 2016). The correct follow-up to telemetry interpretation is based on the type of rhythm that is interpreted, ranging from normal to life-threatening (AACN Clinical Resources Task Force, 2016).

Research Questions and Hypotheses

The following research questions inform this study:

RQ1: What is the effect of a blended format basic telemetry course on telemetry reading proficiency of ECGs in newly licensed RNs with no telemetry experience who work in acute care settings, as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course?

*H*o1: There will be no effect from a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

*H*a1: There will be an effect between a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

RQ2: What is the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months,6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings?

H_o1*:* There will be no difference charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

H_a1*:* There will be a difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

Theoretical Foundation

The theoretical framework for this study is: Benner's middle-range theory of skill acquisition in nursing (1982) and Kirkpatrick's learning outcomes measurement (Kirkpatrick & Kirkpatrick, 2016). First, I discuss Benner's skill acquisition theory and how it applies to continuing education and the development of skills in nursing practice. Then, I discuss Kirkpatrick's Learning Outcomes Measurement to describe and measure how nurses learn and apply what they learn in a blended, basic telemetry course.

Benner's middle-range theory of Skills Acquisition in Nursing was the overarching theory for this study. It can be used to explain the progression of skill attainment in nursing care with the levels of novice to expert (Benner, 1982), attaining the knowledge, applying the knowledge, and becoming proficient at the skill of reading telemetry. Benner's model includes clinical knowledge and practical knowledge that applies to telemetry education and learning (McEwen & Wills, 2014). Benner based her theory on the Dreyfus Model of Skill Acquisition, originally formulated for chess players and pilots, and showed that it could be applied successfully to the transition of nursing skills, from novice to expert (Benner, 1982).

In Benner's (1984) stages of clinical competence, a competent nurse thinks in terms of long-range patient care goals, but lacks the speed and flexibility of a proficient nurse. Proficiency is a nurse's ability to synthesize all the indicators of a patient's condition through an overall observation at once rather than basing the patient's condition on separate pieces of information (Benner, 2004). Proficient nurses use experience and critical thinking to assess and respond to a patient's condition (Benner, 2004). Also, proficient nurses assess a patient by taking in the details of patient’s findings and then making effective decisions that meet the patient’s care needs (Benner, 1982). A competent nurse, on the other hand, is more task-oriented and applies a more conceptual approach. Competence is behavior that a person should demonstrate in his or her work performance, and competency is a person’s ability to perform job tasks effectively (McMullen et al., 2003). One needs to demonstrate competency to become proficient (Benner, 1982) at telemetry practice.

There are three reasons to evaluate training: to improve an educational program, to improve the application of transfer of training for better organizational outcomes, and to show the value of training (Kirkpatrick & Kirkpatrick, 2016). Effective training provides knowledge and skills that are applied on the job (Kirkpatrick & Kirkpatrick, 2016). Kirkpatrick’s Learning Outcome Measurement are a way to measure the effectiveness of learning outcomes. Kirkpatrick’s approach to measuring learning outcomes uses four levels: Level 1 is the reaction to learning, such as through a survey; Level 2 is measuring learning through a posttest or demonstration; Level 3 is behavior changes or the application of learning, such as reading an ECG strip accurately during patient care; and Level 4 is the outcome of training or workflow changes, as evidenced by improved compliance with telemetry policies and usage (Kirkpatrick Partners, 2017). Both Benner’s theory and Kirkpatrick’s outcome measurement can be used to measure and explain how RNs learn and use the skill of reading telemetry. Benner’s model and Kirkpatrick’s framework are explained in greater detail in Chapter 2.

Nature of the Study

The study design for this research was a quantitative, repeated measures design. For RQ1, I conducted a one-group repeated measures, retrospective analysis design. For RQ2, I conducted a repeated measures comparative analysis of three groups of RNs using retrospective data. I obtained the retrospective data from medical records to collect a convenience sample of newly licensed RNs who completed the requirements for a blended, basic telemetry course. All participants worked in a regional healthcare network. As part of course completion, the RNs completed a posttest to show competency in reading telemetry strips. For RQ1, the independent variable was the blended basic telemetry course and the dependent (outcome) variables were the proficiency of accurate telemetry care, as evidenced by documentation of telemetry strip interpretation and documentation of follow-up to telemetry results as indicated by interpretation of ECG results and action taken based on ECG results at 3 months after the telemetry course. For RQ2, the independent variable is the type of unit where the RNs worked and the data were collected via a chart audit (retrospective) from the electronic medical records of patients who were hospitalized and monitored on ECG telemetry and who received care from the RNs who had taken the blended basic telemetry course. I accessed medical records of patients who received care from the RNs who took the telemetry course at 3 months, 6 months, and 12 months after the RNs completed the course.

The target population was newly licensed RNs. The course was offered during Weeks 4–5 of orientation in order to fit into the orientation schedules and to meet prerequisites for upcoming courses that require the ability to read telemetry, such as the

Critical Care Internship and Advanced Cardiovascular Life Support (ACLS). The 3-month timeframe was chosen based on other studies that examined knowledge retention of a basic dysrhythmia course. Sumner et al. (2012) found that basic dysrhythmia knowledge was achieved 4 weeks after a blended basic telemetry course with preservation of knowledge at 3 months. Medical students who received ECG education had a significant decline in ECG knowledge at 2–4 weeks, but had no additional loss of knowledge at 10–12 weeks (Bojsen et al., 2015). The timeframe at 3, 6, and 12 months allowed new RNs time to practice their new skills and advance to the level of proficiency in reading telemetry and reacting appropriately to the results. Based on Benner's skill progression, this happens with practice and experience (Benner, 1982). However, there is a lack of research about the relationship of periods longer than 3 months to increasing levels of proficiency and/or expertise. Therefore, I conducted a repeated measures design to determine the effect of time on a nurse's proficiency of reading telemetry and providing appropriate care. Data were gathered through the healthcare system's electronic medical records retrospectively to determine if the criteria for proficiency were met.

Definitions

The following terms, as defined, were used in this research study.

Basic telemetry course: The basic education required to correctly interpret electrocardiographic waveforms and provide the proper care of patients being monitored by continuous ECG (Sandau et al., 2017).

Blended format telemetry course: A telemetry course that is delivered both online and with face-to-face learning activities (Boelens, Van Laer, De Wever, & Elen, 2015; Sandau et al., 2017).

Blended learning: Is course delivery that is designed to include both online and face-to-face learning activities (Deschacht & Goeman, 2015).

Critical Care Unit: A special care unit of a hospital is an area set aside for the treatment of patients who require extraordinary care on a concentrated and continuous basis. It is for the intensive treatment of critically ill patients with a wide variety of diagnoses (Commonwealth of Pennsylvania, 2019).

Electrocardiography or Electrocardiographic monitoring (ECG): is a standard practice using a cardiac telemetry monitor to determine heart rate, basic heart rhythm, and other more advanced concepts such as complex arrhythmias, myocardial ischemia, and QT measurements (DiLibero, DeSanto-Madyea, & O'Dongohue, 2015; Sandau et al., 2017).

Learning outcomes: Learning outcomes are the product of learning described as knowledge, the application of knowledge, and proven usage of knowledge (Dzelelija & Balkovic, 2014).

Medical-Surgical Unit: A hospital unit were care is given to adult patients who are acutely ill and have a wide variety of medical problems or are recovering from surgery (Academy of Medical-Surgical Nurses, 2019).

Progressive Care Unit: Progressive care patients are moderately stable requiring moderate resources and require intermittent nursing vigilance or are stable with a high potential for becoming unstable and require an increased intensity of care (Stacy, 2011).

Registered Nurse: Any person who holds a license to practice professional nursing in the Commonwealth of Pennsylvania. This person may use the title nurse, registered nurse, and the abbreviation R.N. (Pennsylvania Department of State, 2018).

Telemetry normal measurements: adult heart rate (60-100 beats per minute), regular/irregular rhythms are based on the regularity of complexes on a rhythm strip, PR interval represents the time it takes for atrial depolarization (0.12 – 0.20 seconds), QRS interval represents the time it take for ventricular depolarization (< 0.11 seconds), QT/QTc represents total time it take for ventricular depolarization and repolarization (adults <0.50 seconds) (Aehlert, 2013).

Telemetry proficiency: According to the AHA guidelines and AACN, nurses should be able to correctly skin prep, apply and choose leads, interpret normal and abnormal readings, manage alarms, and appropriately respond to abnormalities (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017).

Telemetry strip documentation: According to AHA (2017) guidelines, documentation of electrocardiographic waveforms is needed to record telemetry results so that subsequrent diagnosis and treatment can be determined. Preserving original telemetry tracing is considered best practice when a telemetry strip is abnormal.

Telemetry strip: is a graphic display of the heart’s electrical activity printed on paper or displayed electronically (Aehlert, 2013).

Telemetry strip follow-up: actions related to paitent care based on interpretation of a telemetry strip (Aehlert, 2013).

Telemetry strip interpretation: interpretation of a telemetry readout that determines what part of the heart is producing the rhythm, the mechanism, and heart rate (Aehlert, 2013).

Assumptions

There were two assumptions for this research: (a) the participants had limited or no prior knowledge of telemetry interpretation before taking the course; (b) RNs who work in the acute care setting desired the knowledge and skills to interpret EKGs correctly and take the correct actions to provide quality patient care.

Scope and Delimitations

The population for this study was newly licensed RNs who had limited or no prior knowledge of how to interpret telemetry. I chose this population because of the limited exposure in nursing school to telemetry interpretation. There are currently no endorsed general competencies in telemetry monitoring for RNs, nor are there established educational standards in telemetry monitoring for RNs (Sandau et al., 2017). The participants received the same blended learning blended basic telemetry course, which allowed for the independent variable to be consistent for the same level of previous telemetry experience. The RNs in this study were employed in critical care, progressive, and medical-surgical acute care units; thus, they were consistently exposed to telemetry patients and interpretation. Acute inpatient rehabilitation units use telemetry, but not consistently, so RNs from these clinical areas were not included in this study.

I considered a quasi-experimental approach for this research, but due to the nature of the education provided in the study, it would have been unsafe to withhold education from any of the RNs who take care of telemetry patients. Branching out to other healthcare facilities, not in the health care network utilized for this research, was a possibility, but it would have been difficult to control what type of education RNs received in another facility with respect to interpreting telemetry.

I considered using Benner's theory alone to support this research but found that using Kirkpatrick's Learning Outcomes Measurement framework offered a defined way to measure learning outcomes. The combination of theory and model offered a complete description of this research, with Benner's theory supporting the progression of nursing skills attainment and Kirkpatrick's framework addressing learning outcomes.

Limitations

I used a convenience sample for this study, which is considered a weak approach to sampling because of the inability to control for bias (Grove, Burns, & Gray, 2013). The healthcare network where this training was carried out is a multisite regional healthcare system; the data were retrospective; the results may not be generalizable to all healthcare facilities or experienced nurses taking a blended, basic telemetry course. Due to the importance of telemetry education and safe patient care for telemetry patients, there was no option to withhold education for a control group.

Choosing only newly licensed RNs limited the amount of exposure to telemetry interpretation compared to an experienced nurse, who may have had the education but had not practiced telemetry for an extended period. Controlling for extraneous influences on a population helped to control for bias but decreased the generalizability of the results (Grove et al., 2013), in this case, for experienced RNs with prior telemetry knowledge.

Significance of the Study

Higher-level measurements of learning outcomes are difficult to obtain due to lack of time, management support, data access, and difficulty in interpretation (Estes et al., 2013). However, organizations use instructional interventions to make changes in how an organization operates or provides services (Estes et al., 2013). The problem with the lack of measuring learning outcomes of nurses at higher levels of behavior and workflow changes, is that there is no way of knowing if the learning outcomes from a blended, basic telemetry course are applied to the practice of taking care of telemetry patients. Job training is a resource that is used to improve organizational outcomes, but unless trainees apply what they learn to their workflow, known as *transfer of training*, then training investments may be wasted (Saks & Burke, 2012). Organizations consider the investment in education successful if the results are transferred to practical situations that are applied on the job (Tonhauser & Buker, 2016). The term, *transfer problem*, is used to describe education that is not transferred to improving job skills. This can be costly to organizations that are paying for the education (Saks & Burke, 2012). There is a gap in the literature on formal training evaluation at the levels of behavior change and workflow (Saks & Burke, 2012). Organizations most often evaluate a reaction to education and not behavior changes on the job or the results of on-the-job training leading to return on investment (Saks & Burke, 2012).

Telemetry education is imperative for staff who are responsible for interpreting and caring for telemetry patients (AACN Clinical Resources Task Force, 2016; Drew et al., 2004; Sandau et al., 2017). ECG interpretation is taught in a multitude of ways and settings, but ECG interpretation skills are not at ideal levels for optimal patient care (Granero-Molina et al., 2015). Even though technology has developed and improved ECG monitoring, there is still the need for human interpretation and monitoring (Zaremba, Carroll, & Manley, 2014). Human intervention requires education and maintaining ECG skills to improve patient outcomes (Zaremba et al., 2014). Initial and ongoing ECG education is required, but the evidence-based recommendations for telemetry education are weak on specific methods, amount of time, and required content (Sandau et al., 2017).

This study sought to determine the effect of a blended telemetry course on RNs' telemetry reading proficiency, interpretation, and action over time, and to determine whether the work unit affected an RN's telemetry interpretation skills. By measuring Kirkpatrick's Level 3 or behavior changes (Kirkpatrick & Kirkpatrick, 2016), it is possible to see if telemetry proficiency is affected by the education provided, in this case, a blended class of eLearning and an instructor-led workshop. There is evidence that various forms of education are effective, but what a nurse takes away from a class and uses in inpatient care is not clear and has not been studied. By examining the learning outcomes of a basic dysrhythmia class, it may be possible to update education to match what nurses use in practice and to eliminate unneeded time spent on subject matter that does not contribute to practice. This research contributed to information on the effectiveness of a hybrid education delivery method of eLearning and instructor-led workshop.

I used Benner's theory of Skills Acquisition in Nursing to describe the attainment of skills in the spectrum of novice to expert in nursing practice (Benner, 1982). In the case of telemetry practice, a nurse can be considered competent by passing a telemetry test after a blended, basic telemetry course. Proficiency takes more investigating to demonstrate or measure—described by Benner as being obvious to the practitioner—but it is not that easy to capture in a narrative (Benner, 2004). A proficient nurse has a practical understanding of a situation (Benner, 2004). Being proficient at taking care of a telemetry patient includes not only the identification of a rhythm, but what actions need to follow once interpretation is determined. The AACN, for example, lists several expected nursing practices related to telemetry practice beyond the interpretation of a telemetry strip (AACN Clinical Resources Task Force, 2016). This research offered the opportunity to demonstrate or describe what proficiency looks like in nursing practice related to telemetry practice, showing another example of Benner's theory.

Telemetry is used to identify lethal and nonlethal dysrhythmias (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017). A telemetry reading shows how a patient's heart is functioning. Identifying what the ECG reading means and taking the correct actions based on the interpretation could be the difference between life and death. If a lethal rhythm is identified, certain steps or treatments must take place as quickly as possible to treat it. Misidentifying a telemetry strip or making an untimely identification can lead to a patient not receiving the treatment needed for a cardiac problem. By having the ability to show the value of training through its effects on behavior and workflow changes, organizations may realize positive social change by increasing education funding and effective evaluation processes (Estes Kennedy et al., 2013). For this research, improving the effectiveness of nursing telemetry education can yield positive social change by giving nurses the tools they need to give effective patient care leading to improved patient safety and positive patient outcomes.

Summary

There is a gap in the research for standardizing telemetry care competencies and education for RNs (Sandau et al., 2017). The methods of education are varied to make a reasonable comparison of the best methods of delivery telemetry education (Schultz, 2011). To standardize education, it is beneficial to know what knowledge transfers from the classroom to nursing practice in the care of telemetry patients. This quantitative repeated measures design study measured the telemetry reading proficiency of RNs using Kirkpatrick’s learning outcomes measurement framework. Chapter 1 provided support for evaluating basic telemetry education at Level 3 of Kirkpatrick’s learning outcomes measurement to evaluate how telemetry education influences telemetry reading proficiency in acute care.

Chapter 2 provides information from the literature on telemetry education for nurses including history, methods, competencies, and research. The literature review covers the use of Benner’s novice to expert theory to support the concept of proficiency. Kirkpatrick’s learning outcomes measurement framework was supported as a method to measure the concept of proficiency by using Level 3 from the framework.

Chapter 2: Literature Review

Introduction

Due to the commonplace use of cardiac telemetry in today's acute care settings, education for nurses on the use of ECG monitoring should start with orientation and be ongoing to ensure the safe and effective use of the technology (Sandau et al., 2017). To date, there are no established standards on what the education process should entail (Sandau et al., 2017). According to the first American Heart Association (AHA) practice standards for telemetry monitoring, published in 2004, there is an increased need for nurses with telemetry monitoring skills because of nursing shortages and inadequate ECG training (Drew et al., 2004). The AHA (2017) practice standards for ECG monitoring in hospital settings were updated in 2017; but there is still a discrepancy with nurses lacking the ability to correctly interpret telemetry and with the lack of best practice standards for the delivery of nurses' telemetry education (Sandau et al., 2017).

To start the process of establishing best practice standards for delivering telemetry education, current learning outcomes from a basic cardiac telemetry course should be examined. Learning outcomes measured at the level of posttest measure current learning, but not (a) what information transfers to use in practice (Kirkpatrick & Kirkpatrick, 2016) nor (b) the workflow of taking care of telemetry patients. The problem with the lack of ability to measure the learning outcomes of nurses from a blended basic telemetry course, at higher levels of behavior and workflow changes, is that there is no way to determine what learning outcomes are applied in the practice of reading telemetry in an acute patient care setting. The purpose of this study was (a) to determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at 3 months, 6 months, and 12 months post-training, as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time and, (b) to compare the difference in charting interpretation (correct measurements of: regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) of RNs who work in critical care, progressive care, and medical-surgical acute care settings at 3 months, 6 months, and 12 months after a blended format telemetry course. This chapter provides detail about the theoretical foundation, the conceptual framework used to measure learning outcomes, and the literature review related to the variables and concepts for this research study.

Literature Search Strategy

The literature search for the concepts in this research study focused on peer-reviewed work. The following databases were used: Google Scholar, CINAHL, MEDLINE, OVID, ERIC, EBSCOHost, ProQuest Central, ProQuest Nursing, and Allied Health Database. The following were used: *arrhythmias, electrocardiogram, electrocardiographic monitoring, ECG, learning outcomes, learning outcomes measurement, cardiac monitoring, nursing education, blended learning, continuing nursing education, telemetry, Benner's novice to expert theory, transfer of training, training evaluation, Kirkpatrick's learning outcomes measurement,* and *learning evaluation*. The timeline for the search was the past 5 years but included older, seminal works. Other works past the 5-year limitation were included because more recent works were not found.

Theoretical Foundation

Nurses learn how to take care of patients with experience and education (Benner, 1982). This concept can be applied to explain how nurses gain clinical knowledge and career progression (Benner, 1982). The theoretical foundation for this research is Benner's Skills Acquisition Model. Also, to measure the learning outcomes from a blended basic telemetry course, Kirkpatrick's Learning Outcome Measurement framework was utilized. Benner's work is important to show the progression of skills attainment but is not a direct way to measure learning outcomes. Kirkpatrick's method of measurement offers a more direct measurement of learning outcomes related to the transfer of knowledge or on the job or training effectiveness (Kirkpatrick & Kirkpatrick, 2016).

Origin of Benner's Skills Acquisition Model

Benner observed the changes in the complexity of nursing care and saw a need to better understand the differences between the experienced nurse and the novice nurse (Benner, 1982). Her work applied the Dreyfus Model of Skills Acquisition to explain how a nurse progresses from novice to expert in the field of nursing (Benner, 1982). The Dreyfus brothers developed the Dreyfus Model of Skills Acquisition to describe the five developmental stages a student progresses through to achieve expertise and mastery of a skill (Dreyfus & Dreyfus, 1980). Understanding skill development is important when developing training programs and materials that facilitate a better transition of skills mastery (Dreyfus & Dreyfus, 1980).

The Dreyfus Model has five developmental stages that a student passes through when learning a skill: novice, competence, proficiency, expertise, and mastery (Dreyfus & Dreyfus, 1980). The Dreyfus model expouses that proficiency comes from experience with applying abstract rules to real tasks and situations leading to higher levels of performance (Dreyfus & Dreyfus, 1980). Through her research, Benner found that the Dreyfus model can be used to explain the incremental achievement in skills performance for nurses based on experience and education (Benner, 1982). Benner (1982) concluded that experience is not just the amount of time spent as a nurse, but encountering actual patient care situations that add to the refinement of expertise. Benner set the groundwork to show that patient care can be improved by an accurate description of nursing practice along with the retention, recognition, and reward of experienced nurses (Benner, 1982).

Benner's Major Theoretical Propositions

Benner described the progression of skill acquisition with five levels or the novice to expert continuum, see figure 1. The first level of skill attainment is a novice, or the nurse has no experience in a situation or setting in which he or she is expected to perform (Benner, 1982). The novice requires the education to be able to approach a task without experience (Benner, 1982), for example, the education about a clinical skill in the classroom before the new clinical experience is applied in the clinical setting. The second level is an advanced beginner where the nurse can demonstrate a basic performance (Benner, 1982). The advanced beginner is unable to delineate the hierarchy of importance in patient care requiring the support of a competent or higher-level nurse to ensure patients receive the correct attention to care (Benner, 1982). The third level is the competent nurse who has 2-3 years of experience and can understand the long-range plans of nursing care actions (Benner, 1982). The competent nurse has a perspective based on applying conscious, abstract, and analytical approaches to a nursing care situation but lacks the speed and adaptability of a proficient nurse (Benner, 1982). The fourth level is the proficient nurse who can see the whole situation and modify plans as needed to meet patient care needs (Benner, 1982). The proficient nurse has more speed and flexibility to meet changing patient situations (Benner, 1982). The fifth level is the expert level in which a nurse no longer relies on analysis and rules but rather, due to education and experience, has an intuitive and accurate grasp of a given patient situation, and does not waste time on long lines of analysis (Benner, 1982). Benner's work is a description of the continuum of attaining nursing knowledge in patient care moving from a student to the expert through the process of education and experience.

Application of Benner's Theory to Professional Development Research Learning to give patients safe and quality nursing care requires the ability to think critically, draw from experience, and apply good clinical judgment (Benner, Hughes, & Sutphen, 2008). A nurse must be engaged in continual education along with professional accountability, good decision-making skills, and developing problem-solving abilities to attain these abilities (Benner et al., 2008). In Benner's continuum of novice to expert, continuing education and experience are required to attain and maintain expertise in clinical skills. Benner's theory has been used in an array of research related to continuing education and transitioning to nursing practice. For example, Benner's skills acquisition model has been used in areas of professional development in acute care settings including examples of education in specific areas of acute care such as transitioning to nursing practice, intravenous therapy, and critical care. The studies that follow show recent use of Benner's theory to support research in the areas of onboarding or transitioning to clinical practice.

Novice nurses often have difficulties with the transition from being a student to a practicing nurse (Bennett, Grimsley, Grimsley, & Rodd, 2017). Bennett et al. (2017) found the education in college for nursing did not always match up with the required preparation needed in a real clinical environment. Nursing students are required to complete clinical experiences in areas that they do not choose, and that may not match up with the chosen areas of practice (Bennett et al., 2017). Bennett et al. (2017) applied Benner's model of skill acquisition to examine the journey from an educational environment to transitioning to clinical practice. New nurses should not be expected to be experts with new job entry, but rather should be supported by hospital administration and provided with the right support systems to be less stressed and excel in the real clinical environment (Bennett et al., 2017). A preceptor program and continued administrative support are two areas that may help to support the transition (Bennett et al., 2017).

Staff development education can potentially lead to an improvement in patient care outcomes. Woody and Davis (2013) used Benner's theory to formulate a performance improvement plan to educate nurses on the prevention of intravenous access complications. Following the novice to expert example of the varying levels of nursing skill, the researchers reviewed the current competency assessment tool, policy, and procedure, created pretests and posttests, and developed an educational module to deliver the education (Woody & Davis, 2013).

Benner's Stages of Clinical Competence

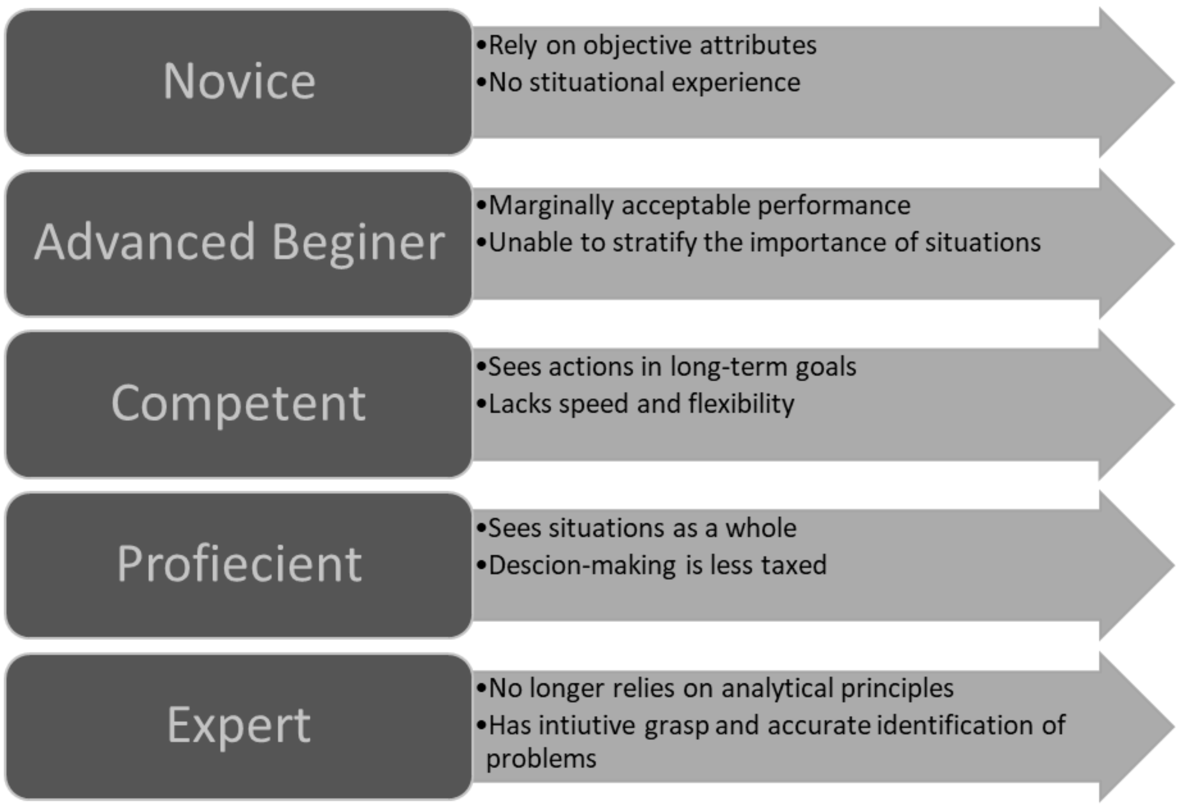

Figure 1. A conceptual model of Benner's Novice to Expert Continuum (Benner, 1984).

The results in patient outcomes over 3 months post the education package was a 50% decrease in the number of intravenous side effects of phlebitis and infiltration (Woody & Davis, 2013). Woody and Davis's (2013) use of Benner's theory allowed them to develop an approach to staff education that took into consideration the skill levels of the individual nurses instead of assuming everyone was at the same skill level.

Today's nurses practice in environments that require high skill levels, for example in the cardiac procedure perioperative areas. The RN circulator role is a challenge to a novice nurse requiring a complex orientation process (Hemingway, Osgood, & Mannion, 2018). Benner's theoretical model was used to design an orientation that takes into consideration the evaluation of the students' progress with skills and knowledge (Hemingway et al., 2018). Benner's theory was useful in designing a simulation approach that linked learning objectives with learning outcomes and metrics (Hemingway et al., 2018). The results of the new educational design for the cardiac scrub nurse role was a shorter orientation time, a higher self-confidence level when scrubbing for cardiac procedures, and a faster increase of cardiac team members (Hemingway et al., 2018).

Several procedures are used to care for patients that can be harmful if not used correctly. Stinson (2016), using Benner's model, examined the use of restraints in the critical care environment. Stinson (2016) focused on the relationship between clinical experience, practice issues, and attitudes towards the use of physical restraints inpatient care and found there was no great difference in any of these areas regardless of where a nurse was on Benner's skill acquisition model. This research can be used to help shape education and initiatives related to restraint use in critical care environments (Stinson, 2017).

Benner's theoretical model of skill acquisition has been applied in varied areas of staff development of new or inexperienced RNs. The above examples are more recent examples that show the need for education because of the complexity of nursing care and the transition a new nurse requires to become proficient or an expert in the chosen specialty. There were no direct examples of telemetry education and the use of Benner's model found in the literature.

Rationale for theory choice.

As seen in the above examples, Benner's skills acquisition model is used in staff development. Zhang and Lihwa (2013) found that telemetry education varies with nurses' different backgrounds or demographics. Benner's theory offers a way to determine skill levels and learning needs. Eventually, depending on research results, the theory can be used to develop education catered to the different levels of nursing skill offering a more efficient approach to telemetry care education.

Relation of Theory Choice to This Research

Nurses are primarily responsible for the care of patients on ECG monitoring including both the interpretation and decision-making aspects of care, but the evidence suggests that nurses lack the necessary skill and expertise to be proficient at this task. (Funk et al., 2017). Telemetry monitoring education is an important part of an orientation program and should match the type of patient being monitored (Sandau et al., 2017). All levels of nurses from novice to expert may be working in a healthcare setting with telemetry patients. Nurses show competence after a blended basic telemetry course by passing a posttest, and the next step is to show proficiency in telemetry skills. Measuring or quantifying proficiency through this research shows further support of Benner's theory.

Kirkpatrick's Learning Outcomes Measurement

Kirkpatrick formulated his model for learning outcomes measurement as the subject of his dissertation research in 1954 (Biech, 2016). Browning (1970) showcased Kirkpatrick's model in a paper with methods of how to improve the effectiveness of short-term training for personnel serving disabled patients. Kirkpatrick wanted to know if his outreach programs were effective and used his model to measure the learning outcomes from the university outreach programs for management and supervision (Kirkpatrick & Kirkpatrick, 2016). Kirkpatrick's model is used to evaluate the learning outcomes in the world of staff development, but has been applied to other areas of education (Kirkpatrick & Kirkpatrick, 2016). Staff development is described by several terms including professional development, instructional development, faculty development, and educational training (De Rijdt, Stes, Van der Vleuten, & Dochy, 2013). Kirkpatrick felt that the evaluation of education was an important part of either improving an educational product or eliminating ineffective education (Browning, 1970). Over the years, Kirkpatrick's work has been criticized for its limitations, but continues to be a broadly excepted model in the areas of training and development of professionals (Estes Kennedy et al., 2013).

Kirkpatrick's learning outcomes model defined

Kirkpatrick's learning outcomes model measures learning outcomes in four areas: level 1 is the learners' reaction to the education, Level 2 is the degree of learning acquired, Level 3 is behavior changes on the job due to the new education, and Level 4 is the workflow changes resulting from the education, see Figure 2. (Kirkpatrick &

Kirkpatrick, 2016). Levels 1 and 2 are used to examine the quality of the educational program (Kirkpatrick & Kirkpatrick, 2016). Levels 3 and 4 are used to evaluate training effectiveness, which stakeholders may find more valuable related to time and cost of educational delivery (Kirkpatrick & Kirkpatrick, 2016). Formulating effective training is the goal of evaluation and allows participants to confidently apply what is learned from the training process in their work (Kirkpatrick & Kirkpatrick, 2016).

Level 1, or reaction to learning, is the most used measure for learning outcomes and is accomplished through summative forms such as surveys or feedback during or after the education or training (Kirkpatrick & Kirkpatrick, 2016). Reaction to learning is the simplest level of learning outcomes to track focusing on learner engagement, relevance, and customer satisfaction (Kirkpatrick & Kirkpatrick, 2016). Level 2, or learning evaluation, measures the extent of participants' acquired knowledge, skills, attitude, confidence, and commitment after the training (Kirkpatrick & Kirkpatrick, 2016). Common measurement methods for Level 2 are knowledge testing, discussions, activities, role-playing, simulation, presentations, teach-back, and demonstration (Kirkpatrick & Kirkpatrick, 2016). Level 3, or behavior, is the ability of the students to apply what they learned to their job (Kirkpatrick & Kirkpatrick, 2016). To evaluate level 3, it is important to establish what critical behaviors are most important to accomplish or influence Level 4 (Kirkpatrick & Kirkpatrick, 2016). Level 3 is a process of comprehensive monitoring and improvement (Kirkpatrick & Kirkpatrick, 2016). Finally, Level 4 is the targeted outcomes that occur because of training (Kirkpatrick &

Kirkpatrick, 2016). Level 4 results are demonstrated workflow improvements and are important to stakeholders (Kirkpatrick & Kirkpatrick, 2016).

Kirkpatrick's model has been applied to several areas of staff training in the healthcare profession, such as evaluation of eLearning, interprofessional education, simulation, workshops, and in-services. For example, using eLearning as a method for education delivery is a common practice. Quintas, Fernandez Silva, and Teixeira (2017) used the Kirkpatrick model to compare eLearning student satisfaction with blended learning student satisfaction. This study focused on level 1 and 2 results showing students' levels of satisfaction and student grades (Quintas et al., 2017). Quintas et al. (2017) found that students preferred face-to-face learning for its immediate results and considered eLearning as a good alternative with the grades from both methods showing no significant differences.

Similarly, Sinclair, Kable, and Levett-Jones (2015) examined the evidence available to show the effectiveness of eLearning for healthcare professionals and patient outcomes. The majority of eLearning evaluation was focused on Kirkpatrick's levels 1 and 2, student experiences and knowledge obtainment, with few studies pursuing Level 3 measurements or changes in healthcare provider behaviors (Sinclair et al., 2015). Level 3 examples found by Sinclair et al. (2015), were in areas related to radiology practice, surgery, and identification of child abuse by emergency department nurses. Sinclair et al. (2015) recommended eLearning research should be done to focus on if eLearning influences clinical practice with sustained changes in behavior and measurable patient outcomes.

According to Estes Kennedy et al. (2013), professional organizations and academic programs in training related fields view Level 3 and 4 evaluations as an accurate way to check the relevance and validity of training programs. Kirkpatrick's model was used by Abdulghani et al. (2014) to evaluate workshops given to healthcare professionals on research methodology. Through summative and formative evaluation, the group was able to assess all four levels of Kirkpatrick's model including the delivery and content of the workshop and the impact and skills attained and utilized in performing research. Level 4 was assessed by evaluating how many participants started research projects (Abdulghani et al., 2014).

Cardiopulmonary resuscitation is important training for nursing staff that needs to be evaluated with the goals of patient survival and prevention of early deaths post sudden cardiac death (Dorri, Akbari, & Sedeh, 2016). Dorri et al. (2016) evaluated the effectiveness of cardiopulmonary resuscitation training using all four levels of Kirkpatrick's learning outcomes measurements. Level 1 was evaluated through surveys, Level 2 through pre- and posttesting, Level 3 through evaluations by supervisors, physicians, and colleagues, and Level 4 through the facilities attainment of strategic goals. The training provided did show effective results using Kirkpatrick's model but recommended that evaluations be repeated at longer time intervals to show a permanent change in behavior citing the resources required to do so as being extensive and time-consuming (Dorri et al., 2016).

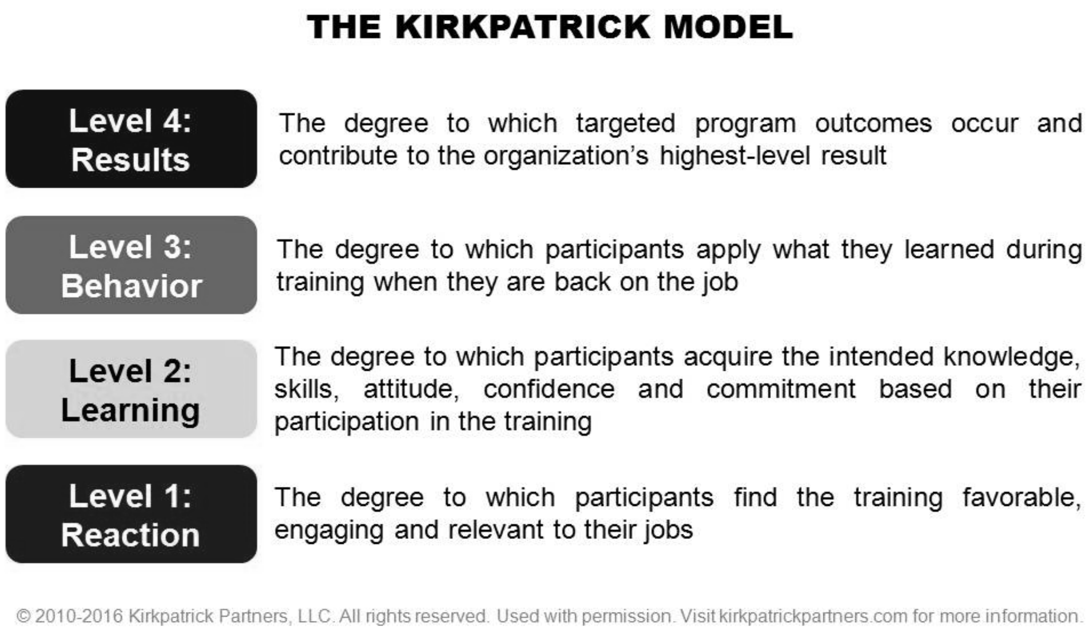

Figure 2. The Kirkpatrick model (Kirkpatrick, J. D., & Kirkpatrick, W. K. (2016). *Kirkpatrick's four levels of training evaluation*. Alexandria, VA: ATD Press. Adapted with permission of the author.)

Post-open-heart surgery requires a complex set of nursing skills that may challenge an experienced RN as the patients may be in health states that deteriorate very quickly (Mowry & Gabel, 2015). Education for this type of nursing is complex requiring knowledge related to assessment, observation, medication management, management of complex equipment, ventilator care, and emergency procedures (Mowry & Gabel, 2015). After designing a multimodal education package, Mowry and Gabel (2015) utilized Kirkpatrick's framework to assess if the education was effective. Level 1 measurements were done with a validated tool to discover the reactions to simulation education (Mowry

& Gabel, 2015). Level 2 measurements were completed using simulation and debriefing. Level 3 measurements were obtained using a competency checklist during actual patient care (Mowry & Gabel, 2015). Finally, Level 4 was measured by looking at the data related to the number and type of complications immediately post open-heart surgery (Mowry & Gabel, 2015).

The above examples demonstrate the use of Kirkpatrick's framework measurements in healthcare staff development. The areas of eLearning, interprofessional education, simulation, workshops, and in-services are all ways of delivering education for staff development. Kirkpatrick's framework is a method that is used to evaluate training programs, and the results are used to improve the educational process (Kirkpatrick & Kirkpatrick, 2016).

The Kirkpatrick Model's Use in this Study

The term *training* can be used to describe education used to elicit a change in behavior (Estes Kennedy et al., 2013), in this case, on-the-job behavior changes related to reading telemetry and caring for telemetry patients. The Kirkpatrick Learning Outcomes Model is an efficient way to examine the products of learning in terms of reaction, learning, behavior, and results (Kirkpatrick & Kirkpatrick, 2016). By using a Level 3 measurement or change in behavior, information is gathered to determine if the blended basic telemetry course transfers to behavior changes in actual telemetry patient care. The information can then be used to improve telemetry education based on the results.

Benner and Kirkpatrick for this Research

I used Benner's theory to describe the way a nurse attains the ability to transform from a novice nurse to an expert nurse (Benner, 1982). Telemetry interpretation is a new skill for novice nurses. A nurse is considered competent after completing the blended basic telemetry course and passing the final test. The next step is proficiency or the ability to see the whole situation and modify plans as needed to meet patient care needs (Benner, 1982). The nurse can analyze the telemetry strip and then follow through with the correct treatment. For this research, Benner's theory supports the attainment of nursing skills.

Kirkpatrick's learning outcomes measurement guided the effectiveness of education. The delivery of education in a work environment was used to change behavior resulting in desired organizational outcomes (Estes Kennedy et al., 2013). A blended basic telemetry course is an educational intervention used to give nurses the skill required to take care of telemetry patients. The desired behavior change is the ability to correctly analyze a telemetry strip and follow through with the correct care of telemetry patients.

The combination of Benner and Kirkpatrick is a complimentary one. First, Benner described the skill attainment of a nurse learning how to take care of a telemetry patient. Kirkpatrick gives a way to measure the learning outcomes from a blended basic telemetry course. Together they give this research the theoretical support and framework to measure learning outcomes in the context of nursing skill attainment in telemetry interpretation and care.

Literature Review Related to Key Variables and Concepts

Telemetry Practice

Cardiac telemetry was invented in 1887 by Augustus Waller M.D. The device was a mercury capillary electrometer that measured fluctuations across two leads of cardiac activity and was the beginnings of today's monitoring devices (Kalahasty, Alimohammad, Mahajan, & Ellenbogen, 2013). Einthoven further refined the instrumentation using a string galvanometer, and his work included standard measurements and calculation, which led to the practical use of the electrocardiogram (Kalahasty et al., 2013). As technological advances led to miniaturization, ECG technology became a common tool in acute patient care settings (Kalahasty et al., 2013). Today's miniature equipment started as hundreds of pounds of equipment that required several operators to manage (Kalahasty et al., 2013). Modern remote monitoring is the result of a long history of refinements. Advancements in pacemaker and implanted cardiac defibrillators, cellular technology, and internet technologies have led to a commonplace use of cardiac telemetry in today's healthcare settings (Kalahasty et al., 2013).

Electrocardiographic (ECG) monitoring is a standard practice used to determine heart rate, basic heart rhythm, and other more advanced concepts such as complex arrhythmias, myocardial ischemia, and QT measurements (DiLibero, DeSanto-Madyea, & O'Dongohue, 2015; Sandau et al., 2017). According to American Heart Association's (AHA) practice standards, telemetry monitoring is used to recognize cardiac arrest, recognize deteriorating conditions, facilitate the management of arrhythmias, diagnose arrhythmias or abnormal cardiac conditions, and monitor treatment outcomes (Sandau et al., 2017). The responsibility of interpreting telemetry and management of the results falls on staff nurses who are directly caring for the telemetry patient (Funk et al., 2017; Sampson, 2018). Other healthcare team members are consulted when problems are identified with telemetry reading results.

Nurses are required to take care of telemetry patients including the technical aspects of ECG monitoring and the clinical decision making of how to respond to telemetry read-outs (Blakemen, Sarsfield, & Booker, 2015; Funk et al., 2017). The technical aspects of telemetry include lead placement, proper application of the electrodes, alarm parameter adjustments, and interpretation of the telemetry read-outs including measurements (AACN Clinical Resources Task Force, 2016; Blakemen, Sarsfield, & Booker, 2015; Funk et al., 2017). Clinical decision-making is based on the telemetry interpretation including establishing monitoring goals and education of patients, adjusting alarm parameters, and the knowledge of how to respond to monitor recordings (AACN Clinical Resources Task Force, 2016; Funk et al., 2017). Nursing treatment responses should include further data collection on patient status, physician notification, and pharmacologic or other therapies consistent with established hospital protocol (Buchanan Keller & Raines, 2005; Varvaroussis et al., 2014).

Telemetry Reading Proficiency

Cardiac telemetry is used on patients in healthcare settings to monitor a patient's cardiac function such as heart rate, interval measurements, diagnosis of normal rhythms and arrhythmias, detection of myocardial ischemia, and detection of abnormal QT measurements (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017). The AHA and the American Association of Critical-Care Nurses (AACN) developed similar guidelines related to nursing practice requirements for continuous ECG monitoring. According to the AHA guidelines and AACN, nurses should be able to correctly prepare the skin, apply and choose leads, interpret normal and abnormal readings, manage alarms, and appropriately respond to abnormalities (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017).

A nurse needs telemetry competence or knowledge to read a telemetry strip, in this case, through a blended basic telemetry course to achieve telemetry competence, which would lead to proficiency with practice. Applying the idea of proficiency to telemetry using recommendations from the AHA translates to a nurse who can correctly apply skin prep and leads, interpret normal and abnormal readings, manage alarms, and appropriately respond to abnormalities synthesizing all the tasks fluidly (Sandau et al., 2017). The AACN's expectations for nursing practice for dysrhythmia monitoring include proper lead placement, individualization of alarms, ability to measure and correct QT measurements for irregular heart rhythms, identify leads, appropriate lead selection, and identify dysrhythmias (AACN Clinical Resources Task Force, 2016). A staff nurse's competence in telemetry interpretation is an important part of starting and carrying out the appropriate care for hospitalized patients on continuous telemetry (Goodridge, Furst, Herrick, Song, & Tipton, 2013). Crimlisk, Johnstone, and Winter (2015), identified competence as a cardiac dysrhythmia test and competency as the ability to pass the dysrhythmia test and demonstrate knowledge and skills in an orientation competency. For this study, competence is defined as completing the required work for a blended basic telemetry course, both eLearning and workshop, and passing a final test. Demonstration of competency and telemetry reading proficiency is the ability of a nurse to read and manage a telemetry strip correctly including correct rhythm identification, appropriate treatment, and correct documentation.

Basic Telemetry Course

Formal guidelines are lacking to support the education that is needed to be competent in telemetry care and telemetry strip interpretation (Sandau et al., 2017; Schultz, 2011). The AHA reported that no standards exist regarding the type, content, and length of time needed for basic telemetry education (Sandau et al., 2017). There are no standardized tests that have regular checks of reliability and validity (Sandau et al., 2017). However, the AHA recommends that telemetry education should take place during orientation and be continued on an ongoing basis to include clinically-based practice (Sandau et al., 2017). Telemetry education is important for the establishment and maintenance of telemetry monitoring competency (Zaremba, Carroll, & Manley, 2014).

Based on 2004 AHA guidelines, Schultz (2011) explored evidence-based strategies for teaching dysrhythmia monitoring to staff nurses and found that due to several teaching methods and different research designs it was not possible to establish consistent support for specific teaching techniques. The current AHA guidelines recommend four areas to include in staff nurse education related to electrographic monitoring goals: electrode placement and skin preparation, goals of monitoring, interpretation of waveforms and data, and an appropriate response to abnormalities

(Sandau et al., 2017). The AACN endorses the same four areas in their current practice alert for accurate dysrhythmia monitoring in adults (AACN Clinical Resources Task Force, 2016). Even with newly established guidelines of 2017, there are no randomized clinical trials, pilot programs by target users, cost estimates, or tools for application to show supporting evidence for the best methods of teaching telemetry (Sandau et al., 2017).

There are several methods for teaching cardiac telemetry described in the literature, which are instructor-led, web-based methods, unit-based activities, unit preceptorship and competency validation, self-directed learning, simulation, and hybrid or combinations of methods (Crimlisk et al., 2015; Schultz, 2011, Spiva et al., 2012; Sumner et al., 2012). The new AHA guidelines continue to show support of web-based learning but state that face-to-face approaches may be necessary for students with no telemetry knowledge (Sandau et al., 2017). Further research is needed to provide supporting evidence of which telemetry teaching methods are most effective (Sandau et al., 2017). The Practical Use of the Latest Standards of Electrocardiography (PULSE) Trial, studied the integration of the AHA's standards into nursing care of telemetry patients (Funk et al., 2017). The interventions of the study had two main parts, educational delivery of telemetry knowledge and strategies to maintain the change in practice (Funk et al., 2017). The areas the study focused on were quality of patient care and accuracy of telemetry interpretation using online learning to establish knowledge and unit champions to continue reinforcement of telemetry knowledge (Funk et al., 2017).

The PULSE trial showed an improvement in nursing knowledge, but there was a decrease in testing scores over time (Funk et al., 2017).

Support for different methods of telemetry education are found in the literature and some use a combination of approaches. Spiva et al. (2012) explored combinations of web-based learning and instructor-based classes varying study times and instructor involvement and found telemetry knowledge, test scores, and confidence levels improved regardless of the approach. Spiva et al. (2012) recommended a hybrid model of eLearning and instructor-led courses to meet learner needs and save time in the overall education process having positive results with posttest outcomes. Varvaroussis et al. (2014) explored didactic methods with nursing students who had no prior telemetry experience and found applicability of a six-stage method used in teaching advanced cardiac life support as an effective teaching method compared to a descriptive teaching method. Crimlisk et al. (2015) used three 4-hour workshops with a posttest and hands-on clinical experience that required telemetry strips be checked by the unit educator and a competency-based checklist be completed. Costanzo, Ehrhardt, and Gormley (2013) approached telemetry education with nine online modules, quizzes, email support, and an instructor-led 6-hour workshop allowing for a shorter completion time than previous methods used by their facility. The orientation time for telemetry skills was shorter, saved money, leadership liked the format because the staff was independent sooner with telemetry patients, and learners found that their use of technology improved with the blended course approach (Costanzo et al., 2013).

Other innovative teaching methods have been utilized to educate nurses about telemetry and ECG. Granero-Molina et al. (2015) incorporated simulation into an online format and found significant results in pre- and posttest results but no differences between the dimensions of learning styles and learning approaches. Sumner et al. (2012) incorporated simulation after a blended basic telemetry course. The simulation was incorporated 3 months after the initial education to help with the retention of information showing the preservation of knowledge in the data. Holthaus and Wright (2017) researched the effects of a 3D application on nursing students' telemetry knowledge levels. Results did not show a significant difference in testing scores from other teaching methods but did introduce the 3D application as another method of teaching telemetry (Holthaus & Wright, 2017). Telemetry education continues to evolve to incorporate new technology.

Learning Outcomes

The purpose of a teaching session, whatever the delivery method, is that the students learn something, or attain learning outcomes (Caspersen, Frolich, Karlsen, & Aamodt, 2014; Dzelelija & Balkovic, 2014; Hussey & Smith, 2008). Learning outcomes are the product of learning described as knowledge, the application of knowledge, and proven usage of knowledge (Dzelelija & Balkovic, 2014). When planning a teaching event, the learning outcomes are a key consideration on how the content is delivered and the intent is to have a lasting change on students if they attain the learning outcomes from the session (Caspersen, Frolich, Karlsen, & Aamodt, 2014; Dzelelija & Balkovic, 2014; Hussey & Smith, 2008). Hussey and Smith (2008) did a concept analysis of learning outcomes and concluded that learning outcomes should be formulated differently for teaching events versus learning modules or short course work. Learning outcomes are most efficiently used when specifying what pieces of knowledge students acquire from a learning session with thought given to incidental or unplanned learning (Caspersen, Frolich, Karlsen, & Aamodt, 2014; Hussey & Smith, 2008).

Learner variables, instructional variables, and motivational variables need to be considered when formulating education (Lim & Morris, 2009). Learner variables include demographics, course participation, and satisfaction with the learning content (Lim & Morris, 2009; Tayebinik & Puteh, 2013). Instructional variables include quality related to the instructor and learning activities, student support, and study workload (Lim & Morris, 2009; Tayebinik & Puteh, 2013). Finally, learning motivation is affected by relevance, interest, self-efficacy, affect, and learner control (Lim & Morris, 2009). A student's attitude and success may be different when looking at whether the education session is voluntary or mandatory, work-related or for personal enrichment, and other adult education needs such as previous experience with the education. Ellström and Ellström (2014) took learning outcomes to the level of managerial support finding that learning outcomes can be attained not only by the individual but with managerial support can take on a broader role in the work team of an organization.

The goal of employee training is to change workplace behavior that will, in turn, improve outcomes for an organization (Estes Kennedy et al., 2013). Education of employees is an investment of company resources and needs to show benefit to the organization to be cost-effective (Saks & Burke, 2012). The goal of education is not just learning but having transferable skills that can be applied on-the-job (Caspersen, Frolich, Karlsen, & Aamodt, 2014). Learning outcomes evaluation is the process of collecting data on an educational program that can be used to determine the effectiveness of education and to improve the educational process (Saks & Burke, 2012). Organizations do not frequently conduct learning outcomes evaluations beyond level 1 and 2 of Kirkpatrick's evaluation model leaving questions about levels 3 and 4 and what happens in practice after education or training is delivered to employees (Estes Kennedy et al., 2013).

Blended Basic Telemetry Course and Expected Learning Outcomes

The blended basic telemetry course for this research was a hybrid of eleven eLearning modules and an eight-hour instructor-led workshop including a posttest for nurses new to telemetry. The course was developed and approved by subject matter experts in the interpretation of telemetry and care of telemetry patients. The eLearning component and instructor-led component are reviewed bi-annually to update content based on changes in telemetry care, regulatory requirements, and learner and stakeholder feedback.

Summary and Conclusions

I presented a review of the literature in Chapter 2 and the search methods and theoretical foundations for this research along with how nurses are educated on the use of ECG monitoring, and the gaps in the literature related to methods of educating nurse on ECG monitoring. The concepts of learning outcomes, telemetry practice, telemetry reading proficiency, and blended basic telemetry course were reviewed.

Electrocardiographic monitoring is standard practice in an acute care setting with the responsibility of interpreting and managing ECG monitoring falling on staff nurses who directly care for the patients. RNs must be able to perform the technical aspects and clinical decision-making related to ECG monitoring. Basic telemetry education is lacking formally established education guidelines or competencies.

Telemetry proficiency for RNs, according to the AHA and AACN guidelines, should include correct skin preparation, applying and choosing the correct leads, interpretation of normal and abnormal readings, alarm management, and appropriate response to abnormalities. There are several teaching approaches in the literature including combinations of methods. Web-based training, instructor-led workshops, simulation, computer applications, or combinations of each have their effectiveness and shortcomings discussed in the literature. Learning outcomes measurements to examine proficiency in reading telemetry after a blended basic telemetry course is one way to examine if the blended learning method is an effective way for RNs to learn telemetry by measuring what transfers to taking care of a telemetry patient.

I present details of the research design in Chapter 3 and further delineate the researcher role, methodology, participant selection logic, and data gathering plan. Also, population selection logic, ethical considerations, data analysis plan, and issues of trustworthiness such as internal and external validity are covered.

Chapter 3

Introduction

The purpose of this study was (a) to determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at 3 months, 6 months, and 12 months posttraining as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time, and (b) to compare the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who worked in critical care, progressive care, and medical-surgical acute care settings. This one-group, repeated-measures, design study sought to determine if the predictor variable of a blended learning telemetry course affected the outcome variable of the proficiency of nurses' ability to accurately interpret telemetry after completing the requirements for a blended basic telemetry course.

In this chapter, I discuss the research design and rationale for the chosen research design, including the variables, population selection, sampling procedures, and data collection. The variables being studied are described along with data analysis methods, validity threats, and ethical procedures.

Research Design and Rationale

Quantitative research measures relationships among variables (Houser, 2015); quantitative designs are applied to samples that represent populations in order to quantify the effects of independent variables on dependent variables (Houser, 2015). I chose a quantitative, one-group, repeated measures design to determine if information learned by nurses during a blended telemetry course is applied to the care of telemetry patients. The purpose of this retrospective analysis study was twofold: (a) to determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at 3 months, 6 months, and 12 months posttraining, from 2016 to 2019, as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time; (b) compare the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or physician extender for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings. Data were collected retrospectively.

The following research questions inform this study:

RQ1: What is the effect of a blended format basic telemetry course on telemetry reading proficiency of ECGs in newly licensed RNs with no telemetry experience who work in acute care settings, as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course?

*H*o1: There will be no effect from a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6months, and 12 months after a blended format telemetry course.

*H*a1: There will be an effect between a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

RQ2: What is the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings?

H_o1*:* There will be no difference charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

H_a1*:* There will be a difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

Study Variables

A blended basic telemetry course is required education for RNs who are working in an acute care setting to correctly interpret electrocardiographic waveforms and provide the proper care of patients being monitored by continuous ECG. Telemetry proficiency, as defined by AHA guidelines and AACN, is a nurse being able to correctly skin prep, apply, and choose leads, interpret normal and abnormal readings, manage alarms, and appropriately respond to abnormalities (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017). The chosen indicators for telemetry proficiency in this research are correct interpretation of a telemetry strip, correct action taken based on the interpretation, and a timeframe of 3 months, 6 months, and 12 months after the telemetry course is completed, which are the outcome variables.

The human heart uses the flow of electrolytes in and out of its cells to create the contractions required for a heartbeat (Aehlert, 2018). Telemetry monitors a patient's rhythm by recording the resultant electrical activity of the heart on paper with a grid for time measurements. Telemetry strip interpretation requires a series of measurements to interpret a strip correctly (Aehlert, 2018). Horizontal measurements on a telemetry strip represent time; and certain time intervals are measured for interpretation of a telemetry strip (Aehlert, 2018). The first determination on a strip is whether the rhythm is regular. The heart rate is the number of times per minute that the heart beats with a normal rate of 72 for an adult or a rate of 60-100 being considered within normal limits (Aehlert, 2018). The PR interval is the time it takes for the atrium to depolarize with a normal measurement of 0.12-0.20 seconds (Aehlert, 2018). The QRS represents the time it takes for the ventricles to depolarize with a normal measurement of 0.08-0.12 seconds (Aehlert, 2018). The QT/QTC represents the time it takes for the ventricles to contract and then fill so the heart is ready for the next heartbeat, in an adult a normal measurement is less than 0.50 seconds, but there are more specific measurements required for accuracy (Aehlert, 2018). QTC is used for irregular heart rhythms requiring extra steps to calculate if the QT is normal (Aehlert, 2018). Telemetry interpretation is based on the above measurements to determine the final interpretation or the patient's heart rhythm (Aehlert, 2018; Sandau et al., 2017). To create interval data for this research, each measurement was assigned 1 for correct answers and 0 for incorrect answers. If the data were not present, I counted the answer is incorrect.

The correct actions post telemetry strip interpretation are based on options falling into five categories: no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), activate the cardiac arrest alerts (Aehlert, 2018; American Heart Association, 2018; Sandau et al., 2017). There was one correct answer considered for each strip. This resulted in a 1 for correct answer and 0 for incorrect answer.

The total scoring ranged from 0-7 and include both ECG interpretation and actions based on interpretation. For nurses who meet the inclusion criteria, this interval level data was collected at 3 months, 6 months, and 12 months. The second research question added the type of unit the nurse worked in allowing for comparison for telemetry proficiency among RNs who work on different types of units medical-surgical, critical care, and progressive acute care units expanding the number of dependent variables to 3.

Study Design

The study design for this research was a quantitative repeated measures retrospective design. To answer RQ1, I used a one-group repeated measures, retrospective analysis design. To answer RQ2, I conducted a comparative analysis repeated measures retrospective analysis among three groups of RNs over time. I used a convenience sample of one group of RNs from an existing data source (Houser, 2015). Telemetry education, the independent variable for RQ1, was required for acute care nurses to safely and effectively care for telemetry patients. I conducted a chart audit to obtain the data at 3, 6, and 12 months after the RN completed the telemetry course to assess the proficiency of the RN's telemetry reading ability and decision making on ECGs blended basic telemetry course. I accessed telemetry charting data through the network's electronic medical records, which included the telemetry strip recordings and the subsequent charting to show actions taken or not taken based on the interpretation of the telemetry strips.

Methodology

The methodology section describes the population, type of sampling, and sampling procedures. The procedures for how the data were accessed and necessary permissions, operational definitions of the variables, statistical tests, and data interpretation are described. The data analysis plan is reviewed, including the software used, data screening, threats to internal and external validity, and threats to statistical conclusion validity.

Population

The target population was newly licensed RNs who took a basic blended basic telemetry course, had been licensed as a nurse for less than a year, and were employed at a regional healthcare system, which is estimated to include 900 nurses between the years 2016-2019. The setting was three different types of units, which are medical-surgical, progressive care, and critical care in an acute care healthcare institution. Telemetry proficiency is a job requirement for RNs to work on any acute care unit that has telemetry patients, which includes medical-surgical, progressive care, and critical care units. I obtained the information from a series of data systems within the acute care facility. I accessed the list of RNs who successfully completed the blended basic telemetry course. Successful completion means that the RN completed all eleven modules, the 8-hour workshop, and earned a passing grade on the final test. After determining eligibility and identifying the RNs who qualified, I accessed a database to show what shifts the RNs worked 3, 6, and 12 months after the completion of the blended basic telemetry course. I did not consider the shift worked but based selection of the RN on completion criteria of the basic telemetry course and on twelve-month longevity in the job. Next, I accessed the medical records of the patients who the RN provided care for on a telemetry floor while hospitalized and assessed the RN’s cardiac rhythm interpretation of measurements of the telemetry complexes and heart rates, lead selection, follow-up if there was an abnormality, response for stable dysrhythmias, and emergency response for life-threatening dysrhythmias as correct or incorrect (AACN Clinical Resources Task Force, 2016). Correct follow-up to telemetry interpretation was based on the type of rhythm that is interpreted, ranging from normal to life-threatening (AACN Clinical Resources Task Force, 2016). All data were retrospective based on the course criteria being met and the specified timeframe of 3, 6, and 12 months.

Sampling and Sampling Procedures

I selected a convenience sample of RNs who met the criteria for blended basic telemetry course completion for this study and who provided care to patients who were on telemetry 3, 6, and 12 months after the RN completed the blended basic telemetry course. A convenience sample is a nonprobability method of selecting a sample that is convenient for the researcher (Houser, 2015). Nonprobability samples increase the likelihood of a nonrepresentative sample but are commonly used in research when a random sample is not feasible (Grove, Burns, & Gray, 2013). In this case, a random sample was not feasible due to the inability to control educational content for other healthcare networks. However, different types of acute care units were used to collect data allowing for the ability to show telemetry care in three levels of patient care to include critical care, progressive care, and medical-surgical care units. Patient stability is determined by healthcare providers based on hemodynamic parameters; patients with the same diagnosis may have varying hemodynamic stability (Sandau et al., 2017). Because of different patient stability levels, telemetry frequency may differ from the different types of units, but care related to the telemetry is the same. The AHA's and AACN's telemetry recommendations and guidelines are not broken down to have different reactions to telemetry results based on units or levels of care content (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017). Both the AACN and AHA have taken great measures to standardize how telemetry is utilized and point out where more research is needed to improve telemetry education and patient care content (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017).

Inclusion and Exclusion Criteria

Inclusion criteria included the characteristics that participants needed to be part of a target population for a research study and exclusion criteria eliminates subjects from a study based on characteristics (Grove, Burns, & Gray, 2013). The inclusion criteria for the target population was new RNs, new to nursing practice, with less than a year experience and no prior telemetry experience beyond preparatory nursing education. Also, the new RNs must have completed the blended basic telemetry course requirements, including completion of the 11 online modules, 8-hour workshop, and earned a passing score on the final telemetry test. The network utilized for the data collection staffs with 12 hours shifts so nurses were chosen based on inclusion criteria but not shift due to telemetry care being the same regardless of the time of day. The exclusion criteria were experienced nurses with or without prior telemetry experience and non-RNs. Since there are several ways to deliver basic telemetry education, the target population was chosen based on being able to control the educational content and delivery. If various course deliver methods were used, I would not be able to determine if a blended basic telemetry course is an effective delivery method on its own.

Effect size, Alpha Level, and Power Level.

To determine the power needed for this research, I used the online power analysis tool G* Power 3.1 to calculate the sample size for statistical analysis (Faul, Erdfelder, Lang, & Buchner, 2009). For RQ1, I conducted a repeated measure analysis of variance (ANOVA) within factors. The power analysis yielded a sample size of 28 with a medium effect size of 0.25, alpha of .05, and power of 0.8. For RQ2, I conducted a repeated measures, within-between factors multivariate analysis of variance (MANOVA). The power analysis included the standard power level of 0.80 and the level of significance of 0.05 for this research, these being considered common parameters for nursing research with a medium effect of .25 (Faul, Erdfelder, Lang, & Buchner, 2009; Grove et al., 2013) yielded a sample size of 98.

Data Analysis

I collected descriptive statistics, which included the type of acute care unit and nursing degree acquired. Patient diagnosis, patient outcomes if there was a telemetry issue, and type of rhythm interpreted was collected to look for patterns related to the type of patient on telemetry. The data were used to assess knowledge retention from a blended format basic telemetry course at 3 months, 6 months, and 12 months. Additionally, the differences between the types of nursing units (critical care, progressive, and medical-surgical) was compared in the maintenance of telemetry reading proficiency. I used the Statistical Package for the Social Sciences (SPSS), Version 23 (I.B.M. Corp, 2013) to analyze the data for RQ1 with a repeated measure ANOVA. RQ1 had one IV (blended telemetry course) and 7 DVs of ECG results (correct measurements of: regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and actions taken as a result of interpretation (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest). Each DV was judged as 1 (correct) or 0 (incorrect). The total possible correct score was 7 and ranged to zero. The assumptions for the one-way analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) were taken into consideration. The first question had one independent factor and a dependent variable with interval data and three factors, in this case timeframes, to meet the requirements of an ANOVA (Green & Salkind, 2014). In RQ2, I analyzed the difference among three groups of RNs who had taken the ECG blended telemetry course, which were from medical-surgical, critical care, and progressive care units. The dependent variables were nurses from medical-surgical, critical care, and progressive care units, which I measured over time at 3 different timeframes to meet the requirements of a MANOVA (Green & Salkind, 2014). The data were cleaned and manually reviewed for completeness and omissions after collected from patient medical records.

The following research questions inform this study:

RQ1: What is the effect of a blended format basic telemetry course on telemetry reading proficiency of ECGs in newly licensed RNs with no telemetry experience who work in acute care settings, as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course?

*H*o1: There will be no effect from a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

*H*a1: There will be an effect between a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

RQ2: What is the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings?

H_o1: There will be no difference charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

H_a1: There will be a difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

Threats to Validity

Validity is an important consideration when addressing whether research results can be incorporated into practices (Grove, Burns, & Gray, 2013). There can be mistakes made when doing research that affect the validity of the results, and this in turn, can raise questions about the research conclusions (Creswell, 2014). The conclusions of a study may be inaccurate, leaving questions as to whether the interventions affected the outcomes or were other factors the reason for the results (Creswell, 2014). Validity issues need to be addressed when designing a research study. I will discuss the possible threats to the validity of this research.

Threats to Internal Validity

Internal validity answers the question if the independent variable caused the dependent variable to change (Frankfort-Nachmias, Nachmias, & DeWaard, 2015). To aide in controlling this, this inclusion criteria were that the nurses had less than one-year experience in nursing with no prior telemetry experience and had taken and passed the same basic telemetry course. Selection effects can be the result of intrinsic and extrinsic factors (Frankfort-Nachmias, Nachmias, & DeWaard, 2015). To avoid selection effects, I chose nurses based on the inclusion and exclusion criteria and adhere to this methods of measurement.

Threats to External Validity

Telemetry practices have the possibility of changing; this can be a threat to external validity, making it difficult to replicate if telemetry practice changes. I based this data on the latest AHA and AACN guidelines (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017), however if they change, different measurements of data would be required. The data for this study depended on the RNs from a single healthcare network who all took the same blended telemetry course. There may be threats to the external validity of the study because of the use of a single network. Second, the data collected is inputted into the system by the RNs being studied. There would be no control over the quality of the input.

External validity relates to the ability to apply what is learned in this research to other populations (Frankfort-Nachmias, Nachmias, & DeWaard, 2015). Representativeness of sample and reactive arrangements are components of external validity (Frankfort-Nachmias, et al., 2015). This research included nurses from three different types of acute care units to include how the setting affects telemetry proficiency at different timeframes. The chart audits were in actual patient charts, which would be considered the natural setting for patient care documentation, avoiding the influence of an artificial environment, such as a classroom or simulation. The timeframes required were from over a year ago to collect follow-up for a total of a year.

Threats to Construct or Statistical Validity

Construct validity is that the research conceptual definitions measure the theoretical construct operational definitions they are supposed to measure (Grove, Burns, & Gray, 2013). For this research, theoretical constructs were explained and utilized to define the operational definitions of variables. Statistical validity addresses false conclusions being drawn related to the relationships between variables (Grove, et al, 2013). Adequate sample size was used to avoid low statistical power, the assumptions for the statistical tests were observed, and extraneous data results were eliminated from the data.

Ethical Procedures

Careful considerations were made to protect the rights and identities of the nurses and patients in the data set. All information was kept confidential and de-identified. Institutional Review Board (IRB) permissions where be obtained from the healthcare network and Walden University. Once IRB permission was obtained (Approval No. 03-23-20-0123792), the participants were identified based on the inclusion/exclusion criteria and length of time required to meet the one-year post basic telemetry course mark.

Summary

Telemetry interpretation is a common practice for nurses in the acute care environment (Sampson, 2018), including multiple levels of care medical-surgical, progressive, and critical care. There was a gap in the literature related to formal training evaluations (Saks &Burke, 2012) and standardization of telemetry care competencies and education (Sandau et al., 2017). This research study adds to the current body of knowledge and provides data related to the effectiveness of a blended basic telemetry course on telemetry reading proficiency over time. Chapter 3 covered the research design and rationale for the research design including the variables, population selection, sampling procedures, and data collection. The variables were described along with data analysis methods, validity threats, and ethical procedures.

Chapter 4 discusses the data collection procedures, results gathered during the study, statistical analysis findings, display of the findings, and a discussion of the overall results along with challenges, external validity challenges, and support or rejection of the hypotheses.

Chapter 4: Results

Introduction

The purpose of this retrospective analysis design study was to (a) determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at three months, 6 months, and 12 months from 2016 to 2019 post-training as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time and (b) compare the difference in charting of interpretation (correct measurements of: regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who worked in critical care, progressive care, and medical-surgical acute care setting. The research questions and the hypotheses for this research study were:

> *RQ1*: What is the effect of a blended format basic telemetry course on telemetry reading proficiency of ECGs in newly licensed RNs with no telemetry experience who work in acute care settings, as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course?

*H*o1: There will be no effect from a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, six months, and 12 months after a blended format telemetry course.

*H*a1: There will be an effect between a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

RQ2: What is the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6six months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings?

H_o1: There will be no difference charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

H_a1: There will be a difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

Chapter 4 discusses the data collection for this study, including the demographics, statistical results, and demographics.

Data Collection

Data collection was completed during the summer of 2020 after the Institutional Research Board (IRB) from Walden University granted approval (#03-23-20-0123792) and after approval was obtained from the IRB of the healthcare network. Participants were informed via email about the study allowing for them to receive a modified informed consent and the option to not be included in the retrospective chart review. The content of the modified informed consent was approved by the IRB committee at the healthcare network where I collected the data. The data collection took place over the month of June 2020 and took approximately 80 hours to complete.

The healthcare facility where the data were collected has electronic medical records. They used EPIC programs for all the systems. EPIC is the electronic medical record software used by the network in all their facilities. The analytics team formulated a report that I could run to find specific charting related to specific participants in the patient charting system. I reviewed an initial report with an EPIC educator to make sure the report output contained the required data I needed for this study. The program allowed me to find the data on an RN who charted on a patient's cardiac status. I could then find the related scanned telemetry strips for analysis of the RN's telemetry interpretation for this data collection. I searched the telemetry strips since there was no way to formulate a report that gave exact locations of scanned EKG strips for each participant. The data were collected and recorded on a spreadsheet on a secure network computer.

Baseline Descriptive and Demographic Data

The G* Power calculation determined the needed sample size for validity was 98 newly licensed RNs from medical-surgical, critical care, and progressive units (see Table 1). Of the 98 newly licensed RNs, 73 nurses held a bachelor's in nursing, 22 had an associate degree in nursing and 1 had a diploma (see Table 2). Three telemetry strips were collected for each participant at 3 months, 6 months and 12 months for a total of 294 telemetry strips. The most common cardiac rhythms identified were normal sinus rhythm (NSR), atrial fibrillation (Afib), paced rhythms, sinus tachycardia (STach), sinus bradycardia (SB) and atrial flutter (Aflutter). The rest were variations on the above including bundle branch blocks, premature ventricular rhythms, premature atrial beats, and atrioventricular blocks (see Table 3). There were four singular examples of sinus arrhythmia, junctional, accelerated junctional, and ventricular tachycardia. Among the 294 telemetry strips examined 35 were interpreted incorrectly 20 for medical-surgical units, 10 for progressive units, and 5 for critical care units. There was one example of incorrect actions related to the rhythm interpretation.

Table 1

Unit Types

	n	%
Medical-Surgical	32	32.5
Critical Care	32	32.5
Progressive	34	35

Table 2

Nursing Degrees of Participants

	n	%
Bachelor’s	73	74.5
Associate’s	22	24.5

Diploma	1	1

Table 3

Identified Rhythms

	n	%
NSR	139	47
A fib	29	9.8
Paced	27	9.1
S Tach	27	9.1
SB	11	3.7
Aflutter	4	1.3
Variations of above rhythms	53	17.9
Other	4	1.3

Results

To analyze the data for RQ1 I used a repeated measure ANOVA. RQ1 has one IV (blended telemetry course) and 7 DVs of ECG results (correct measurements of: regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and actions taken as a result of interpretation (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest). Each DV was judged as 1 (correct) or 0 (incorrect). The total possible correct score is 7 and ranges to zero. RQ1has one independent factor and a dependent variable with interval data and three factors, in this case timeframes, to meet the requirements of an ANOVA (Green & Salkind, 2014). The assumptions for ANOVA were considered by using three levels of with-in subject factors, the dependent variable was normally distributed, and there was no dependency between the data scores thereby maintaining sphericity (Green & Salkind, 2014). The mean and standard deviation for the DV scores are represented in Table 4. The results for the ANOVA indicated no significant results, Wilk's $\Lambda = .824$, $F(1,27) = 2.78$ $p = <0.1$, $\eta^2 = .176$. The Ho1 was retained for RQ1, there was no significant difference of telemetry reading proficiency over the defined time frames of 3 months, 6 months, and 12 months.

Table 4

Means and Standard Deviations for DV Scores ANOVA

Months	Mean	Standard deviation
3	6.68	.905
6	6.43	.920
12	6.07	1.514

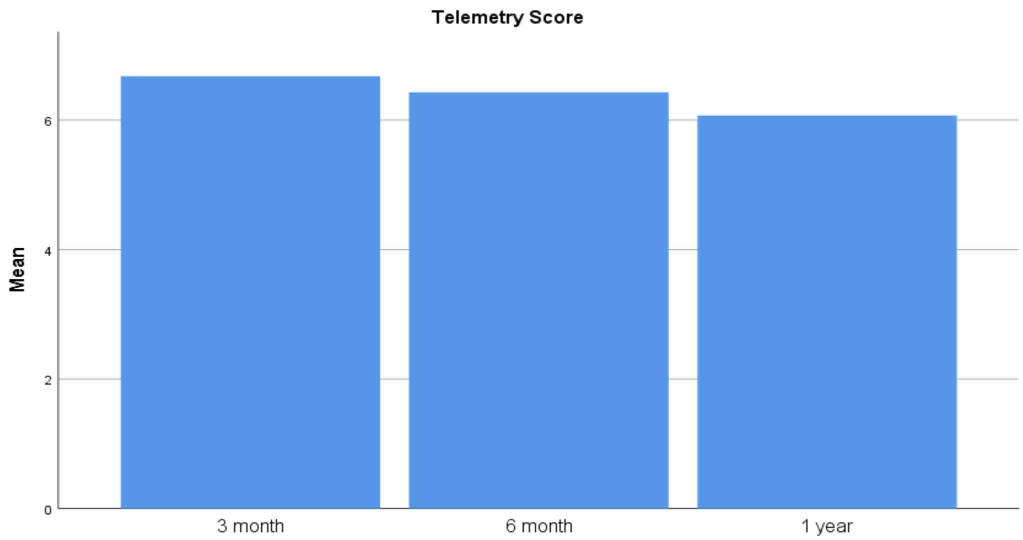

Figure 4. Telemetry scores for medical-surgical, progressive, and critical care units.

In RQ2, I analyzed the proficiency difference among three groups of RNS who took the blended basic telemetry course over time. The IVs are nurses from medical-surgical, critical care, and progressive care units, which I measured over time at three different timeframes (3 months, 6 months, and 12 months) and the DV is the telemetry score to meet the requirements of a MANOVA (Green & Salkind, 2014). The assumptions of a MANOVA were observed by using three quantitative dependent variables, a sufficient sample size was based on G* Power 3.1 analysis, and the dependent variable was normally distributed with no dependency between the data scores thereby maintaining homogeneity (Green & Salkind, 2014). No significant differences were found among the three groups of nurses at the defined timeframes Wilk's $\Lambda = .920$, $F(6, 186) = .132$ $p = <0.1$ (see Table 5). The Ho1 was retained for RQ2, there was no significant difference of telemetry reading proficiency over the defined time frames of 3 months, 6 months, and 12 months comparing nurses from medical-surgical, progressive, and critical care units, see Figure 2.

Table 5

Means and Standard Deviations for DV Scores for MANOVA

Months	Mean	Standard deviation
3	6.52	1.0228
6	6.53	.802
12	6.35	1.285

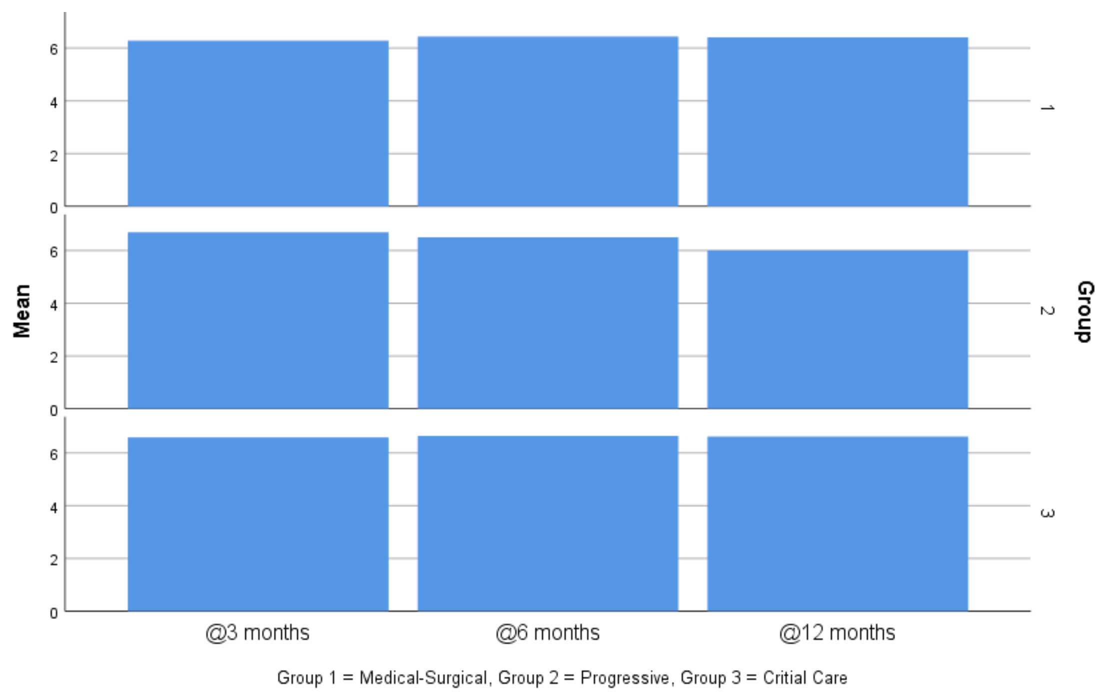

Figure 3. Telemetry scores for medical-surgical, progressive, and critical care units.

Summary

Chapter 4 provided the breakdown of the statistical results for this research. Charts and tables were provided to show the descriptive statistics, ANOVA and MANOVA results. The results showed no significant difference of the effects on telemetry reading proficiency from a basic blended telemetry course over the time periods of 3 months, 6 months, and 12 months comparing three groups of nurses working in medical-surgical, progressive, and critical care units. Chapter 5 covers the interpretation of the findings, limitations of the study, and future recommendations.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this retrospective analysis design study was to (a) determine the effect of a blended learning telemetry course on the telemetry reading proficiency of RNs in an acute care setting at three months, six months, and 12 months from 2016 to 2019 post-training as evidenced by chart audits to assess for level of interpretation of telemetry strips or rhythm identification, documentation, and follow-up to the results over time, and (b) compare the difference in charting of interpretation (correct measurements of: regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who worked in critical care, progressive care, and medical-surgical acute care settings.

The two research questions investigated in this research were:

> *RQ1*: What is the effect of a blended format basic telemetry course on telemetry reading proficiency of ECGs in newly licensed RNs with no telemetry experience who work in acute care settings, as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further

orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course?

*H*o1: There will be no effect from a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months,6 months, and 12 months after a blended format telemetry course.

*H*a1: There will be an effect between a blended format telemetry course on telemetry reading proficiency of ECGs in nurses who work in an acute care setting as evidenced by charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocol, contact physician or advanced practice for further orders, emergent response (RRT), cardiac arrest) at 3 months, 6 months, and 12 months after a blended format telemetry course.

RQ2: What is the difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings?

H_o1*:* There will be no difference charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

H_a1*:* There will be a difference in charting of interpretation (correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation) and action based on ECG results (no action required, follow protocols, contact physician or advanced practice for further orders, emergent response) at 3 months, 6 months, and 12 months after a blended format telemetry course of RNs who work in critical care, progressive care, and medical-surgical acute care settings.

Interpretation of the Findings

Planning a teaching event should take into consideration whether the content will make a lasting positive change on students if they attain the learning outcomes (Caspersen, Frolich, Karlsen, & Aamodt, 2014; Dzelelija & Balkovic, 2014; Hussey & Smith, 2008). The gap addressed in the literature, for this research, was the lack of standardization of telemetry care competencies and education for RNs (Sandau et al., 2017). This research sought to establish the potential for a basic blended telemetry course being effective in developing telemetry reading proficiency for newly graduated RNs. Telemetry proficiency was effectively demonstrated over the period of a year, regardless of the three types of units examined: medical-surgical, progressive, and critical care.

Telemetry Reading Proficiency

Competence for the blended basic telemetry course used in this research, was established by using a posttest or Kirkpatrick's model Level 2 or the degree of learning acquired (Kirkpatrick & Kirkpatrick, 2016). For this study, competence was established by completing the required work for a blended basic telemetry course, both eLearning and workshop, and passing a final test. This research demonstrated Kirkpatrick's level three measurement or change in behavior (Kirkpatrick & Kirkpatrick, 2016). A level three measurement was used to determine if the blended basic telemetry course transfers to behavior changes in actual telemetry patient care by demonstrating telemetry proficiency. Demonstration of competency and telemetry reading proficiency is the ability of a nurse to read and manage a telemetry strip correctly including correct rhythm identification, appropriate treatment, and correct documentation. This research demonstrated evidence of level three measurements by examining the application of telemetry knowledge gained from a basic telemetry course, thru a chart review of the telemetry strips done during patient care. The chart review showed on-the-job application of knowledge learned in a required basic telemetry course. The data related to correct measurements of regular/irregular rhythm, PR interval, QRS, QT/QTC, heart rate, and interpretation and action based on ECG were examined. These are the requirements of telemetry care recommended by AHA and AACN (AACN Clinical Resources Task Force, 2016; Sandau et al., 2017).

This research also sought to determine if time from completion of course and type of patient unit affected telemetry proficiency. This results for this population showed that proficiency was maintained at 3 months, 6 months, and 12 months with no significant change in telemetry reading proficiency. In addition, no significant differences were noted by the type of unit where the patient care was taking place.

Telemetry Education for Newly Licensed RNs

There are several methods for teaching cardiac telemetry including instructor-led, web-based methods, unit-based activities, unit preceptorship and competency validation, self-directed learning, simulation, and hybrid or combinations of methods (Crimlisk et al., 2015; Schultz, 2011, Spiva et al., 2012; Sumner et al., 2012). The new AHA guidelines continue to show support of web-based learning but state that face-to-face approaches may be necessary for students with no telemetry knowledge but recommend that further research is needed to find what teaching methods are most effective (Sandau et al., 2017). This research demonstrated the effectiveness of the blended approach for a basic telemetry course for this population of newly licensed RNs.

Theoretical Implications

I used Benner's middle-range theory of Skill Acquisition in Nursing (1982) and Kirkpatrick's Learning Outcomes Measurement (Kirkpatrick & Kirkpatrick, 2016) to guide this research. Benner's Skill Acquisition in Nursing (1982) was supported by the demonstration of the evolution of telemetry knowledge and telemetry care from beginner in a basic telemetry course to competent with completing the required work and testing successfully to proficient. Proficiency was demonstrated by the new RN independently charting correctly on telemetry strips done during patient care. Benner's theory was the overarching theory used to support the evolution of a new nurse's skill acquisition in telemetry care.

Kirkpatrick's Learning Outcomes Measurement (Kirkpatrick & Kirkpatrick, 2016) was used as a framework to measure the application of knowledge learned from an educational offering and then applied on-the-job. The level 3 measurement was supported by demonstrating what information a new RN took from a basic telemetry course and applied to taking care of a telemetry patient. This framework was used to measure the application of knowledge. Benner's theory was supported by the progression of knowledge to proficiency and Kirkpatrick was used to measure the progression.

Limitations of Study

There are limitations to this research. First, the population used was newly licensed RNs with no prior telemetry experience who completed the requirements of a basic blended telemetry course. This research may only be generalizable to similar RN populations with a similar educational delivery. A multi-site regional healthcare system was utilized, and the research may not be applicable to larger or smaller healthcare systems. The data collected were retrospective and may not apply in the current climate of healthcare settings. The generalizability may be limited to similar settings with a similar method of education. Although telemetry interpretation has not changed recently there is always the chance the care standards and recommendations may evolve.

Recommendations

Future research is recommended to make the findings of this study more generalizable to other populations. Using a similar educational approach of a blended basic telemetry course with varied sizes of healthcare systems and possibly other populations of RNs with no telemetry experience would improve the generalizability of this research. The AHA states that a face-to-face methods of delivering telemetry education maybe necessary for students new to telemetry and eLearning can be used to build on existing knowledge but further research is needed to confirm this educational delivery (Sandau et al., 2017). In this case the combination of methods has proved to be effective for this population, but would need further study to confirm effectiveness for other types of RN populations.

Implications

Positive Social Change

The ANA's (American Nurses Association) position statement on role competence stresses nurses are responsible for maintaining professional competence and that the nursing profession is responsible to guide processes assuring nursing competence (ANA, 2014). Today's healthcare delivery requires structure and processes that lead to positive patient outcomes (Kronick et al., 2015). Positive patient outcomes are an indicator that healthcare is achieving the intention of optimal care for patients. Telemetry is a nursing skill that can lead to better patient care through correct usage. Having the correct teaching methods and content in a telemetry course can lead to more effective and efficient educational delivery. This research has shown the potential of a basic blended telemetry course for effective learning application leading to better patient outcomes through the correct use and proper detection of telemetry issues.

Recommendations for Practice

Telemetry education is varied in the literature with a multitude of methods to deliver the education. The AHA recommendations published in 2017 use the word "education" 74 times in their report (Sandau et al., 2017). Education is clearly an important component of effective telemetry usage. There are no established minimal competencies or educational standards for nurses in the use of telemetry in patient care (Sandau et al., 2017). Further research is recommended to first establish competencies and educational standards for nurses and then to determine the most effective educational way to deliver the information to meet the competencies and standards.

Conclusion

Telemetry is a common tool used to monitor a patient's cardiac status in an acute care setting. Nurses who use telemetry in patient care need telemetry competence or knowledge to read a telemetry strip. This research showed that a blended basic telemetry course can be used to achieve telemetry competence, which led to telemetry proficiency, as evidenced by the retrospective chart review of the various components of telemetry care and interpretation. The knowledge was maintained over the period of a year regardless of the type of unit the nurses were practicing on. A basic blended telemetry course has the potential to be an effective method of teaching telemetry with the result of the knowledge being used in practice.

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