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Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit

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DYSRHYTHMIA MONITORING PRACTICES OF NURSES ON A TELEMETRY UNIT

by

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Abstract

Standards of practice for hospital electrocardiogram monitoring were recommended in 2004 by the American Heart Association; however they are not widely followed. Many nurses monitor in a single lead regardless of diagnosis and are unable to differentiate wide QRS complex tachycardias. The purpose of this project was to evaluate the effectiveness of an interactive web-based education program combined with unit-based collaborative learning activities on both telemetry staff nurses‘ knowledge of dysrhythmias and their monitoring practices for patients at risk for wide QRS complex tachycardias. This interventional, one group before-and-after cohort study design consisted of four components: interactive web-based educational program with a pretest and posttest, unit-based collaborative activities, competency skills validation, and patient audits of electrode placement and lead selection at baseline, six weeks, and 18 weeks. There were 34 nurses who consented to participate, 16 started the program, and nine finished all the components. The pretest scores ranged from 0 – 60% with median of 36.5%. The posttest scores ranged from 47 – 93% with median of 80%. The Wilcoxon Signed Ranks test showed a significant difference between the pretest and posttest scores ($p = .008$). The patient audit results did not indicate significant differences in proportions of correct electrode placement and correct lead selection between baseline, 6 weeks, and 18 weeks. The program was effective in increasing nurses‘ knowledge about dysrhythmias; however, it was not effective in changing monitoring behavior. More research is needed to see if this type of program is more effective if it involves all the staff on the unit who are responsible for monitoring, and if additional strategies are used, such as unit champions and group rewards.

Chapter 1: Introduction

Chapter 1 introduces the challenges and problems with electrocardiogram (ECG) monitoring, provides an abbreviated literature review, and describes the project briefly. It also includes the research questions and definition of terms.

Challenges

Electrocardiogram monitoring in hospitals has become more complex since it was first introduced over 40 years ago (Drew & Funk, 2006). Practice standards for ECG monitoring in hospital settings have been established for arrhythmias, ischemia, and corrected QT (QTc) intervals (Drew et al., 2004). Due to these advances, nurses who work in telemetry and critical care units in hospitals have an important responsibility to monitor patients‘ cardiac rhythms appropriately and to intervene promptly.

Sudden cardiac death or cardiac arrest is defined as ―cessation of cardiac mechanical activity and is confirmed by the absence of signs of circulation" (Lloyd-Jones et al., 2009, p. e32). While ventricular fibrillation (VF) is listed as the cause of relatively few deaths, the overwhelming majority of sudden cardiac deaths from coronary disease (estimated at 310,000 per year) are nonetheless thought to be from VF (Lloyd-Jones et al., 2009). In addition, an acute increase in QTc-interval length is associated with risk for torsades de pointes, a type of polymorphic ventricular tachycardia (VT), which without prompt defibrillation results in syncope and sudden death (Sommargren & Drew, 2007). Consequently, it is important for nurses to recognize these dysrhythmias immediately.

The discharge survival rates following in-hospital cardiac arrests are 27% among children and 18% among adults (Lloyd-Jones et al., 2009). A total of 303 facilities reported 21,748 in-hospital cardiac arrest events to the National Registry for Cardiopulmonary Resuscitation in 2007. Of these, 93% were monitored or witnessed and 17.9% had VF or pulseless ventricular tachycardia as the first recorded rhythm. Furthermore, 79% of the latter individuals received a defibrillation attempt within 3 minutes (Lloyd-Jones et al., 2009). Hospitals that adopt good monitoring practices may impact these statistics favorably.

As wide complex tachycardias are typically caused by several mechanisms, one may find it challenging to recognize the difference between VT and supraventricular ventricular tachycardia (SVT) with aberrancy or bundle branch block (Urden, Stacy, & Lough, 2010). It is important to correctly determine the cause of the tachycardia and treat it appropriately because patients can become hemodynamically unstable very quickly. Analysis of the ECG by a specialist is recommended (Urden et al., 2010; Zipes et al., 2006).

Studies have shown that nurses often monitored in a single lead (regardless of diagnosis), failed to properly prep the skin, misplaced electrodes, and were unable to differentiate wide complex QRS tachycardias, all of which could lead to false alarms or misdiagnoses (AACN Practice Alert, 2008; Drew & Funk, 2006; Funk et al., 2009; Keller & Raines, 2005). To prevent error, nurses working on monitored units need to know how to identify patients who are at risk for potentially lethal dysrhythmias, distinguish between true and false alarms, correctly measure intervals, quickly recognize dysrhythmias, and initiate the appropriate treatment promptly.

The chief executive officers of many hospitals, including the one where this project was conducted, are pursuing Magnet Hospital Recognition for Excellence in Nursing Services, a program sponsored by the American Nurses Credentialing Center ("Magnet Recognition Program Overview," 2009). This project supports three of the 14 forces of magnetism: quality of care, quality improvement, and professional development (Malloch & Porter-O'Grady, 2010), which may help the hospital achieve its goal for magnet recognition.

Abbreviated Literature Review

In 2004, the American Heart Association (AHA) published a scientific statement recommending standards of practice for dysrhythmia monitoring (Drew et al., 2004). Since large randomized clinical trials did not exist, recommendations were classified according to level of evidence and were based on expert opinions. In addition, an executive summary with recommendations on how to implement the AHA standards was written by Drew and Funk (2006). Based on the data from these two documents, the American Association of Critical-Care Nurses (AACN) wrote a practice alert with specific recommendations for skin preparation, electrode placement, lead selection, and QTc interval measurements (AACN Practice Alert, 2008).

The literature was reviewed to determine the best practices for educating staff nurses on ECG or dysrhythmia monitoring. One multi-site randomized clinical trial, called the PULSE Trial, is currently underway to evaluate implementation of the AHA practice standards for dysrhythmia monitoring, but will not be completed until 2013 (Funk et al., 2009). Funk et al. are using an online ECG education program and unit-based strategies led by unit champions to implement and sustain change.

Two studies on effectiveness of written self-study packets for teaching dysrhythmias to nursing staff showed conflicting results. Cadden (2007) found that a self-study learning package, supplemented with unit-based materials and learning activities with an educator, effectively developed staff competency regarding the operation of ECG monitors and the interpretation of arrhythmias. Van Arsdale (1998), however, concluded that a self-instruction reading packet was not as beneficial as instructor-led classes, which he based on lower posttest scores and students' comments that they would have preferred interaction with an instructor.

Jeffries (2005) and Morris et al. (2009) conducted two other studies with nursing staff that evaluated the effectiveness of critical care courses, each including computer-based ECG training. Both studies found that all participants successfully completed the computer-based ECG course and demonstrated competency with ECG interpretation, which was one component of the critical care course.

Due to the limited number of studies on nursing staff, studies that evaluated ECG teaching methods with nursing students were also reviewed. Two studies of nursing students compared interactive computer-based learning formats to traditional classroom instruction on interpreting dysrhythmias and performing12-lead ECG (Jang, Hwang, Park, Kim, & Kim, 2005; Jeffries, Woolf, & Linde, 2003). They found computer-based formats to be just as effective as, if not more effective than traditional formats. Frith and Kee (2003) compared the effectiveness of different instructional communication methods between groups of nursing students who participated in a web-based cardiac rhythm interpretation course. Their results showed that both groups passed the posttest exam and

there were no significant differences between groups concerning exam scores or completion rates.

Studies on the effectiveness of computer-based or web-based teaching methods for ECG were also limited, so the search was consequently expanded to include studies with nursing staff on subjects other than ECG. Belcher & Vonderharr (2005) found that a web-based audio-streaming program on evidence-based practice provided a cost-effective way to educate staff. Dumpe, Kanyak, and Hill (2007) studied the usefulness of an online system to validate employees‘ competencies on the Health Information Privacy and Portability Act (HIPPA) and other nursing competencies, which they discovered was an effective way to reach large numbers of staff. Over 90% of the nursing staff reported they were satisfied with the method and it was easy to use. Another study by Durkin (2008) found interactive computer-based learning was more effective than text-only computer-based learning on the topic of cranial nerve education.

Project Description

This project was designed to improve the quality of care of patients with ECG monitoring and enhance the professional development of the nursing staff on one telemetry unit. It supported the hospital‘s strategic plans for Magnet Recognition and the implementation of evidenced-based practice. It also provided a standardized educational program and competency assessment method which could potentially be implemented on other telemetry or critical care units.

This interventional, one group before-and-after cohort study design consisted of four components:

1) An interactive web-based educational program about evidence-based practice standards for dysrhythmia monitoring of wide QRS complexes with a pretest and posttest, using the organization‘s existing online learning management system.
2) Unit-based collaborative learning activities with other staff nurses, led by the primary investigator, to reinforce knowledge of wide QRS complex dysrhythmias and monitoring practices.
3) Validation of staff‘s competency using a skills checklist which included the placement of electrodes, lead selection, QTc interval monitoring, QRS morphology analysis, and nursing interventions for wide-QRS complexes.
4) Audits by the investigator of electrode placement and lead selection before the interventions (education, unit-based activities, and staff competency validation), at the conclusion of the interventions (6 weeks), and 12 weeks after the interventions (week 18 of the study).

AACN posted a downloadable educational tool kit on their website that included the practice alert, slides, audit tool, and pocket reference card (AACN Practice Alert, 2008; Audit Tool, 2008; Drew, 2002; Richards, 2008). These documents formed the basis for this research and are attached in Appendix A, B, C, and D. Permission from AACN to use these materials is included in Appendix E.

It is important to note both Drew et al. (2004) and Drew and Funk (2006) also recommended continuous ST segment monitoring for patients with acute coronary syndrome and percutaneous coronary interventions, with monitoring in leads other than VI or II. ST segment monitoring was not included in this project because the nurses on

the telemetry unit where it was conducted have already received education and competency validation twice in the past two years on acute coronary syndrome and ST segment monitoring. Patients who required ST segment monitoring in leads other than VI or II were excluded.

The Problem

The discharge survival rate following in-hospital cardiac arrests is 18% among adults (Lloyd-Jones et al., 2009). Studies have shown that nurses often monitored in a single lead regardless of diagnosis, failed to properly prepare the skin, misplaced electrodes, and were unable to differentiate wide complex QRS tachycardias, all of which could lead to false alarms or misdiagnoses (AACN Practice Alert, 2008; Drew & Funk, 2006; Funk et al., 2009; Keller & Raines, 2005).

Evidence-based standards for dysrhythmia monitoring have been established (Drew et al., 2004), but they have not yet been fully adopted in everyday practice on telemetry units. The educator at the hospital where this project was conducted, identified during clinical rounds that the nurses on the telemetry units required further education on locating the correct placement for VI electrode, identifying best lead for monitoring patients, measuring QTc intervals, recognizing bundle branch blocks, and differentiating wide QRS complex tachycardia (T. Debile, personal communication, January 20, 2010).

Therefore, the purpose of this project was to evaluate the effectiveness of an interactive web-based educational program combined with unit-based collaborative learning activities on telemetry staff nurses‘ dysrhythmia knowledge and monitoring practices for patients at risk for wide QRS complex tachycardias. There were two outcomes of interest in this study. The first outcome was that nurses would demonstrate

correct electrode placement and lead selection for arrhythmias, identify when and how to measure QTc intervals, differentiate between wide QRS complexes tachycardias, and describe the appropriate nursing interventions. This outcome was evaluated through the use of pretest and posttest in the web-based educational program and a competency skills checklist. The second outcome of interest was that patients would be monitored in the optimal lead for their arrhythmias with electrodes placed properly on their chest. This outcome was evaluated with an audit tool on electrode placement and lead selection at baseline, 6 weeks, and 18 weeks.

The hypotheses for this study were:

1. There will be no significant differences in nurses‘ pretest and posttest scores.
2. There will be no significant differences in proportion of correct electrode placement at baseline, 6 weeks, and 18 weeks.
3. There will be no significant differences in proportion of optimal lead selection at baseline, 6 weeks, and 18 weeks.

Research Questions

The research questions that this study sought to answer were:

1. What is the effect of a web-based education program on telemetry nurses‘ dysrhythmia monitoring practices over a three month period?
2. What is the quality of evidence for the ―AACN Practice Alert: Dysrhythmia Monitoring Practices‖ (2008)?
3. What is the quality of evidence for the Drew et al. (2004) ―Practice Standards for ECG monitoring in Hospital Settings?‖

4. What are the best practices for educating nursing staff on dysrhythmia monitoring practices or electrocardiography?

Definition of Terms

Bundle branch block. Complete interruption of conduction through the right bundle or the entire left bundle band, which results in QRS 0.12 seconds or longer in duration (Urden, Stacy, & Lough, 2010, p. 376).

Cardiac death or cardiac arrest. Cessation of cardiac mechanical activity confirmed by the absence of signs of circulation (Lloyd-Jones et al., 2009, p. e32).

QRS complex. Represents ventricular depolarization and is normally less than 0.10 second (Urden et al., 2010, p. 367).

QT interval. The total time interval from the onset of depolarization to the completion of repolarization. It is measured from the beginning of the QRS complex to the end of the T wave (Urden et al., 2010, p. 369)

QTc: The QT interval shortens with faster heart rates and lengthens with slower heart rates. Therefore, it is often written as ‗corrected' value QTc, meaning the QT value was mathematically corrected as if the heart rate were 60 beats/min. It is calculated by dividing the measured QT interval by the square root of the RR cycle length. Normal QTc is less than 0.46 second in women and less than 0.45 second in men. Prolongation beyond 0.5 second increases the risk of polymorphic VT (Urden et al., 2010, p. 369)

Supraventricular Tachycardia (SVT). A varied group of dysrhythmias that originate above the AV node, resulting in rates above 100 beats per minutes. Also referred to as a narrow complex tachycardia with QRS that is less than 0.12 second (Urden et al., 2010, p. 382).

SVT with aberrant conduction. Supraventricular tachycardia with a QRS interval of 0.12 second or wider, caused by a delay in conduction through the bundle branches or an anomalous congenital accessory pathway. It is frequently misdiagnosed as VT (Urden et al., 2010, p. 382).

Ventricular Tachycardia (VT). Dysrhythmia caused by a ventricular pacing site firing at a rate of 100 times or more per minute, resulting in QRS complexes of 0.12 second or wider (Urden et al., 2010, p. 393).

Torsades de pointes. Polymorphic form of VT that is very rapid with QRS complexes that appear to twist in a spiral pattern around the baseline. QT prolongation is a contributing factor (Urden et al., 2010, p. 392).

Wide complex tachycardia. Heart rates above 100 with QRS complexes of 0.12 second or wider, which could be caused by VT or SVT with aberrant conduction (Urden et al., 2010, p. 393).

Chapter 2: Review of the Literature

The purpose of this chapter is to present a critical appraisal of the literature to determine the best practices for instructing staff nurses on dysrhythmia recognition and monitoring practices. A literature search was conducted using CINAHL, Medline, and ERIC for nursing research articles utilizing key search terms of *electrocardiography*, *teaching methods*, *critical care nursing staff*, and *computer assisted instruction*. Articles in the past 10 years that contained at least two of these key search terms were critiqued if appropriate. The following three websites were also accessed for evidence on guidelines: Cochrane Collaboration (www.cochrane.org), National Guideline Clearinghouse (www.guideline.gov), and American Association of Critical-Care Nurses (www.aacn.org). (See Appraisal Table in Appendix F for detailed analysis on each article that was reviewed.)

ECG Monitoring Practice Standards

In 2004, the AHA Science Advisory and Coordinating Committee approved a scientific statement recommending standards of practice for hospital ECG monitoring to provide clinicians with information they need in order to monitor children and adults safely and effectively (Drew et al., 2004). Since randomized clinical trials on hospital cardiac monitoring were nearly nonexistent, formal guidelines were not established. The statement provided experts‘ opinions (from three AHA councils and one international society) that were based on clinical experience and related research. Their

recommendations for monitoring arrhythmias, ischemia, QTc intervals and staff training were classified according to a rating system with three classes (see Appendix G). All recommendations were rated either Class I (cardiac monitoring is indicated in most, if not all, patients in this group) or Class II (cardiac monitoring may be of benefit in some patients but is not considered essential for all patients).

Upon analysis with the Appraisal of Guidelines for Research and Evaluation (AGREE) criteria (Hanson, Hoss, &Wesorick, 2008), it was determined that the article by Drew et al. (2004) provided the best available evidence on dysrhythmia monitoring practices available at the time. Their work became the foundation for the standard of practice in subsequent years and other researchers frequently reference them. It was also published on the National Guideline Clearinghouse website and was the most recent set of standards identified and available on this subject.

Drew and Funk (2006) wrote an executive summary of the AHA Practice Standards from Drew et al. (2004) with recommendations for nurses on how to implement them into practice. The key nursing responsibilities were described for arrhythmia monitoring, ST-segment ischemia monitoring, QTc interval monitoring, lead selection, electrode placement, and staff training on ECG concepts and skills. Detailed charts were provided on what content should be included in ECG education, although no recommendations were made on what should be taught in basic or advanced courses. The recommended topics in the guideline charts included electrophysiology concepts, ECG dysrhythmias and abnormalities, and specific monitoring skills.

The AACN is the professional organization that provides certification, education, and evidenced-based resources to nurses practicing in critical care areas, including

progressive care and telemetry units. The AACN has issued over a dozen practice alerts to help close the gap between research and practice and to standardize practice for acute and critically ill patients. In 2008, they published "AACN Practice Alert: Dysrhythmia Monitoring." The Practice Alert summarized the organization's recommendations for dysrhythmia monitoring, including but not limited to:

- selecting Lead VI to diagnose wide QRS complex and Lead II to diagnose atrial activity and measure heart rate;
- placing electrodes in proper placement for accurate diagnosis;
- preparing patient's skin before attaching ECG electrodes; and
- measuring the QTc interval and calculating the QTc using a consistent lead if at high risk for torsades de pointes.

These recommendations were based on supporting evidence from research that was rated level IV or V on a scale of V (Refer to Appendix H). Level IV was defined as "limited clinical studies to support recommendations" (AACN Practice Alert, 2008, p. 2). Level V was defined as "clinical studies in more than one or two patient populations and situations to support recommendations" (AACN Practice Alert, 2008, p. 2). The references for the Practice Alert included the AHA Practice Standards from Drew et al. (2004) and Drew and Funk (2006).

In a related evidenced-based medicine article on electrocardiography, Zipes et al. (2006) reported on practice guidelines for management of ventricular arrhythmias, including diagnosing, medications, implanted devices, ablation, and surgical interventions developed by the American College of Cardiology, the American Heart Association, and the European Society of Cardiology. They classified recommendations

in three classes (I, II, III) and three levels of evidence (A, B, C) with 1,085 references (See Appendix I). Important nursing implications that were included in this analysis were how to manage specific arrhythmias, what symptoms to assess, and when to obtain a resting 12-lead ECG (e.g. for all patients who were being evaluated for ventricular arrhythmias). These guidelines may also be found on the National Guideline Clearinghouse website.

Research on ECG Monitoring Practice Standards

Currently, one study called the PULSE Trial is being conducted to evaluate the implementation of the AHA practice standards for ECG monitoring on nurses' knowledge, quality of care, and patient outcomes (Funk et al., 2009). It is a 5-year multi-site randomized clinical trial on adult cardiac units at 17 hospital sites in the United States with a projected completion data in 2013. The interventions involve an online ECG education program as well as strategies to implement and sustain change, each led by unit champions. The online education program consists of four interactive modules alongside incentives to complete both the modules and posttests (paid leave time, continuing education credit, and a $40 gift card). The unit champions are advanced practice nurses who implement change strategies such as mentoring, case studies, monitoring rounds, and random checks; these strategies, however, are still being developed at this time (B. Drew, personal communication, January, 2010).

In the PULSE Trial (Funk et al., 2009), quality of care data to be collected is electrode placement and lead selection by direct observation, arrhythmia detection and interpretation by reviewing the monitors and nurses' documentation, and finally the appropriateness of monitoring by reviewing current medical records. The outcomes to be

evaluated are mortality, lengths of stay, and the rates of life-threatening arrhythmias or new myocardial infarctions. One half of the hospitals were randomized to receive the intervention during the first year, and the other half of the hospitals will receive intervention during the second year. The quality of care and patient outcomes will be measured at baseline, after one year, and at the end of two years.

Funk et al. (2009) presented their baseline data on 1,821 patients and it revealed substandard ECG monitoring. This included incorrect electrode placement, inaccurate rhythm interpretation, over-monitoring for arrhythmias, under-utilization of ischemia monitoring, and failure to monitor for QTc prolongation when indicated.

ECG Teaching Methods for Nursing Staff

The preceding study by Funk et al. (2009) was the only study found that evaluated the implementation of the AHA practice standards for dysrhythmia monitoring. The effectiveness of the education program is not yet available, so a literature review was conducted to determine the best practices for teaching nurses about ECG and monitoring practices.

One qualitative study was conducted by Keller & Raines (2005) on nurses‘ perceptions of which arrhythmias should be categorized as basic, intermediate, or advanced. A focus group methodology was conducted on a tiered schedule over one year with 25 critical care nurses from three large metropolitan community hospitals. Critical care nurses categorized heart blocks, aberrant conduction, and tachyarrhythmias as advanced arrhythmia knowledge. The authors concluded there was a significant lack of ability on the part of the nurses to recognize these arrhythmias. This study provided

evidence for developing levels of arrhythmia competency and the need for ongoing education after a basic dysrhythmia interpretation course.

Four different methods for teaching cardiac dysrhythmias were compared by Van Arsdale (1998). The study was conducted at three moderate sized hospitals in a rural setting over two years using 244 registered nurses from the emergency room, critical care, and telemetry units. The two most effective methods for teaching arrhythmia interpretation to staff nurses were those with instructor-led classes in two-hour sessions conducted once a week over 10 weeks (Group 1) and those conducted twice a week over five weeks (Group 2), as evidenced by significantly higher posttest scores than the following two groups. All of the nurses from Group 3, who received a one week course with two-hour sessions twice a day, indicated too much new information was presented and they felt uncomfortable with their skills. Almost all of the nurses (91%) in Group 4, who received the self-instruction reading packet, indicated some classroom sessions would have been beneficial for asking questions or discussing rhythms. Limitations of this study included that the nurses were not randomized to groups, analysis was not provided on whether the groups were similar, and the course did not include bundle branch blocks. In addition, the self-study packet did not include any form of computer-assisted instruction.

Cadden (2007) described methods used to teach cardiac monitoring to 17 nursing staff who worked on a stroke unit. Training was required because the unit was adding cardiac monitoring and the nurses did not have prior training in ECG interpretation. This study found that a self-study learning package, supplemented with bedside resource tools, unit-based practice sessions, and collaborative learning activities, effectively developed

staff competency for interpreting arrhythmias and operating ECG monitors. These findings contrast with results found by Van Arsdale (1998), who did not include any unit-based materials or activities to supplement the self-study packet. Some limitations of this study included no control group and the psychometric evaluation of the exam instruments was not reported.

The effectiveness of an online critical care course was studied by Jeffries (2005). There were 15 participants who were taking the course primarily for professional development and continuing education credit, except three individuals who were senior baccalaureate students. The 10-week course included 10 interactive computer-based modules, one of which was dysrhythmia recognition, 112 clinical hours with a preceptor in the critical care unit, and access to a Virtual Center of Best Practices, or resource center. This course was designed using an instructional model based on seven principles of best practices of undergraduate education (Chickering & Gamson, 1987). The online program consisted of mini-lectures, vignettes of patient scenarios, and interactive activities such as games, a discussion board, a diary of reflections, and various web links. Pilot testing of this course showed that all students were able to both successfully complete the course with passing test scores and demonstrate the required competencies. The investigator concluded that nurses could learn critical care concepts and skills through e-learning. Limitations of this small pilot study were the passing criteria for the tests were not defined and the skill competencies which were assessed by the preceptors were not described in the article.

Morris et al. (2009) measured the outcomes of a critical care course, of which one component was an online web-based ECG tutorial, designed to train the 173 critical care

nursing staff who participated. Nurses were assigned to one of three groups based on experience level and the orientation program for each group was tailored to their needs. The program used multiple teaching strategies that included unit specific orientation with preceptors, case studies, human patient simulations, three computerized-assisted online learning modules, instructor-led modules, reference material on compact disc, and pocket guides. One limitation of this study was that the results could not be attributed to any one teaching strategy, since the model included all of them.

One strength of the above critical care orientation model by Morris et al. (2009) was that they evaluated multiple outcomes in five cohorts over three years. The results revealed improved retention rates, decreased turnover/vacancy rates, and increased satisfaction of preceptors, educators, and managers. Three computerized assisted online learning modules, including a web-based dysrhythmia tutorial, were essential parts of the model and nurses achieved passing rates of 85% or higher. The simulations in the lab and the pocket cards were rated the most useful by the nurses (each scoring 4.85 on a 5 point Likert scale, 5 indicating highly useful). The length of the orientation was unchanged and the cost was increased, due to licensing fees for web-based programs and the need for a fulltime education consultant. The authors concluded that the additional cost was offset by increased retention of the nurses.

ECG Teaching Methods for Nursing Students

Since there were limited nursing research studies on evaluating effectiveness of ECG training programs with nursing staff, and none of them compared traditional formats to computer-based or web-based formats, the search was expanded to include research on the effectiveness of ECG training programs with nursing students. For

example, Jang et al. (2005) studied the effectiveness of an ECG course for nursing students using a quasi-experimental design with pretest/posttest design. In a non-randomized convenience sample, 54 students completed the web-based ECG course and 51 completed the traditional lecture method. Both programs lasted 16 weeks and were conducted in different time periods. Differences were documented between web-based and lecture-based teaching methods in two of four areas studied; the group who received the web-based program had higher scores in ECG dysrhythmia interpretation but lower scores in knowledge of ECG principles. No differences were seen between groups on satisfaction and motivation.

Jeffries et al. (2003) compared a traditional instructor-led program to a student-led program using a compact disk read only memory (CD ROM) to teach students how to perform 12 lead ECGs. Both groups received the same self-study module, but the experimental group received an interactive, multimedia CD ROM embedded with virtual reality instead of traditional lecture and demonstration. The results showed that both groups experienced significant improvement from pretest to posttest scores with no considerable differences between groups. The authors concluded that instructor-led classroom teaching and student-led self study with interactive multi-media CD ROM were each equally effective in teaching skills for performing 12-lead ECGs. Both methods were similar in students' self ratings of satisfaction and self-efficacy. The researchers reported high validity and reliability of the questionnaires and inter-rater reliability for the procedural checklist. Even though this course did not include instruction about dysrhythmia recognition, it did include instruction on correct lead placement, which is relevant to this project.

An experimental study was conducted by Frith and Kee (2003) that compared the effectiveness of different communication methods between the instructor and nursing students in a Web-based course on cardiac rhythm interpretation. The outcomes measured were students‘ cognitive learning on midterm and final exams, their satisfaction with the computer-assisted format, and the motivation to complete the online course. Both groups received the same online didactic content. Initially, 175 students were randomly selected and assigned to a group, but only 75 students completed it (35 in control and 40 in experimental). The control group received an internal-only conversation method, which limited instructor communication with students regarding directions or answering questions about content or technical problems. The experimental group had access to frequent online communication between both the instructor and the students. Students worked together on case studies, utilizing online chats to enhance their understanding of the self-test. The instructor led chat sessions, contributed to discussion forums, provided online office hours, and emailed answers to questions. The results showed significant differences in satisfaction between groups, but not in exam scores or completion rates. This may have been because the instructional design methods were too similar.

Web-based or Online Methods to Nursing Staff on other Subjects

Only two studies were found on ECG teaching methods that compared effectiveness between computer-assisted and traditional lecture format (Jang et al., 2005; Jeffries et al., 2003). The other two studies with web-based ECG teaching methods utilized multiple teaching strategies during critical care courses and the teaching methods were not evaluated separately (Jeffries, 2005; Morris et al., 2009). As a result, the

literature search was expanded to include other subjects besides ECG that were taught to nursing staff using web-based formats.

Belcher and Vonderharr (2005) developed a web-based educational program to teach nursing staff about evidence-based practice. The program included audio-streamed content alongside video slides, graphics, text, and interaction with content and instructor by email (although no staff nurses used the email). They found that a web-based program provided a cost-effective way to educate staff on evidence-based practice principles. This study lacked a control group for comparison, however, and evaluations were self-reported by participants with no validation of competency or learning.

Another study on the usefulness of online programs via the organization‘s learning management system was conducted by Dumpe et al. (2007). First it was used to validate employees‘ competencies on the Health Information Privacy and Portability Act (HIPPA). Later, a program was developed with 16 annual online competencies to be completed by nursing staff (subjects not provided). Over 18,000 personnel completed the HIPPA competency and 4,064 nurses logged onto the learning management system to access the nursing competencies (percentage of staff was not provided). Surveys showed that 90% of the nurses reported they were satisfied, or very satisfied, with the system; 92% reported it was easy, or very easy, to complete; and lastly, 87% reported they were able to complete the competencies on their own unit.

Durkin (2008) compared differences between text-only computer-based learning and interactive computer-based learning on cranial nerve education with 41 nurses on a medical patient care unit. Nurses were randomly assigned to the groups and 31 completed all of the requirements (13 in text-only group and 18 in the interactive group).

The interactive program included the same text document as the other group, but in addition their program included humor, color, animation, review questions, interactive games, and several cycles of repetition. Both groups showed significant improvement between pretest and the first posttest, but only the interactive group had significantly higher scores on the second posttest taken a few weeks later. The author concluded that the interactive computer-based learning was more effective than text-only computer-based learning when promoting learning and retention.

Best Practices in E-learning

Over the past decade, computer-based teaching methods (or e-learning) have evolved from an experimental method to a ―mainstream staple for teaching everything from life-saving medical procedures to spiritual vision" (Horton, 2006, p. 1). E-learning is defined as ―the use of information and computer technologies to create learning experiences" (Horton, 2006, p. 1). Horton described eight steps that should be followed when designing e-learning courses:

1. Identify your underlying goal and align it with the organization's goals
2. Set learning objectives
3. Identify prerequisites
4. Decide the teaching sequence of our objectives
5. Create objects to accomplish objectives
6. Create tests
7. Select learning activities (―absorb, do, connect" as described below)
8. Evaluate and re-design but do not repeat

Horton then recommended that three types of learning activities should be incorporated into e-learning courses: absorb, do, and connect. Absorb activities are when the learner is passive but mentally active, such as reading, listening, and watching. Do activities involve active participation on the part of the learner with the content, such as practicing a procedure, playing a game, or answering questions. Connect activities require the individual to relate what they are learning to their work, lives, or prior learning (Horton, 2006).

Two of the educational programs described above (Jeffries, 2005; Jeffries et al., 2003) were based on the seven principles for good practice in undergraduate education (Chickering & Gamson, 1987). These principles include:

1. Encourages student-faculty contact;
2. Develops reciprocity cooperation among students;
3. Uses active learning techniques;
4. Gives prompt feedback;
5. Emphasizes time on task;
6. Communicates high expectations;
7. Respects diverse talents and ways of learning (Chickering & Gamson, 1987, p. 3)

In an online critical care course, Jeffries (2005) made a direct comparison of Chickering and Gamson‘s seven principles of best practices to the program components. Students perceived that the principles of best practices in education were highly incorporated into the online course. When teaching how to perform 12-lead ECGs, Jeffries et al. (2003) based the learning method on Chickering and Gamson‘s seven principles of best practices in education. The participants in both studies successfully

completed the courses with passing test scores, met the required competencies, and reported satisfaction with learning method.

These principles have been widely used and applied in education over the years for classes and online education for other students besides nurses (Chickering & Ehrmann, 1996; Koeckertiz, Malkiewicz, & Henderson, 2002). These two articles were not research studies, but provided explanations of how all seven principles were applicable to online programs.

Evaluation of the Evidence

The AHA Practice Standards (Drew et al., 2004) provided the best available evidence to support the AACN Practice Alert recommendations for dysrhythmia monitoring. Only one study was found that is currently being conducted to evaluate the implementation of AHA Practice Standards for ECG monitoring (Funk et al., 2009). Although the results are not yet available, their interactive online education modules and unit-based change strategies, led by a unit champion, are similar to the design of this study, which will utilize an interactive web-based education program and unit-based collaborative learning activities that are led by the primary investigator.

There were no studies found on the best way to teach the dysrhythmia monitoring practices contained in the AACN Practice Alert. Consequently, studies that investigated methods for teaching ECG were critiqued. The studies on ECG instruction described in the preceding section used different research designs and variable teaching methods (from instructor-led to online, or a combination of both). Although most of these studies did not provide specific information regarding which dysrhythmias were included in their ECG courses, all of them were concerned with the initial instruction of nurses or nursing

students. Accordingly, it is difficult to make direct comparisons between the best practices for teaching dysrhythmia monitoring skills and advanced arrhythmia interpretation to nursing staff.

After appraising the literature, the best practices for teaching cardiac arrhythmias and monitoring skills to nursing staff in the hospital setting were determined to be interactive computer-based programs when combined with unit-based activities and skills validation (Cadden, 2007; Jeffries, 2005; Jeffries et al., 2003; Morris et al., 2009). These programs should utilize the seven principles of good practice in undergraduate education established by Chickering and Gamson (1987), which are also applicable to online learning (Chickering & Ehrmann, 1996; Koechertiz et al. 2002).

Listed below are suggestions on how these principles were applied to this project and the evidence in the literature that supported these strategies. Also refer to Appendix J for a summary of principles of good practice and how they correlate with evidence-based strategies for teaching nursing staff.

1. Student-educator contact was fostered in the online program by providing the students with the instructor‘s email (Belcher &Vonderharr, 2005; Frith & Kee, 2003). The investigator also established regular times on the unit to reinforce learning (Cadden, 2007; VanArsdale, 1998).
2. Cooperation among staff nurses was encouraged by planning opportunities for nurses to collaborate on interpreting dysrhythmia strips or ECGs (Cadden, 2007). Online discussion forums were not as useful for this hospital setting because learners were only expected to access the program one time (Dumpe et al., 2007).

3. Active learning activities were integrated throughout the online program by using case studies, games, and self-check practice questions. Active learning was also reinforced by requiring return demonstration of skills with competency assessment checklists (Cadden, 2007; Durkin, 2008; Frith & Kee, 2003; Jeffries, 2005; Jeffries et al., 2003; Morris et al., 2009).
4. Prompt feedback to answers on practice questions was built into the online course through the use of self-check questions interspersed between power point slides (Jang et al., 2005; Frith & Kee, 2003). When the investigator met with the nurses on the unit, immediate feedback was provided when each nurse completed an objective from the skills checklist (Cadden, 2007; Jeffries, 2005; Morris et al., 2009).
5. Time on task was provided through the online course because nurses could access the program on the internet from home or work at the learner‘s convenience (Belcher &Vonderharr, 2005; Dumpe et al., 2007; Durkin, 2008; Jang et al., 2005; Jeffries, 2005). The program was designed with a ―home" button so learners could return to the table of contents and navigate back and forth within the program as they wished (Durkin, 2008; Jang et al., 2005; Jeffries, 2005; Jeffries et al., 2003). Time on task was also reinforced by providing continuing education credits for each individual who completed all components (Belcher &Vonderharr, 2005; Frith & Kee, 2003; Keller & Raines, 2005).
6. High expectations were communicated through learning objectives and evaluated with pretest and/or posttest questions (Belcher &Vonderharr, 2005; Durkin, 2008; Jang et al., 2005; Jeffries et al., 2003). A competency skills checklist was also

used to reinforce what skills should be accomplished (Cadden, 2007; Dumpe et al., 2007).

7. Respecting diverse ways of learning was promoted by incorporating a variety of teaching methods, such as utilizing audiovisuals and graphics in the computer program, supplying printed materials and pocket reference cards, and offering interactive hands-on activities on the unit (Belcher & Vonderharr, 2005; Cadden, 2007; Durkin, 2008; Jang et al., 2005; Jeffries, 2005; Morris et al., 2009).

In conclusion, based on the findings in this literature review, there is evidence to support using an interactive web-based learning format for teaching dysrhythmia monitoring practices to nursing staff. The program should include Chickering and Gamson‘s (1987) seven principles of good practice in undergraduate education. The effectiveness can be enhanced by using unit-based collaborative activities led by an instructor and validating nurses‘ competency with a skills checklist. Nurses‘ participation can be reinforced by offering continuing education credit.

Chapter 3: Design and Methodology

The focus of this chapter is to explain the design and methodology of the study. The design was an interventional one group before-and-after cohort study. The purpose of this project was to evaluate the effectiveness of an interactive web-based education program combined with unit-based collaborative learning activities upon telemetry staff nurses‘ dysrhythmia knowledge and monitoring practices for patients at risk for wide QRS complex tachycardias.

Sample

The sample consisted of staff nurses who have worked at least three months on a telemetry unit (4 Center) at a private 500 bed religious-based hospital in northeast Florida. Permission to conduct this study on the nursing unit was obtained from the nursing manager (see Appendix K). The ages of the nurses ranged between 21 and 65. All nurses who were hired on the unit completed a basic dysrhythmia course and passed a dysrhythmia test during their first three months. The basic course did not include bundle branch blocks or differentiating wide QRS complex tachycardias. There were some nurses who floated to the unit from a pool or other telemetry units, and they were included if they floated regularly to the unit (at least once every two weeks) and agreed to participate. All nurses worked 12-hour shifts, either 7 AM to 7 PM or 7 PM to 7 AM. Demographic data were obtained from the nurses who completed the web-based education program. It included age, gender, ethnicity, highest educational degree, years

licensed as a registered nurse, length of time worked on that unit, dysrhythmia education, experience with online learning or web-based instruction, and whether English was a second language or not (see Appendix L).

The patients on this adult 38-bed telemetry unit were all continuously monitored, typically aged 40-90 years of old, although occasionally some were younger or older. While most of the rooms were private, one room was semi-private. Most patients had several chronic medical conditions and co-morbidities. The most common diseases included coronary artery disease, congestive heart failure, diabetes, chronic obstructive lung disease, renal failure, and anemia. A smaller percentage of the patients had a history of recent surgeries, cardiac catheterizations, endoscopies, or other procedures. Demographic information was obtained and reported as aggregate data on age, gender, ethnicity, and admitting diagnoses for the patients who were audited.

Inclusion and exclusion criteria were established for both nurses and patients. Inclusion criteria were as follows:

- Nurses who worked at least three months on 4 Center and agreed to participate in the study.
- Nurses who floated regularly to the unit (at least once every two weeks) and agreed to participate in the study.
- All patients who were present on the day of the audits and did not need ST segment monitoring in other leads besides VI or II, which included current diagnoses of acute coronary syndrome, chest pain, angina, and myocardial infarction.

The exclusion criteria were as follows:

- New orientees who started within the past three months and were still in the new employee probationary period.
- Patients who needed ST segment monitoring in leads other than VI or II, which included current diagnoses of Acute Coronary Syndrome, Chest Pain, Angina, and Myocardial Infarction.

This was not an experimental study and subjects were not randomized. Bias was minimized by including all staff nurses and all patients on the unit who met the inclusion criteria. The patient audits of electrode placement and lead selection were a part of ordinary and standard care for patients being monitored on telemetry units.

All nurses who met the inclusion criteria were invited to participate. After approval was obtained from the Institutional Review Boards (IRB) at the hospital and University of North Florida (UNF), the investigator invited nurses to participate by meeting with them on the unit, posting a flyer, and placing information in their mailboxes (See Appendix M). The investigator then returned on both shifts to meet with them, explain the study, and encourage them to participate. If they refused, the investigator did not ask the nurses more than once to participate. Staff were given two weeks to complete the learning program before unit based activities were scheduled.

The nurses‘ participation in the study and inclusion in the results were voluntary. As an incentive to participate, laminated pocket reference cards and continuing education credit for 2.5 hours were offered free of charge to those who completed all the components.

Methods

This interventional, one group before-and-after cohort study design consisted of four components:

1) An interactive web-based educational program about evidence-based practice standards for dysrhythmia monitoring of wide QRS complexes with a pretest and posttest, using the organization‘s existing online learning management system.
2) Unit-based collaborative learning activities with other nurses, led by the primary investigator, to reinforce knowledge of wide QRS complex dysrhythmias and monitoring practices.
3) Validation of staff‘s competency using a skills checklist that included the placement of electrodes, lead selection, QTc interval monitoring, QRS morphology analysis, and nursing interventions for wide-QRS complexes.
4) Audits by the investigator of electrode placement and lead selection prior to interventions (education, unit-based activities, and staff competency validation), when the interventions are concluded (6 weeks), and 12 weeks later (week 18 of the study).

There were two outcomes of interest in this study. The first outcome was that nurses would demonstrate correct electrode placement and lead selection for arrhythmias, identify when and how to measure QTc intervals, differentiate between wide QRS complexes tachycardias, and describe the appropriate nursing interventions. This outcome was evaluated through the use of pretest and posttest in the web-based educational program and a competency skills checklist. The second outcome of interest

was patients would be monitored in the optimal lead for their arrhythmias with electrodes placed properly on their chest. This outcome was evaluated with an audit tool on electrode placement and lead selection at baseline, 6 weeks, and 18 weeks.

Time Frame

The time frame for this study was 18 weeks. The study was initiated in May, 2010, and completed in September, 2010. IRB approval was obtained in April from the hospital and the UNF. The web-based educational program was created and loaded in the hospital's learning management system during April and May.

When the web-based educational program was ready, the investigator conducted the first audit of electrode placement and lead selection to obtain a baseline before the interventions. Flyers were posted in the lounge and in their mailboxes (see Appendix M for the Recruitment Announcements). The investigator informed nurses about the program and gave them written instructions on how to access it. After the nurses expressed an interest in participating in the study, the investigator obtained their written consent (see Appendix N for Informed Consent). Nurses were allowed up to six weeks to complete the educational program, unit-based activities, and competency skills checklist. During that time the investigator went to the unit three or four times per week on both shifts to remind nurses to complete it, offer assistance with registration, and scheduled times to conduct the unit-based activities. At the end of 6 weeks, the second audit of electrode placement and lead selection was done. The final audit was conducted at the end of 18 weeks.

Web-based Educational Program

The web-based educational program and unit-based collaborative learning activities incorporated the seven principles of good practice in undergraduate education (Chickering & Gamson, 1987; Chickering & Ehrmann, 1996; Koeckertiz et al., 2002). Horton's eight steps for designing e-learning courses were also used, including absorb, do, and connect activities (Horton, 2006).

The overall design of the program included introduction, demographic survey, pretest, educational program, posttest, and course evaluation (see Appendix O for Format of Learning Program). The demographic data from the nurses were obtained electronically through the software before they began the educational program. The pretest was imbedded in the software and required before they began the educational program. A home page with a table of contents for the educational program was accessible in order for them to navigate easily from one section to another and repeat a section if they desired to do so. The program was set up in such way that the participant must attempt all of the other sections before taking the posttest. A link was inserted for the hospital's emergency standing orders from their procedure manual, for each nurse's convenience. A reference list was also included at the end of the program.

The educational program was based on the PowerPoint "Dysrhythmia Monitoring Practices" downloaded from AACN's website (Richards, 2008) (as shown in Appendix B). An audio script, based on articles in the reference list, was prepared for each slide of the PowerPoint and the audio ".wav" files were imbedded in the slides so that they played automatically (See Appendix P for audio script). The learners could print the PowerPoint

with script after they completed the pretest. The objectives of the educational program were as follows.

1. Describe the skin preparation and correct placement for the five electrodes monitoring system.
2. Identify the optimal lead to monitor patients for their diagnoses or arrhythmias.
3. Recognize the difference in QRS morphology between bundle branch block aberrancy and ventricular ectopy.
4. Calculate the QTc interval from a single lead strip.
5. Describe which drugs or conditions prolong the QTc interval and the potential complications that may result from a prolonged QTc interval.
6. Describe nursing interventions for SVT with bundle branch block aberrancy and for ventricular tachycardia.
7. Analyze case studies with wide QRS complex tachycardias on 12 lead electrocardiograms and differentiate between supraventricular tachycardia with aberrancy and ventricular tachycardia.

The educational program also contained interactive activities developed by the primary investigator, consistent with absorb, do, and connect activities recommended by Horton (2006). The absorb activities consisted of reading and listening to the online program. The do activities were done in the educational program through use of the self-check questions interspersed throughout the slides, ending with a Million Dollar Game (available in Lectora software). The do activities were also accomplished on the unit by completing the skills checklist on the unit. The connect activities consisted of two cases studies on torsades de pointes in the educational program, and unit based activities with

two ECG case studies on a poster and ECGs on their patients on the unit. (Refer to Appendices Q, R, S, and T for the questions in the Test Bank, Case Studies, Million Dollar Game, and Unit-based Activities Poster).

Additional ECG figures were used with permission to enhance the self-check and test questions (Drew, 2007; Jacobson, 2006; Jacobson, 2007; McClennen, Nathanson, Safran, & Goldberger, 2003; Nathanson, McClennen, Safran, & Goldberger, 2007; Pelter & Carey, 2006; Sommargren & Drew, 2007; Zipes et al., 2006). Copyright rules were observed for fair usage of any ECGs used in the educational program or unit-based activities and permission was obtained as necessary (Copyright Basics, 2008). Refer to Appendix U for permission to use these published materials.

The content validity of the educational program was verified by three experts who were familiar with the subject and served as the Clinical Resource Coordinators (nursing educators) for the telemetry and critical care units (refer to Appendix V for content validity evaluation). All nursing educators ―strongly agreed" that the materials used from the AACN website were current and accurate. They ―strongly agreed" that the interactivities and test questions were based on relevant literature and reinforced the content in the power point slides. Two ―strongly agreed" that the audio script was relevant and reinforced the content; one ―disagreed" primarily because she found it difficult to read the slides and listen to the audio at the same time. When asked if the instructional method was effective for this topic, two marked ―strongly agree" and the other answered ―strongly disagree" because she thought it would be too hard for the staff nurses who have not had prior 12 lead ECG training. Two of the nursing educators

commented that they wished they had printed the program because they thought they would have understood the content better if they could read it.

Unit-based Collaborative Learning Activities

The unit-based collaborative learning activities consisted of learning exercises that the staff nurses completed together in small groups or with the investigator. The activities included conducting audits on correct electrode placement and lead selection, evaluating monitor strips and 12 lead ECGs in the current medical records, locating QTc intervals on ECGs, analyzing dysrhythmias using pocket reference cards on cardiac monitoring (Drew, 2002) and interpreting 12 lead ECGs displayed on a poster. On the poster were two case studies with 12 lead ECGs (Nathanson et al., 2007), one showing SVT with aberration, and the other VT. (See Appendix T for a photo of the poster displayed on the unit).

The primary investigator was present on the unit between two and four times a week on both shifts (25 visits over four weeks) and conducted unit based activities with the nurses who reported they had completed the online program. The dates and times of these activities were posted on the unit and offered during their working hours at non-peak times. The primary investigator gave the laminated pocket reference cards to the nurses who completed the learning program (see Appendix C). It took approximately 20-30 minutes to complete the activities with the investigator.

The unit-based collaborative learning activities concluded with the completion of a competency skills checklist with the investigator, which was conducted privately between the nurse and investigator (see Appendix W). If nurses were unsure about something, the investigator provided additional instruction and another opportunity to

demonstrate competency if needed. When verifying placement of electrodes on a patient, the instructor relayed expectations prior to entering the room, gave feedback nonverbally while inside (such as pointing to the correct landmark on the patient‘s chest), and discussed it later outside the patient room. A continuing education certificate for 2.5 contact hours was given to each participant who completed all of the components.

Project Evaluation Plan

The "Audit Tool for Electrode Placement and Lead Selection" and directions for use are included as an attachment in Appendix D (Audit Tool, 2008). The investigator audited all patients on the unit at baseline, 6 weeks, and 18 weeks. The questions on the tool (listed below) were answered with yes or no responses, unless there was an improper lead selection, in which case the incorrect lead was checked.

1. Are electrodes placed in the appropriate anatomical regions?
2. If electrodes are not properly placed, identify the incorrect lead(s) and document any contraindications.
3. Has the appropriate lead been selected based on the patient's actual or potential dysrhythmia? (Audit Tool, 2008, p. 1).

A pretest and posttest were used to evaluate the learner‘s knowledge of the content (See Appendix X). The pretest consisted of 15 multiple-choice, true-false, or matching questions and it could only be taken one time. The posttest consisted of 15 multiple-choice, multiple answers, true-false, or matching questions, similar to, but not identical with, the pretest questions. Both tests had the same number of questions per objective, which was between one and three questions per objective. The tests were

evaluated for content validity and reliability by three nursing experts who were nursing educators at that hospital and familiar with the topic (see Appendix Y).

The staff nurses were asked to complete an evaluation form after they finished the educational program. They were informed that their evaluations would be reported in the aggregate in table format. The form that was used was the same one used by the hospital's education department to evaluate continuing education programs. It included questions and answers with a five point Likert scale (see Appendix Z).

The nurses‘ competencies were validated with a competency skills checklist, which was developed by the investigator with feedback from the nursing educators (see Appendix W). It also included documentation of the unit-based collaborative activities. The nurses' performance was rated according to the standard three-level criteria the hospital has used in the past for other competency assessments (2 = Competent, 1 = Needs Improvement, 0 = Not Competent). A satisfactory skills checklist was defined as competent in all objectives.

Feasibility

This project was designed to improve the quality of care for patients with ECG monitoring and enhance the professional development of the nursing staff on a telemetry unit while simultaneously supporting the hospital‘s strategic plans for Magnet Recognition and the implementation of evidenced-based practice. It also provided a standardized educational program and competency assessment method that could be used for nurses‘ annual competency assessment. Feedback on the program and skills competency checklist was obtained from the nursing educators. The education program,

unit-based learning activities, and competency skills checklist had the potential to be implemented on other telemetry or critical care units.

For the past 3 years, the hospital has used an online learning management system for staff education and annual competency evaluation. A computer with internet access is required, which may be accessed from hospital computers or home. A user ID and password (provided to all employees) are required to access the learning management system. The investigator asked an educator authorized by the Director of Education to retrieve the test scores, demographic data, and program evaluation summary. The demographic data and evaluations of the education program were confidential and only available as aggregate data.

The primary investigator provided the educational material, test questions, informed consent, and demographic data in Microsoft Word or PowerPoint format to the Instructional Designer in the Education Department at the hospital. The Instructional Designer loaded it into the learning management system using software by Lectora. A pilot test of the educational program was then conducted by the investigator and three nursing educators to ensure correct functioning. Only one problem was found with a self-check question and it was corrected before nurses were invited to participate. The primary investigator‘s contact information was included in the educational program software in case any nurses had questions about the content or problems occur with the software. An application for continuing education credit was completed by the investigator and the program was approved by the Director of Education for 2.5 contact hours.

Income and Expenses

The income for this project was $1,250 (from a graduate fellowship and scholarship grant). The expenses for this project were estimated to be $2,723.69 for the investigator and $425 for the hospital (see Appendix AA). The hospital did not charge the investigator for preparing the educational program or certificate of continuing education because it was being provided to the hospital‘s own employees.

The participants were not required to pay for any components of the study, such as the web-based education program, unit-based activities, competency skills validation, the pocket reference, or the contact hour certificate. There was no compensation given to participants for routine costs or injuries that normally came up as a result of traveling to their place of employment and completing continuing education requirements. They were not reimbursed for their time or any expenses related to completing the web-based education program. The unit-based activities and competency validation were completed during the nurses‘ normal working hours.

Institutional Review Board

Applications for IRB approval were submitted to hospital and UNF (See Appendix BB for IRB approval documents). It was approved by both facilities under Expedited Review, Category #4 and #7 (Code of Federal Regulations, 2009).

Benefits and Risks

The possible benefits of this study were as follows:

1. Free continuing education certificate for 2.5 contact hours was given by the investigator to all participants who consented to participate in the study and completed all of the components.

2. Free pocket reference card about cardiac monitoring was given to all nurses who consented to participate.
3. Improved ability to differentiate wide QRS complex tachycardias and to initiate the appropriate treatment.
4. Increased accuracy in placing electrodes and selecting optimal leads to monitor patients.

One risk of this study was the potential for professional embarrassment, but it was not anticipated. Testing and competency information was kept confidential from other nurses and the nursing manager. The unit-based activities were conducted individually or in small groups with the staff nurses who were working that shift. Nurses were given the choice to participate at that time or reschedule for another time. When they were demonstrating skills on the checklist with the investigator, it was done privately. If nurses were unsure about something, the investigator provided additional instruction and another opportunity to demonstrate competency if needed. When verifying placement of electrodes on a patient, the instructor explained what was expected before going in the room, gave feedback nonverbally while in the room (such as pointing to the correct landmark on the patient‘s chest), and discussed it later outside the patient room.

Confidentiality

Steps were taken to protect confidentiality and to mitigate risks of the patients and nurses. Records were kept confidential to the furthest extent as required by federal, state and local law. Confidential documents and data collected during this study were scanned and uploaded on a secure electronic server at the UNF, which was password protected

and available only to the investigator. After the documents were scanned, they were shredded or placed in a confidential shred bin at the hospital.

To maintain confidentiality of patient information, patient identifiers were not recorded and data were not linked to individuals. During patient audits, no room numbers were recorded on the audit tool. In order to assure that data were not duplicated or omitted during audits, a separate Audit Check-off Sheet listing only the last two digits of the four digit room numbers was used to check off which rooms were audited (see Appendix CC). A unit census sheet was obtained in order to obtain demographic data from only the patients that were audited. The gender, age, length of stay, and admitting diagnoses were recorded on the Patient Demographic Data Collection Tool (see Appendix DD). After the necessary information was collected and before leaving the nursing unit, the census sheet and Audit Check-off Sheet were discarded in the confidential shred bin on the nursing unit. During unit-based learning activities, protection of patient confidentiality was maintained by reviewing only the monitor strips or ECGs of patients assigned to those nurses and by not disclosing or documenting patient identifiers.

The nurses‘ data were stored in the hospital‘s learning management system, which had restricted access by employees who were authorized by the Director of Education at the hospital. The investigator asked an authorized educator to retrieve the test scores, demographic data, and program evaluation summary. The demographic data and evaluations of the education program were confidential and only available as aggregate data. The confidentiality of nurses‘ test scores was protected by using a numbering system to code the individual nurses‘ names when the data was retrieved. The master list

of nurses' code numbers was uploaded to UNF‘s secure server and the paper copy was shredded. See Appendix EE for what data were recorded in the statistical software program and saved on UNF's secure server.

The nurses‘ competency skills checklists, which included a list of the unit-based activities, used the nurses‘ code number instead of a name. This was kept by the nurse until after it was completed or the time period for interventions was over. Upon completion, the investigator recorded the nurses' code number, the number of unit-based activities done, and the number of attempts to complete the competency skills checklist. The checklist was then scanned and uploaded to UNF's secure server, after which the checklist was placed in a confidential shred bin on the unit. The nurses‘ scores on the tests and competency skills checklist were kept confidential from other nurses and their nursing manager. The investigator did not disclose confidential information of the nurses' competency. The only situation in which the investigator might have disclosed information was if patient safety was in imminent jeopardy (for example, if the nurse did not identify new onset ventricular tachycardia and initiate immediate interventions). Although this situation did not occur, if it had, the investigator would have discussed the situation and the relevant competency with the nurse and nursing manager afterwards. The nurses were able to print their own transcript of their test scores from the learning management system and were allowed to make a copy of their signed competency skills checklist for their own records.

The participants were informed that the following people may inspect and copy the study records: the study sponsor (UNF), the hospital‘s Institutional Review Board

(IRB), and the employees who are authorized by the Director of Education to access the learning management system.

Data Analysis

The significance level that was used for all tests was 0.05. Statistical formulas were used to estimate differences between population proportions (Daniel, 2005). The null hypotheses and statistical analysis for each outcome in this study were as follows:

1. There will be no significant differences in nurses' pretest and posttest scores.

   Null H_o: Pretest scores $\mu 1 = \mu 2$ posttest scores or $\mu 1 - \mu 2 = 0$

   Alternate H_1: Pretest scores $\mu 1 \neq \mu 2$ posttest scores or $\mu 1 - \mu 2 \neq 0$

   Test type: Two-tailed, difference between two population means, matched pairs before and after. Since this is not a random sample, normal distribution cannot be assumed. The nonparametric Wilcoxson matched-pair signed-ranks test was used.

2. There will be no significant differences in proportion (Ṕ) of correct electrode placement at baseline ($Ṕ_{1)}$, 6 weeks ($Ṕ_{2)}$, and 18 weeks ($Ṕ_3$)

   Null $H_{o:}$ $Ṕ_1 - Ṕ_2 = 0$ $Ṕ_1 - Ṕ_3 = 0$ $Ṕ_2 - Ṕ_3 = 0$

   Alternate H_1: $Ṕ_1 - Ṕ_2 \neq 0$ $Ṕ_1 - Ṕ_3 \neq 0$ $Ṕ_2 - Ṕ_3 \neq 0$

   Test type: Difference between two population proportions, Independent samples, two-tailed, calculated using statistical formulas (Daniel, 2005, p. 260).

3. There will be no significant differences in proportion (Ṕ) of optimal lead selection at baseline ($Ṕ_{1)}$, 6 weeks ($Ṕ_{2)}$, and 18 weeks ($Ṕ_3$)

   Null $H_{o:}$ $Ṕ_1 - Ṕ_2 = 0$ $Ṕ_1 - Ṕ_3 = 0$ $Ṕ_2 - Ṕ_3 = 0$

   Alternate H_1: $Ṕ_1 - Ṕ_2 \neq 0$ $Ṕ_1 - Ṕ_3 \neq 0$ $Ṕ_2 - Ṕ_3 \neq 0$

Test type: Difference between two population proportions, Independent samples, two-tailed, calculated using statistical formulas (Daniel, 2005, p. 260).

In conclusion, this interventional, one group before-and-after cohort study design consisted of four components: interactive web-based educational program with a pretest and posttest, unit-based collaborative activities, competency skills validation, and patient audits of electrode placement and lead selection at baseline, six weeks, and 18 weeks. The education program and unit-based activities, which were conducted over six weeks, focused on demonstrating correct electrode placement and lead selection for arrhythmias, identifying when and how to measure QTc intervals, differentiating wide QRS complexes tachycardias, and describing the appropriate nursing interventions.

Chapter 4: Results

The purpose of this chapter is to report the results of the study, which had two outcomes of interest. The first outcome was the nurses would demonstrate correct electrode placement and lead selection for arrhythmias, identify when and how to measure QTc intervals, differentiate between wide QRS complexes tachycardias, and describe the appropriate nursing interventions. This outcome was evaluated through the use of pretest/posttest in the web-based educational program and a competency skills checklist. The second outcome of interest was that patients would be monitored in the optimal lead for their arrhythmias with electrodes placed properly on their chest. This outcome was evaluated with an audit tool on electrode placement and lead selection at baseline, 6 weeks, and 18 weeks.

The first outcome was met as evidenced by significant increases in pretest and posttest scores and completion of competency skills checklists by nine nurses. The second outcome was not met as evidenced by no significant increases between the first, second, and third audits of electrode placement and lead selection. A detailed description ensues to what extent each outcome was or was not met.

Participation in Study

There were 42 nurses who worked full-time or floated regularly to the unit. Initially there was a good response from the staff nurses, as 34 out of 42 (81%) met the inclusion criteria and agreed to participate. There were 8 (19%) nurses excluded because

6 did not agree to participate and 2 had worked there less than three months. However, only 9 of the 34 (26%) completed all the components. There were 6 (18%) who never registered for the program, 12 (35%) registered but never started the pretest, and 7 (21%) completed the pretest but did not finish the program. (See Appendix FF for data collected on the nurses.)

Description of the Sample

There were eight nurses who completed all of the questions in the nurses‘ Demographic Survey. There was no information in the report from one nurse for unknown reasons (refer to Appendix GG). The demographic survey was collected as anonymous aggregate data from the learning management system, so it was not possible to correlate results with demographics. The survey included questions on age, sex, ethnicity, degree, years of experience in nursing and dysrhythmias interpretation, comfort with online learning, and if English was a second language. A description of the sample follows.

All of the participants in this study were female, which was not typical of the unit because 3 (7%) were male. Four (50%) of the participants were Caucasian, 2 (25%) were Asian or Pacific Islander, 1 (12.5%) was American Indian/Alaska Native and 1 (12.5%) person selected other. There were 4 (50%) who had an Associate degree and 4 (50%) who had a Bachelors degree. In regard to instruction in QT interval measurements, 5 (62.5%) reported that they had ―some instruction in QT intervals, but not comfortable yet”, 2 (25%) reported ―only a little instruction”, and 1 (12.5%) reported ―no instruction”. There were 7 (87.5%) who reported they had studied online before and 1 (12.5%) who had not. There were 7 (87.5%) who reported they were somewhat comfortable with

online learning and 1 (12.5%) who reported very comfortable. English was a second language for 3 (37.5%). The average age was 40.62, years licensed as an RN was 8, years worked on the unit was 4, and years since first dysrhythmia class was 5.

Test Content Validity and Reliability

The tests were evaluated for content validity and reliability by three nursing experts who were nursing educators at that hospital and familiar with the topic. First, they individually completed the entire educational program. The educators pretest scores ranged from 53 – 93% with a median of 80% and posttest scores ranged from 87 – 100% with a median of 93%. The Wilcoxon Signed Ranks test on the nursing educators‘ test scores did not show a significant difference from pretest to posttest (Z = -1.6333, p= .102) (refer to Appendix Y). This lack of significance could be attributed to prior knowledge of the material, a large range between pretest and posttest, and the very small sample size.

The investigator then met with each nursing educator individually and asked them to evaluate the program and tests. To establish content validity of the tests, they were asked if they thought the pretest and posttest were based on the learner objectives and relevant to the content being taught. All three educators checked –strongly agree”. To establish reliability of the pretest and posttest, the three educators were given printed copies of the tests, after they had completed the program. They completed both the pretest and the posttest during the meeting without referring back to either the test or reference material. The three educators‘ answers on the pretest and posttest were entered in SPSS statistical software and coded so that the answer keys for the pretest and posttest were the same. It was analyzed using the Cronbach's α test, which is a model of internal

consistency, based on the average inter-item correlation. The closer the rating is to 1.0, the higher the reliability (Daniel, 2005). The Cronbach's α test showed a reliability of 0.975 between the nursing educators' answers on the pretest and posttest questions (see Appendix Y).

Pretest and Posttest Results

The nurses' knowledge of dysrhythmias and monitoring practices were evaluated through the pretest and posttest in the interactive web-based education program. There were 16 nurses who completed the pretest and nine who completed the posttest (refer to Appendix HH). The pretest scores ranged from 0 - 60% with a median of 36.5%. The posttest scores ranged from 47 - 93% with a median of 80%. The Wilcoxon Signed Ranks test showed a significant difference between the pretest and posttest scores ($Z = -2.670$, $p = .008$). Of the 16 who completed the pretest, there were 6 nurses who scored zero. The test attempt details showed that the nurses who scored zero had completed the pretest, but answered the questions wrong or left some unanswered. The questions that were answered wrong or were left unanswered were "select all that apply" questions or QRS morphology questions that were not taught in their previous dysrhythmia classes.

Reliability testing was performed on the pretests and posttests taken by the nine nurses who completed the program (see Appendix II). The Cronbach's α test showed a reliability of 0.84 on the pretest and 0.963 on the posttest. The closer Cronbach's α is to 1, the higher the internal consistency. There were five questions in the pretest not answered by some of the nurses; the software excluded the questions with missing data and calculated the pretest reliability on 10 questions that were answered by all nurses.

All of the questions in the posttest were answered by every nurse, so all 15 questions were included in the calculation.

Educational Program Evaluation Results

There were 10 nurses who completed the program evaluation on the learning management system, which was collected anonymously as aggregate data (refer to Appendix JJ). One of the 10 nurses completed the evaluation after the 6 week time period, but it was not possible to separate that nurse‘s responses from the others. Below are the questions that were asked and the percentage of responses for Strongly Agree (SA), Agree, (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

- The posttest was based on the learner objectives (SA=20%, A=80%).
- This type of learning is worthwhile (SA=20%, A=70%, D=10%).
- The content met my professional educational needs (SA=30%, A=40%, D=30%).
- The instructional method was effective for this topic (SA=10%, A-50%, N=10%, D=30%).
- I would recommend this module to others (SA=20%, A-50%, D=30%).
- Self-study modules meet my needs for ongoing education (SA=20%, A-50%, N=10%, D=20%).
- The content was accurate and current (SA=40%, A=60%).

The verbal responses the investigator also received in person were as follows. Several nurses said they thought the program was hard and two stated they would have preferred attending a class. A couple of night nurses said they studied the program at work and had trouble hearing the audio script or concentrating on it due to interruptions. Two said they wished that they had printed the program because they learn better by

reading than by studying online programs. Another said she didn‘t finish the program because she thought the content was over her head and she admitted she had not had any prior instruction on 12 Lead ECGs.

Unit-based Activities

The unit-based collaborative learning activities were led by the investigator and included conducting audits on correct electrode placement and lead selection, evaluating monitor strips and 12 lead ECGs in the current medical records, locating QTc intervals on ECGs, analyzing dysrhythmias using pocket reference cards on cardiac monitoring (Drew, 2002) and interpreting 12 lead ECGs displayed on a poster. The unit-based collaborative learning activities concluded with the completion of a competency skills checklist with the investigator (as shown previously in Appendix W).

All of the nurses who completed the online educational program also completed each of the unit-based activities and the skills checklist. The activities are summarized below in three categories: patient audits, ECG interpretation, and skills checklist.

During the patient audits the nurses did with the investigator, all of the nurses were able to satisfactorily demonstrate correct skin prep, electrode placement, and lead selection. The audits conducted by the nurses mirrored the results of the unit audits conducted by the investigator. Correct electrode placement was observed in 6 out of 20 (30%). V1 was the electrode incorrectly placed in 14 out of 20 patient (70%). Lead selection was correct in 12 out of 20 (60%). If incorrect electrode placement or lead selection were noted, steps were taken to correct it.

The nurses practiced interpreting wide QRS complexes with the investigator. They looked at single lead monitor strips, 12 lead ECGs from their patients‘ charts, and

two 12 lead ECG case studies (Nathanson et al., 2007) on a poster created by the investigator. The investigator showed them how to use the reference card to compare the QRS morphology. Some of them needed a review of the material taught in the online program, but they were able to answer questions correctly after the review and using the reference card. The nurses told the investigator that the review of the unit helped them to understand the complicated material better, especially how to analyze QRS morphology when differentiating between aberration and ventricular dysrhythmias.

All of the nurses except for two received a "Competent" rating on all eight of the objectives on the skills checklist. Two nurses did not score at least 80% on the posttest, so "Needs Improvement" was recorded for that objective; they were, however, able to verbalize or demonstrate competency on the rest of the objectives on the checklist. Those two nurses also said they preferred classes over online modules and English was their primary language. All nurses completed the skills competency checklist on the first attempt.

Patient Audit Results

Patient audits of electrode placement and lead selection were conducted by the investigator on the unit before the interventions (baseline), at the conclusion of the interventions (6 weeks), and 12 weeks after the interventions (week 18 of the study). (See Appendix KK). The correct locations of the electrodes were pictured on the audit tool, as shown in Appendix D. The correct monitoring leads for dysrhythmia identification were listed on the audit tool and were defined as "Appropriate lead selection includes the following: Lead V1 to distinguish VT from SVT with aberrant conduction; left or right BBB; Lead II to monitor atrial activity" (Audit Tool, 2008 p. 1).

The criteria did not specify the optimal lead for patients with pacemakers, so either lead was considered appropriate as long as it had adequate QRS waveforms to calculate heart rate.

All patients who met the inclusion criteria and were present on the unit at the time of the audit were audited at baseline, 6 weeks, and 18 weeks (n=30, n=23, and n=24 respectively). Data on the patients‘ admitting diagnoses and cardiac rhythms were collected in order to determine if the patient should be included and to determine if the optimal lead was selected for their condition or dysrhythmia. The results of all three audits and the patient demographic data are reported as aggregate data (refer to Appendices LL, MM, NN).

The electrode placement was correct in 13 out of 30 (43%) of the patients at baseline, 9 out of 23 (39%) at 6 weeks, and 9 out of 24 (38%) at 18 weeks. There were no significant differences in the proportions of patients with correct electrode placement between baseline/6 weeks (p = .76), baseline/18 weeks (p = .66), and 6 weeks/18 weeks (p = .91). Of the misplaced electrodes, V1 was the most frequently misplaced (94%, 100%, and 100% at baseline, 6 weeks, and 18 weeks respectively), followed by Left Leg (LL) (12%, 0%, and 7%) and Left Arm (LA) (6%, 7%, and 0%).

The lead selection was correct in 21 out of 30 (70%) of the patients at baseline, 15 out of 23 (65%) at 6 weeks, and 19 out of 24 (79%) patients at 18 weeks. There were no significant differences in the proportions of correct leads selected between baseline/6 weeks (p = .72), baseline/18 weeks (p = .45), and 6 weeks/18 weeks (p = .29). When percentages of patients monitored appropriately in VI and Lead II were looked at separately, there were no statistically significant differences between audits. The

percentage of patients who were monitored in V1 when it was indicated was 0%, 29%, and 43% at baseline, 6 weeks, and 18 weeks respectively. The percentage of patients who were monitored in Lead II when it was indicated was 78%, 81%, and 94% at baseline, 6 weeks, and 18 weeks respectively.

In conclusion, the results of this study were as follows. Of the 42 nurses who worked on the unit, 34 consented to participate, 16 started the program, and nine finished all of the components. The pretest scores ranged from 0 – 60% with a median of 36.5%. The posttest scores ranged from 47 – 93% with a median of 80%. The Wilcoxon Signed Ranks test showed a significant difference between the pretest and posttest scores ($p = .008$). The patient audit results did not indicate significant differences in proportions of correct electrode placement and correct lead selection between baseline, 6 weeks, and 18 weeks. The unit-based collaborative learning activities and competency skills validation reinforced content taught in the program.

Chapter 5: Discussion

The focus of Chapter 5 is to analyze the results in comparison with other research studies and to make recommendations for this site and other settings. Also included are the limitations of this study and implications for further research.

Participation in Study

Initially, there was a good response from the staff nurses who said they were interested (34 out of 42, 81%), however, only 9 of the 34 (26%) who agreed to participate completed all of the components. To encourage participation, information about the study was placed in their mailboxes and posted in the lounge. A colorful tri-fold poster with ECGs and information about the study was accessible in their lounge throughout the study (see Appendix T). In addition to this, the investigator assisted some nurses to register for the program and showed others (after they completed the pretest) how to print the educational program with the audio script. The investigator met the nurses face-to-face on their unit numerous times (25 visits over first 6 weeks) during the middle portion of their work shifts to explain the purpose of the study and to schedule or reschedule additional times for unit-based activities. Incentives, in the form of a free laminated reference card and 2.5 hours towards continuing education, were also offered.

One of the possible reasons for this low completion rate was that participation was voluntary, so it was a low priority for them. Some of the reasons the nurses gave for not starting or not completing it were due to vacations, weddings, illnesses, too busy at

work or home, too busy studying for school, no computer at home, or not enough contact hours. Two nurses on night shift resigned during the study period. The nursing educator told the investigator that she has had trouble in the past getting the nurses to complete the mandatory education, perhaps because there are so many required every year. The investigator and the unit's nursing educator heard some nurses verbalizing to others that the program was hard, so that might also have deterred some from starting or finishing the program (T. Debile, personal communication, July, 2010).

A wide disparity was noted when comparing completion rates of this study to other studies with web-based educational programs offered to nursing staff. Belcher and Vonderharr (2005) reported a lower completion rate of 4% (64 nurses out of 1500 in the hospital) in their voluntary web-delivered program to nursing staff on evidence based practices. In the study by Dumpe et al. (2007), which studied the usefulness of a learning management system to validate employee competencies, they reported that 4,064 nurses accessed the online competency modules, but did not include what percentage of the total nurses accessed it because mandated or if each completed all or the modules. Durkin (2008) reported in her voluntary study on the differences between text-only and interactive computer-based learning on cranial nerves that out of 85 nurses on the units, 31 started it and 41 finished it (76%). Jeffries (2005) reported a 100% a completion rate (12 nurses and 3 nursing students) in an online critical care course, most of whom were taking it for professional development. The completion rates for the voluntary web-based programs to nursing staff in the literature review varied between 4%, 76%, and 100%, as compared to 26% completion rate for the participants in this project.

Unit Champions

Another possible reason for the initial high consent rate (81% of staff on unit) and low completion rate (26% of staff who signed consents) may be because of the investigator‘s relationship with the nurses and because she was the only person soliciting nurse participation and leading the unit-based activities. The investigator was a peer to the other nurses because she worked two shifts per month as a staff nurse in a PRN position on that unit. The investigator may also have been perceived by the other nurses as an expert in dysrhythmias because she was the former educator for the unit six years ago and taught dysrhythmia interpretation to many of them while in that position as well as afterwards (because the videotape of the dysrhythmia class was still being used to train new staff). The investigator‘s relationship with the staff may have influenced many to agree to participate but it was not enough to overcome the multiple factors that led to only 26% of them completing the project.

While the nursing manager and nursing educator were supportive of the program by encouraging the nurses to participate and not scheduling other mandatory education programs during the initial six weeks of this study, they did not actively participate on the unit. There were two assistant nurse managers who signed consent forms, but neither one completed the study and they were not involved in encouraging the staff to do it. This design with one instructor to conduct the unit-based activities was similar to Cadden‘s study (2007); however, Cadden‘s program was mandatory for the nursing staff. Jeffries (2005) and Morris et al. (2009) utilized unit preceptors to supervise practicum or orientation hours and validate learner‘s skill competency.

In the PULSE trial currently being conducted by Funk et al. (2009), their study design calls for "unit champions" or "super users," who are mentors that conduct random checks, provide incentives, and reinforce learning with case studies or other activities. Their results are still pending. Perhaps this study would have had a different outcome if there were some unit champions on each shift (besides the investigator) to encourage staff to participate and help lead unit-based activities.

Comfort with Online Learning

Another possible reason for the low participation rate was that the nurses may not have felt comfortable with online learning formats. Out of the 8 nurses who completed the demographic survey, 7 (87.5%) reported they were "somewhat comfortable" and 1 (12.5%) reported "very comfortable." The comfort level of the other nurses was unknown. The learning management system had been used for mandatory education over the past three years, although some of them had not used it often enough to remember their user information. Some reported difficulty registering for the program, so the investigator assisted them with signing up on a computer in the nursing station. In the study by Dumpe et al. (2007), 90% of the nurses reported they were satisfied, or very satisfied, with the online method of instruction.

Perhaps, if there was a computerized learning resource center at the hospital where staff could complete learning management system modules without unit interruptions, more staff would have accessed and completed it. The hospital where this study was conducted has started developing a center, but it was not completed at the time of this study. It would also be important to have a support team or technicians to assist staff in the learning resource center.

Incentives

Another factor that may have affected the nurses‘ participation was that the incentives may not have been valued by the nurses. For the first six weeks, two incentives were used: free continuing education for 2.5 hours and a laminated pocket reference card. Four other studies provided free continuing education credit to participants (Belcher & Vonderharr, 2005; Frith & Kee, 2003; Funk et al., 2009; Keller & Raines, 2005). Funk et al. (2009) also provided $40 gift cards and paid leave time to complete the modules as incentive.

Web-based Educational Program

The web-based educational program used in this study was found to be effective in increasing nurses‘ knowledge of dysrhythmias and monitoring practices for patients at risk for wide QRS complex tachycardias. This online program incorporated the seven principles of good practice in undergraduate education (Chickering & Gamson, 1987) and the eight steps for designing e-learning courses, including absorb, do, and connect activities (Horton, 2006). The results of this study substantiated the findings of other research studies that Chickering and Gamson‘s seven principles provided an effective framework for online programs to nursing staff or students (Jeffries, 2005; Jeffries et al., 2003).

There were two nurses who did not score at least 80% on the posttest. Some of the reasons they gave for why they did not do well was because they did it while working night shift and had frequent interruptions or trouble hearing the script. One said she learned better by reading or attending classes than by taking online courses. In addition, 30% of the participants selected ―disagree‖ on the program evaluation when asked if the

instructional method was effective and that they would recommend it to others. This web-based educational program implemented Chickering and Gamson's (1987) seventh principle of good practice –Respects diverse talents and ways of learning" by incorporating a variety of teaching strategies, such as printed material, audio, visual, and interactive activities. Other studies used a similar variety of strategies in their online programs (Belcher &Vonderharr, 2005; Durkin, 2008; Jang et al., 2005; Jeffries, 2005; Jeffries et al., 2003; Morris et al., 2009). However, some learners may prefer traditional face-to-face instructional methods, so perhaps it would be beneficial to offer classes on this subject or compare effectiveness of classes versus online instruction, as was done by other researchers (Jang et al., 2005; Jeffries et al., 2003).

Unit-based Activities

The nurses were required to complete the educational program before doing the unit-based activities with the investigator, in order to prevent affecting pretest or posttest results. The unit-based activities were beneficial for reinforcing what they learned in the educational program and providing prompt feedback. Other studies found that it was effective to require return demonstration of skills with competency assessment checklists and/or human patient simulation (Cadden, 2007; Jeffries, 2005; Jeffries et al., 2003; Morris et al., 2009).

While validating the nurses' competencies with the skills on the checklist, the investigator found that they remembered some things very well, such as V1 placement, best lead to select for dysrhythmias, and where to measure QT interval. Some nurses needed a review on subjects like normal QTc interval and treatments for wide complex tachycardias, while almost all of them needed practice in analyzing QRS morphology.

They told the investigator that the laminated reference card helped them differentiate between SVT with aberration and VT and that they understood it better after reviewing it with the investigator. The nurses informed the investigator that they had seen the poster but had not studied the ECGs on the poster until they completed the unit-based activities with the investigator. The main reasons they gave for not studying the poster was because they were so busy on the unit when they worked and they were too tired after their 12-hour shift to look at it later. Other studies used references on the unit such as posters, flyers, and reference cards and found them to be beneficial supplements to the education program (Belcher & Vonderharr, 2005; Cadden, 2007; Jeffries, 2005; Morris et al., 2009).

One incongruent observation was made regarding electrode placement and lead selection. Even though the nurses had finished the online program and assessed their patients before the investigator did the audits with them during their shift, only 6 out of 20 patients (30%) had the V1 electrode in the correct location and 12 out of 20 (60%) were monitored in the correct lead. The nurses were able to demonstrate correct location for V1 and state the best lead to select to monitor their patients, but they did not demonstrate a change in their practice after completing the online educational program. This illustrates that knowledge alone does not beget compliance and that educational programs are more effective when combined with unit based activities and skills competency validation (Cadden, 2007; Jeffries, 2005; Jeffries et al., 2003; Morris et al., 2009). The PULSE trial currently underway by Funk et al. (2009) also incorporates a model that includes online education plus unit-based strategies led by unit champions.

Patient Audits

There is only one comparable study underway that is researching the effectiveness of a training program on ECG monitoring practices, which is the PULSE trial by Funk et al. (2009). In their preliminary results of the baseline data of 1821 patients from 17 hospital sites, they found that 76% of the patients were monitored with the 5 lead wire system, as was used in all patients at the hospital in this research project. At this time, their results provide the best available benchmark data to use for comparison. Of those using the 5 lead wire system, inaccurate position of electrodes was found in V1 for 75.6% of the patients, LL 27.1%, LA 19.5%, RA 15.3% and RL 0.7% (Funk et al., 2009). In this study, inaccurate placement of V1 was also the most commonly misplaced electrode in 53-70% of the patients, which is lower than the findings by Funk et al. (2009). The other electrodes in this study were inaccurately placed in less than 12% of the patients. One reason for the lower results in this study could be related to the small sample size in this study compared to the Funk et al.'s multi-site study.

It is not possible to compare proportions of correct lead selection with Funk et al.'s (2009) study because they did not report percentages that were correct or incorrect in their baseline data. Funk et al. did report that 71% of the patients were monitored in Lead II and 22% in V1. When compared to this study, the results were similar for Lead II (78-83%) but dissimilar for V1 (which ranged from 0% at baseline to 17- 22% at the other audits). One explanation for the increase in patients being monitored in V1 during the audits at 6 and 18 weeks could be due to the training that was provided to all monitor technicians by the hospital educator during the first weeks of the study, which included monitoring recommendations consistent with AACN's Practice Alert (2008).

The most likely explanation for why no significant differences were seen in electrode placement and lead selection after six weeks was because not enough employees were educated on the correct procedures. Only 9 out of 42 nurses (24%) who worked on the unit completed the educational program and unit-based activities. The PULSE trial underway by Funk et al. (2009) includes education and training to all levels of staff on the nursing unit.

There were other personnel on the unit who were responsible for electrode placements and lead selection, but they were excluded from this study. The Associate Care Providers (ACPs) frequently apply or replace the electrodes. Monitor technicians (techs) select or adjust the monitoring lead based on nurses‘ input and the presence of artifact. Educating and validating competency on the entire staff at the same time may result in a significant difference in patient outcomes of electrode placement and lead selection.

Unintended Consequences

The nursing educator, who plans education for the telemetry staff, informed the investigator that all monitor techs were required to attend in-services during the first six weeks of the study (T. Debile, personal communication, July, 2010). This training was the result of an incident that occurred on another telemetry unit when artifact on a paced rhythm was misinterpreted and the patient‘s electrodes and condition were not checked in a timely manner. The in-service for the monitor techs included dysrhythmia and pacemaker interpretation, hospital monitoring policies, communication policies for artifact, and optimal lead selection. The instructions on lead selection were consistent with recommendations by AACN and the education provided to the nurses in this study.

The investigator observed a difference in unanalyzable rhythms between the first and second audit, but since that was not one of the outcomes included in the approved protocol for this study, it was not included in the study results. On the first audit, 4 out of 30 (13%) tracings were unanalyzable, 2 due to artifact (6.5%) and 2 due to alarms silenced inappropriately (6.5%). The alarms were off because processing was suspended when patients left the unit and they were not resumed immediately when the patients returned. This was considerably higher than the percentage noted in the baseline data of the PULSE trial, which was 2.7% for unanalyzable tracings and 2% for alarms silenced inappropriately. On the second and third audits, which occurred after the monitor tech training, there were zero unanalyzable tracings. This may have been due to the training program, or it may have been due to the differences in employees who were on duty at the time of the audit. These findings reinforce the need to educate all employees on a telemetry unit who have responsibility for cardiac monitoring. They also highlight the need to monitor data on the percentage of unanalyzable tracings and inappropriately silenced alarms.

The unit nursing educator also informed the investigator that education and competency validation on skin preparation, electrode placement, and communication with monitor techs was initiated for all nurses and ACPs in August (during weeks 14-18 of this study). Some of the material in the web-based education program was used by the educator to create a reading self-study module that all ACPs and nurses received, but the competency validation for ACPs and nurses did not take place as planned prior to the final audit at 18 weeks. Since there were no significant differences in correct electrode

placement between the three audits, it may be concluded that the training did not affect the results of the final patient audits.

Another unintended consequence was that nurses were not expected to calculate QTc intervals on their high risk patients as recommended in the guidelines by Drew et al. (2004) and the AACN Practice Alert (2008). The cardiologists at the hospital where this study was conducted informed the nurse educator and investigator that they did not support teaching the nurses how to calculate QTc because they did not believe monitor tracings were as accurate as 12 lead ECGs. The cardiologists said they would be ordering and examining 12 lead ECGs when necessary. The investigator explained the importance of monitoring trends on QTc intervals in a consistent lead every shift for high risk patients, but the nurse educator and nurse manager did not recommend including it on the skills checklist. A compromise was made by including instruction on how to calculate QTc in the educational program, but this was not required on the competency skills checklist. Nurses were expected to locate QTc interval on the ECG, but not to demonstrate how to measure QT intervals or calculate QTc manually.

There were no known incidences of torsades de points during this study, although at least one high risk patient was identified during the second unit audit. This patient had three risk factors for torsades de points because she was receiving an antiarrhythmic that prolonged QT interval, had a prolonged QTc on 12 lead ECG, and had hypokalemia (which was being treated). However, there was not a cardiologist on her consult list because she was admitted for a non-cardiac problem. The patient‘s admitting physician was a hospitalist and there was no mention of this problem in his admission assessment or progress notes. The investigator brought this to the attention of the primary nurse,

who was not aware of the prolonged QTc, and he said he would notify the admitting physician. The investigator did not hear of any bad outcomes with that patient, but it illustrated the need to have staff nurses educated on QTc monitoring for high risk individuals, especially when there isn‘t a Cardiologist on the case.

Nursing Implications and Recommendations

The strategic plan for the hospital includes obtaining Magnet Recognition and promoting implementation of evidenced-based practice. Nursing administrators encourage nursing staff to become involved in shared governance by participating in Unit Practice Councils and Magnet Councils (which are focused on quality, research, nursing practice, education, and environment). An expansion of this project into all monitored units of the hospital could be compatible with both initiatives.

In addition, the hospital administrators were encouraging nurses to participate in the Clinical Practice Developmental Program, which is a pay-for-performance plan that rewards nurses with increases in salary if they obtain certification and participate in educational and leadership activities. Staff nurses who become unit-based champions could earn points towards their Clinical Practice Developmental Program. Expansion throughout all monitored units was beyond the scope of this project and it would require participation and follow-up by several nurse managers and educators.

The first recommendation for this site and other hospitals is to revise their monitoring policy so that it includes the recommendations for QT interval monitoring as recommended by Drew and Funk (2006). The nursing manager or unit educator could be responsible for updating the policy. The policy at this site already included what information should be communicated between nurses and monitor techs, which

conditions require continuous monitoring by a nurse when transported to other departments, alarm protocols, and when to use ST segment ischemia monitoring. The policy should have included the top four priorities for QT monitoring that Drew and Funk (2006) identified, which are listed below.

1. Patients started on antiarrhythmic drugs known to cause torasades de points (especially disopyramide, dofetilide, ibutilide, procainamide, quinidine, and sotalol).
2. Patients who overdose from potentially proarrhythmic agent.
3. Patients who have new-onset bradyarrhythmias (e.g., complete heart block, long sinus pauses).
4. Patients who have severe hypokalemia or hypomagnesemia (p. 161).

In addition to the above, another nursing implication was delineated in a new scientific statement that was recently released by Drew et al. (2010) for prevention of torsades de pointes in hospital settings. Drew et al. (2010) stated,

> Of utmost importance, however, is that a hospital protocol be established so that a single consistent method is used by all healthcare professionals charged with the responsibility for cardiac monitoring. The protocol should stipulate the equipment to use for QT measurement, the method to determine the end of the T wave, the formula for heart rate correction, lead-selection criteria, (e.g., the lead that has a visible T wave with a clear-cut ending), and the importance of measuring the same lead in the same patient over time (p. 1055).

The second recommendation is to expand the training on dysrhythmia monitoring practices at the appropriate level for all monitor techs, associate care providers (ACPs),

and nurses who work in monitored units. Units that should be included are telemetry units, intensive care units, progressive care units, emergency departments, and anywhere else that cardiac monitoring is performed. All of the educators for those areas could collaborate to develop and teach the courses. The educators could decide to do it in phases by concentrating on educating selected staff or units in a stepwise fashion (i.e., nurses first, followed by ACPs and monitor techs). It should be mandatory for all staff and enforced by nursing managers, with consequences for failure to complete the competency validation by a particular date.

The ACPs should be taught (or reeducated) about skin preparation, electrode placement, and lead selection. The training should include return demonstration of the skills, so it should be offered as a face-to-face class, or a combination of online modules on the learning management system with skills competency validation on the unit. The monitor techs should receive a basic dysrhythmia course similar to what is provided to the nurses, as well as additional hands-on training on how to operate the monitors and what to do about artifact.

For nurses, their dysrhythmia and monitoring education should include the following four components:

1) basic dysrhythmia course to include skin preparation, electrode placement, lead selection, and hospital monitoring policies;
2) emergency standing orders and drip calculations;
3) ST segment monitoring; and
4) QTc monitoring and differentiating between wide QRS complex tachycardias.

The nurses should be given a time frame to complete the modules, along with a list of skills to demonstrate on the unit for each module. The third and fourth components should be done after they have demonstrated competency with basic dysrhythmia interpretation. Nurses‘ preferred learning styles may need to be considered and some classes could be offered face-to-face if needed.

For the nurses‘ education on the first component, a new interactive web-based learning module could be developed or purchased to replace the six-year old videotaped dysrhythmia class. There are already some dysrhythmia modules provided on the learning management system which are not used, so a group of staff nurses should be asked to evaluate their usefulness. For the second and third components, new nursing staff could view the two existing modules on ST segment monitoring and emergency standing orders/drip calculations that were used for annual competency of other nurses‘ validation in the past.

To educate nurses on the fourth component of QTc monitoring and wide QRS complex tachycardias, the web-based educational program used in this research project could be modified by removing the pretest, because it is not necessary for ongoing education, and it may have deterred some nurses from finishing the program. Continuing education credit was an important incentive to some nurses, so it should continue to be offered. In order to make it easier to distribute continuing education certificates to large numbers of nurses, the application for continuing education could be resubmitted eliminating the 30 minutes devoted to unit-based activities. The nurses may then print their own certificate for two contact hours after completion of the posttest. The unit-

based activities and skills validation should still be conducted because they reinforced the content taught in the program and helped nurses apply what they learned to their patients.

One method to promote completion of both the online educational program and unit-based activities would be to make it a part of their orientation or yearly mandatory competency assessment. A checklist similar to the one used in this research project could be used for nurses and modified for ACPs and monitor techs. The educators and assistant nurse managers are usually the ones responsible for competency validation and enforcement of compliance with mandatory education.

It would be beneficial for the hospital to provide a learning center with computers and technical support. It would help to reduce some of the barriers encountered in this study, such as distractions, noise, computer access when off the unit, and technical hardware or software problems. The telemetry educator informed the investigator that construction has already started towards establishing a computer room for staff to use for continuing education. The staff in the centralized Education Department would be responsible for the roll-out of the computerized learning resource center.

Another recommendation to improve participation of staff is to ask for volunteers from each job class and shift to be ―unit champions," who would motivate the staff and lead unit-based collaborative learning activities similar to ones that were done in this research project. The unit educator or assistant nurse managers should validate the unit champion‘s skill competency and then determine if the champion may document other staffs‘ competency with the skills.

For ongoing reinforcement, the unit champions, assistant nurse managers, or educators should conduct periodic patient audits of electrode placement, lead selection,

unanalyzable tracings, and inappropriately silenced alarms once a month initially, then every 6-12 months. Graphs could be posted on the unit comparing their unit with other units and the results could be discussed in staff meetings by the nursing manager. If an employee is consistently not following the policy, the nursing manager should provide individual feedback and assist the nurse to develop an action plan for improvement. If the unit shows an improvement towards meeting or exceeding the hospital average, incentives or rewards could be provided to the whole unit, as has been done in the past at this particular hospital (e.g., awarding pizza parties, ice cream socials, or public recognition by administration).

Limitations and Recommendations for Further Research

There were several limitations to this study. First, it was conducted with a very small sample size of nurses on one telemetry unit and results cannot be generalized to other groups. It should be replicated with larger sample sizes in other telemetry units, as well as emergency departments, intensive care units, and other locations where patients are monitored.

Second, nurses were the only staff members who received the education and were included in the study. The patient outcomes of electrode placement and lead selection were impacted by other staff workers, such as ACPs and monitor techs, who were also responsible for electrode placement and lead selection at the monitors. In addition, electrodes were often placed on the patients in other departments, such as admissions from the emergency or transfers from intensive care units.

A third limitation to this study was that it only evaluated the monitoring practices related to wide QRS complex tachycardias. The other components in the practice

standards for ECG monitoring in hospitals by Drew and Funk (2006) included appropriateness of arrhythmia monitoring, analyzability of ECG tracings, accuracy of nurse‘s arrhythmia interpretation, use of ST segment monitoring for ischemia, and training of staff. The PULSE study currently underway by Funk et al. (2009) is more comprehensive and includes each of these components.

A fourth limitation is that the study did not look at other quality patient outcomes or financial impacts. Other outcomes being evaluated by Funk et al. (2009) included life threatening dysrhythmias, patient mortality, transfers to intensive care units, increased length of stay, and costs over a three year time period (concluding in 2012).

The recommendations for further research are summarized below.

- Replicate with all staff on other telemetry units, intensive care units, and emergency rooms.
- Evaluate effectiveness when other strategies are used, such as unit champions or group rewards.
- Compare classroom & online methods for instructing associate personnel on electrode placement and instructing nurses on advanced dysrhythmias, such as wide QRS complex tachycardias.
- Evaluate outcomes after all staff on the unit and/or in the hospital are trained.
- Expand design to include all components of the practice standards (analyzability, accuracy of interpretation, ST segment ischemic monitoring).
- Evaluate quality patient outcomes over the long term (incidences of life-threatening dysrhythmias, transfers to intensive care, length of stay, mortality).

Conclusions

The interactive web-based educational program used in this DNP project was effective in increasing nurses‘ knowledge about dysrhythmias and monitoring practices for patients at risk for wide QRS complex tachycardias. However, the project was not effective in changing monitoring behavior related to electrode placement and lead selection on the unit. This may be related to the small percentage of staff on the unit who completed the project. The unit-based collaborative learning activities and competency skills validation helped reinforce the content of the educational program. In order to improve patient outcomes, this type of program may be more effective if it were to involve all of the staff members on the unit who are responsible for applying electrodes and selecting the monitoring leads. More research is needed to establish if this type of program is more effective in improving patient outcomes when all staff are included and if additional strategies are used, such as unit champions and group rewards.

Appendix A: AACN Practice Alert on Dysrhythmia Monitoring

AACN PRACTICE ALERT

DYSRHYTHMIA MONITORING

Expected Practice:

- ☑ Select the best monitoring leads for dysrhythmia identification (display two leads when possible).
  - o Lead V_1 to diagnose wide QRS complex.
  - o Lead II to diagnose atrial activity and measure heart rate.
- ☑ Proper electrode placement is required for accurate diagnosis (Figure 1).
- ☑ Prepare the patient's skin before attaching ECG electrodes.
- ☑ Measure QT interval and calculate QTc using a consistent lead if high risk for Torsades de Pointes.

Scope and Impact of the Problem:

- Studies show that nurses often monitor in a single lead regardless of diagnosis.[1-2]
- Failure to properly prep skin prior to electrode placement may cause inappropriate monitoring alarms.[3-4]
- When an electrode is misplaced by as little as 1 intercostal space, QRS morphology can change and misdiagnosis may occur (i.e., ventricular tachycardia [VT] may be misidentified as supraventricular tachycardia [SVT] or vise versa).[5]

Supporting Evidence:

- V_1 is the lead of choice to diagnose wide QRS complexes (VT vs. SVT with aberrant conduction; left vs. right BBB). A 5 lead monitoring system is required to monitor V leads. MCL_1 may differ in QRS morphology as compared to V^1 and should be used only when a 5 lead monitoring system is unavailable.[6-10] (Level V)
- When V_1 electrode placement is not possible, V_6 may be used. [7,11] (Level IV)
- Electrode site preparation includes clipping excessive hair and cleansing oily skin with alcohol.[3-4] (Level IV)
- QTc >0.50 sec (500 ms) is dangerously prolonged and associated with risk for Torsades de Pointes. The QT interval should be corrected for heart rate (QTc) and monitored with any of the following:[9-10,12-15] (Level IV)
  - o Antidysrhythmic, antibiotic, antipsychotic, and other drugs that prolong QTc
  - o Severe bradycardia
  - o Hypokalemia or hypomagnesemia
  - o Any drug overdose
- Perform an atrial electrogram (AEG) in cardiac surgical patients with atrial epicardial wires to assist in identifying atrial activity.[16-17] (Level V)

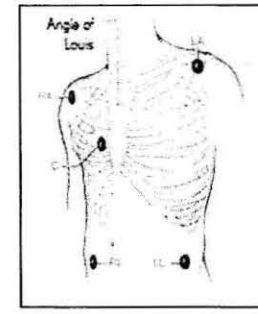

Figure 1

Pediatric Specific

Abnormal prolongation: QTc >0.40 sec ± 10%. Pediatric limits are age specific and shorter than adult ranges.[18]

Actions for Nursing Practice:

- Ensure that your organization has written policies and procedures related to cardiac monitoring.
- Provide appropriate ECG education for staff.
- Develop proficiency standards for all staff involved with ECG monitoring to ensure accurate and effective monitoring.

- Consider conducting an audit to assess:
  - Electrode placement
  - Lead selection

Need More Information or Help?

1. Audit tool for measuring compliance with lead selection and lead placement available at www.aacn.org
2. Talk with a clinical practice specialist for additional information / assistance (www.aacn.org, select PRN).

AACN Grading Level of Evidence

Level I:	Manufacturer's recommendations only
Level II:	Theory based, no research data to support recommendations: Recommendations from expert consensus group may exist
Level III:	Laboratory data, no clinical data to support recommendations
Level IV:	Limited clinical studies to support recommendations
Level V:	Clinical studies in more than one or two patient populations and situations to support recommendations
Level VI:	Clinical studies in a variety of patient populations and situations to support recommendations.

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Appendix B: AACN Dysrhythmia Monitoring Power Point Slides

AACN PRACTICE ALERT

Practice Alert
Dysrhythmia Monitoring

Authors & Reviewers:
Nancy M. Richards, RN, CNS, MSN, CCRN, CCNS

Issued April 2008

Practice Alert - Dysrhythmia Monitoring 1

AACN PRACTICE ALERT

Lecture Content

Skin Preparation
Lead Placement
Ventricular Dysrhythmias
QT Intervals

Practice Alert - Dysrhythmia Monitoring 2

AACN PRACTICE ALERT

Skin Preparation

- Skin oil and debris can cause noisy signals
  - Clip excessive hair before placing electrodes
  - Clean skin with alcohol or washcloth to remove skin oils and/or debris

Practice Alert - Dysrhythmia Monitoring 3

AACN PRACTICE ALERT

Electrode Placement

- Limb leads (I,II,III)
  - Place to decrease muscle artifact during limb movement
- Placement
  - Right Arm (RA) infra-clavicular fossa close to right shoulder
  - Left Arm (LA) infra-clavicular fossa close to left shoulder
  - Left Leg (LL) below rib cage on left side of abdomen
  - Ground (RL) anywhere on torso

Practice Alert - Dysrhythmia Monitoring 4

AACN PRACTICE ALERT

Electrode Placement

- Precordial Leads
  - Dependent on patient's needs and goals of monitoring
  - Consider marking electrode location with indelible ink
    - Ensures electrodes will be placed in same position.
- Precordial leads misplaced by 1 ICS can change the QRS morphology

Practice Alert - Dysrhythmia Monitoring 5

AACN PRACTICE ALERT

Dysrhythmia Monitoring

- Lead V_1 to distinguish Ventricular Tachycardia (VT) from Supraventricular Tachycardia (SVT) with aberrant conduction
- V_1 lead of choice for dysrhythmia monitoring
  - Lead II or III if patient condition indicates need to monitor for atrial dysrhythmias

Practice Alert - Dysrhythmia Monitoring 6

AACN PRACTICE ALERT

Dysrhythmia Monitoring
Lead Placement

- V_1 (5 lead system)
  - 4th intercostal space (ICS) to the right of the sternum
- MCL_1 (3 lead system)
  - 4th intercostal space (ICS) to the right of the sternum

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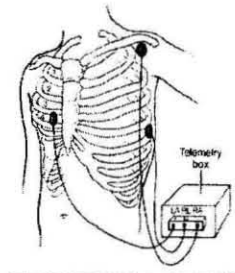
3 Lead Electrode Placement



- Simple 3-electrode lead system
- Electrode placement for MCL_1
- Only 1 lead can be monitored with a 3 lead system

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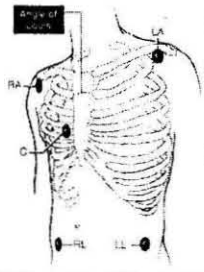
5 Lead Electrode Placement



- 5 lead systems allow for the recording of any of the six limb leads plus one precordial (V) lead.
- Shown lead placement for recording V_1 or V_6.
- 5 Lead monitoring systems are recommended over 3 lead systems for monitoring QRS morphology

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QRS Morphology
Ventricular Tachycardia

- V_1 or MCL_1
  - Monophasic R wave
  - Notched R wave with taller left peak
  - Biphasic RS
  - Biphasic qR
  - Any of the following in V_1 or V_2
    - R > 30ms
    - Slurred or notched S descent
    - QRS onset to S nadir >60 ms
- V_6 or MCL_6
  - Biphasic rS with R:S ratio <1.0
  - Monophasic Q
  - Notched QS
  - Biphasic qR
  - Intrinsicoid deflection ≥ 70ms

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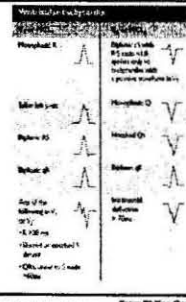
QRS Morphology



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QRS Morphology
SVT with Aberration

- V_1 or MCL_1
  - Bimodal rR' or triphasic rsR'
  - All of the following in V_1 or V_2
    - R < 30 ms or no R
    - Straight S descent
    - QRS onset to S nadir < 60 ms and no Q in V_6
- V_6 or MCL_6
  - Triphasic qRs with R:s ratio ≥ 1.0
  - Intrinsicoid deflection ≤ 50 ms

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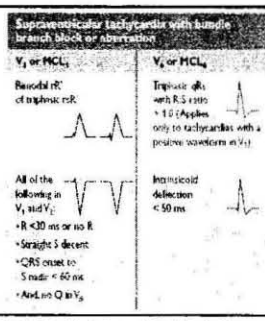
QRS Morphology



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QRS Morphology Not Helpful

- ◆V_1 or MCL_1
  - ❖R slurred or notched with taller right peak
- ◆V_6 or MCL_6
  - ❖Monophasic R
  - ❖Notched R with taller left or right peak
  - ❖Biphasic Rs with R:S ratio > 1.0

Applies only to tachycardias with a positive waveform in V_1

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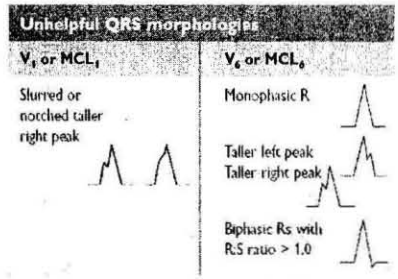
QRS Morphology



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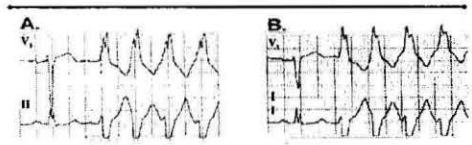
Accurate Lead Placement



(A) Onset of wide QRS complex tachycardia shows a "taller right peak" pattern in lead V_1, which is unhelpful in distinguishing between ventricular tachycardia and supraventricular tachycardia with aberrant conduction. Examination of the patient revealed that the V_1 electrode was misplaced to the 5th, rather than the 4th intercostal space

(B) After lead placement was corrected, another episode of wide QRS complex tachycardia showed the "taller left peak" pattern in lead V_1 which is strongly suggestive of ventricular tachycardia (Wellens, et al 1978). Subsequent invasive cardiac electrophysiologic study confirmed the patient had ventricular tachycardia.

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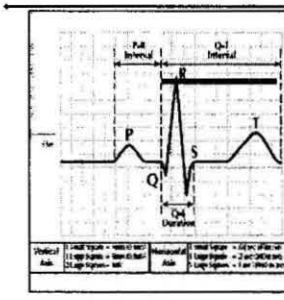
QT Interval

- ◆Approximate measure of the duration of ventricular repolarization.
- ◆Measured from the beginning of the Q wave to the end of the T wave
- ◆Varies with heart rate
  - ❖Lengthens with bradycardia
  - ❖Shortens with tachycardia

AACN PRACTICE ALERT

QT Interval



Measure from beginning of the QRS complex to the end of the T wave

AACN PRACTICE ALERT

QTc Interval

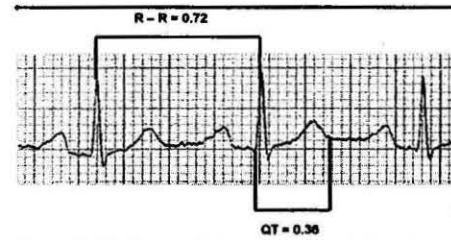
- QT interval corrected for heart rate (QTc)
- Formula for calculating QTc *(Bazett's formula)*

$$QT_c = \frac{QT}{\sqrt{RR}}$$

- QTc > 0.50 seconds considered dangerously prolonged and is associated with a higher risk of Torsades de Pointes.

AACN PRACTICE ALERT

Measuring the QTc



- Measure the QT of the second complex used in R – R measurement.
- Using Bazett's formula: QTc = 0.36 / √0.72 = 0.36 / 0.85 = 0.42 $QT_c = \frac{QT}{\sqrt{RR}}$

QTc = 0.42

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Torsades de Pointes

- Polymorphic Ventricular Tachycardia
- Precipitated by prolonged QT interval
- Not responsive to and may be exacerbated by class Ia and some Ic medications

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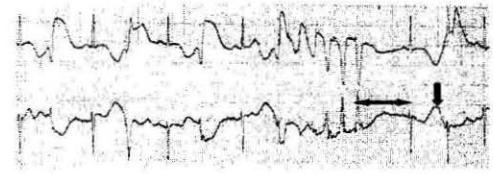

Arrhythmias associated with prolonged QT interval that place the patient at immediate risk for developing torsades de pointes. ECG characteristics include underlying prolonged QT interval, T wave alternans, polymorphic ventricular premature beats that fall near the T-U portion of repolarization, pause-dependent enhancement of the QT interval (arrow), and non-sustained polymorphic ventricular tachycardia.

AACN PRACTICE ALERT

Torsades de Pointes

- Monitor QT interval for patients identified at high risk:
  - Patients on medications known to prolong QT interval
    - Quinidine, procainaminde, disopyraminde, sotalol, dofetilide, ibutilide
    - For more information see: http://www.arizonacert.org/medical-pros/drug-lists/printable-drug-list.cfm
  - Patients who overdose on potentially pro-dysrhythmic medications
  - New onset bradycardia
  - Severe hypokalemia or hypomagnesemia

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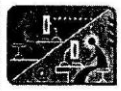
Treatment

Emergency
- IV Magnesium
- Defibrillation
- Overdrive pacing

Long Term
- Monitor QTc interval
- Discontinue or modify drug dose if QTc interval increases ≥ 0.50 secs

AACN PRACTICE ALERT

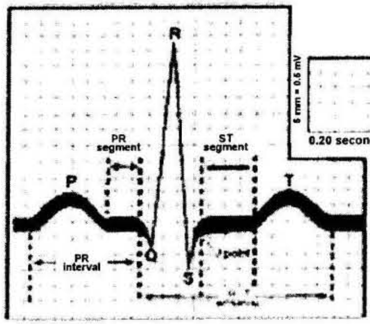
Need Further Assistance?



For more information or further assistance, please contact a clinical practice specialist with the AACN Practice Resource Network.

Email:
practice@aacn.org

Phone:
(800) 394-5995, x217



Cardiac Monitoring (rev)

Barbara Drew, RN, PhD
University of California
San Francisco

PHILIPS

American Association of Critical-Care Nurses

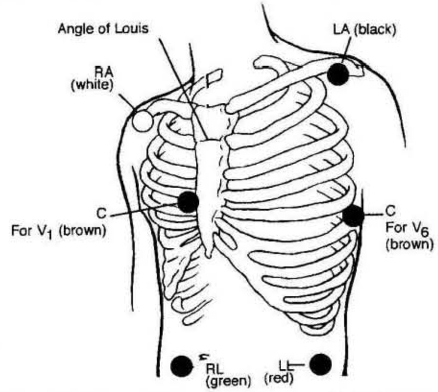
A Supplement to *Critical Care Nurses*

Philips PN #5990-0487
Printed in USA
March 15, 2002

Normal ECG criteria

Rate	Atrial and ventricular rates are the same. In adults, 60 to 100 cycles/min; in infants and children, within normal limits for age
Rhythm	Regular, with variance between P-P and R-R intervals less than 0.16 second
P wave	Present and 1:1 with the QRS
Shape	Uniformly rounded without peaking or notches
Size	Amplitude <3.0 mm, width 1.5 - 2.5 mm or duration of 0.06 - 0.11 second
Axis	0 to +90 degrees
Deflection	Upright in leads I, II, aVF, V_4 through V_6; inverted in aVR; may be flat, inverted, or biphasic in leads III, V_1, and V_2
PR interval	Consistent; in adults, 0.12 - 0.20 second; in infants and children, 0.11 - 0.18 second
QRS	Follows the P wave; QRS interval is 0.04 - 0.10 second
Q wave	Duration is <0.03 second; depth is 1-2 mm in leads I, aVL, V_5, and V_6; deep QR or QS in aVR and possibly in lead III
Amplitude	5-25 mm in limb leads, 5-30 mm in V_1 and V_6, 7-30 mm in V_2 and V_5, 9-30 mm in V_3 and V_4
Axis	-30 to +100 degrees
QT interval	Interval <50% preceding R-R; QTc <0.42 second (men) and <0.43 second (women)
ST segment	Follows isoelectric line, slight curve at proximal portion of the T wave
	Not depressed more than 1 mm
	May be normally elevated 1-2 mm in V_1 through V_3
T wave	Asymmetric and slightly rounded, without sharp points or large notches
Deflection	Should be in the same direction as QRS: upright in leads I, II, aVF, V_4 through V_6; inverted in aVR; varied in leads III, aVL, and V_1 through V_3

Standard electrode placement with a 5-lead set



Leads recommended for arrhythmia monitoring

For monitors with 5-leadwire patient cables

1st choice

Single-lead monitoring: V_1

Dual-lead monitoring: V_1 + II

2nd choice

Substitute V_6 for V_1 when the patient cannot have an electrode at the sternal border or when QRS amplitude is not adequate for optimized computerized arrhythmia monitoring.

Leads recommended for ischemia monitoring

Inferior myocardial infarction or RCA angioplasty/stent	II, III, or aVF
Anterior myocardial infarction or LAD angioplasty/stent	V_2 or V_3
Posterior or LCX angioplasty/stent	V_2 or V_3

Wide QRS tachycardias: distinguishing supraventricular tachycardia with bundle branch block or aberrant conduction from ventricular tachycardia (VT)

Four-step approach to diagnosis

Using the bedside monitor:

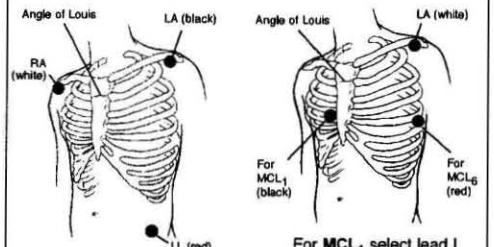
1. Presence of A-V dissociation → Yes = VT
2. QRS width > 0.16 second → Yes = VT
3. Electrical axis -90° - ±180° → Yes = VT
4. QRS morphology in leads V_1 or V_6 → Yes = VT

(MCL_1 or MCL_6) suggestive of VT (see table right)

Axis determination using lead I and aVF

QRS polarity lead I	QRS polarity lead aVF	Axis
⅄	⅄	Normal (0° to +90°)
V	⅄	Right (+90° to ±180°)
⅄	V	Left (0° to -90°)
V	V	Highly abnormal (-90° to ±180°)

Electrode placement with a 3-lead set



Standard lead placement

For MCL_1 select lead I
For MCL_6 select lead II

Leads recommended for monitors with 3-lead patient cables: 1st choice, MCL_1; 2nd choice, MCL_6; 3rd choice, lead II

V_1 or MCL_1	V_6 or MCL_6
Ventricular tachycardia	
Monophasic R	Biphasic rS with R:S ratio <1.0 *
Taller left peak	Monophasic Q
Biphasic RS	Notched QS
Biphasic qR	Biphasic qR
Any of the following in V_1 or V_2: a) R >30 ms b) Slurred or notched S descent c) QRS onset to S nadir >60 ms	Intrinsicoid deflection ≥ 70 ms
Supraventricular tachycardia with bundle branch block or aberration	
Bimodal rR' or triphasic rsR'	Triphasic qRs with R:S ratio >1.0 *
All of the following in V_1 and V_2: a) R ≤ 30 ms or no R b) Straight S descent c) QRS onset to S nadir ≤ 60 ms ***And,*** no Q in V_6	Intrinsicoid deflection ≤ 50 ms
Unhelpful QRS morphologies	
Slurred or notched taller right peak	Monophasic R
	Taller left or right peak
	Biphasic Rs with R:S ratio >1.0

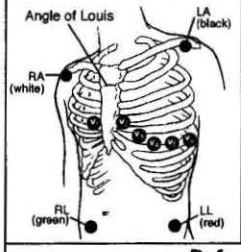
*Applies only to tachycardias with a positive waveform in V_1.

ECG indicators of myocardial damage

Ischemia Inverted T wave / ST depression	• Inverted T waves in leads with upright QRS deflections. • Deeply inverted T waves in precordial leads. • Transient ST-segment depression reflects acute ischemia. • Permanent ST-segment depression may indicate digitalis effect, LVH.
Injury Elevated ST segment	• Sign of an acute process; returns to baseline with time. • ST elevation may indicate pericarditis. • Determine location of injury similar to MI location process. • ST depression that occurs in an ECG and that also has ST elevation in other leads reflects reciprocal changes.
Infarction Q wave changes	• Evaluate Q wave size—normally small in leads V_5 and V_6; normally deep in leads III and aVR • Prolonged Q wave is ≥ 0.04 second. • Loss of R wave V_1 through V_3

12-lead placement

Mason-Likar (modified)



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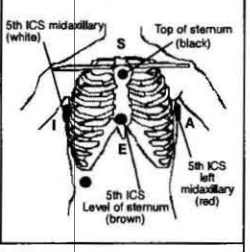

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3. Drew BJ, Krucoff MW, for the ST-Segment Monitoring Practice Guideline International Working Group. Multilead ST-segment monitoring in patients with acute coronary syndromes: a consensus statement for healthcare professionals. *Am J Crit Care.* 1999;2:372-388.

Appendix D: AACN Audit Tool

AACN PRACTICE ALERT

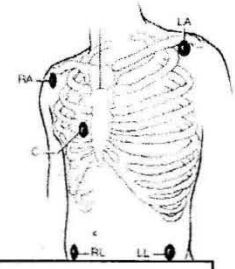
ELECTRODE PLACEMENT AND LEAD SELECTION AUDIT TOOL

Purpose: To determine compliance with correct electrode placement and lead selection
Instructions: *Modify per unit preference.*

Date: _____ Time: _____Room number: _____

Nurse: _____

1. Are electrodes placed in the appropriate anatomical region (See illustration) ☐ Yes ☐ No



If answer is Yes, move to question 3

2. If electrodes are not properly placed, identify the incorrect lead(s) and document any contraindications.

   Incorrect lead(s): ☐ V__ ☐ LA ☐ RA ☐ LL ☐ RL

   Contraindications: ☐ Yes ☐ No

Contraindications include: presence of incisions/wounds/lines, implantable devices, or an anatomical abnormality.

3. Has the appropriate lead been selected based on the patient's actual or potential dysrhythmia? Yes No

Appropriate Lead Selection includes the following: Lead V_1 to distinguish VT from SVT with aberrant conduction; left or right BBB; Lead II to monitor atrial activity.

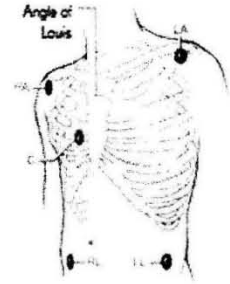
ELECTRODE PLACEMENT AND LEAD SELECTION AUDIT INSTRUCTIONS

PURPOSE

To determine compliance with correct electrode placement and lead selection.

PROCEDURE

1. Assess each patient on the unit for correct electrode placement and lead selection according to the following criteria:
    a. Are electrodes placed in the appropriate anatomical regions (use the illustration below)?
    b. If electrodes are not properly placed, which leads are incorrect and are there contraindications (presence of incisions/wounds/lines, implantable devices, or an anatomical abnormality)?
    c. Has the appropriate monitoring lead been selected based on the patient's actual or potential dysrhythmia (Lead V_1 to distinguish VT from SVT with aberrant conduction; left or right BBB; Lead II to monitor atrial activity)?
2. To determine the % compliance with correct electrode placement, divide the number of audits where the electrodes were placed correctly by the total number of patients audited. For example, if 10 patients were audited, and 8 of those patients had correct electrode placement, the % compliance would be 80%.
3. Follow the same procedure for determining % compliance for appropriate lead selection.
4. Audits of electrode placement may be performed collectively (either all electrodes are correctly placed or not) or individually (do a separate audit for each electrode) according to unit needs and preferences.



Appendix E: Permission from AACN

From: Pamela.Shellner@aacn.org [mailto:Pamela.Shellner@aacn.org]
Sent: Wed 1/13/2010 3:49 PM
To: Schultz, Susan
Subject: Re: Practice Alert permission

Susan,
You may download the Practice Alert and tools for PA and the toolkit connected with itfrom the Website and utilize the information for your course. They must maintain the American Association of Critical-Care Nurses Practice Alert title at the top. You may NOT edit the content for purposes of your course.

There are no additional forms or fees for this. Acknowledgement of permission for multiple copies can be made either on the document or in your program.

You may post a link to the AACN website that links to the practice alerts page from your e-learning site for students to access the practice alerts.

Pamela Shellner, RN MA
Clinical Practice Specialist
101 Columbia
Aliso Viejo, CA 92656
phone 800-394-5995 x321
fax 949-448-5551
Pamela.Shellner@aacn.org

"Act with Intention" Beth Hammer

From: Schultz, Susan
Sent: Wed 1/13/2010 10:25 AM
To: pamela.shellner@aacn.org; practice@aacn.org
Subject: Practice Alert permission

I'm planning on conducting research for a Doctor of Nursing Practice degree on dysrhythmia monitoring practices based on AACN's Practice Alert. I would like permission from American Association of Critical-Care Nurses to use the following resources posted on www.aacn.org :

AACN Practice Alert: Dysrhythmia Monitoring
AACN Practice Alert: Electrode Placement and Lead Selection Audit Tool
PowerPoint entitled "Practice Alert Dysrhythmia Monitoring" by Nancy M. Richards
Pocket reference: Cardiac Monitoring, AACN 2002, by Barbara Drew.

I plan to use the materials to educate telemetry staff nurses via an online learning module that is accessible only by the nurses in that hospital. I will not alter the content or parts of the documents that give credit to American Association of Critical-Care Nurses.

Please advise me if I should contact someone else for permission or if further information is required. Thank you
Susan Schultz, RN, MSN, CNE, CCRN
DNP Student at University of North Florida, Jacksonville, FL

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Dear Sir/Madam:

This is a request to reproduce the following material in my Doctor of Nursing Practice project called Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit to be submitted to the University of North Florida, Jacksonville, Florida:

Description of material:

AACN practice alert: Dysrhythmia monitoring. (2008). *Critical Care Nurse 28*(5), 90-91. Also available online from American Association of Critical-Care Nurses website at http://www.aacn.org/WD/Practice/Docs/Dysrhythmia_Monitoring_04-2008.pdf

Audit Tool: Electrode placement and Lead Selection (2008). American Association of Critical-Care Nurses Retrieved from http://www.aacn.org/WD/Practice/Docs/PracticeAlerts/Electrode_Placement-Lead_Selection_Audit_Tool_04-2008.pdf

Drew, B.J. (2002). Cardiac monitoring (rev), pocket card. Phillips PN 5990-0487, American Association of Critical-Care Nurses, Downloaded from http://www.aacn.org/WD/Practice/Docs/REV4_02_pocket_card.pdf

Richards, N. M. (2008). Practice alert dysrhythmia monitoring. Power point slide educational presentation, American Association of Critical-Care Nurses, retrieved from http://www.aacn.org/WD/Practice/Content/practicealerts.pcms?menu=Practice

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Pamela Shellner, RN, MA
Clinical Practice Specialist, American Association of Critical-Care Nurses
Signature of Copyright Holder

Yours truly, Susan Schultz

Appendix F: Appraisal Tables

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Belcher &Vonderharr (2005) Descriptive Interventional Study Evaluated web-delivered program to nursing staff on evidence based practice (guided by Gagne's instructional design principles)	64 staff nurses (out of 1500 in the hospital) voluntarily completed the audio and visual portion of the program and written evaluation. One hour CEU offered free. University students also used the program in an online course, but their evaluations were excluded from this article.	One hour online program (in WebCT) was developed by university faculty with hospital educator input. It included audio-streaming coordinated with video slides. Also had graphics, text, and interaction with content and instructor by email (although no one used email). Program objectives were about defining research-based practice, roles, processes, and how to implement.	none	1) Written course evaluations on participants' assessment of their achievement of learning outcomes, satisfaction and overall effectiveness. 2) Estimates of cost-effectiveness of web-based compared to traditional lecture	"All the staff nurses agreed that the learning objectives were achieved, they were satisfied with the program, and their personal learning needs were met." "Web-based program was marginally more cost effective ($30 less), given our small number of users"	Even though it was not an ECG educational program, it described detailed components of web-based program and how it was developed. Self-paced program, which allowed them to rewind and repeat. Program was standardized and accessible by multiple learners. Developed collaboratively between university and hospital.	Evaluations were self-reported perceptions with no validation of competency or learning. Vague summary of results with no statistical analysis. Not randomized. No control group for comparison. Cost effectiveness based on estimates and showed marginal difference, perhaps due to small percentage of staff who participated.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Cadden (2007) Descriptive Interventional Study Described teaching methods used to teach cardiac monitoring to nursing staff on a stroke unit, barriers encountered, and implications. Based it on principles by Quinn	17 out of 17 permanent nurses working on the unit without prior training in ECG monitoring. It was mandatory training because unit was adding cardiac monitoring.	1) new unit standard was written for cardiac monitoring, 2) education sessions provided *(not described)* 3) personal copy of learning package with cardiac A&P, rhythm interpretation, and activities *(not described)* to complete within 2 weeks. 4) beside tools provided (resource folder, access to journals, data sheet attached to monitors with step-by-step instructions, posters) 5) practice sessions with monitors and regular access to the educator and CCU nurses 6) collaborative ECG strip interpretation on unit with simulator and volunteer patients 7) ECG interpretation competition	none	1) completion of learning packet 2) competency-based assessment on skills with operating monitor and identifying rhythms 3) Questionnaire two months after cardiac monitoring begun on unit which asked about learning package's effectiveness, staff's confidence, and suggestions for future education.	All 17 completed learning packet. 16 out of 17 passed competency assessment on first attempt, 1 passed on second attempt. Questionnaire showed that most nurses felt learning package was adequate for their learning needs and they felt more confident. Only one reported needed more time to complete the package. Suggestions included desire to attend study days and more learning of monitor use while monitors connected to patients	Unit- based learning activities were conducted after the educational program to reinforce learning and skill acquisition. Evaluation included objective competency assessment by educator as well as subjective responses on questionnaire by learners.	Didn't describe what was in education sessions or what the required activities in learning package were. Did not report statistical analysis, validity or reliability of instruments Small study without control group or pretest for comparison

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Dumpe, Kanyak, & Hill (2007) Studied usefulness of a Learning Management System (LMS) to validate multidisciplinary employee competencies on HIPAA. Later, developed program for 16 annual online competencies to be completed by nursing staff.	HIPAA mandatory for over 18,000 total hospital employees Nursing competencies were accessed by 4064 nurses (total population unknown)	All employees for HIPPA and all nursing staff for 16 online competencies.	N/A	Completion and satisfaction rates.	Over 2 months, 18,000 employees successfully completed the HIPAA online course (but don't know percentage). Participant survey regarding their satisfaction showed 75% were satisfied or very satisfied with the online course. 65% preferred online training to traditional instructor-led training. 4064 nursing personnel accessed the online nursing competencies. 90% reported satisfied or very satisfied with the system 92% reported it was easy or very easy to complete 87% reported they were able to complete the competencies on their own unit.	LMS was an effective way to standardize competencies and reach large numbers of staff for HIPPA training and nursing competency assessment.	Did not report statistics or percentages of staff that completed the programs. Didn't describe what the subjects were for the nurses' annual competency assessments.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Durkin (2008) Quasi-experimental pilot study. Studied if retention of knowledge was different between text-only and interactive computer-based learning (CBL) formats on cranial nerve function and assessment. Topic was selected because staff on medical patient care unit did not have much knowledge of it or use it in their regular practice.	Out of 85 total nurses, 41 nurses started it, 31 completed program and were randomly assigned (13 in text CBL and 18 in interactive CBL). 10 nurses were dropped because did not complete posttest, took the test without viewing the content, or did not log out of the system.	Intervention group received interactive computer based learning program. It included the same text in portable document format (Pdf) as the control group. It also included humor, color, animation, review questions, interactive games, several cycles of repetition, and option to participate, opt out, and skip forward and backward. No restriction of length of time it took to complete the module or tests, although they were encouraged to take the course and posttest 1 within 2 weeks of pretest, and then 2 weeks later to complete Posttest 2.	Control group received text-only computer based learning program in same Pdf format as intervention group. They could read it as often as they wished.	1) Pretest, Posttest #1 right after completing program, Posttest #2 taken 2 or more weeks after first posttest. Same test used for both groups and each testing opportunity although questions were randomized. Students saw their test scores but not the questions they missed or the correct answers. Validated for accuracy and appropriateness by expert neuro nurses. 2) Elapsed time for pretest, course, and posttests (from learning management system).	1) No significant difference in pretest between groups. 2) Both groups showed significant improvement between Pretest and Posttest #1 ($p<.000$). 3) Only interactive CBL group had significantly higher Posttest #2 scores when compared to Pretest scores. ($p<.000$). 4) Elapsed time from pretest and posttest 1 and then from posttest 1 to posttest 2 was not significantly different between groups. The average number of days were between 34-44 (instead of the expected 14 days) 5) No significant difference between groups on how long it took to complete the programs.	Subjects were randomized to groups. All statistics reported in text were congruent with data listed in tables. Results compared to other studies but no direct comparison could be made because little research has been published about the effectiveness of different formats of CBL. Longer retention was shown to occur in the interactive CBL group.	Did not study dysrhythmia instruction, but provided insight into CBL. Same test given three times, although measures taken to reduce learning from the test. Small sample size. Length of time to complete modules and tests was variable. Learning management system was not very sophisticated and didn't allow for interactive courses with scenario branching, dialogue and animation (although authors reported earlier the program did include animation).

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Frith and Kee (2003) Posttest only, control group experimental design. Compared the effectiveness of different instructional communication methods in a Web-based (Web-CT) cardiac rhythm interpretation course. Both groups were exposed to the same content in a 6-week course divided into four study units that contained content, instructions, practice questions, glossary, case studies, and self-tests.	174 students out of 388 were recruited from undergraduate nursing programs in US. They randomly selected and assigned 87 students per group (power analysis indicated 32 students per group were necessary but increased number due to anticipated attrition rates). 75 students completed it (40 exp and 35 control). CEUs but no course credit offered.	Frequent online communication among students or between instructor and students. Students worked together on case studies, and used online chats to enhance their understanding of the self-test. Instructor led chat sessions, responded in discussion forums, and provided online office hours, and emailed answers to questions.	Students completed all activities independently with limited instructor conversations that consisted of directions to start next unit, and answers to questions about content or technical problems.	1) students' cognitive learning on two multiple-choice exams midterm and final, 2) student's satisfaction using Allen's Attitude Toward Computer-Assisted Instruction. and 3) motivation to complete the course obtained by calculating completion, attrition, and non-starting rates from Web CT.	No significant differences ($p>.05$) in midterm and final exam scores. Significant difference ($p=.034$) found between groups on satisfaction scores. No significant differences ($p>.05$) in completion rates. Completion rate for all students was 43%, lower than national average of 57% (dropped due to technical reasons and time).	Well-designed randomly assigned experimental study. Compared sample to the population well. Statistics explained thoroughly. The collaborative activities between students and increased conversations with instructor did improve students' satisfaction with course, although it did not affect cognitive learning or completion rates.	Instructional design methods may have been too similar. All students volunteered and may have had a higher comfort level with web-based courses. Theoretical framework of guided didactic conversation may have been to narrow in scope.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Jang, et al. (2005) Quasi-experimental study with experimental and control groups and a pretest-posttest design. Studied effects of web-based teaching method on undergraduate nursing students' learning of electrocardiography.	Non-randomized, convenience sample from university in Korea. All 121 senior nursing students verbally agreed to participate, but 16 students were excluded due to insufficient information. 54 were in experimental group conducted in 2002 and 51 were in control group which was conducted in 2003.	Web-based ECG program included learning objectives, electrophysiology, types of arrhythmias, and patterns of hypertrophy. It also included immediate feedback to questions, navigation tabs to select desired content, and ability to print material. It was self-paced over 4 weeks and they could take it at the most convenient time for them. A one hour presentation about the web-based program was provided.	Traditional lecture method on same ECG content as web-based program, taught over 16 hours (2 hours, twice a week for 4 weeks)	1) Learning Achievement Tool with 45 items on knowledge of ECG principles and 15 items on ECG interpretation (pretest and posttest reliability KR 20=.833) 2) Satisfaction (18 item questionnaire using 4-point scale) (posttest only Reliability Cronbach's alpha =.79) 3) Learning Motivation, using version of Keller's Instructional Materials Motivation Survey. (posttest only. Reliability Cronbach's alpha = .87)	Used SPSS, sig=0.05, Chi square, paired t tests and ANCOVA, 1) No sig difference at baseline between groups. 2) Knowledge of ECG principles: exp group lower than control ($p<.001$) 3) ECG Interpretation: exp group higher than control ($p<.005$), 4) No sig dif in satisfaction or motivation	Validity and Reliability of tools were reported. Control group had sig higher scores in Adult Health Nursing Course taken prior to study (mean 91.5 vs. 89% $p<0.5$), but controlled with ANCOVA and findings were the same.	Conducted with nursing students instead of hospital staff nurses. Did not say which web-based system was used. Results not consistent with other studies that showed web-based instruction was better than lecture, or showed no sig differences.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Jeffries (2005) Pilot Study, Descriptive Intervention Designed an online critical care course, using an instruction model based on Chickering and Gamson's seven principles of best practices in education. Usability testing was done before pilot study.	15 participate, 12 RNs and 3 senior BSN students with diverse backgrounds and experience. Did not say how recruited. Ages ranged 20-49. Most were RNs taking course for professional development. Two thirds lived more than 100 miles from campus. Course lasted 10 weeks.	Model included three components: 1) core didactic online program with mini-lectures, vignettes of patient scenarios, interactive activities such as games, discussion board, diary of reflections, and web links that learners could select as needed. Program incorporated three dimensions of general principles, process, and critical thinking. Student-centered, allowing selection of content, activities, and materials. 2) Practicum of 112 clinical hours with preceptor in critical care unit 3) Access to Virtual Center of Best Practices (VCBP) which served as a learning resource center and provided standards or protocols, current research, and asynchronous consultation with clinical experts.	1) competency in reaching learning outcomes on 10 modules as measured by multiple choice pretests and post tests for each modules and final exam. Correct answers with rationales displayed on pretest 2) skills acquisition assessment by preceptor 3) Students' perception of educational practices 4) Students' satisfaction 5) convenience of course (For 3, 4, 5, used EEUWIN instrument)	1) All students successfully completed the course with passing scores (didn't clarify what was passing). 2) All students met the required competencies 3) Students perceived that the principles of best practices in education were highly incorporated into the online course (means from pilot study were higher than means national benchmark). 4) Mean course satisfaction was 4.17 out of 5 (SD=0.80). 5). Mean for perceived convenience was 4.01 out of 5 (SD = 0.82)	Included direct comparison of Chickering and Gamson's seven principles of best practices to the program components and students' ratings of how well program met the principles. Pilot study showed that critical care concepts and skills could be learned through e-learning.	Small pilot study with mix of RNs and student nurses. Did not say how students recruited. Didn't specify what cardiac dysrhythmias were included in the critical care course.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Control Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Jeffries, Woolf &Linde (2003) Experimental design. Compared technology-based vs. traditional instructional methods to teach the skill of performing a 12-lead ECG. Based learning method on Chickering and Gamson's seven principles of best practices in education.	Randomized 77 BSN senior students in groups of 8-10, based on clinical sections (32 control, 45 experimental). 76 completed pretest and 73 completed posttest. Students taking a required critical care course at large Midwestern university were invited and 100% of the students in the class agreed to participate and signed consent forms. Ages, sex, and race provided for all participants but not for each group. No significant difference between groups in computer proficiency skills.	Same content as control group using an interactive, multimedia CD_ROM embedded with virtual reality and supplemented with same self-study module used in control group. Learner-controlled which allowed self-pacing, selection of topic sequence, and exit at any time. Students were scheduled 90 minutes in lab where they took pretest and viewed CD ROM. Outcomes one week later.	Traditional method with self-study module, 15 minute lecture and demonstration, hands-on practice with manikin and 12-lead ECG machine as time allowed. Instructor-controlled. One instructor delivered content in 90 minute classes to each group. Outcomes measured one week later	1) Cognitive learning with Pretest and Posttest (not a part of the course grade). Both tests contained same multiple choice questions in different order. 2) skill performance on a hired simulated patient was measured by three trained nurse evaluators who were blinded to group (inter-rater reliability established). A weighted 22-item procedural checklist used. 3) Student satisfaction 4) Perceived self-efficacy	Both groups showed significant ($p<.0001$) improvement from pretest to posttest scores. No significant ($p<.05$) differences between groups in pretest scores, cognitive gains on posttests, student satisfaction with learning method, or perception of self-efficacy in performing the skill. Both groups were similar in their ability to demonstrate the skill correctly on a live, simulated patient.	Reported how established validity of each tool. Reliability scores on instructor-developed pretest/posttest were Cronbach's alpha 0.67 and 0.52. Reliability of instructor-developed satisfaction and self-efficacy questionnaires were reported from two previous studies (Cronbach's alpha were 0.84 and 0.92 in this study, similar to prior studies)	Pretest and posttest contained same items (threat to internal validity). Single convenience sample used and needs to be replica-ted in other settings.Course did not include dysrhythmia recognition, but did include correct lead placement.

Authors Study Purpose	Sampling Method, Size	Intervention Group	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Keller & Raines (2005) Qualitative study. Focus group methodology, conducted on a tiered schedule over 1 year. Purpose was to elicit perceptions of nurses about the level of knowledge needed to recognize a cardiac arrhythmia. Provided evidence for developing levels of arrhythmia competency	25 critical care nurses from three large metropolitan community hospitals were asked to volunteer and incentive was arrhythmia update program with continuing education (CE) credits. Purposeful sampling with group-specific criteria used to create groups between 4-8 people per group.	Group 1: 5 ACLS instructors Group 2: 4 nurses with less than one year critical care experience. Group 3: 4 nurses with more than 1 year critical care experience Group 4: 8 nurses with more than 1 year critical care experience Group 5: 4 nurses with more than 1 year critical care experience	Nurse's perceptions whether ECG rhythm strips represented basic or advanced knowledge. A third category of intermediate knowledge was added.	Consensus was reached on 17 of the 30 strips, with 12 categorized as basic and 5 as advanced. Of the remaining 13, there continued to be lack of consensus. These arrhythmias included torsades de pointe, heart blocks, atrial fibrillation with right BBB, ventricular tachycardia, and WPW with atrial fibrillation. A chart listing which arrhythmias could be categorized as basic, intermediate, and advanced was displayed. They concluded there was significant lack of ability of nurses to recognize and differentiate heart blocks, aberrant conduction, and tachyarrhythmias.	Group methodology explained well. Verbatim extracts from transcripts of group discussions were included to back up author's conclusions.	Sample not randomized. Incentive of CE credits for arrhythmia update may have adversely affected sample by attracting more nurses who didn't know arrhythmias very well.

Authors Study Purpose	Sampling Method, Size	Intervention Groups	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Morris, et al. (2009) Prospective, quasi-experimental design with both quantitative and qualitative methods, Purpose was to determine the effect of a new model of critical care orientation.	All newly hired nurses who attended orientation to critical care between July 2005-Dec 2006 were asked to participate. Informed consent obtained from 173 out of 197 new hires (87.8%). New hires placed in 3 groups based on experience. GNs had less than 1 year experience. RNs had years experience ranging from 1 to 20 years. Gender and Race described.	1. New GNs (110) 2. RNs without Critical Care experience (44) 3. RNs with Critical Care experience(43) Orientation program was learner-centered and included unit specific orientation, case studies, human patient simulations, computerized assisted online learning modules (for ECG, PA catheters, Critical Care orientation), pocket guides, CD Rom, and preceptor training. All 3 groups received unit orientation, case studies, and simulations. In addition, RN with CC exp took pretest and completed online modules if needed. RN without CC exp completed all online modules, GNs had instructor-led classes in addition to online modules. Dysrhythmias were taught with "Mosby's ECG Online" web-based tutorial	Satisfaction, Retention, Turnover, vacancy, Preparedness to manage patient care assignment, Length of orientation and Cost of orientation. Total time was 34 months. Collected data on 5 cohorts over 1 and half years. Retention rates calculated at 1 year, 18 months, 2 years, and 3 years (if available) for each cohort.	1 year retention rates increased from 91.2% before the program to 93.7%. 2 year retention was 100% RN with CC exp, 79% RN no CC exp, GN 94%. Annual turnover decreased from 8.77% to 6.29%, and vacancy rates decreased (from 14.3% to 4.8%). Satisfaction of preceptors, educators, and managers ranged from 61-93%. Preparedness to manage patient care assignment rated by managers ranged 53-80%. Sim lab and pocket cards rated most useful (4.85 on 5 point Likert scale). Length of orientation was unchanged. Cost of orientation increased by $24,820 more than old program, due to licensing fees for web-based programs and FT education consultant	Evaluated multiple outcomes over the long term (3 years) and at intervals inbetween. Three computerized assisted online learning modules, including dysrhythmia tutorial, were essential parts of the model and nurses achieved passing rates of 85% or higher.	Results cannot be contributed to any one teaching strategy, since the model included all of them. Critical thinking was evaluated subjectively by managers and preceptors instead of with a valid or reliable instrument.

Authors Study Purpose	Sampling Method, Size	Intervention Groups	Outcomes Measured	Results	Major Strengths	Major Weaknesses
Van-Arsdale, (1998) Comparative study, posttest only, multiple treatment group design. Evaluated four different teaching methods in the development of skills necessary to identify cardiac dysrhythmias	Not randomized. Included 244 R.N.s from ER, CCU, and telemetry units from three hospitals (200-500 beds) in a rural setting over a 2 year period of time. Nurses were assigned to one of four groups depending on when they were employed and which method was being used at that time. Only nurse who had never attended a program on dysrhythmia interpretation were included.	All groups received a 20-hour basic dysrhythmia course with same objectives, content, and reference book. All groups were taught by the same critical care clinical specialist. Group 1: 72 RNs 2-hour sessions once a week over 10 weeks Group 2: 48 RNs 2-hour sessions twice a week over 5 weeks Group 3: 60 RNs 2-hour sessions twice a day over 5 days Group 4: 64 RNs Self-instructional module (reading packet)to be completed within 10-weeks (reading packet)	1) Posttest. 90% of the questions dealt with interpretation of rhythm strips. Explained how validity was established. Reliability was .90. 2) Course evaluation surveys by students	1) ANOVA showed there were significant differences between groups on posttest scores (p= .0001) 2) Follow-up (Tukey) revealed that Group 1 and 2 scored significantly higher on the posttest than Group 3 and 4. 3) 90% from Group 1 and 2 indicated objectives were attained, length appropriate, and felt prepared. 4) 100% from Group 3 indicated too much new information was presented and they felt uncomfortable with their skills. 5) 91% from Group 4 indicated some classroom sessions would be beneficial to ask questions or discuss rhythms.	All statistics reported in text were congruent with data listed in tables. Group interactions not a factor because courses not taught simultaneously. Consistent educational materials and posttests were used for each group. Posttest had high reliability (Kuder-Richardson .9).	Study was conducted over two years prior to 1998. Self-instruction module was only a reading packet, with no computer- based learning strategies (perhaps because they were not readily available then) Analysis of group characteristics was not provided so don't know if all groups were similar. Course included basic dysrhythmia categories but not bundle branch blocks.

Appendix G: ACC/ ECC Rating System

American College of Cardiology Emergency Cardiac Care Committee Rating System

Class I: Cardiac monitoring is indicated in most, if not all, patients in this group.

Class II: Cardiac monitoring may be of benefit in some patients but is not considered essential for all patients.

Class III: Cardiac monitoring is not indicated because a patient's risk of a serious event is so low that monitoring has no therapeutic benefit

(Taken from Drew et al., 2004)

AppendixH: AACN Levels of Evidence

American Association of Critical-Care Nurses' Grading Level of Evidence

Level I: Manufacturer's recommendations only

Level II: Theory based, no research data to support recommendations; Recommendations from expert consensus group may exist

Level III: Laboratory data, no clinical data to support recommendations

Level IV: Limited clinical studies to support recommendations

Level V: Clinical studies in more than one or two patient populations and situations to support recommendations

Level VI: Clinical studies in a variety of patient populations and situations to support recommendations.

(Taken from AACN Practice Alert, 2008)

Appendix I: ACC/AHA/ESC Levels of Evidence and Classifications

Levels of Evidence

- **Level of Evidence A**: Data derived from multiple randomized clinical trials or meta-analyses.

- **Level of Evidence B**: Data derived from a single randomized trial, or nonrandomized studies.

- **Level of Evidence C**: Only consensus opinion of experts, case studies, or standard-of-care.

Classification of Recommendations

- **Class I**: Conditions for which there is evidence and/or general agreement that a given procedure/treatment is beneficial, useful, and effective.

- **Class II**: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

    - **Class IIa**: Weight of evidence/opinion is in favor of usefulness/efficacy.

    - **Class IIb**: Usefulness/efficacy is less well established by evidence/opinion.

- **Class III**: Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful or effective and in some cases may be harmful.

(Taken from Zipes et al., 2006)

Appendix J: Principles of Good Practice andEvidence-based Strategies

Seven Principles of Good Practice [1]	Evidence-based Strategies Applicable to Staff Nurses	References
1. Encourages student-faculty contact	• Provide the instructor‘s contact information for the students in the program.	• Belcher &Vonderharr, 2005; Frith&Kee, 2003.
	• Establish regular times for educator to be online or present to reinforce learning.	• Cadden, 2007; Frith&Kee, 2003.
2. Develops reciprocity and cooperation among students.	• Plan opportunities for nurses to collaborate on interpreting case studies and ECGs	• Cadden, 2007; Frith&Kee, 2003; Morris et al., 2009.
	• Use online chats or discussion forums when learners are expected to access the program more than once.	• Dumpe, Kanyak, & Hill, 2007; Frith&Kee, 2003; Jeffries, 2005.
3. Uses active learning techniques.	• Incorporate case studies, games, and self-check practice questions in the online educational program.	• Durkin, 2008; Frith&Kee, 2003; Jeffries, 2005; Jeffries, Woolf, &Linde, 2003.
	• Require return demonstration of skills with competency assessment checklists and/or human patient simulation.	• Cadden, 2007; Jeffries, 2005; Jeffries, Woolf, &Linde, 2003; Morris et al., 2009.
4. Gives prompt feedback.	• Provide answers on practice questions throughout the online course and after the posttest.	• Durkin, 2008; Frith&Kee, 2003; Jang et al., 2005.
	• Offer unit training with a preceptor or educator who gave them daily feedback.	• Cadden, 2007; Jeffries, 2005; Morris et al., 2009.

Seven Principles of Good Practice [1]	Evidence-based Strategies Applicable to Staff Nurses	References
5. Emphasizes time on task.	• Develop web-based courses that may be accessed at the learner's convenience from home or work.	• Belcher &Vonderharr, 2005; Dumpe, Kanyak, & Hill, 2007; Durkin, 2008; Jang et al., 2005; Jeffries, 2005.
	• Design software that displays table of contents and allows learners to navigate back and forth through the program.	• Durkin, 2008; Jang et al., 2005; Jeffries, 2005; Jeffries, Woolf, &Linde, 2003.
	• Provide continuing education credits	• Belcher &Vonderharr, 2005; Frith&Kee, 2003; Keller & Raines, 2005.
6. Communicates high expectations.	• State the learning objectives of the program clearly and evaluate how well they were met with pretest and/or posttest questions.	• Durkin, 2008; Frith&Kee, 2003; Jang et al., 2005; Jeffries, 2005; Jeffries Woolf, &Linde, 2003.
	• Require competency-based skills validation.	• Cadden, 2007; Dumpe, Kanyak, & Hill, 2007; Jeffries, 2005; Jeffries, Woolf, &Linde, 2003; Morris et al., 2009.
7. Respects diverse talents and ways of learning	• Incorporate variety of teaching methods such as printed materials for self-study, pocket cards, references on the unit, audio, visual, graphics, animation, virtual reality, hands-on, and interactive activities.	• Belcher &Vonderharr, 2005; Cadden, 2007; Durkin, 2008; Jang et al., 2005; Jeffries, 2005; Jeffries, Woolf, &Linde, 2003; Morris et al., 2009.

[1]Chickering, A. W. &Gamson, Z. F. (1987, March), Seven principles for good practice in undergraduate education. *American Association for Higher Education (AAHE) Bulletin*, *39* (7), 3-7.

Appendix K: Permission to Conduct Study

Appendix E: Permission to Conduct Study

I, Kathy Koenig, Nursing Manager for 4 Center at St. Vincent's Medical Center, give permission for Susan Schultz, DNP student at University of North Florida, to conduct a research study on 4 Center as described in the abstract below, providing that IRB approval is obtained from the hospital and the university.

Signature Deleted

Kathy Koenig 2/19/10 Date

Abstract: Dysrhythmia Monitoring Practices by Nurses on a Telemetry Unit

Nurses who work in telemetry and critical care units in hospitals have an important responsibility to monitor patients' cardiac rhythms appropriately and to intervene promptly. However, many nurses often monitor in a single lead regardless of diagnosis and are unable to differentiate wide QRS complex tachycardias. The purpose of this project is to evaluate the effectiveness of an interactive web-based education program combined with unit-based collaborative learning activities on telemetry staff nurses' dysrhythmia knowledge and monitoring practices for patients at risk for wide QRS complex tachycardias. The first outcome that will be measured is nurses will demonstrate correct electrode placement and lead selection for arrhythmias, identify when and how to measure QTc intervals, differentiate between wide QRS complexes tachycardias, and describe the appropriate nursing interventions. The second outcome is that patients will be monitored in the optimal lead for their arrhythmias with electrodes placed properly on their chest. The first outcome will be evaluated through the use of a pretest/posttest in the web-based educational program and a competency skills checklist. The second outcome will be evaluated with an audit tool on electrode placement and lead selection.

Appendix L: Nurses' Demographic Questionnaire

1. Gender
    a. Male
    b. Female

2. Ethnicity
    a. American Indian or Alaska Native
    b. Asian or Pacific Islander
    c. Black or African American
    d. Hispanic or Latino
    e. White or Caucasian

3. Highest educational degree:
    a. Associates
    b. Bachelors
    c. Masters
    d. Doctoral

4. How much instruction have you received before today on QRS morphology and QT interval monitoring?
    a. no instruction
    b. only a little instruction
    c. some instruction but not comfortable yet
    d. enough instruction to feel comfortable
    e. sufficient instruction to be able to teach others

5. Have you ever studied online or web-based educational programs?
    a. Yes
    b. No

6. How comfortable are you with online learning or web-based instruction?
    a. Not comfortable at all
    b. Somewhat comfortable
    c. Very comfortable

7. Is English a second language for you?
    a. Yes
    b. No

8. How old are you? _____

9. Years licensed as RN: _____

10. Length of time worked on this unit: _____

11. How many years ago was your first class on dysrhythmia interpretation? _____

Appendix M: Recruitment Announcements

Attention 4 Center Telemetry Staff Nurses:

You are invited to participate in an evidence-based nursing research study on:

Dysrhythmia Monitoring Practices

Research project by Susan Schultz, MSN
DNP Student, University of North Florida

What is the purpose?

To evaluate the effectiveness of an interactive web-based education program combined with unit-based collaborative learning activities on telemetry staff nurses' dysrhythmia knowledge and monitoring practices for patients at risk for wide QRS complex tachycardias.

What does it involve?

Complete the education module, unit-based activities, and competency skills checklist during May, 2010.Your participation is voluntary. The total time it will take is expected to be 2.5 hours. The inclusion criteria will be:

- Nurses who have worked at least 3 months on 4 Center and agree to participate in the study.
- Nurses who float regularly to the unit (at least once every two weeks) and agree to participate in the study.

What are the benefits to me?

- Free continuing education credit (approval pending)
- Free laminated pocket reference card on cardiac monitoring
- Improved competency in recognizing wide QRS complex tachycardias
- Increased accuracy in placing electrodes and selecting optimal leads to monitor patients

How do I find out more information?

Log onto St. Vincent's Learning Management System
and select the program "Dysrhythmia Monitoring Practices"
Or contact Susan Schultz C 904-608-8563 or s.schultz@unf.edu

Dysrhythmia Monitoring Practices

Research Project with Susan Schultz, MSN,
DNP Student, University of North Florida

PROJECT TIMELINE

May 17- 20, 2010	Conduct first audit of electrode placement and lead selection
May 20 – June 13	Sign consent forms and study educational module on LMS
June 2 – June 26	Work on unit-based activities and skills checklist

Susan Schultz is planning to be on 4 Center during these times:

Wed. June 2,	1:00 – 3:00 pm	11:00 pm – 12:30 am
Thu. June 3	----------	11:00 pm – 12:30 am
Fri. June 4	1:00 – 3:00 pm	11:00 pm – 12:30 am
Sat. June 5	1:00 – 3:00 pm	----------
Wed. June 9	1:00 – 3:00 pm,	11:00 pm – 12:30 am
Thur. June 10	1:00 – 3:00 pm,	11:00 pm – 12:30 am
Fri. June 11	1:00 – 3:00 pm,	10:30 pm – 12:30 am
Sat. June 12	1:00 – 3:00 pm,	
Mon. June 14	4:00 – 5:00 pm,	10:30 pm – 12:30 am
Wed. June 16	1:00 – 3:00 pm,	10:30 pm – 12:30 am
Thur. June 17	1:00 – 3:00 pm,	10:30 pm – 12:30 am
Fri. June 18	1:00 – 3:00 pm,	10:30 pm – 12:30 am
Tue. June 22	----------	10:30 pm – 12:30 am
Thu. June 24	1:00 – 3:00 pm	----------
Fri. June 25	----------	10:30 pm – 12:30 am
Sat. June 26	12:00 – 1:00 pm	----------

June 24-26	Conduct second audit of electrode placement and lead selection
Sept. 1-3	Conduct third audit of electrode placement and lead selection

Contact Information: Susan Schultz, Cell (904) 608-8563,s.schultz@unf.edu

Appendix N: Informed Consent

(IRB - 4)

INFORMED CONSENT

ST. VINCENT'S MEDICAL CENTER
St. Vincent's HealthCare

Informed Consent to Participate in a Research Study

Title: Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit

Protocol #: St. Vincent's #10-05-01; UNF #10-031

Sponsor: University of North Florida (UNF), Jacksonville, Florida

Principal Investigator: Susan J. Schultz, MSN, CNE, CCRN

Contact Information: 904-608-8563 or s.schultz@unf.edu

Supervising Faculty: Carol Ledbetter, PhD, FNP, BC, FAAN, Professor UNF

Contact Information: 904-620-1212 or carol.ledbetter@unf.edu

Introduction

You are asked to take part in a research study that looks at dysrhythmia monitoring practices of nurses. Susan Schultz, doctoral student at University of North Florida, will be in charge of this study. You have been asked to be in this study because you are a nurse who works at St. Vincent's on a telemetry unit.

Your being in this study is completely voluntary. That means you do not have to be in this study if you do not want to. You should read the information below. You may ask questions about things that are not clear before deciding to take part in this study. We encourage you to talk to your coworkers or manager before you decide.

Why is this study being done?

This study is being done because nurses who work in telemetry units in hospitals have an important responsibility to monitor patients' cardiac rhythms appropriately and to

intervene promptly. However, many nurses often monitor in a single lead regardless of diagnosis and are unable to differentiate wide QRS complex tachycardias. The American Association of Critical-Care Nurses has established recommendations for monitoring patients at risk of wide QRS complex tachycardias and this study will be based on their recommendations.

The purpose of this study is to evaluate the effectiveness of an interactive web-based education program combined with unit-based collaborative learning activities on telemetry staff nurses‘ dysrhythmia knowledge and monitoring practices for patients at risk for wide QRS complex tachycardias.

How many people will take part in this study?

About 35 staff nurses may be in this study. You may be able to be in the study if you meet the inclusion criteria. You will be given 4 weeks to complete the education and activities in this study. The entire study could last up to 18 weeks. It requires between one and three visits to the hospital, some of which may be completed during your scheduled working hours.

What is involved in this study?

This interventional, one group before-and-after cohort study design will consist of four components:

1) An interactive web-based educational program about evidence-based practice standards for dysrhythmia monitoring of wide QRS complexes with a pretest and posttest, using St. Vincent‘s online Learning Management System.
2) Unit-based collaborative learning activities with other staff nurses, led by the primary investigator, to reinforce knowledge of wide QRS complex dysrhythmias and monitoring practices. Examples of activities are conducting audits, calculating QTc intervals, and interpreting dysrhythmias and 12 lead electrocardiograms.
3) Validation of staff‘s competency using a skills checklist which will include placement of electrodes, lead selection, QTc interval monitoring, QRS morphology analysis, and nursing interventions for wide QRS complexes
4) Audits done by the investigator of electrode placement and lead selection before the interventions (education, unit-based activities, and staff competency validation), at the conclusion of the interventions, and 12 weeks after the interventions.

The procedures are based on evidence-based practice and standards of care established by the American Association of Critical-Care Nurses. None of the procedures are experimental.

What are the risks or discomforts of being in this study?

Your participation in this study is voluntary and it will not affect your employment. There is the potential for professional embarrassment (due to insufficient knowledge about the subject), but it is not anticipated. Your testing and competency information will be kept confidential. The unit-based activities will be conducted in small groups with the staff nurses who are working that shift and you will be given a choice whether to participate with them or to do it another time. When you are demonstrating skills on the checklist with the investigator, it will be done privately. If you are unsure about something, the investigator will provide additional instruction and another opportunity to demonstrate competency if needed. When verifying placement of electrodes on a patient, the instructor will explain what is expected before going in the room, give you feedback nonverbally while in the room (example: by pointing to the correct landmark on the patient's chest), and discuss it later with you outside the patient room.

What if you are pregnant or may become pregnant?

This study will not involve any risks to pregnant women or unborn children.

What are the possible benefits?

The possible benefits of the study are:

- Free continuing education certificate for contact hours will be given by the investigator to all participants who consent to participate in the study and complete all of the components (education program pretest and posttest, program evaluation, unit-based collaborative activities, and competency skills checklist).
- Free laminated pocket reference card about cardiac monitoring will be given to all nurses who consent to participate.
- Improved ability to differentiate wide QRS complex tachycardias and to initiate the appropriate treatment.
- Increased accuracy in placing electrodes and selecting optimal leads to monitor patients

Since this is a research study, there is no guarantee that the education program will be of any help to you.

Are there other treatment options?

Being in this study – or saying no – is up to you. If you do not agree to participate in the study, you may access some of the educational materials from the American Association of Critical-Care Nurses at their website www.aacn.org

What about new findings?

The principle investigator, Susan Schultz, will tell you of any new findings developed during the study. These new findings may make you change your mind about wanting to stay in the study.

Is there any compensation if you are injured?

The sponsor or principle investigator will not pay for health care costs your health insurance does not cover if you are injured because of this study. This will include emergency treatment and follow-up care. The sponsor will not pay for treatment of problems the study did not cause. You will not be paid for lost pay, lost time, or pain and suffering. You do not waive any legal rights by signing this consent form.

How will your records be kept confidential?

If you agree to be in this study, your performance records will be kept confidential to the extent provided by federal, state and local law. Nothing about you or your performance on the tests, unit-based activities, or competency skills checklist will be made public or shared with other staff, except as stated in this consent. Confidential documents and data collected during this study will be scanned at the hospital and uploaded on a secure electronic server at UNF, which is password protected and available only to the investigator. After the documents are scanned, they will be shredded or placed in a confidential shred bin at the hospital. The investigator will store for up to three years the confidential scanned documents and electronic statistical data in UNF's secure electronic server. If the scanner at the hospital is not immediately available, then the documents will be completely deidentified and stored temporarily in a locked briefcase in a padlocked metal locker in the 4 Center nurses' conference room. The briefcase and locker will only be accessible by the investigator.

Your testing data will be stored in the hospital‘s Learning Management System (LMS), which has restricted access by employees who are authorized by the Director of Education at the hospital. The investigator will ask an authorized educator to retrieve the test scores, demographic data, and program evaluation summary. The demographic data and evaluations of the education program will be confidential and only available as aggregate data. To protect confidentiality of test scores, the investigator will use a numbering system to code the individual nurses‘ names Only the nurses‘ code number will be recorded in the software. The master list of nurses' code numbers will be uploaded to UNF‘s secure server and then shredded.

The competency skills checklists will also use your code number instead of a name. It will be kept by you until after it is completed or the time period for interventions is over. You may make a copy of your competency skills checklist if you want it for your records. After it is completed, the investigator will record your code number, number of unit-

based activities done, and number of attempts to complete competency skills checklist. Then the checklist will be scanned and uploaded to UNF's secure server, after which the checklist will be placed in confidential shred bin on the unit.

Your performance on the tests and competency skills checklist will be kept confidential from other nurses and the nursing manager. The investigator will not disclose confidential information of your competency unless patient safety is in imminent jeopardy (for example a nurse does not identify new onset ventricular tachycardia and initiate immediate interventions). In that case, the investigator may discuss the situation and the relevant competency with you and your nursing manager afterwards.

The following people may inspect and copy your records:

- the study sponsor (University of North Florida)
- St. Vincent‘s Medical Center Institutional Review Board (IRB) {a group of doctors, health professionals, and community representatives who review the research study to protect your rights}
- St. Vincent‘s Medical Center employees who are authorized by Director of Education to access the Learning Management System records (in order to retrieve test scores, demographic data, and evaluation summary)

As part of this study, the principle investigator will keep records of your being in the study. These records may include:

- results of tests you have taken during the study.
- information about which unit-based activities were completed
- information on whether your performance of the skills on the competency checklist were satisfactory or unsatisfactory

There are rules that say your study records cannot be used or given to others without your approval. You may not be in the study unless you give your approval. If you sign this consent you will be agreeing to the terms below:

- Some or all of the test results will be given to the sponsor, University of North Florida. These results may be given to people that are helping to make sure the study is done right. Your study records will be given a code number by the investigator. Your name will not be in the study records.

- There may be people from University of North Florida visiting the hospital to look at how the study is doing. They may look at your study records.

- SVMC‘s IRB may also look at your study records. This committee looks at how each research study is done. The IRB will look at your study records only for reasons associated with this study. Your name will be kept confidential. The IRB will not give your study records to anyone else unless law permits.

- Susan Schultz may use and disclose your testing information for the following reasons:

1. for this study
2. for future studies
3. for printing in professional journals
4. for talks about this study
5. for control reasons
6. for payment support reasons

You will not be named in anything written about this study. Unless asked for by law, Susan Schultz will not let your study records go to anyone other than the people mentioned above. You will have the right to look at your records while the study is in progress and after the study has ended.

This consent does not expire. This means that your information can be used at any time in the future. However, you have the right to revoke this consent at any time. To revoke this consent, you must send an email to Susan Schultz at s.schultz@unf.edu Even though you can revoke your consent, you must understand that we cannot take back any uses or disclosures of your information we have already made in reliance on your consent.

You will not be able to stay in the study if you revoke this consent. You do not have to revoke your consent if you drop out of the study. The principle investigator may still use the information in your study records even if you drop out or revoke your consent. In that case, your information will only be used to protect the study.

If you decide to drop out of the study, information already in your records may still be used. There may be other items in your records used as part of this study. You may be able to look at your information as allowed by law. The care you were given may need to be kept confidential until it is studied.

It is possible that the information disclosed under this consent may be re-disclosed by someone who receives it. In that case, privacy laws may no longer protect the information.

Who do you call if you have questions or problems?

If you have any questions about the study or develop a study-related problem or question, you should contact the following principle investigator:

Susan Schultz, Cell: 904-608-8563 Email: S.Schultz@unf.edu

If you have any questions about your rights as a research subject, you should contact the hospital Institutional Review Board at (904) 308-8124 or Katherine Kasten chair of UNF's Institutional Review Board at (904) 620-2498.

What are your rights?

Your participation in this study is voluntary. This means you do not have to be in this research study if you do not want to, and you can drop out of the study at anytime. You will not be penalized or lose any benefits if you do not participate in the study or if you drop out of the study.

Your enrollment, eligibility, or employment will not be conditioned on whether you sign this consent.

You can agree to be in the study now and change your mind later. You will not be penalized or lose any benefits if you change your mind. If you do drop out of the study, you may speak with your nursing manager about other choices.

The following people may take you out of the study at any time without your consent:

- the principle investigator
- the sponsor University of North Florida
- the hospital IRB or UNF's IRB

Costs You Will Be Responsible For:

You will be required to pay for routine costs that normally come up as a result of your employment and completion of continuing education requirements. These are costs you would incur whether or not you take part in this study. There will be no compensation for costs that come up as a result of your participation in this study, including travel expenses and time to complete the web-based education program. The unit-based activities and competency validation may be done during normal working hours, but if you do them outside of your scheduled work hours, you will not be reimbursed.

Costs You Will Not Be Responsible For:

You will not be required to pay for testing and services done only because of the study. For example, you will not be charged for the following: web-based education program, unit-based activities, competency skills validation, pocket reference card, or contact hour certificate.

Questions About Costs:

If you have any questions about possible expenses, please talk with the principle investigator.

Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit

Agreement to be in the study:

Being in this study is up to you. You have the right to say no or stop your consent without putting your employment in danger. This form has information to help you decide to be in this study. Please ask Susan Schultz if you have any questions that have not been answered. Please answer Yes or No to the following questions:

1.	Have you understood the consent form?	1. _____
2.	Have you had a chance to ask questions and discuss this study?	2. _____
3.	Have you been satisfied with the answers to your questions?	3. _____
4.	Have you been given enough information about the study?	4. _____
5.	Do you know that you are free to leave the study at any time? without having to give a reason and without affecting your employment?	5. _____
6.	Do you understand that your records may be looked at by the company sponsoring the study and by the IRB authorities?	6. _____
7.	By your signatures below, you are asserting that you are over the age of 18 and would like to participate in this research study.	7. _____

If you answered No to any of the seven questions listed above, you should not sign this informed consent.

STATEMENT OF CONSENT

I have read this form. I know why the study is being done and what I have to do. I have been told about the risks I may face. I have been given the answers to all my questions.

I want to be in this study, and I agree freely to take part. I authorize my testing information to be used and disclosed in accordance with the terms of this document. I agree that the sponsor may keep, publish, use, or disclose the results of this study.

I will receive a signed copy of this consent form with all blanks filled in. I voluntarily consent to take part in this research study.

_____	_____
Employee Name Printed	Date and Time
_____	_____
Signature of Employee	Date and Time
_____	_____
Signature of Witness	Date and Time
_____	_____
Signature of Investigator	Date and Time

Appendix O: Format of Educational Module
"Dysrhythmia Monitoring Practices"

Table of Contents	Objective	Power point slides	Pretest Questions	Posttest Questions	Self-Check Questions
Introduc-tion	Overview, objectives, instructions, table of contents, and demographic survey. Post on the screen my name and contact information.				
Pretest	Insert Pretest questions; let learners see score but not the correct answers and not the feedback. Only 1 attempt.				
Skin Prep and Lead Placement	1. Describe the skin preparation and correct placement for the five electrodes monitoring system.	Slides 1-9	7, 11	8, 12	7,8,11,12
	2. Identify the optimal lead to monitor patients for their diagnoses or arrhythmias.	Slide 6	2, 5	1, 6	1,2,3,4,5, 6
	Post link to Practice Alert on Dysrhythmia Monitoring (pdf file) and insert self-check questions from objectives 1 and 2				
QRS Morpho-logy	3. Recognize the difference in QRS morphology between Bundle Branch Block Aberrancy and Ventricular Ectopy.	Slides 10-16	34, 38, 48	35, 38, 50	13, 14, 32, 33, 34, 35, 36, 37, 39
	Insert self-check questions for objective 3. Post link to the wav file called _BBB VT Rhythm.wav'				
QTc Measure-ment	4. Calculate the QTc interval from a single lead strip.	Slides 17-20	15, 21, 25	16, 22, 26	15, 16, 17, 18, 19, 20, 23, 24, 25, 26, 31
	Insert self-check questions for objective 4.				
Nursing Interven-tions	5. Describe which drugs or conditions prolong the QTc interval and the potential complications that may result from a prolonged QTc interval.	Slides 21-22	27, 28	28, 30	27, 28, 29, 30,

Table of Contents	Objective	Power point slides	Pretest Questions	Posttest Questions	Self-Check Questions
	6. Describe nursing interventions for SVT with Bundle Branch Block Aberrancy and for Ventricular Tachycardia.	Slides 23-25	40, 41, 44	40, 42, 45	9, 10, 40, 41, 42, 43, 44, 45
	Post link to file of St. Vincent's Emergency Standing Orders Directive 3.13 in Clinical Standards Module (file is preferred, not an intranet link, so that they can view it from home) Insert self-check questions for objective 5 and 6.				
Case Studies	7. Analyze case studies with wide QRS complex tachycardias on 12 lead electrocardiograms and differentiate between Supraventricular Tachycardia with aberrancy and Ventricular Tachycardia.	N/A	N/A	N/A	46-53 (case studies) Game: all 10 questions about ECGs
	Insert case study questions 46-53. Note that 49 and 53 have instructions to click on each answer choice to see the results of their interventions (if possible!)				
Million Dollar Game	Test your knowledge with this game on the main points from the learning module. If you answer all 10 questions correctly, then you "earn" a million dollars! You may take it as many times as you want.				
Posttest	Insert Posttest. Allow only one attempt. When done, allow them to see score, correct answers, and feedback. Set up program so that they have to view all the slides, self-check questions, case studies, and game before the posttest will open.				
References	See references below.				
Program Evaluation	Use standard program evaluation for online courses. Make this required before they can print certificate of completion.				
Completion Certificate	Printable only after all the components have been completed. They will also need to complete unit-based activities before they get the continuing education certificate from the instructor.				

Appendix P: Audio Script for Educational Module

Slide 1

Credits: The power point slides are used with permission from the American Association of Critical Care Nurses. A copy can be downloaded from their website at www.aacn.org The audio and script were added by Susan Schultz using the sources in the reference list.

Slide 2

The purpose of this presentation is to discuss the evidenced-based practices for optimal skin preparation, lead placement, ventricular dysrhythmia monitoring, and QT interval measurement.

Slide 3

"Carefully preparing the skin by cleaning the electrode sites with soap and water and drying with a rough washcloth or gauze is worth the extra minutes, because of the time that is saved in responding to false alarms. If the patient is diaphoretic or the skin excessively oily, an alcohol pad may be used, but this may dehydrate and cause increased skin resistance. Excessive hair at electrode sites should be clipped rather than shaved because shaving may cause nicking and irritation" (Drew & Funk, 2006, p. 165).

Slide 4

Do not place electrodes over large muscle groups, such as deltoids or quadriceps, as this may create a noisy signal. "The RA and LA electrodes should be placed just below the clavicle and as close as possible to the shoulder. … If arm electrodes are moved medially toward the sternum, more striking changes in waveforms occur, which make the resultant 12-lead ECG invalid. RA and LA electrodes can be placed high on the patient's upper back as long as they are close to the respective shoulders" (Drew & Funk, 2006, p. 163). "RL and LL electrodes should be placed on the right and left abdomen below the rib cages. Using this placement, the 12 lead ECG is similar, but not identical, to the standard 12-lead ECG. … It should also be pointed out that the RL electrode [only provides a ground] and does not contribute to the waveform morphology; therefore, it can be placed anywhere on the body" (Drew & Funk, 2006, p. 163).

Slide 5

When a 12-lead ECG is performed, the precordial leads, also called "V" leads, should be carefully placed in the correct intercostal spaces. If serial ECGs are to be performed, marking the location with indelible ink is advisable to make sure they are placed in the same position every time. If the precordial leads are misplaced by 1 intercostal space, it can change the QRS morphology and ST segment elevation, and possibly lead to misdiagnosis (Drew et al., 2004).

Slide 6

"Lead V1 is considered the best lead for diagnosing right and left bundle-branch block, … and to distinguish ventricular tachycardia from supraventricular tachycardia with aberrant ventricular conduction" (Drew et al., 2006, p. 2734)

~~L~~ead II [is best used] to diagnose atrial activity and measure heart rate" because of the upright rounded P waves and tall R waves (AACN Practice Alert, 2008, p. 1).

Slide 7
To monitor a patient in V_1 with the 5 electrode lead system, the ~~C~~" or Chest electrode should be placed in the 4th intercostal space on the Right Sternal Border. The same location is used for MCL_1. See next 2 slides for a picture and description of how to accurately locate the 4th intercostal space.

Slide 8
The 3-electrode lead system can be used to obtain a Modified Chest Lead 1, which is a bipolar substitute for the V1 lead. As shown in the picture, the RA electrode is moved to the left shoulder and the LA electrode is placed in the 4th ICS, RSB. When Lead I is selected on the monitor, it generates an image from the RA electrode (which is negative) to the LA electrode on the 4th ISC (which is positive).

~~M~~MCL_1 has been shown to differ in QRS morphology in 40% of patients with ventricular tachycardia and as such is not recommended for diagnosing wide QRS complex tachycardia. Bipolar lead monitoring also is inadequate for ST-segment monitoring because it does not provide multi-lead monitoring or precordial leads, which often are the most sensitive for detecting ischemia" (Drew et al., 2004, p. 2734).

Slide 9
"The single most important landmark for accurate precordial lead placement is the sternal angle (also referred to as the Angle of Louis). This bony prominence in the upper sternum is caused by fusion of the upper and lower sternum in utero. The sternal angle marked the point where the second rib joins the sternum" (Drew & Funk, 2006, p. 164). The best way to find this landmark is a follows: With the patient is in a recumbent position, the suprasternal notch at the base of the throat is located. Just below this notch is the flat part of the upper sternum, which is called the manubrium. When placing the index and middle fingers together with fingertips points laterally, the sternal angel can be felt just below these two fingers. The fingers are next moved up over the body prominence of the sternal angel to just below it. Next the fingers are moved to the right side of the sternum, which corresponds to the second intercostal space. From the second intercostal space, it is easy to palpate down to the third and fourth intercostal spaces. Lead V1 is placed in the fourth intercostal space at the right sternal border" (Drew & Funk, 2006, p. 164).

Slide 10
Wide QRS complex tachycardias can be caused by ventricular tachycardia or supra-ventricular tachycardia with abnormal conduction through the bundle branches. It is important to differentiate the cause of the wide complex tachycardia, because the treatments are different. In fact, the incorrect medication could cause severe hypotension or loss of consciousness (Urden, Stacy, & Lough, 2010).

–Contrary to popular belief, hemodynamic stability or instability does not help to differentiate between VT and SVT with a wide QRS complex" (Urden et al., 2010, p. 395). Generally, nurses expect patients to remain conscious with an adequate BP during SVT and to become unconscious and pulseless during VT. However, in some cases VT may be well tolerated, especially if the rate is less than 150. And some patients with a rapid SVT may have severe reduction in cardiac output and become hemodynamically unstable.

When a patient's rhythm strip exhibits a wide QRS complex tachycardia, a 12-lead ECG is better than any single lead and should be obtained (Drew & Funk, 2006; Zipes et al., 2006). But continuous 12-lead ECG monitoring is not always readily available. Fortunately, there are many useful clues about the shape of the QRS (or morphology) that can be seen in V_1 or V_6. V_1 is the preferred lead for continuous monitoring of patients with wide QRSes, but V_6 may be used if V_1 is unavailable (Jacobson, 2007). The next slide shows examples of each.

Slide 11
First, here is a brief review of QRS morphology: –The letter Q is used to describe an initial negative deflection; in other words, only if the first deflection from the baseline is negative will it be labeled a Q wave. The letter R applies to any positive deflection. If there are two positive deflections in one QRS complex, the second is labeled R prime… The letter S refers to any subsequent negative deflections" (Urden et al., 2010, p. 335). The normal QRS in V_1 should be less than 0.10 seconds with a small positive r wave and a large negative S wave. All the QRSes pictured on this slide are wider than 0.10 and are considered to have originated in the ventricle (which means they could be PVCs or V Tach).

The first QRS in the upper left corner of this diagram is entirely positive with one peak, and that is called a monophasic R wave. The QRS below it is an R wave with two points, and when the first one is taller, it's called a –taller left peak", which indicates a ventricular beat.

The third and fourth QRSes on the left hand side are biphasic, which means 2 directional. The last QRS on the left side is primarily negative, but it is important to notice that it initially starts with a positive deflective (r wave). An R wave wider than 30 msec (or wider than one little box of 0.04 seconds) is indicative of a ventricular beat. Other indications that the impulse is ventricular in origin is a slurred or notched S on the way down. Both the wide R wave and slurred or notched S descent cause a prolongation from the onset of the QRS to the deepest point of the S (called the nadir). When the nadir is greater than 60 msec (or 0.06 seconds), then it indicates a ventricular beat (Jacobson, 2007).

As you can see on the right hand side of the diagram, most of the QRSes seen in V6 are negative. If the wave form is entirely negative, then it is called a either a monophasic Q or a notched QS. Small and large cap letters are used to indicate relative sizes of the wave forms.

Slide 12
Supra Ventricular Tachycardias with Aberration have different QRS morphologies in leads V_1 and V_6 than ventricular beats. Aberration means abnormal conduction caused by a bundle branch block or accessory pathway. The QRS measurements are prolonged in both SVT with aberration and VT. However, QRS measurements of less than 0.14 favor aberrant conduction. QRS measurements of 0.16 or greater strongly suggest VT (Urden, et al., 2006).

AV dissociation is another clue to help differentiate supraventricular dysrhythmias from ventricular dysrhythmias. SVTs may have visible P waves or atrial flutter waves that are associated with the QRS. When a Premature Atrial Contraction is followed by a wide QRS, that may be a sign of an intermittent BBB which occurred because one of the bundle branches was still refractory when the premature impulse started. One other condition that favors SVT is a ventricular rate over 200 (Jacobson, 2006; Urden et al., 2010).

Slide 13
The classic clues for RBBB are a bimodal rR‘ortriphasicrsR‘ (as displayed in left upper side of diagram). Bimodal means the QRS goes in 2 directions. Triphasic means it has 3 deflections from baseline, such as it goes up, then it goes down below baseline, then it goes back up again. When a QRS has more than one positive deflection, then the smaller one is written in lower case r and the taller ones is written upper case, or a capital letter R. An apostrophe or PRIME symbol is usually written after the second R wave.
In the lower left side of the diagram the classic clues for LBBB are displayed.

This primarily negative wave form is different from ventricular beats in 3 ways:
1) R wave is < 30 msec wide or it has no R wave at all,
2) it has a straight S descent (sometimes called a slick downstroke), and
3) the measurement of the QRS onset to the nadir of the S (deepest point) is less than 60 msec (or 0.06 sec).
To be considered LBBB, it should have all three components as well as no Q in Lead V6 (Jacobson, 2007).

In V6, the most memorable part of the QRS morphology that represents RBBB is the qRS complex with a ―wide S” wave, caused by late right ventricular depolarization. A wide S wave makes the R:S ratio more than 1:1. The intrinsicoid deflection is a measurement from the onset of the QRS to the tallest point of the R wave. When it is < 50 ms, then it favors supraventricular origin (Jacobson, 2007).

All the QRS morphologies pictured on this diagram point to dysrhythmias that started above the ventricles and encountered delays as it traveled down the bundle branches, also may also be called SVT with aberration.

Slide 14
If you see any of the QRS morphologies described here, then they are not helpful in differentiating between SVT with aberration or ventricular tachycardia. This applies only

to tachycardias with a positive waveform in V_1. Lead II does not provide any helpful QRS morphology and sometimes the QRSes can look identical even when etiology is different. It would be a good idea to recheck the placement of the V electrodes on the patient's chest, in particular the Chest lead. When the V lead is placed one intercostal space too high or too low, it can show unhelpful or misleading QRS morphology.

Slide 15
The QRSes pictured here are not helpful in determining the origin. Remember to look for the clues in V1 and V6 that were shown on previous slides to help differentiate wide QRS complex tachycardias.

When uncertain, a 12-lead ECG is recommended to confirm diagnoses. However, "There are some tachycardias that do not follow any of the rules and cannot be diagnosed by 12 lead ECG…. An electrophysiology study is needed in such cases to determine for sure the mechanism of the tachycardia" (Jacobson, 2007, p. 95).

So here is a rhyme to help you remember for all time.
When looking at V_1…

A slick downstroke or rsR prime, are Bundle Branch Block, so take your time.
A notched downstroke or taller left peak, warn of V. tach. Help go seek!

Slide 16
In this example, the lead placement affected the QRS morphology and may have caused delayed recognition of life-threatening ventricular tachycardia. Remember to check the placement of V1 every shift. A good time to do this is when you are listening to your patients' heart sounds. If you carry some spare electrodes in your pocket, it will only take a few seconds to correct it (and possibly save the patient's life!)

Slide 17
"The QT interval is an approximate measure of the duration of ventricular repolarization. A prolonged QT interval indicates an alteration in cardiac membrane channel function, and can occur as a congenital or acquired disorder" (Sommargren & Drew, 2007, p. 285).

"Ideally, the same lead should be used for QT monitoring over time because of variation in QT-interval length across the 12 leads. …. Choose an ECG lead in which the T-wave end is well defined…. Lead II usually has a large positive T wave, and if U waves are present they are more likely to be separated from the T wave, resulting in a clearly defined T-wave end" (Sommargren & Drew, 2007, p. 286). The QT interval normally shortens with faster heart rates and lengthens with slower heart rates.

Slide 18
The QT Interval is measured from beginning of the QRS complex to the end of the T wave. When the T wave is notched, the end of the T wave should be used as the end of the QT interval. When a U wave occurs after the T wave has reached the baseline, the end of the T wave should be used as the end of the QT interval (exclude the U wave)

(Sommargren& Drew, 2007, p. 285). The QT interval for this diagram is 11 little boxes times 0.04, which equals .44 seconds.

Slide 19
"The QT interval normally shortens with faster heart rates and lengthens with slower heart rates. Therefore, it is crucial to factor heart rate into the measured QT interval to accurately detect changes in repolarization over time. Correction of the QT interval for heart rate calculates what the patient's QT interval would be if the heart rate always remained at 60 beats per minutes" (Sommargren & Drew, 2007, p. 287).

Bazett's formula is used to calculate the QTc. QTc = QT (seconds) divided by the square root of the previous R to R interval (in seconds). QTc greater than 0.50 second in either males or females is considered dangerously prolonged and is associated with a higher risk for Torsades de Points (a polymorphic form of VT that may be lethal) (Sommargren & Drew, 2007).

Slide 20
In this example, the QT interval is 0.36 (which is 9 little boxes times 0.04). The preceding R to R is 0.72 (18 little boxes times 0.04). The square root of 0.72 = .85. QTc is 0.36 divided by 0.85 which = 0.42. Since the QTc is below 0.5, it is considered within normal limits. A consistent lead should be used to measure QTc intervals before beginning QTc prolonging medications and then every 8-12 hours.

Slide 21
Acute increases in QT-interval length are associated with increased risk for torsades de pointes, which is a type of polymorphic ventricular tachycardia that resembles ventricular fibrillation. Torsades de pointes is a French term meaning "twisting of the points". It is characterized by a continuously changing QRS shape that appears to twist around the baseline, alternating between positive and negative deflections. Some class IA and IC antiarrhythmic medications that may prolong QT interval will be described later.

Slide 22
This slide shows PVCs occurring close to T waves and non-sustained torsades de pointes. The arrows point to a pause-dependent enhancement of the QT interval, which is another thing associated with increased risk for torsades de points.

Slide 23
Some class IA and IC antiarrhythmic medications that may prolong QT interval include Quinidine, Procainamide (Pronestyl), Disopyramide (Norpace), Sotalol (Betapace), Dofetilide (Tikosyn) , and Ibutilide (Corvert). In addition to the antiarrhythmics mentioned in the slide, Amiodarone may cause extreme QTc prolongation. However, since Amiodarone lengthens repolarization time equally throughout the layers of the myocardium, it has a low frequency of torsades de pointes.

Besides antiarrhythmics, some antipsychotics and antibiotics may also prolong the QT interval. Some Antipsychotics are Thorazine, Haldol, and Mellaril. Some of the

antibiotics are Erythromycin and Levaquin. Refer to the website for additional medications.

The risk is increased if patients are receiving more than 1 drug known to prolong QTc, if they overdose on one of those medications, if they have renal or hepatic failure, or if they take another drug that impairs its metabolism (such as dofetilide and cimetidine). Patients with slow heart rhythms or long pauses, such as complete heart block or sinus pauses, are considered to be at high risk because the initiation of torsades de pointes' pause-dependent characteristic.

Lastly, it is important to monitor and correct hypokalemia or hypomagnesemia, especially in patients receiving any of the medications known to prolong QT interval. Diuretics and malnutrition also exacerbate electrolyte imbalances. (Sommargren & Drew, 2007)

Slide 24
Emergency treatment of torsades de pointes may include IV magnesium, defibrillation, or overdrive pacing (Zipes et al., 2006). If the patient is unstable or nonresponsive, call Code Blue and initiate Emergency Standing Orders. Immediate defibrillation is indicated for pulseless V Tach or V Fib. Emergency Synchronized Cardioversion is indicated for unstable VT with a pulse.

For wide complex tachycardias with a pulse, the emergency standing orders allow for Lidocaine to be given. However, in the presence of suspected torsades de points, a Cardiologist should be consulted before administering antiarrhythmics. A Magnesium drip or overdrive pacing should be considered. Other things that the nurse may order per emergency standing orders are STAT 12 Lead ECG (for chest pain or rhythm change) and Chem 7 (for electrolyte levels). It is also recommended that you consult the Rapid Response Nurse if prolongation of QTc occurs or other warning signs of torsades de pointes are suspected. Refer to the Emergency Standing Orders, Directive 3.13 in St. Vincent's Clinical Standards Manual (on the intranet).

Slide 25
Please read the Emergency Standing Orders, complete all the self-check questions, case studies, and the Million Dollar Game, then proceed to the posttest.

Appendix Q: Test Bank for Educational Program

Below are questions that will be in the online test pool for pretest, posttest, and self-check questions. Questions may be multiple choice, true or false, and matching.

1. Select the best lead to diagnose atrial activity and measure heart rate.
    A. I
    B. II
    C. III
    D. V_1

Correct answer: B
Feedback: Lead II is best to diagnose atrial activity and measure heart rate because of the upright rounded P waves and tall R waves. Lead V_1 is best to diagnose wide QRS complexes, which occur in bundle branch block aberrancy or ventricular rhythms (AACN Practice Alert, 2008, p. 1).

2. Select the best lead to diagnose wide QRS complexes.
    A. I
    B. II
    C. III
    D. V_1

Correct answer D
Feedback: Lead V_1 is best to diagnose wide QRS complexes, which occur in bundle branch block aberrancy or ventricular rhythms. Lead II is best to diagnose atrial activity and measure heart rate because of the upright rounded P waves and tall R waves(AACN Practice Alert, 2008, p. 1).

3. An advantage of the 5 lead monitoring system is that it allows for the recording of any of the limb leads plus one precordial (V) lead.
    A. True
    B. False

Correct answer: A
Feedback: The 5 lead system is recommended over the 3 lead system for monitoring QRS morphology because it includes on precordial (V) lead (Drew, et al., 2004).

4. An advantage of the 3 lead monitoring system is that it allows for the recording of any of the limb leads plus one precordial (V) lead.
    A. True
    B. False

Correct answer: B
Feedback: The 5 lead system is recommended over the 3 lead system for monitoring QRS morphology because it includes on precordial (V) lead (Drew, et al., 2004).

5. Which of the following patient conditions would be best lead to monitor in V1? (Select all that apply)

_____a Atrial fibrillation with intermittent wide QRS complexes
_____b First, Second or Third Degree AV heart block
_____c Supra-Ventricular Tachycardia with aberrant conduction
_____d Sinus Bradycardia or Sinus Rhythm with pauses

Correct answers: A, C
Feedback: Lead V_1 is best to diagnose wide QRS complexes, which occur in bundle branch block aberrant conduction or ventricular rhythms such as PVC, VT, and Torsades de Pointes. Lead II is best to diagnose atrial activity, heart blocks, and measure heart rate because of the upright rounded P waves and tall R waves (AACN Practice Alert, 2008).

6. Which of the following patient conditions would be best lead to monitor in V1? (Select all that apply)

_____ Normal Sinus Rhythm with 5 beat run of Ventricular Tachycardia
_____ Possible Torsades de Pointes
_____ Diagnosing Atrial Flutter versus Atrial Fibrillation
_____ Sinus Tachycardia with intermittent right Bundle Branch Block

Correct answers: A, B, D
Feedback: Lead V_1 is best to diagnose wide QRS complexes, which occur in bundle branch block aberrant conduction or ventricular rhythms such as PVC, VT, and Torsades de Pointes. Lead II is best to diagnose atrial activity, heart blocks, and measure heart rate because of the upright rounded P waves and tall R waves (AACN Practice Alert, 2008).

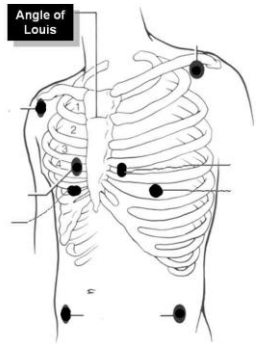
7. Match the description of the electrode placement to the correct electrode.

_____ below rib cage on left side of abdomen
_____ infra-clavicular fossa close to left shoulder
_____ anywhere on torso, usually lower right side of chest or abdomen
_____ 4^{th} Inter Costal Space, Right Sternal Border
_____ infra-clavicular fossa close to right shoulder

A. RA
B. LA
C. C
D. LL
E. RL

Correct answers: D, B, E, C, A
Feedback: Limb leads should be placed below the clavicles or on the abdomen because there is decreased muscle artifact in those locations. The C (Chest or V lead) is most often placed in V_1 location at the 4th ICS, RSB; but if that location is unavailable, then V_6 may be used (AACN Practice Alert, 2008).

8. Drag and Drop the electrodes to the correct locations. Only 5 locations will need to be labeled.

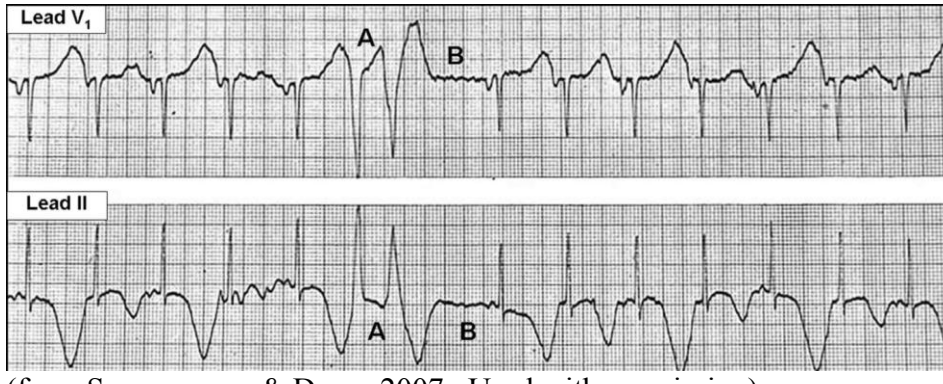


(Adapted from Richards, 2008. Used with permission)

RA, LA, C-V_1, RL, LL

Correct Answer (see slide 9 of power point)
Feedback if correct: Good job! Feedback if incorrect: Try again!

9. What is the approximate QTc interval of the following strip?

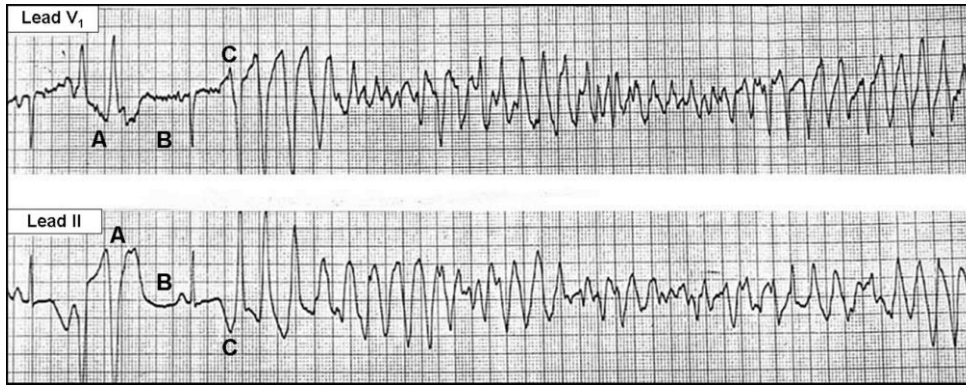


(from Sommargren & Drew, 2007. Used with permission)

A. 0.20 – 0.25
B. 0.25 – 0.50
C. 0.48 - 0.52
D. 0.58 – 0.63

Correct answer = D
Feedback: QTc is prolonged >.50 second. ~~–~~ECG signs of impending torsades de pointes in a patient with QTc over .50 are (A) a ventricular couplet, followed by (B) a compensatory pause. Also note T-wave alternans, which is most apparent in the Lead II rhythm strip" (Sommargren & Drew, 2007, p. 290).

10. The same patient from the previous question exhibited this change in rhythm. Interpret the following dysrhythmia.



(from Sommargren & Drew, 2007. Used with permission)

A. SVT with aberration
B. Monomorphic ventricular tachycardia
C. Torsades de Pointes
D. Ventricular Fibrillation

Correct answer C
Feedback: ~~–~~In a subsequent rhythm strip from the patient shown in previous questions. (A) a ventricular couplet, followed by (B) a compensatory pause; (C) torsades de pointes is triggered on the T wave following the pause" (Sommargren & Drew, 2007, p. 290). Note the alternating direction of the QRS complexes, initially negative deflection, then ~~–~~twisting" to positive deflection, and ~~–~~twisting" again back to negative.

11. What is the best way to prepare the skin before placing electrodes?

A. Clip excessive hair and clean skin with alcohol or washcloth before placing electrodes.
B. Clean skin with soap and water only if there is visible sweat, oil, or powder.
C. Apply electrodes; if artifact noted, then clean the skin and replace electrodes.
D. If chest is hairy, shave with shaving cream and razor, dry thoroughly, then apply electrodes.

Correct answer: A

Feedback: Sweat, oil, lotion, powder, and dead skin cells may not be visible, so the skin should be routinely cleaned before applying electrodes. Shaving skin with a razor can cause irritation, so it is better to clip the excess hair (Drew & Funk, 2006).

12. Place the steps for applying electrodes in the proper order.

A. Apply new electrodes and press firmly to skin
B. Clip excessive hair from selected locations
C. Visually select locations without implanted devices, dressings, or muscle artifact that could interfere with monitoring
D. Clean skin with alcohol or washcloth and dry thoroughly

Correct order: C, B, D, A
Feedback: Sweat, oil, lotion, powder, and dead skin cells may not be visible, so the skin should be routinely cleaned before applying electrodes. Shaving skin with a razor can cause irritation, so it is better to clip the excess hair (Drew & Funk, 2006).

13. When the V_1 electrode is misplaced by as little as one intercostal space, QRS morphology can change and misdiagnosis may occur.

A. True
B. False

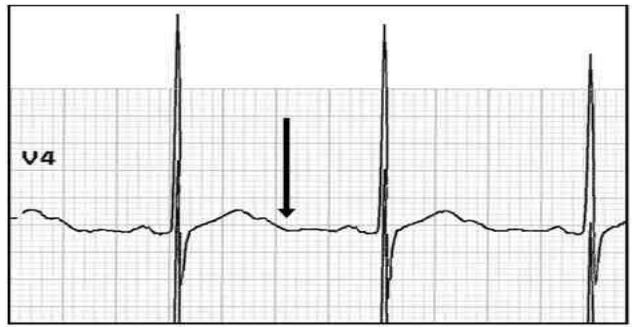
Correct answer: A
Feedback: Inaccurate lead placement may produce QRS morphology that is unhelpful or misleading in differentiating SVT with aberrant conduction or Ventricular Tachycardia (Drew, et al., 2004).

14. When the V_1 electrode is placed one intercostal space above or below the preferred location, QRS morphology will be unchanged.

A. True
B. False

Correct answer: B
Feedback: Inaccurate lead placement may produce QRS morphology that is unhelpful or misleading in differentiating SVT with aberrant conduction or Ventricular Tachycardia (Drew et al., 2004).

15. Calculate the QT, R-R, and QTc for this strip *(√ = square roots. Accurate divisions have been provided in the answers; you just need to select the correct intervals)*



(From Sommargren & Drew, 2007. Used with permission.)

A. QT = .24, R-R = .48; √.48 = .693; QTc = .24 / .693 = .35 seconds
B. QT = .36, R-R = .60; √.6 = .775; QTc = .36 / .775 = .46 seconds
C. QT = .44, R-R = .80; √.8 = .894; QTc = .44 / .894 = .49 seconds
D. QT = .56, R-R = .80; √8 = .894; QTc = .56 / .894 = .63 seconds

Correct answer: C
Feedback: QT is 11 boxes x .04. Preceding R to R is 20 boxes x .04

16. Calculate the QT and QTc interval for this strip. *(√ = square roots. Accurate divisions have been provided in the answers; you just need to select the correct intervals)*

(From Drew, 2007. Used with permission.)

A. QT = .24, R-R = .48; √.48 = .693; QTc = .24 / .693 = .35 seconds
B. QT = .40, R-R = .80; √.8 = .894. QTc = .40 / .894 = .48 seconds
C. QT = .44, R-R = .60; √.6 = .775; QTc = .44 / .775 = .57 seconds
D. QT = .56, R-R = .80; √8 = .894; QTc = .56 / .894 = .63 seconds

Correct answer B
Feedback QT is 10 boxes x 0.04; preceeding R to R is 20 boxes x 0.04

17. The QT interval is measured from beginning of QRS to end of T wave
A. True
B. False

Correct answer: A
Feedback: The QT interval is an approximate measure of the duration of ventricular repolarization and is measured from beginning of QRS to end of T wave. (Sommargren & Drew, 2007)

18. The QT interval is measured from beginning of QRS to beginning of T wave.
    A. True
    F. False

Correct answer: B
Feedback: The QT interval is an approximate measure of the duration of ventricular repolarization and is measured from beginning of QRS to end of T wave (Sommargren & Drew, 2007).

19. The QTinterval lengthens with bradycardia and shortens with tachycardia.
    A. True
    B. False

Correct answer: A
Feedback: QT shortens with tachycardia because repolarization is quicker (Sommargren & Drew, 2007).

20. The QT interval shortens with bradycardia and lengthens with tachycardia.
    A. True
    B. False

Correct answer: B
Feedback: QT shortens with tachycardia because repolarization is quicker (Sommargren & Drew, 2007).

21. Which of the following are true statements (select all that apply).
    A. QT interval is measured from beginning of QRS to end of T wave
    B. QT**c** interval is the QRS interval plus the T wave
    C. QT interval lengthens with bradycardia and shortens with tachycardia.
    D. QT interval shortens with bradycardia and lengthens with tachycardia.
    E. QT**c**interval is the QT interval corrected for heart rate

Correct answer: A, C, E
Feedback: The QT interval is an approximate measure of the duration of ventricular repolarization and is measured from beginning of QRS to end of T wave. QT shortens with tachycardia because repolarization is quicker, which makes it necessary to correct the QT interval for the heart rate (Sommargren & Drew, 2007).

22. Which of the following are true statements (select all that apply).
    A. QT**c** interval is the QRS interval plus the T wave
    B. QT interval shortens with bradycardia and lengthens with tachycardia.
    C. QT**c**interval is the QT interval corrected for heart rate
    D. QT interval is measured from beginning of QRS to end of T wave
    E. QT interval lengthens with bradycardia and shortens with tachycardia.

Correct answer: C, D, E
Feedback: The QT interval is an approximate measure of the duration of ventricular repolarization and is measured from beginning of QRS to end of T wave. QT shortens with tachycardia because repolarization is quicker, which makes it necessary to correct the QT interval for the heart rate (Sommargren & Drew, 2007).

23. The QT**c**interval is the QT interval corrected for heart rate.
    A. True
    B. False

Correct answer: A
Feedback: The QT**c** interval is the QT interval corrected for heart rate because QT intervals shorten when heart rate is faster (Sommargren & Drew, 2007).

24. The QT**c** interval is the QRS interval plus the T wave.
    A. True
    B. False

Correct answer: B
Feedback: The QTc interval is the QT interval corrected for heart rate because QT intervals shorten when heart rate is faster (Sommargren & Drew, 2007).

25. What QTc interval is associated with Torsades de Pointes?
    A. > 0.20 sec (200 msec)
    B. > 0.24 sec (240 msec)
    C. > 0.50 sec (500 msec)
    D. < 0.12 sec (120 msec)

Correct answer: C
Feedback: QTc interval greater than 0.50 sec (500 msec) is dangerously prolonged and associated with risk for Torsades de Pointes (Sommargren & Drew, 2007).

26. What QTc interval is associated with Torsades de Pointes?
    A. < 0.12 sec (120 msec)
    B. > 0.20 sec (200 msec)
    C. > 0.24 sec (240 msec)
    D. > 0.50 sec (500 msec)

Correct answer: D
Feedback: QTc interval greater than 0.50 sec (500 msec) is dangerously prolonged and associated with risk for Torsades de Pointes (Sommargren & Drew, 2007).

27. Which drugs may prolong the QTc?
    A. Antiarrhythmics (Procainamide/Pronestyl, Sotalol/Betapace)
    B. Antipsychotics (Chlorpromazine/Thorazine, Haloperidol/Haldol)
    C. Antibiotics (Erythromycin/EES, Levofloxacin/Levaquin)
    D. All of the above

Correct answer: D
Feedback: Selected antiarrhythmics, antipsychotics, and antibiotics are some of the drugs that can increase risk of prolonged QTc (Sommargren & Drew, 2007).

28. Which of the following conditions should have QTc interval monitoring?
    A. New onset or severe bradycardia
    B. Hypokalemia or hypomagnesemia
    C. Overdose on potentially prodysrhythmic medications
    D. All of the above

Correct answer: D
Feedback: Severe bradycardia, hypokalemia or hypomagnesemia, and overdose on potentially prodysrhythmic medications can all potentiate prolongation of QT interval (Sommargren & Drew, 2007).

29. Which of the following patients should have QTc interval monitoring? (select all that apply)
    A. 58 year-old male with acute MI and on Lidocaine drip 2 mg/min, Potassium 4.0
    B. 36 year-old female admitted with overdose on Chlorpromazine/Thorazine
    C. 54 year-old female with new onset atrial fibrillation and started on oral Sotalol/Betapace
    D. 49 year-old alcoholic male with cardiomyopathy taking Quinidine and has Magnesium of 1.8
    E. 75 year-old female admitted with pneumonia and started on Levofloxacin/Levaquin

Correct answer: B, C, D, E
Feedback: Medication (certain antiarrhythmics, antipsychotics, and antibiotics), hypokalemia or hypomagnesemia, and overdose on potentially prodysrhythmic medications can all potentiate prolongation of QT interval. Lidocaine and a normal potassium level do not elevate risk of Torsades de Pointes (Sommargren & Drew, 2007).

30. Which of the following patients should have QTc interval monitoring? (select all that apply)
    A. 75 year-old female admitted with pneumonia and started on Erythromycin (EES)

B. 36 year-old female admitted with overdose on Haloperidol/Haldol
C. 54 year-old female with new onset atrial fibrillation and started on oral Procainamide/Pronestyl
D. 58 year-old male with acute MI and on Lidocaine drip 2 mg/min, Potassium 4.0
E. 49 year-old alcoholic male on Chlorpromazine/Thorazine with Magnesium of 1.8

Correct answer: A, B, C, E
Feedback: Medications (certain antiarrhythmics, antipsychotics, and antibiotics), hypokalemia or hypomagnesemia, and overdose on potentially prodysrhythmic medications can all potentiate prolongation of QT interval. Lidocaine and a normal potassium level do not elevate risk of Torsades de Pointes (Sommargren & Drew, 2007).

31. Analyze the QT intervals and QTc measurements in the figure below and select the correct interpretation.

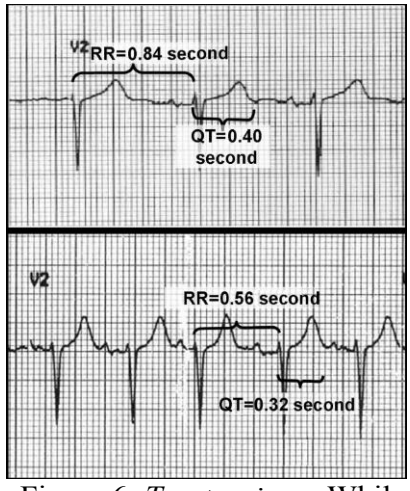


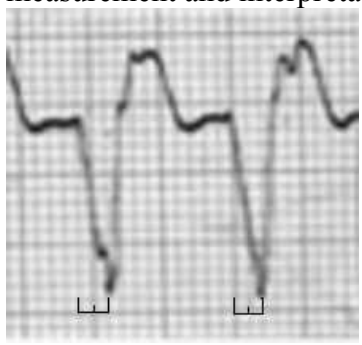
Figure 6: *Top tracing*—While lying quietly in bed, a patient has a QT interval of 0.40 second and an RR interval of 0.84 second. Applying Bazett's formula, QTc = 0.40 / √0.84 = 0.436 second (normal). *Bottom tracing*—Several minutes later, while the patient was walking, the QT interval shortened to 0.32 second, but the RR interval decreased to 0.56 second because of a faster heart rate. Again applying Bazett's formula, QTc = 0.32 / √0.56 = 0.428 second (normal)" (From Sommargren & Drew, 2007, p. 288, used with permission)

A. In the second strip, the QT interval is shorter, but the QTc is not substantially changed from the first strip.
B. In the first strip the QTc is prolonged and the second strip the QTc is normal
C. It is unusual to see a shorter QT interval when the heart rate is faster.
D. There are no significant differences (< .06) in RR rate or QT intervals between the strips.

Correct answer: A
Feedback: The QT interval is expected to be longer when the heart rate is slower and shorter when the heart rate is faster, but after the QT is corrected for heart rate with the

Bazett's formula, there should not be significant differences in the QTc (Sommargren & Drew, 2007).

32. Measure the descent of the S from the onset of QRS to the nadir (lowest point of the S). Exact distance to measure is shown. Select the answer choice that has the correct measurement and interpretation

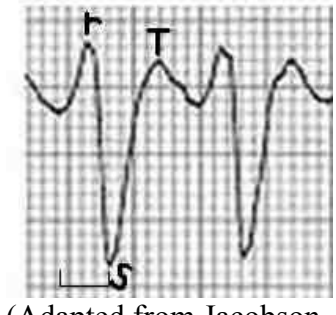


(Adapted from Jacobson, 2007. Used with permission)

A. 0.04 seconds (40 msec); nadir is normal and represents aberration
B. 0.08 seconds (80 msec); nadir is prolonged and represents VT
C. 0.16 seconds (160 msec); nadir is normal and represents aberration
D. 0.20 seconds (200 msec); nadir is prolonged and represents VT

Correct answer B
B. Measurement is 2 little boxes which equals 0.08 seconds or 80 msec. When nadir is > 60 msec, it represents ventricular tachycardia (Jacobson, 2006).

33. Measure the descent of the S from the onset of QRS to the nadir (lowest point of the S). Exact distance to measure is shown. Select the answer choice that has the correct measurement and interpretation.

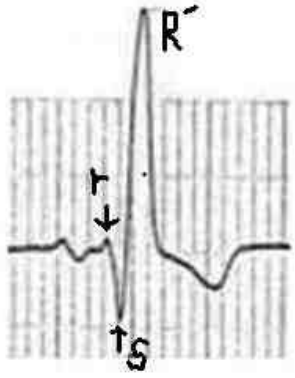


(Adapted from Jacobson, 2007. Used with permission)

A. 0.04 seconds (40 msec); nadir is normal and represents aberration
B. 0.08 seconds (80 msec); nadir is normal and represents aberration
C. 0.14 seconds (140 msec); nadir is prolonged and represents VT
D. 0.24 seconds (240 msec); nadir is prolonged and represents VT

Correct answer C
Feedback: Measurement is 3 ½ little boxes which equals 0.14 seconds (140 msec). When nadir is > 60 msec, it represents ventricular tachycardia (Jacobson, 2007).

34. What does a triphasicrsR‘ morphology (shown below) in V1 indicate?



(Adapted from Jacobson, 2007. Used with permission)

A. RBBB aberration
B. LBBB aberration
C. Ventricular beat
D. None of the above

Correct answer: A
Feedback: RBBB in V_1 shows a classic bimodal rR‘ or triphasicrsR‘ morphology (Jacobson, 2007).

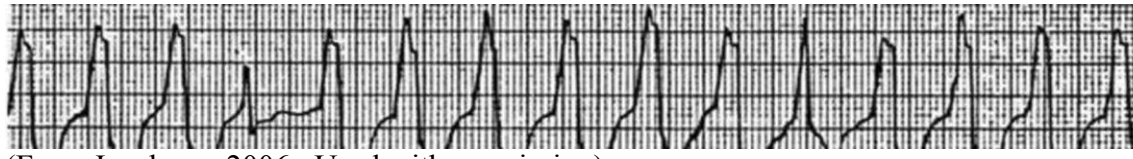
35. Measure the descent of the S from the onset of QRS to the nadir (lowest point of the S). Exact distance to measure is shown. Select the answer choice that has the correct measurement and interpretation.

(Adapted from Jacobson, 2007. Used with permission)

A. 0.04-0.06 seconds (40-60 msec); nadir is normal and represents LBBB aberration
B. 0.10 seconds (100 msec); nadir is normal and represents RBBB aberration
C. 0.14 seconds (140 msec); nadir is prolonged and represents VT
D. 0.24 seconds (240 msec); nadir is prolonged and represents VT

Correct answer is A
Feedback: Measurement is 1 to 1 ½ little boxes 0.04 – 0.06. This strip shows a slick downstroke with a nadir < 60 msec, which indicates a left bundle branch block aberration, not a ventricular beat (Jacobson, 2007).

36. What does a notched R wave with taller left peak in V1 indicate (as shown below)?


(From Jacobson, 2006. Used with permission)

A. LBBB aberration
B. RBBB aberration
C. Ventricular Tachycardia
D. SVT with aberration

Correct answer: C
Feedback: A monophasic R or R with taller left peak in V1 indicate ventricular tachycardia (Jacobson, 2007).

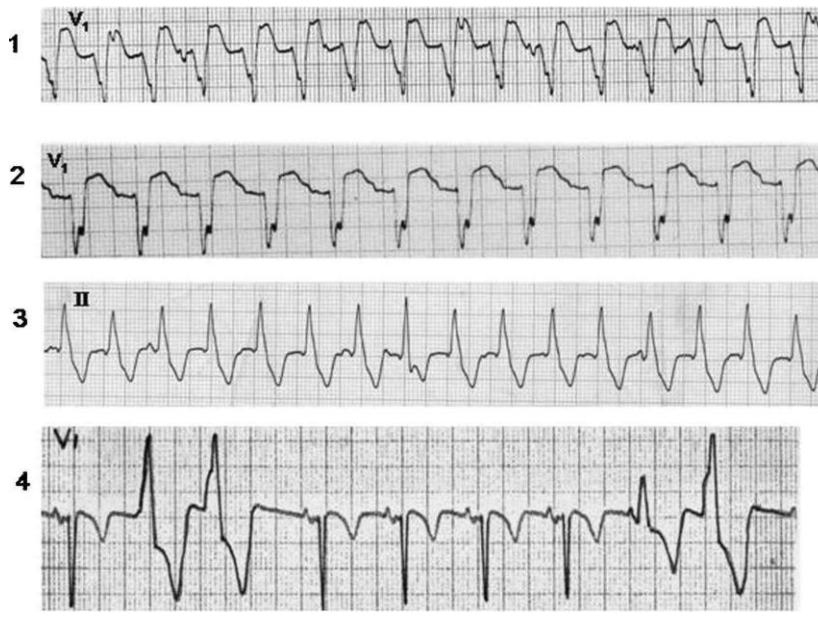
37. What is the interpretation of this strip?

(From Jacobson, 2006. Used with permission)

A. Normal Sinus Rhythm with PVCs
B. Sinus Tachycardia with PVCs
C. Normal Sinus Rhythm with intermittent RBBB
D. Normal Sinus Rhythm with intermittent LBBB

Correct answer: A
Feedback: The morphology of the 2 wide QRSes is indicative of ventricular origin with a taller left peak (not a BBB pattern). The P waves in front of them are not premature (which would favor BBB) and are too close to the QRSes to have conducted the QRSes. The PVCs happened to come right after the sinus P waves fired and were not associated with the P waves (Jacobson, 2006).

38. Match the strip with the correct interpretation using QRS morphology and AV dissociation cues.

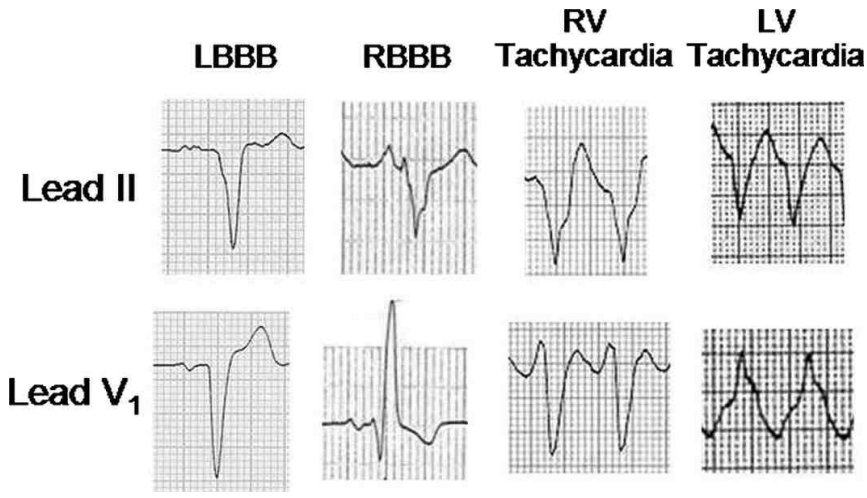


(From Jacobson, 2006. Used with permission)

A. Sinus rhythm with 2 pairs of PVCs.
B. Sinus tachycardia with LBBB aberration.
C. Ventricular Tachycardia (positive deflection).
D. Ventricular Tachycardia (negative deflection)

Correct answers: 1=D, 2=B, 3=C, 4=A
Feedback:
1: QRS morphology shows slurred or notched S decent, typical of VT. "AV dissociation is clearly present throughout the strip"
2: QRS is typical of LBBB morphology with straight S descent. "P waves can be seen near the end of the T wave and preceding every QRS complex"
3. Although it is in Lead II and QRS morphology is not helpful, "independent P waves can be seen indicating AV dissociation, and the 8th beat is a fusion beat"
4: Monophasic shape of wide QRSs is typical of VT. "The first beat of the second pair is a fusion beat. The P wave preceding the fusion beat is not premature; it is the normal sinus P that happens to precede an end-diastolic PVC, resulting in fusion" (Jacobson, 2006, p. 465).

39. Study the QRS morphologies below and choose the WRONG statement.



(From Jacobson, 2007. Used with permission)

A. LBBB in V_1 shows all of the following: R < 30 ms or no R, straight S descent, and QRS onset to S nadir < 60 ms
B. RBBB in V_1 shows a classic bimodal rR‘ or triphasicrsR‘ morphology
C. LV Tachycardia in V_1 shows a monophasic R or an R with a taller left peak
D. Lead II provides useful QRS morphology clues to differentiate BBB and VT.
E. RV Tachycardia in V1 shows R > 30ms, or Slurred or notched S descent, or QRS onset to S nadir >60 ms

Correct answer: D
Feedback: D is wrong because Lead II does NOT provide useful clues. In this example all the QRSes in Lead II look similar and have a negative deflection (Jacobson, 2007).

40. What treatments have been shown to be effective for Torsades de Points?

A. IV Magnesium
B. Defibrillation
C. Overdrive pacing
D. All of the above

Correct answer: D
Feedback: IV magnesium, defibrillation, and overdrive pacing have all been shown to be effective in Torsades de Points (Zipes, et al., 2006).

41. What are appropriate treatments for wide-complex ventricular tachycardia without a pulse (per hospital Emergency Standing Orders)? (select all that apply)

A. Call Code Blue and begin CPR
B. Defibrillate immediately with 360 joules or equivalent with a biphasic defibrillator
C. Give drug trial of Lidocaine before defibrillating.
D. Initial external pacemaker at rate of 60-80 with milliamps 10% above the threshold

Correct answer: A, B
Feedback: Pulselses VT and VF should be treated with Code Blue and immediate defibrillation (See Directive 3.13, St. Vincent‘s Clinical Standard Manual).

42. What treatment is indicated for unstable Ventricular Tachycardia with a pulse (per hospital Emergency Standing Orders)?

A. IV Amiodarone bolus and drip
B. Defibrillation with 360 joules or equivalent with a biphasic defibrillator
C. Synchronized Cardioversion
D. All of the above

Correct answer: C
Feedback: For unstable wide-complex tachycardias with a pulse, Emergency Standing Orders list vagal maneuvers, Lidocaine and emergency synchronized cardioversion. (See Directive 3.13, St. Vincent‘s Clinical Standard Manual).

43. What treatments may be indicated for Supra-Ventricular Tachycardia with a narrow QRS complex, rate 168, BP 90/50 (per hospital Emergency Standing Orders)? (Select all that apply)

A. Ask patient to cough and bear down
B. Give Lidocaine 1-1.5 mg/kg IVP
C. Prepare for emergency synchronized cardioversion
D. Defibrillation with 360 joules or equivalent with a biphasic defibrillator

Correct answers: A, C
Feedback: For unstable SVT (narrow complex with a pulse) vagal maneuvers, Adenosine IVP, and synchronized cardioversion may be indicated. (See Directive 3.13, St. Vincent‘s Clinical Standard Manual).

44. Which intervention is the most important for the nurse to initiate first when a new wide QRS complex tachycardia is identified by the monitor tech?

A. Look at the strip with the monitor tech
B. Order STAT 12 Lead ECG
C. Call the Rapid Response Nurse
D. Assess the patient

Correct answer: D
Feedback: The most important intervention is to assess how the patient is tolerating the rhythm (check LOC, pulse, and blood pressure) because the findings will guide the next actions.

45. Which intervention is the most important for the nurse to initiate first when a new wide QRS complex tachycardia is identified by the monitor tech?

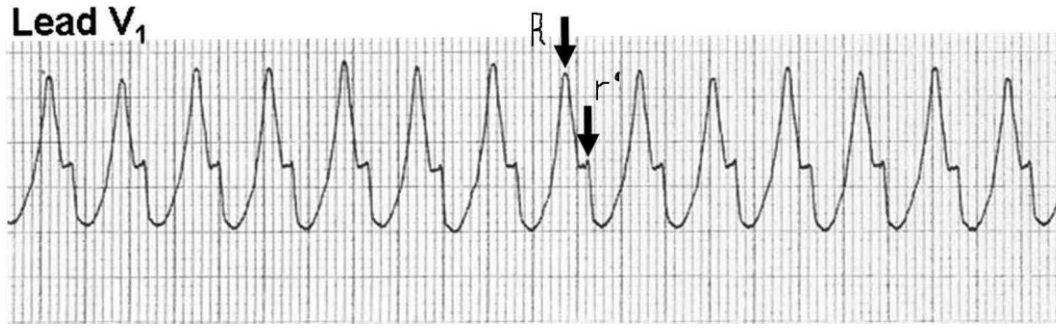
A. Assess the patient
B. Look at the strip with the monitor tech
C. Ask Unit Clerk to call for STAT 12 Lead ECG
D. Call Code Blue

Correct answer: A
Feedback: The most important intervention is to assess how the patient is tolerating the rhythm (check LOC, pulse, and blood pressure) because the findings will guide the next actions.

Appendix R: Case Studies for Educational Program

Case Study #1 Test Bank Questions 46-49
(Case study is from Drew, 2007. Used with permission)

46. Mr. B. is a 50-year-old male who experienced an acute STEMI (ST elevation myocardial infarction) and stent placement 3 days ago. He is expecting to be discharged from the telemetry unit later today. He insists on walking briskly up and down the halls to keep in shape for going home'. While walking past the central nurses' station, he leans on the counter and states that his heart is pounding and he feels faint. He is taken back to his room and the rhythm strip below is printed out (Drew, 2007, p. 311).



(From Drew, 2007. Used with permission)

What is your interpretation of this rhythm?

A. Ventricular Tachycardia
B. SVT with aberration
C. Narrow QRS complex tachycardia

Correct answer A
Feedback: It is a wide QRS complex tachycardia (rate, 188) with a prolonged QRS of more than 0.16 second. The QRS configuration is positive and notched, with the first notch taller than the second notch. The Rr' configuration in lead V1 is a strong indication for ventricular tachycardia
(arrows)." Not all patients experience hemodynamic instability and a loss of consciousness with ventricular tachycardia, although many do (Drew, 2007, p. 315).

47. Fortunately the rhythm spontaneously converted back to normal sinus rhythm in less than a minute and he remained conscious with BP 100/60. The physician was called and ordered Sotolol (betapace) orally. What additional things should now be monitored and what lead should the patient be monitored in?

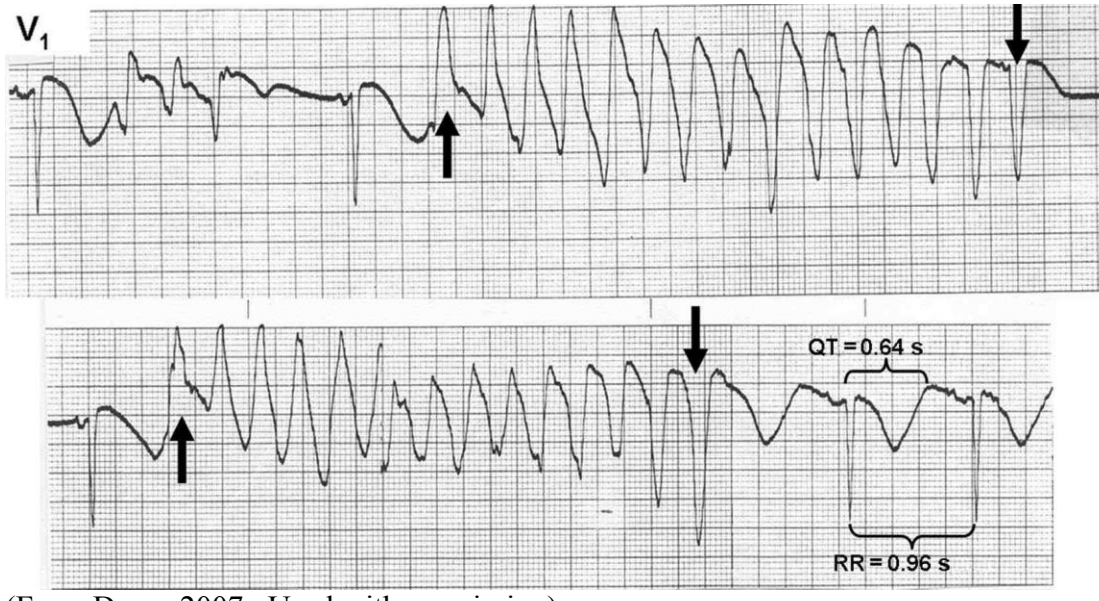
A. QTc intervals, BUN and Creatinine; monitor in Lead II
B. QTc intervals, potassium and magnesium levels; monitor in Lead V_1
C. PR interval and Digoxin levels; monitor in Lead II

Correct answer B

Feedback: Now that Mr B. has been started on a drug that can prolong ventricular repolarization
and lead to torsades de pointes, the nurse should document the baseline QTc interval before sotolol is started and at least every 8 to 12 hours thereafter (Drew, 2007, p. 315).

(put on new slide) QTc Review: "If Mr. B. has an increase of 0.06 second or more in his QTc interval from the predrug to the postdrug period, the nurse should be concerned and watch for QT-related arrhythmias such as polymorphic ventricular premature beats and couplets, T wave alternans, and nonsustainedtorsades de pointes. If the QTc interval lengthens to 0.50 second or more, the nurse should notify the physician to consider stopping the offending drug (sotolol). The nurse should also make sure Mr B. does not have Hypokalemia and that he is not having severe bradycardia or long pauses, which could trigger torsades de pointes and cardiac arrest" (Drew, 2007, p. 315).

48. Mr. B.'s cardiac monitor arrhythmia alarm sounds and the following tracing is automatically printed out. What is your interpretation of the rhythm?



(From Drew, 2007. Used with permission)

A. SVT with aberration
B. Ventricular tachycardia, monophasic
C. Torsades de Pointes

Correct answer C
Feedback: "Episodes of drug-induced torsades de pointes. The first beat on the top tracing is a sinus beat followed by 3 polymorphic ventricular premature beats. The beat after the pause is a junctional escape beat that is dissociated from the sinus P wave that just precedes it. Then, nonsustainedTorsades de Pointes occurs. It has the characteristic "twisting of the points' pattern (i.e., QRS complexes point in one direction initially and

then switch to the opposite direction [arrows]). Another episode occurs on the bottom rhythm strip. The QT interval measures 0.64 second; the RR interval measures 0.96 second. The QTC is 0.65 second, which is more than the critical threshold of 0.50 second. This rhythm strip indicates that Mr. B. is at a high risk for developing sustained torsades de pointes and cardiac arrest unless the nurse acts immediately" (Drew 2007, p. 315).

49. What should the nurse do? *(click on each answer choice to see the results)*

A. Assess the patient, order STAT 12 lead ECG, and notify Rapid Response Nurse or M.D.
B. Assess the patient, ask him to cough or bear down, administer Adenosine 6 mg IVP for narrow complex tachycardia per Emergency Standing Orders.
C. No intervention is necessary because he is already on antiarrhythmic medication and the arrhythmia was not sustained.
D. When in danger, when in doubt, run in circles, scream and shout.

Correct answer A

Feedback for Answer A: Mr. B's BP remained alert and responsive with a BP above 100/60. A 12-lead ECG confirmed prolongation of QTc above 0.50. A Magnesium drip was ordered and begun. Sotolol was discontinued, and within 24 hours he had no further ventricular arrhythmias and was discharged. The nurse was commended for her prompt recognition of Torsades de Pointe and taking corrective actions.

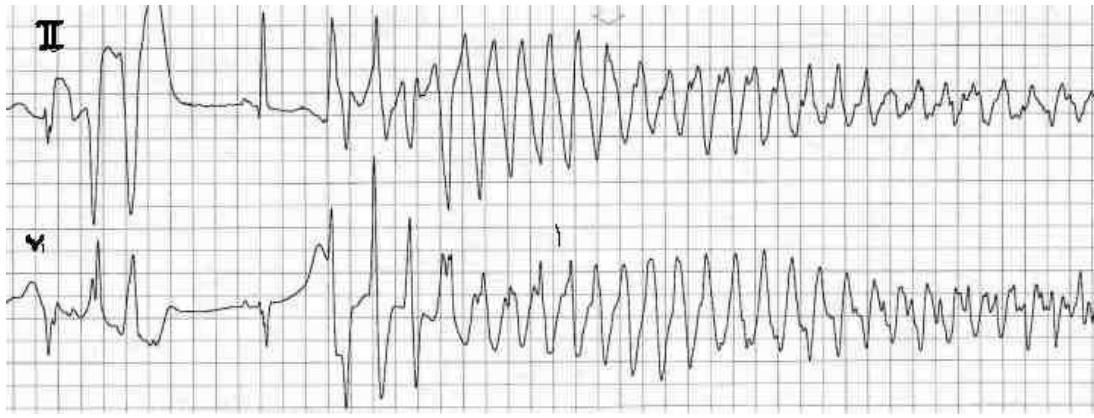
Feedback for Answer B: Mr. B's BP remained alert and responsive with a BP above 100/60. Immediately after IV Adenosine given, the patient went into third degree AV block and ventricular standstill, so a Code Blue was called. He was successfully revived and transferred to ICU. The nurse was required to complete a remediation program on arrhythmia interpretation and treatment.

Feedback for Answer C: Thirty minutes later the monitor alarms sounded again and this time the Torsades de Pointes deteriorated into ventricular fibrillation and cardiac arrest. A Code Blue was called but the patient died. The nurse was required to complete a remediation module on arrhythmia interpretation and treatment.

Feedback for Answer D: The other nurses came to see what all the screaming was about, assessed the patient, and called the Rapid Response Nurse, who initiated appropriate treatment. The nurse who was running in circles and screaming was later fired.

Case Study #2 Test Bank Questions 50-53
(From Pelter & Carey, 2006. Used with permission)

"Scenario: This ECG was obtained in a 79-year-old woman admitted to the intensive care unit for acute exacerbation of chronic obstructive pulmonary disease and pneumonia treated with erythromycin. The bedside monitor alarmed for "V Tach." The nurse could not assess the patient's mental status because the patient was intubated and sedated with propofol. The patient's
blood pressure was 109/48 mm Hg and her pulse oximeter reading was 93%. The rhythm spontaneously returned to normal sinus rhythm after 30 seconds" (Pelter & Carey, 2006, p. 437).



(From Pelter & Carey, 2006. Used with permission)

50. What is your interpretation of this rhythm?

A. SVT with aberration
B. Ventricular tachycardia, monophasic
C. Torsades de pointes (TdP)

Correct Answer C.
Feedback: "The strip begins with a ventricular triplet. These complexes are further labeled as multiform because of the different QRS morphologies. The fourth beat is a normal sinus beat with a long QT interval (0.64 seconds). This beat is followed by an R-on-T premature ventricular contraction (PVC) inducing torsades de pointes (TdP)" (Pelter & Carey, 2006, p. 438).

51. Select the best lead to monitor this patient's dysrhythmia.

A. I
B. II
C. III
D. V_1

Correct Answer D
Feedback: Lead V_1 is best to diagnose wide QRS complexes, which occur in bundle branch block aberrancy or ventricular rhythms. Lead II is best to diagnose atrial activity and measure heart rate because of the upright rounded P waves and tall R waves (AACN Practice Alert, 2008, p. 1)

52. What predisposing factors did this patient have that increased her risk of developing torsades de pointes (TdP)? (select all that apply)

A. Chronic obstructive pulmonary disease and pneumonia
B. Erythromycin
C. Sedated with propofol
D. Probably prolonged QTc (as seen with the QT in the one recorded sinus beat).

Correct answers: B and D
Feedback: ~~O~~ne drug that can cause TdP is erythromycin, a likely cause in this patient. Importantly, because the QTc interval is typically longer in women than in men, women may be more vulnerable to the effects of drugs that prolong the QT interval. This example shows the characteristic onset of TdP immediately preceding the arrhythmia; ventricular ectopy (3 beats in this example), followed by a pause, then a sinus beat, and finally an R-on-T PVC" (Pelter & Carey, 2006, p. 438).

53. What are the appropriate nursing actions that should be done for this patient? *(click on each answer choice to see the results)*

A. Give next scheduled dose of erythromycin early to counteract the pneumonia.
B. Hold sliding scale Potassium if K is 3.5 mEq until Creatinine levels can be checked
C. Call a Code Blue and defibrillate immediately with 360 joules
D. Assess the patient, hold erythromycin, check electrolyte levels, notify Rapid Response Nurse and M.D, and put crash cart outside the room.

Correct answer D.

Feedback for A: About 15 minutes after giving erythromycin, the patient goes back into Torsades de Pointes and this time it progresses to Ventricular Fibrillation. A Code Blue is called but the patient dies. The nurse was later fired.

Feedback for B: About an hour later the patient goes back into torsades de pointes and this time she is symptomatic with BP of 80/50. A Code Blue is called, emergency synchronized cardioversion is done, and a Magnesium drip is begun. The patient remained in ICU for several more days and was finally discharged one week later. The nurse was required to complete a remediation module on arrhythmia interpretation and treatment.

Feedback for C: After you call for help and attach the debrillation patches to her chest, another nurse yells at you, ―What are you doing? Don‘t shock her! She‘s back in Normal Sinus Rhythm!" The Code Blue is cancelled and a Cardiology consult is ordered. Erythromycin is discontinued and a new antibiotic started. Magnesium and potassium boluses are given. The nurse was required to complete a remediation module on arrhythmia interpretation and treatment.

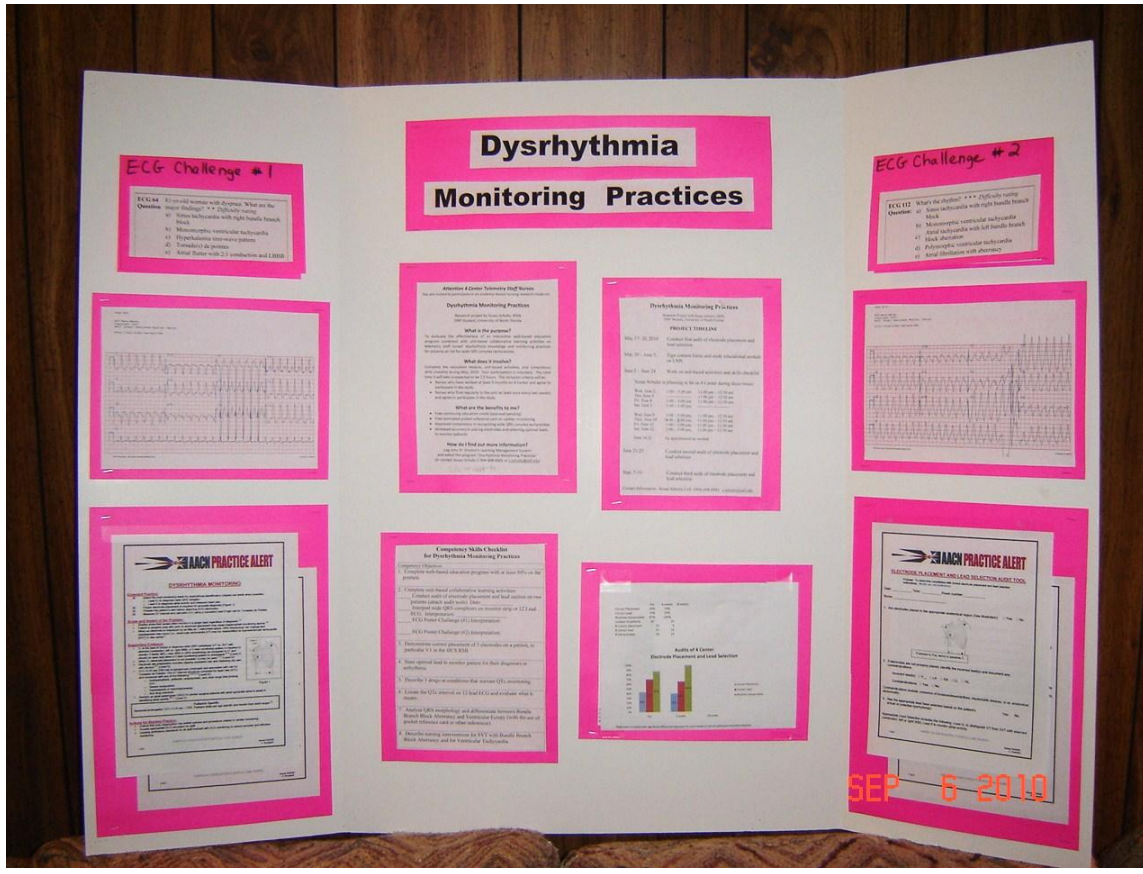
Feedback for D: Correct! ―Because TdP can quickly degenerate into ventricular fibrillation, the crash cart should be readily available for immediate defibrillation, offending agent such as the erythromycin should be D/C, and magnesium and antiarhythmic drugs should be given. The nurse should also carefully measure the QT interval as per the unit protocol" (Pelter & Carey, 2006). The nurse was commended for her prompt recognition of torsades de pointes and was later promoted to Assistant Nurse Manager.

Appendix S: Million Dollar Game for Educational Program

Amount	Question	Answer Choices	Correct
$2,000	1. Where should the V1 electrode be places?	a. Upper left chest b. Upper right chest c. 5th intercostal space, left sternal border d. 4th intercostal space, right sternal border	d
$4,000	2. What is the best lead to diagnose wide QRS complexes?	a. Lead I b. Lead II c. Lead III d. Lead V1	d
$8,000	3. Which of the following is a true statement about QT and QTc intervals?	a. QT interval shortens with bradycardia b. QTc interval is the QT interval corrected for heart rate c. QTc interval is the QRS interval plus the T wave d. QT interval lengthens with tachycardia	b
$16,000	4. What QTc interval is associated with Torsades de Pointes?	a. 0.20 sec (200 msec) b. 0.24 sec (240 msec) c. >0.50 sec (500 msec) d. Less than 0.12 sec (120 msec)	c
$25,000	5. Which drugs or conditions may prolong the QTc?	a. Antiarrhythmics (Procainamide/Pronestyl, Sotalol/Betapace) b. Hypokalemia or Hypomagnesemia c. Antibiotics (Erythromycin/EES, Levofloxacin/Levaquin) d. All of the above	d
$50,000	6. What does a triphasicrsR‘ morphology in V1 indicate?	a. RBBB aberration b. LBBB aberration c. Ventricular beat d. None of the above	a
$100,000	7. What does a notched R wave with taller left peak in V1 indicate?	a. LBBB aberration b. RBBB aberration c. Ventricular Tachycardia d. SVT with aberration	c
$250,000	8. What does it indicate when a wide QRS in V1 shows a slick downstroke with a nadir less than 60 msec?	a. RBBB aberration b. LBBB aberration c. Ventricular Tachycardia d. V1 is not a useful lead to analyze QRS morphology	b

$500,000	9. What does it indicate if V1 shows R>30 msec, or slurred or notched S descent, or QRS onset to S nadir > 60 msec?	a. RBBB aberration b. LBBB aberration c. Ventricular Tachycardia d. SVT with aberration	c
$1,000,000	10. Which intervention is the most important for the nurse to initiate first when a new wide QRS complex tachycardia is identifies by the monitor tech?	a. Assess the patient‘s LOC and VS b. Order STAT 12 lead ECG c. Call the Rapid Response Nurse d. Defibrillate immediately with 360 joules or equivalent biphasic	a

Appendix T: Unit-based Activities Poster



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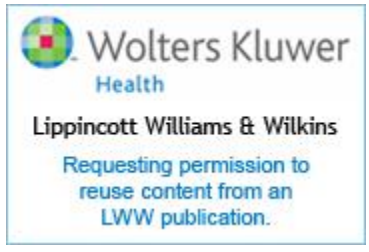

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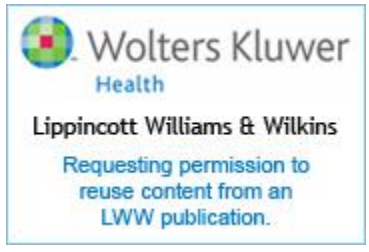

Title: Preventing Torsades de Pointes by Careful Cardiac Monitoring in Hospital Settings

Author: Claire Sommargren and Barbara Drew

Publication: AACN Advanced Critical Care

Publisher: Wolters Kluwer Health

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Course name	Dysrhythmia Monitoring Practices
Institution name	St. Vincent's Medical Center
Instructor name	Susan Schultz
Expected course start date	May 2010
Total	Not Available

Permission to use ECGs from Wave-Maven

From:	agoldber@caregroup.harvard.edu [agoldber@caregroup.harvard.edu]	Sent:	Thu 3/18/2010 1:19 PM
To:	Schultz, Susan		
Cc:	lnathans@bidmc.harvard.edu		
Subject:	RE: ECG Wave-Maven Feedback		

Attachments:

Hi Susan--yes, with pleasure! The citation for the site is at the home page. Very best, Ary Goldberger, MD

Citation: Nathanson, L. A., McClennen, S., Safran C, Goldberger, A. L. (2007). ECG Wave-Maven: Self-Assessment Program for Students and Clinicians. http://ecg.bidmc.harvard.edu

-----Original Message-----
From: Automatic Notification
Sent: Thursday, March 18, 2010 12:41 PM
To: Nathanson,Larry A.,MD (Emerg. Med. + IS Clinical R&D); Goldberger,Ary (HMFP - Interdisciplinary Medicine Cardiology)
Subject: ECG Wave-Maven Feedback

Name From: Susan Schultz
Email From: s.schultz@unf.edu
Case Number:
Session: 201003181025.371966649

Comments:
Your website provides wonderful opportunities to learn ECG interpretation better.
I would like permission to use some of the ECGs in a educational program I'm preparing for staff nurses in telemetry and ICU units at St. Vincent's Medical Center at Jacksonville, Florida. This program is a part of my doctorate of nursing practice research. The program will be put on the hospital's intranet and only accessible by employees. The program is based on American Association of Critical Care nurses' Practice Alert on Dysrhythmia Monitoring Practices and emphasizes the importance of monitoring and differentiating wide QRS complex tachycardias. I would give full credit to the copyright holder. The ECG cases that I would like to download are 1, 10, 64, 112, 170, 177, 239, 274, 343, 362, 396, 403. Please let me know if this is OK. Thank you

Susan Schultz, RN, MSN
DNP student University of North Florida, Jacksonville, FL
s.schultz@unf.edu

Appendix V: Content Validity Evaluation
"Dysrhythmia Monitoring Practices" by Susan Schultz

Evaluator name: Educator 1 Date: 7/15/10
Job title: Clinical Resource Coordinator Area of specialty: Critical Care
Years in current position: 10 Years licensed as a nurse: 32
Educational degrees/years: ADN, BSN, MSN
Certifications: CCRN
Number of years experience with dysrhythmia interpretation: 31

Evaluator name: Educator 2 Date: 7/7/10
Job title: Clinical Resource Coordinator Area of specialty: med/surg/tele
Years in current position: 2 Years licensed as a nurse: 29
Educational degrees/years: BSN, Diploma
Certifications: RN,C-Medical surgical nurse
Number of years experience with dysrhythmia interpretation: 7

Evaluator name: Educator 3 Date: 7/29/10
Job title: Clinical Resource Coordinator Area of specialty: Telemetry
Years in current position: 5 Years licensed as a nurse: 27
Educational degrees/years: BSN
Certifications: PCCN
Number of years experience with dysrhythmia interpretation: 27

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The content in the power point from the American Association of Critical Care-Nurses' was current and accurate.	3				
2. The audio script was from relevant literature and reinforced the content in the power point slides.	2			1	
3. The interactivities interspersed throughout the slides (self-check questions, case studies, and game) were from relevant literature and reinforced the content in the power point slides.	3				
4. The pretest and posttest were based on the learner objectives and relevant to the content taught in the module.	3				
5. The instructional method was effective for this topic.	2				1

Would you recommend this learning module to the nurses in your units?

Yes, but it would require time commitment
It would be too hard for the nurses on the unit
Yes, definitely

What did you like the most about it?

Liked interactive questions
The games and test that were spread out
Challenge—raised my level of expertise in tele filed.
Organization of module; the audio was great

What modifications do you suggest?

I should have printed the material. I would have gotten more from it – could highlight key points and probably retained.
Would have power point slides that more closely matched the voice over. I found it hard to follow the voice over. I needed something in writing to be able to study in order to really understand the material.
None

Appendix W: Competency Skills Checklist for Dysrhythmia Monitoring Practices

Nurses' Code Number: _____

Competency Objectives	Rating Key	Method	Date & Validator Initials
1. Complete web-based education program with at least 80% on the posttest.			
2. Complete unit-based collaborative learning activities: _____ Conduct audit of electrode placement and lead section on two patients (attach audit tools) Date:_____ _____ Interpret wide QRS complexes on monitor strip or 12 Lead ECG. Interpretation: _____ _____ ECG Poster Challenge (#1) Interpretation: _____ ECG Poster Challenge (#2) Interpretation:			
3. Demonstrate correct placement of 5 electrodes on a patient, in particular V1 in the 4ICS RSB			
4. State optimal lead to monitor patient for their diagnoses or arrhythmia.			
5. Describe 3 drugs or conditions that warrant QTc monitoring.			
6. Locate the QTc interval on 12 lead ECG and evaluate what it means.			
7. Analyze QRS morphology and differentiate between Bundle Branch Block Aberrancy and Ventricular Ectopy (with the use of pocket reference card or other references).			
8. Describe nursing interventions for SVT with Bundle Branch Block Aberrancy and for Ventricular Tachycardia.			

Rating Key: 2=Competent, 1=Needs Improvement, 0-Not Competent
Method of evaluation: **Verb**alized, **Test**ed, **Skill** observation, **Sim**ulation

Comments and/or Action Plan:
_____
_____
_____

Validator's Initials and Signature: _____ _____

Appendix X: Pretest and Posttest Questions

Dysrhythmia Monitoring Practices
Pretest Questions

1. Match the description of the electrode placement to the correct electrode.

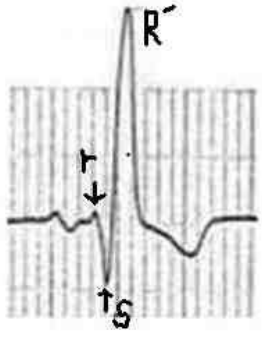
A. RA	_____ below rib cage on left side of abdomen
B. LA	_____ infra-clavicular fossa close to left shoulder
C. C	_____ anywhere on torso, usually lower right side of chest or abdomen
D. LL	_____ 4th Inter Costal Space, Right Sternal Border
E. RL	_____ infra-clavicular fossa close to right shoulder

2. What is the best way to prepare the skin before placing electrodes?
   A. Clip excessive hair and clean skin with alcohol or washcloth before placing electrodes.
   B. Clean skin with soap and water only if there is visible sweat, oil, or powder.
   C. Apply electrodes; if artifact noted, then clean the skin and replace electrodes.
   D. If chest is hairy, shave with shaving cream and razor, dry thoroughly, then apply electrodes.

3. Select the best lead to diagnose wide QRS complexes.
   A. I
   B. II
   C. III
   D. V_1

4. Which of the following patient conditions would be best lead to monitor in V1? (Select all that apply)
   A. Atrial fibrillation with intermittent wide QRS complexes
   B. First, Second or Third Degree AV heart block
   C. Supra-Ventricular Tachycardia with aberrant conduction
   D. Sinus Bradycardia or Sinus Rhythm with pauses

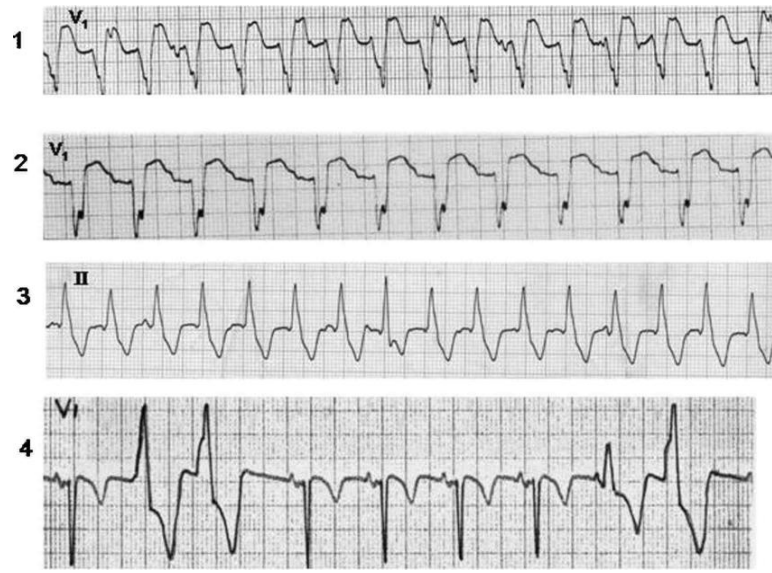
5. What does a triphasicrsR‘ morphology (shown below) in V1 indicate?



(Adapted from Jacobson, 2007. Used with permission)

A. RBBB aberration
B. LBBB aberration
C. Ventricular beat
D. None of the above

6. Match the strip with the correct interpretation using QRS morphology and AV dissociation cues.

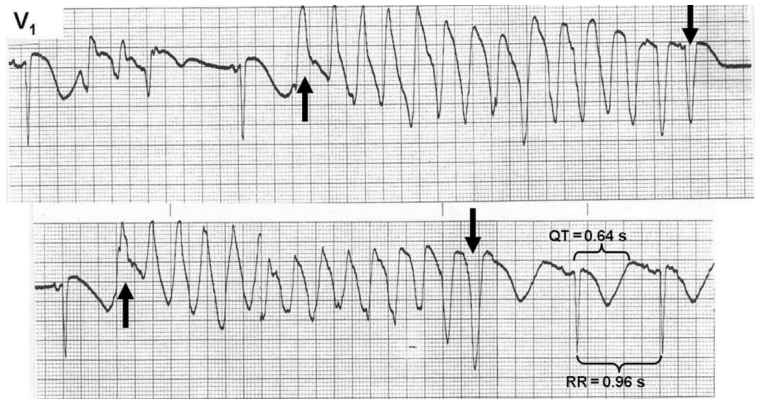


(From Jacobson, 2006. Used with permission)

A. Sinus rhythm with 2 pairs of PVCs.
B. Sinus tachycardia with LBBB aberration.
C. Ventricular Tachycardia (positive deflection).
D. Ventricular Tachycardia (negative deflection)

7. Mr. B.'s cardiac monitor arrhythmia alarm sounds and the following tracing is automatically printed out. What is your interpretation of the rhythm?

A. SVT with aberration
B. Ventricular tachycardia, monophasic
C. Torsades de Pointes



(From Drew, 2007. Used with permission)

8. Calculate the QT, R-R, and QTc for this strip *(√ = square roots. Accurate divisions have been provided in the answers; you just need to select the correct intervals)*

From Sommargren & Drew, 2007. Used with permission.)

A. QT = .24, R-R = .48; √.48 = .693; QTc = .24 / .693 = .35 seconds
B. QT = .36, R-R = .60; √.6 = .775; QTc = .36 / .775 = .46 seconds
C. QT = .44, R-R = .80; √.8 = .894; QTc = .44 / .894 = .49 seconds
D. QT = .56, R-R = .80; √8 = .894; QTc = .56 / .894 = .63 seconds

9. Which of the following are true statements (select all that apply).
A. QT interval is measured from beginning of QRS to end of T wave
B. QT**c** interval is the QRS interval plus the T wave
C. QT interval lengthens with bradycardia and shortens with tachycardia.
D. QT interval shortens with bradycardia and lengthens with tachycardia.
E. QT**c**interval is the QT interval corrected for heart rate

10. What QTc interval is associated with Torsades de pointes?
A. > 0.20 sec (200 msec)
B. > 0.24 sec (240 msec)
C. > 0.50 sec (500 msec)
D. < 0.12 sec (120 msec)

11. Which drugs may prolong the QTc?
    A. Antiarrhythmics (Procainamide/Pronestyl, Sotalol/Betapace)
    B. Antipsychotics (Chlorpromazine/Thorazine, Haloperidol/Haldol)
    C. Antibiotics (Erythromycin/EES, Levofloxacin/Levaquin)
    D. All of the above

12. Which of the following patients should have QTc interval monitoring? (select all that apply)
    A. 58 year-old male with acute MI and on Lidocaine drip 2 mg/min, Potassium 4.0
    B. 36 year-old female admitted with overdose on Chlorpromazine/Thorazine
    C. 54 year-old female with new onset atrial fibrillation and started on oral Sotalol/Betapace
    D. 49 year-old alcoholic male with cardiomyopathy taking Quinidine and Magnesium 1.8
    E. 75 year-old female admitted with pneumonia and started on Levofloxacin/Levaquin

13. What treatments have been shown to be effective for Torsades de points?
    A. IV Magnesium
    B. Defibrillation
    C. Overdrive pacing
    D. All of the above

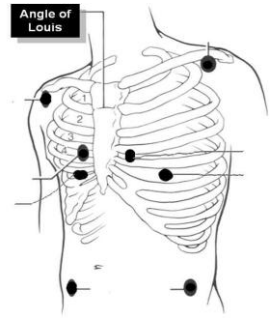
14. What are appropriate treatments for wide-complex ventricular tachycardia without a pulse (per hospital Emergency Standing Orders)? (select all that apply)
    A. Call Code Blue and begin CPR
    B. Defibrillate immediately with 360 joules or equivalent with a biphasic defibrillator
    C. Give drug trial of Lidocaine before defibrillating.
    D. Initial external pacemaker at rate of 60-80 with milliamps 10% above the threshold

15. Which intervention is the most important for the nurse to initiate first when a new wide QRS complex tachycardia is identified by the monitor tech?
    A. Look at the strip with the monitor tech
    B. Order STAT 12 Lead ECG
    C. Call the Rapid Response Nurse
    D. Assess the patient

Answers to Pretest:
1.D, B, E, C, A; 2.A; 3.D; 4.A, C; 5.A; 6.D, B, C, A; 7.C; 8.C; 9.A, C, E; 10.C; 11.D; 12.B, C, D, E; 13.D; 14.A, B; 15.D.

Dysrhythmia Monitoring Practices
Posttest Questions

1. Drag and Drop the electrodes to the correct locations (or write them next to the correct location). Only 5 locations will need to be labeled. RA, LA, C-V_1, RL, LL



(Adapted from Richards, 2008. Used with permission)

2. Place the steps for applying electrodes in the proper order (select the answer choice with the steps in the correct order).

W. Apply new electrodes and press firmly to skin
X. Clip excessive hair from selected locations
Y. Visually select locations without implanted devices, dressings, or muscle artifact that could interfere with monitoring
Z. Clean skin with alcohol or washcloth and dry thoroughly

A. Y, X, Z, W
B. Y, Z, X, W
C. W, X, Y, Z
D. Z, X, Y, W

3. Select the best lead to diagnose atrial activity and measure heart rate.

A. I
B. II
C. III
D. V_1

4. Which of the following patient conditions would be best lead to monitor in V1? (Select all that apply)

A. Normal Sinus Rhythm with 5 beat run of Ventricular Tachycardia
B. Possible Torsades de Pointes
C. Diagnosing Atrial Flutter versus Atrial Fibrillation
D. Sinus Tachycardia with intermittent right Bundle Branch Block

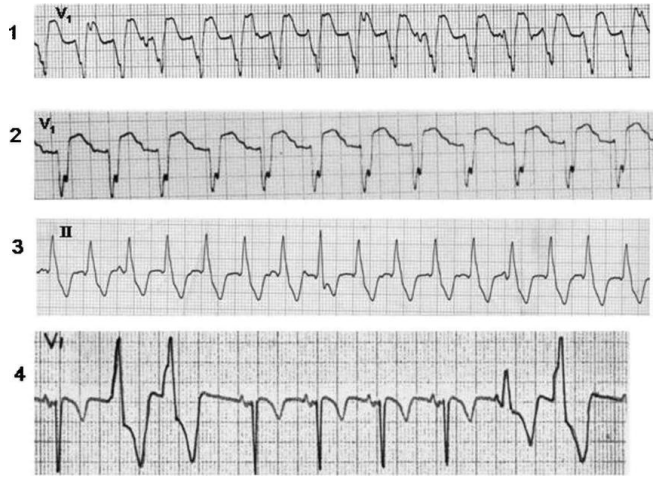
5. Measure the descent of the S from the onset of QRS to the nadir (lowest point of the S). Exact distance to measure is shown. Select the answer choice that has the correct measurement and interpretation.

(Adapted from Jacobson, 2007. Used with permission)

A. 0.04-0.06 seconds (40-60 msec); nadir is normal and represents LBBB aberration
B. 0.10 seconds (100 msec); nadir is normal and represents RBBB aberration
C. 0.14 seconds (140 msec); nadir is prolonged and represents VT
D. 0.24 seconds (240 msec); nadir is prolonged and represents VT

6. Match the strips with the correct interpretations using QRS morphology and AV dissociation cues. (draw lines to connect the letters and numbers)

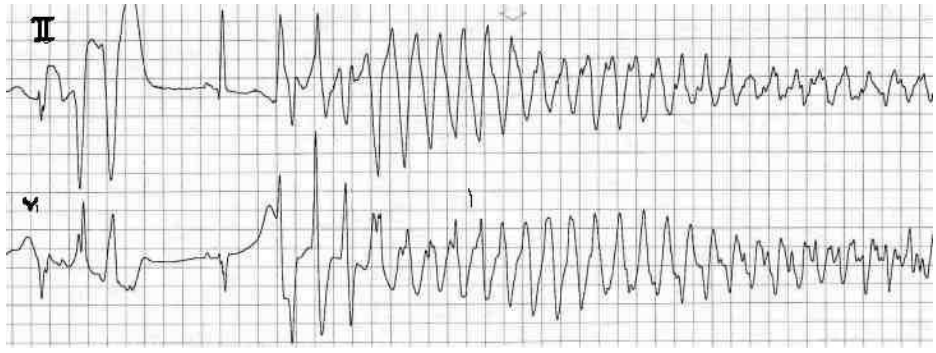
A. Sinus rhythm with 2 pairs of PVCs.	1
B. Sinus tachycardia with LBBB aberration.	2
C. Ventricular Tachycardia (positive deflection).	3
D. Ventricular Tachycardia (negative deflection)	4



(From Jacobson, 2006. Used with permission)

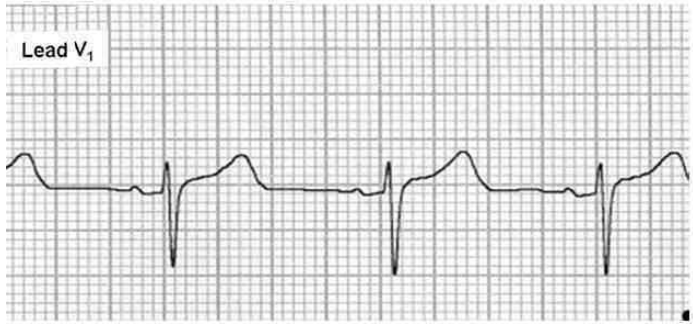
7. What is your interpretation of the rhythm below?

A. SVT with aberration
B. Ventricular tachycardia, monophasic
C. Torsades de Pointes (TdP)



(From Pelter & Carey, 2006. Used with permission)

8. Calculate the QT and QTc interval for this strip. *(√ = square roots. Accurate divisions have been provided in the answers; you just need to select the correct intervals)*



(From Drew, 2007. Used with permission.)

A. QT = .24, R-R = .48; √.48 = .693; QTc = .24 / .693 = .35 seconds
B. QT = .40, R-R = .80; √.8 = .894. QTc = .40 / .894 = .48 seconds
C. QT = .44, R-R = .60; √.6 = .775; QTc = .44 / .775 = .57 seconds
D. QT = .56, R-R = .80; √8 = .894; QTc = .56 / .894 = .63 seconds

9. Which of the following are true statements (select all that apply).
A. QT**c** interval is the QRS interval plus the T wave
B. QT interval shortens with bradycardia and lengthens with tachycardia.
C. QT**c**interval is the QT interval corrected for heart rate
D. QT interval is measured from beginning of QRS to end of T wave
E. QT interval lengthens with bradycardia and shortens with tachycardia.

10. What QTc interval is associated with Torsades de Pointes?
A. < 0.12 sec (120 msec)
B. > 0.20 sec (200 msec)
C. > 0.24 sec (240 msec)
D. > 0.50 sec (500 msec)

11. Which of the following conditions should have QTc interval monitoring?
    A. New onset or severe bradycardia
    B. Hypokalemia or hypomagnesemia
    C. Overdose on potentially prodysrhythmic medications
    D. All of the above

12. Which of the following patients should have QTc interval monitoring? (select all that apply)
    A. 75 year-old female admitted with pneumonia and started on Erythromycin (EES)
    B. 36 year-old female admitted with overdose on Haloperidol/Haldol
    C. 54 year-old female with new onset atrial fibrillation and started on oral Procainamide/Pronestyl
    D. 58 year-old male with acute MI and on Lidocaine drip 2 mg/min, Potassium 4.0
    E. 49 year-old alcoholic male on Chlorpromazine/Thorazine with Magnesium of 1.8

13. What treatments have been shown to be effective for Torsades de points?
    A. IV Magnesium
    B. Defibrillation
    C. Overdrive pacing
    D. All of the above

14. What treatment is indicated for unstable Ventricular Tachycardia with a pulse (per hospital Emergency Standing Orders)?
    A. IV Amiodarone bolus and drip
    B. Defibrillation with 360 joules or equivalent with a biphasic defibrillator
    C. Synchronized Cardioversion
    D. All of the above

15. Which intervention is the most important for the nurse to initiate first when a new wide QRS complex tachycardia is identified by the monitor tech?
    A. Assess the patient
    B. Look at the strip with the monitor tech
    C. Ask Unit Clerk to call for STAT 12 Lead ECG
    D. Call Code Blue

Answers to Posttest:
1. RA, LA, C, RL, LA; 2.A; 3.B; 4.A, B, D; 5.A; 6.D, B, C, A; 7.C; 8.B; 9.C, D, E; 10.D; 11.D; 12.A, B, C, E; 13.D; 14.C; 15.A.

Appendix Y: Pretest and Posttest Scores and Reliability (Educators)

Educators' Pretest and Posttest Scores

Educator	Pretest	Posttest
1	93	100
2	53	93
3	80	87

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Median
Pretest	3	75.33	20.404	53	93	80
Posttest	3	93.33	6.506	87	100	93

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	3[b]	2.00	6.00
	Ties	0[c]		
	Total	3		

a. Posttest < Pretest

b. Posttest > Pretest

c. Posttest = Pretest

Test Statistics[b]

	Posttest - Pretest
Z	-1.633[a]
Asymp. Sig. (2-tailed)	.102

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

Educators' Pretest and Posttest Answers*

Question	Educ1Pre	Educ1Post	Educ2Pre	Educ2Post	Educ3Pre	Educ3Post	Correct
1	6	5	5	5	5	5	5
2	1	1	1	1	1	2	1
3	4	4	4	4	4	4	4
4	5	5	5	5	6	5	5
5	1	1	3	1	1	1	1
6	5	5	5	5	5	5	5
7	3	3	3	3	3	3	3
8	3	3	3	3	4	3	3
9	5	6	5	5	5	5	5
10	4	4	4	4	3	3	4
11	4	4	4	4	4	4	4
12	5	5	6	5	5	5	5
13	4	4	1	2	4	4	4
14	5	6	5	5	5	5	5
15	4	4	4	4	4	4	4

* Answers coded so they had the same answer key (A=1, B=2, C=3, D=4, and ~~–~~Matching" or ~~–~~Select All that Apply" answered correctly = 5, Incorrect = 6

Reliability Testing (of Educators' pretests and posttests taken after program completed)

Case Processing Summary

		N	%
Cases	Valid	15	100.0
	Excluded[a]	0	.0
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.975	.976	6

Appendix Z: Education Program Evaluation Form

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The posttest was based on the learner objectives.	1	8			
This type of learning is worthwhile.	1	7		1	
The content met my professional educational needs.	2	4		3	
The instructional method was effective for this topic.	1	4		3	
I would recommend this module to others.	1	5		3	
Self-study modules meet my needs for ongoing education.	1	5	1	2	
The content was accurate and current.	3	6			

Appendix AA: Income and Expenses for DNP Project

Income received by investigator	**Quantity**	**Unit Price**	**Total**
Patricia H. Foster Graduate Nursing Fellowship	1	$1000	$1000
Graduate Scholars (UNF)	1	$250	$250
Total			**$1250**

Expenses incurred by investigator	**Quantity**	**Unit Price**	**Total**
Printing expenses: Pocket Reference Cards (laminated), consent forms, skills checklists, audit forms	50 cards	$1.253	$62.65
Printing expenses: Flyers, consent forms, skills checklists, audit forms, certificates of attendance	1	26.37 39.19	$65.56
Poster supplies for ―ECG Poster Challenges"	1	61.33	$61.33
Gift cards (Winn Dixie and Gate Gas) for drawing to provide incentives to staff nurses	2	50	$100.00
Copyright permissions: Copyright Clearance Center	1	$103	$103
Copyright permissions: Wolters Kluwer Health License	3 1	$156.23 312.46	$781.15
Subtotal			**$1173.69**
Investigator's time to develop interactive, web-based education program with pretest, posttest, and self-check practice questions. Collaborate with hospital's instructional designers to finalize the program	24 hours	$25/hr	$600.00
Investigator's time to lead unit-based collaborative learning activities with staff nurses (16 1-hour sessions over 4 weeks)	16 hours	$25/hr	$400.00
Investigator's time to validate staff's competency on the skills checklist (4 2-hour sessions per week for 2 weeks)	16 hours	$25/hr	$400.00
Investigator's time to conduct the audits on electrode placement and lead selection(3audits taking about 2-hours each)	6 hours	$25/hr	$150.00
Subtotal			**$1550.00**
Total expenses incurred by investigator			**$2723.69**

Expenses incurred by hospital	**Quantity**	**Unit Price**	**Total**
Hospital's instructional designers time to import the educational program into Lectora software and deploy it in the Learning Management System (not charged to investigator)	16 hours	$25/hr	$400
Continuing Education application (Education Director's time to process; no application fee charged to investigator)	1 hour	$25/hr	$25
Total expenses incurred by hospital			$425

Appendix BB: IRB Approval Documents

UNF
UNIVERSITY of
NORTH FLORIDA.

Office of Research and Sponsored Programs
1 UNF Drive
Jacksonville, FL 32224-2665
904-620-2455 FAX 904-620-2457
Equal Opportunity/Equal Access/Affirmative Action Institution

MEMORANDUM

DATE: April 30, 2010

TO: Ms. Susan J. Schultz

VIA: Dr. Carol Ledbetter
Nursing

FROM: Dr. Katherine Kasten, Chairperson
UNF Institutional Review Board

RE: Review by the UNF Institutional Review Board IRB#10-031:
"Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit"

This is to advise you that your project, "Dysrhythmia Monitoring Practices of Nurses on a Telemetry Unit," has undergone "expedited, category #7" review on behalf of the UNF Institutional Review Board and was approved.

This approval applies to your project in the form and content as submitted to the IRB for review. Any variations or modifications to the approved protocol and/or informed consent forms as they relate to dealing with human subjects must be cleared with the IRB prior to implementing such changes. Any unanticipated problems involving risk and any occurrence of serious harm to subjects and others shall be reported promptly to the IRB.

Your study has been approved for a period of 12 months. If your project continues for more than one year, you are required to provide a Continuing Status Report to the UNF IRB prior to **03/30/2011** if your study will be continuing past 04/29/2011. *We suggest you submit your status report 11 months from the date of your approval date as noted above to allow time for review and processing.*

As you may know, **CITI Course Completion Reports are valid for 3 years.** Your completion report is valid through 11/12/2012. If your completion report expires soon please take CITI's refresher course. Once you complete all of the CITI modules a completion report will be emailed to our office. For faster file updating purposes, however, please notify this office when you complete your CITI refresher course.

Should you have questions regarding your project or any other IRB issues, please contact the Office of Research and Sponsored Programs at 904.620.2455.

Thank you,

Research Integrity Staff

UNF IRB Number: 10-031
Approval Date: 4-30-10
Revision Date: _____

ST. VINCENT'S
MEDICAL CENTER
St. Vincent's HealthCare

Institutional Review Board
1 Shircliff Way, Suite 1223
Jacksonville, FL 32204
(Phone) 904/308-8124
(Fax) 904/308-7326

April 9, 2010

Susan J. Schultz, MSN
4854 Scotch Pine Court
Jacksonville, FL 32210

RE: ***IRB #10-05-01; Dysrhythmia Monitoring Practices by Nurses on a Telemetry Unit***

Dear Ms. Schultz:

As permitted by the 45 CFR 46.110, I have granted expedited review and approval for the following information:

- **New Study: "Dysrhythmia Monitoring Practices by Nurses on a Telemetry Unit"**
- **Consent Form**
- **Recruitment Announcement**
- **Competency Skills Checklist for Dysrhythmia Monitoring Practices**
- **Audit Check-off Sheet**
- **Patient Demographic Data Collection Tool**
- **Nurses' Demographic Questionnaire**
- **Sample Test Questions**
- **Program Evaluation Form**
- **American Association of Critical Care Nurses Power Point Presentation**

This approval will expire on **April 9, 2011**. At that time, we will need an annual report of your experience with the protocol prior to the expiration date. Timely submission of your renewal report will be important to avoid unnecessary interruptions in your study. In the meantime, please call immediately should any questions arise.

As the Principal Investigator of this study, it is your responsibility to protect human research subjects and satisfy the intent and procedures as specified in federal regulations, 45 CFR Part 46 and other federal, state or local laws or regulations that apply to human research subjects.

Please report promptly to the IRB any injuries to subjects or unanticipated problems involving risks to the subjects or others. It is also your responsibility to report any changes to the protocol or informed consent before implementation and to obtain yearly re-approval of the protocol as required.

ST. VINCENT'S
MEDICAL CENTER
St. Vincent's HealthCare

Institutional Review Board
1 Shircliff Way, Suite 1223
Jacksonville, FL 32204
(Phone) 904/308-8124
(Fax) 904/308-7326

April 29, 2010

Susan J. Schultz, MSN
4854 Scotch Pine Court
Jacksonville, FL 32210

RE: ***IRB #10-05-01; Dysrhythmia Monitoring Practices by Nurses on a Telemetry Unit***

Dear Ms. Schultz:

As permitted by the 45 CFR 46.110, I have granted expedited review and approval for the following information:

- **Revisions dated 04/28/2010 to: 1) IRB application; 2) application attachment cover sheet; 3) consent form; 4) "Recruitment Announcement" form; 5) "Nurses' Demographic Questionnaire" form**

This information will be submitted to the Institutional Review Board on May 6, 2010 as information only.

Sincerely,

Signature Removed

Phil Perry, MD, MBA
Sr. V.P. and Chief Medical Officer
Chair, Institutional Review Board

PP/ts

Enclosure: IRB approved/stamped consent form

Appendix CC: Audit Check-off Sheet

Number	Audit Done (√ or NA)	Data recorded (√ or NA)	Number	Audit Done (√ or NA)	Data recorded (√ or NA)
1			21		
2			22		
3			23		
4			24		
5			25		
6			26		
7			27		
8			28		
9			29		
10			30		
11			31		
12			32		
13			33		
14			34		
15			35		
16			36		
17			37		
18			38		
19			39		
20			40		

When audit is finished, this check-off sheet will be discarded in confidential bin before leaving the unit.

Appendix DD: Patient Demographic Data Collection Tool

Number of Males: _____ Number of Females: _____

Ages: _____

Length of stay (in days): _____

Admitting diagnoses: _____

_____

_____

_____

Appendix EE: SPSS Statistical Software Data

Nurse‘s codenumber

Consent Signed (0 = No, 1= Yes)

Pretest (percentage)

Posttest (percentage)

Number of unit-based activities done (0, 1, 2, 3, 4)

Competency skills checklist completed (0 = No, 1= Yes)

Number of attempts to complete competency skills checklist (0, 1, 2)

Status of nurses‘ participation in educational program:

0 = Never registered

1 = Registered but never started pretest

2 = Registered, pretest in progress, no posttest

3 = Pretest completed, posttest in progress

4 = Pretest and posttest completed

5 = Excluded

Appendix **FF: Dysrhythmia Monitoring Nurses' Data**

CodeNumber	ConsentSigned	Status	Pretest	Posttest	SkillsChList	UnitBasedAct
1	Yes; Signed Consent	Pretest Completed, Module in Progress	0		no	0
2	Yes; Signed Consent	Never Registered				
3	Yes; Signed Consent	Pretest Completed, Module in Progress	47		no	0
4	Yes; Signed Consent	Registered but never started Pretest				
5	Yes; Signed Consent	Registered but never started Pretest				
6	Yes; Signed Consent	Pretest and Posttest Completed	0	93	yes	4
7	Yes; Signed Consent	Registered but never started Pretest				
8	Yes; Signed Consent	Never Registered				
9	Yes; Signed Consent	Pretest and Posttest Completed	47	87	yes	4
10	Yes; Signed Consent	Never Registered				
11	Yes; Signed Consent	Registered but never started Pretest				
12	Yes; Signed Consent	Pretest Completed, Module in Progress	60		no	0
13	Yes; Signed Consent	Pretest Completed, Module in Progress	0		no	0
14	Yes; Signed Consent	Pretest Completed, Module in Progress	33		no	0
15	Yes; Signed Consent	Never Registered				
16	Yes; Signed Consent	Registered but never started Pretest				
17	Yes; Signed Consent	Pretest and Posttest Completed	60	93	yes	4
18	Yes; Signed Consent	Pretest Completed, Module in Progress	40		no	0
19	Yes; Signed Consent	Pretest and Posttest Completed	53	80	yes	4
20		Number not drawn				
21	Yes; Signed Consent	Never Registered				
22	Yes; Signed Consent	Registered but never started Pretest				
23	Yes; Signed Consent	Pretest and Posttest Completed	0	67	yes	4
24	Yes; Signed Consent	Pretest and Posttest Completed	53	80	yes	4
25	Yes; Signed Consent	Registered but never started Pretest				

CodeNumber	ConsentSigned	Status	Pretest	Posttest	SkillsChList	UnitBasedAct
26	Yes; Signed Consent	Registered but never started Pretest				
27	Yes; Signed Consent	Pretest and Posttest Completed	0	47	yes	4
28	Excluded; New nurse	Excluded				
29	Excluded; New nurse	Excluded				
30	Yes; Signed Consent	Registered but never started Pretest				
31	Excluded; Declined	Excluded				
32	Excluded; Declined	Excluded				
33	Excluded; Declined	Excluded				
34	Excluded; Declined	Excluded				
35	Excluded; Declined	Excluded				
36	Excluded; Declined	Excluded				
37	Yes; Signed Consent	Pretest and Posttest Completed	40	80	yes	4
38		Number not drawn				
39	Yes; Signed Consent	Pretest Completed, Module in Progress	27		no	0
40	Yes; Signed Consent	Registered but never started Pretest				
41	Yes; Signed Consent	Pretest and Posttest Completed	0	87	yes	4
42	Yes; Signed Consent	Registered but never started Pretest				
43	Yes; Signed Consent	Registered but never started Pretest				
44	Yes; Signed Consent	Never Registered				

		Frequency	Percent
Valid	Never Registered	6	18
	Registered but never started Pretest	12	35
	Pretest Completed, Module in Progress	7	21
	Pretest and Posttest Completed	9	26
	Total	34	100.0

Appendix GG: Nurses' Demographic Data

Frequency Tables

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	8	100.0	100.0	100.0

Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	American Indian/Alaska Native	1	12.5	12.5	12.5
	Asian or Pacific Islander	2	25.0	25.0	37.5
	White or Caucasian	4	50.0	50.0	87.5
	Other	1	12.5	12.5	100.0
	Total	8	100.0	100.0	

Degree

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Associates	4	50.0	50.0	50.0
	Bachelors	4	50.0	50.0	100.0
	Total	8	100.0	100.0	

QT Instruction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No instruction	1	12.5	12.5	12.5
	Only a little instruction	2	25.0	25.0	37.5
	Some instruction but not comfortable yet	5	62.5	62.5	100.0
	Total	8	100.0	100.0	

Studied Online

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	87.5	87.5	87.5
	No	1	12.5	12.5	100.0
	Total	8	100.0	100.0	

Comfort online learning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat comfortable	7	87.5	87.5	87.5
	Very comfortable	1	12.5	12.5	100.0
	Total	8	100.0	100.0	

Age and Years of Experience

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age	8	28	23	51	40.62	9.039
Years RN License	8	28	1	29	8.25	9.925
Years worked on Unit	8	12	1	13	4.38	4.274
Years since first class	8	14	1	15	5.38	5.449
Valid N (listwise)	8					

Enrollment Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never Registered	6	14.3	14.3	14.3
	Registered but never started Pretest	12	28.6	28.6	42.9
	Pretest Completed, Module in Progress	6	14.3	14.3	57.1
	Pretest and Posttest Completed	10	23.8	23.8	81.0
	Excluded	8	19.0	19.0	100.0
	Total	42	100.0	100.0	

Appendix HH: Pretest and Posttest Results (Nurses)

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Median
Pretest Score	16	28.75	24.534	0	60	36.5
Posttest Score	9	79.33	13.916	47	93	80

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest Score - Prestest Score	Negative Ranks	0[a]	.00	.00
	Positive Ranks	9[b]	5.00	45.00
	Ties	0[c]		
	Total	9		

a. Posttest Score <Prestest Score

b. Posttest Score >Prestest Score

c. Posttest Score = Prestest Score

Test Statistics[b]

	Posttest Score - Pretest Score
Z	-2.670[a]
Asymp. Sig. (2-tailed)	.008

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

Appendix II: Pretest and Posttest Reliability (Nurses)

Nurses' Pretest Answers

Questions	Nurse6	Nurse9	Nurse17	Nurse19	Nurse23	Nurse24	Nurse27	Nurse37	Nurse41	Correct
1	B	C	C	C	B	C	B	C	A	C
2	B	A	A	A	B	A	B	A	C	A
3	A	A	B	B	A	A	A	A	A	B
4	B	A	A	B	B	A	B	A	B	C
5		A	C	C		A		B		A
6	B	C	C	C	B	C	B	C	A	C
7	A	A	B	B	A	A	A	A	B	C
8		A	C	C		A		A	D	C
9	D	D	C	A	D	D	D	D	A	C
10	A	C	B	C	B	C	B	C	B	C
11		D	D	A		D		D	C	D
12	B	B	A	D		B		B		C
13	B	A	A	A	B	A	B	A	C	D
14	B	B	C	C	B	C	B	B	A	C
15		D	D	D		D		D	B	D

Case Processing Summary

		N	%
Cases	Valid	10	66.7
	Excluded[a]	5	33.3
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.840	.813	9

Nurses' Posttest Answers

Questions	Nurse6	Nurse9	Nurse17	Nurse19	Nurse23	Nurse24	Nurse27	Nurse37	Nurse41	Correct
1	C	C	C	C	C	C	C	C	C	C
2	A	A	A	A	A	A	A	C	B	A
3	C	C	C	C	C	C	C	C	C	C
4	C	B	C	C	A	C	A	C	C	C
5	A	A	A	B	A	B	A	A	A	A
6	C	C	C	C	B	C	B	C	C	C
7	C	C	C	C	C	C	B	C	C	C
8	B	B	B	B	C	B	C	B	B	B
9	C	C	C	A	B	A	B	C	C	C
10	D	D	D	D	D	D	D	D	D	D
11	D	D	D	D	D	D	C	D	D	D
12	C	D	D	C	D	C	D	D	D	C
13	C	C	C	C	C	C	C	A	C	C
14	B	C	C	B	C	B	C	C	C	C
15	A	A	A	A	A	A	B	A	A	A

Case Processing Summary

		N	%
Cases	Valid	15	100
	Excluded[a]	0	0
	Total	15	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.963	.964	9

Appendix JJ: Education Program Evaluation Results

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The posttest was based on the learner objectives.	2	8			
This type of learning is worthwhile.	2	7		1	
The content met my professional educational needs.	3	4		3	
The instructional method was effective for this topic.	1	5	1	3	
I would recommend this module to others.	2	5		3	
Self-study modules meet my needs for ongoing education.	2	5	1	2	
The content was accurate and current.	4	6			

Appendix KK: Patient Audits (Baseline, 6 Weeks, 18 Weeks)

Baseline

CASE	Correct placement?	Incorrect electrode	Correct Lead?	Actual lead	Recom Lead	Rhythm	Admitting Diagnosis	Age	Sex	LOS
1	Y		Y	II	II	NSR	CHF, diabetes	65	F	3
2	N	V1	Y	II	II	SB, NSR	LE edema, Diabetes	50	M	6
3	Y		Y	II	II	NSR	Status Migrainosis	50	F	0
4	N	LA	Y	II	II	PACED	Gangrene/sepsis/renal failure	75	F	29
5	N	V1	Y	II	II	AFIB, PACED	Afib, pneumonia, Diltiazem drip	94	M	3
6	Y		Y	II	II	NSR	Drug OD, encephalopathy, substance abuse	43	M	0
7	N	V1	Y	II	II	AFIB	Dementia, CVA	82	F	6
8	N	V1	Y	II	II	SR 1^{o}	Coagulopathy, dehydration	63	F	3
9	N	V1	N	I	II	NSR	hypoglycemia	73	M	3
10	N	V1	Y	II	II	NSR	Cancer pain, untreated DVTs	66	M	5
11	N	V1	N	III	II	NSR	AMS, hepatic encephalopathy	52	M	2
12	N	V1, LL	N	I	II	NSR	Resp Failure	54	F	2
13	Y		Y	II	II	ST	Dehydration/Hypokalemia	24	F	2
14	Y		Y	II	II	SR 1^{o}	Severe GERD/chest pain, EKG/Enzymes -	64	F	2
15	Y		Y	II	II	NSR	Chest pain, r/o MI, HTN, depression; EKG/Enzymes -	48	F	0
16	Y		N	I	II	SB	DVT	81	F	1
17	N	V1	N	II	V1	SR 1^{o,} PVC	Pneumonia, HTN, CHF, COPD	97	M	1
18	Y		Y	II	II	NSR	CVA, HTN	65	F	2

	Correct	Incorrect	Correct	Actual	Recom	Rhythm	Admitting Diagnosis	Age	Sex	LOS
19	N	V1, LL	Y	II	II	PACED	Ischemic R foot	79	M	6
20	Y		Y	II	II	NSR	Hypoxemia, Resp Failure	59	M	17
21	Y		N	I	II	PACED, SUSP	RUL Pneumonia	89	F	4
22	N	V1	Y	II	II	SR	COPD exacerbation	68	M	2
23	Y		N	II	V1	SR, IVCD	Pulm edema, AMS, end stage renal disease	75	F	3
24	Y		N	II	V1	PACED, ICD	Infected ICD	60	M	3
25	N	V1	Y	II	II	NSR, small R wave, SUSP	RUA hematoma	69	F	5
26	N	V1	Y	II	II	NSR	Suspected meningitis	43	F	1
27	N	V1	N	I	II	NSR, no HR d/t artifact, SUSP	Chest pain, EKG/Enzymes, and stress test -	36	F	1
28	N	V1	Y	II	II	AFIB	New onset A fib, Diltiazem drip	37	M	0
29	N	V1	Y	II	II	NSR	Chest pain, EKG/Enzymes, and stress test -	48	F	0
30	Y		Y	II	II	NSR, artifact, SUSP	RUL lung mass	63	F	2

6 Weeks

CASE	Correct placement?	Incorrect electrode	Correct Lead?	Actual lead	Recom Lead	Rhythm	Admitting Diagnosis	Age	Sex	LOS
1	N	V1	Y	V1	V1	Afib PVCs	UTI, Pneumonia	80	M	2
2	N	V1, LA	Y	II	II	SR + IVCD (ECG QRS=.10)	Vascular Failure	62	M	1
3	N	V1	Y	II	II	NSR	GI Bleed	88	F	5
4	N	V1	N	II	V1	A-PACED, VT YESTERDAY	Hypoglycemia, CHF	89	F	7
5	Y		N	II	V1	AFIB, IVCD, RBBB	Aspiration Pneumonia, Resp Distress	87	M	2
6	Y		Y	II	II	V-PACED, AFIB	CHF	87	M	19
7	Y		Y	II	II	A-PACED	CHF	95	F	6
8	Y		Y	II	II	SR + IVCD (ECG QRS=.10)	Pleural Effusion, CHF	84	F	7
9	Y		N	II	V1	SR + 1 AVB IVCD .12	ETOH Intoxication	70	F	0
10	N	V1	Y	II	II	NSR	Syncope, Dehydration	50	F	4
11	N	V1	Y	II	II	ST	Chest &Abd Pain, Diarrhea – MI, no ECG Changes	62	M	0
12	N	V1	N	V1	II	SB 1 AVB	A Fib	76	F	1
13	Y		N	II	V1	SB 1 AVB +IVCD .12 A-PACED	Pneumonia	44	M	2
14	N	V1	N	V1	II	A FIB	Sepsis	61	F	15
15	N	V1	Y	II	II	SB 1 AVB	Chest Pain – MI, noECG Changes	67	F	1
16	N	V1	N	V1	II	NSR,	COPD	69	M	10

	Correct	Incorrect	Correct	Actual	Recom	Rhythm	Admitting Diagnosis	Age	Sex	LOS
17	N	V1	Y	II	II	NSR,	HA, TIA	75	F	0
18	Y		Y	V1	V1	SR PVC 1 AVB IVCD	AMS, UTI	86	M	5
19	N	V1	Y	II	II	SR 1 AVB	Malignant HTN	90	F	4
20	Y		Y	II	II	NSR,	DVT Leg	56	F	1
21	N	V1	Y	II	II	ST	Small Bowel Obstruction, Colon CA	34	M	10
22	Y		N	II	V1	A-PACED 1 AVB IVCD, QT 608	Pancreatitis, Chest Pain, - MI, no ECG Changes,	66	F	4
23	N	V1	Y	II	II	NSR, SVT	PSVT	59	M	1

18 Weeks

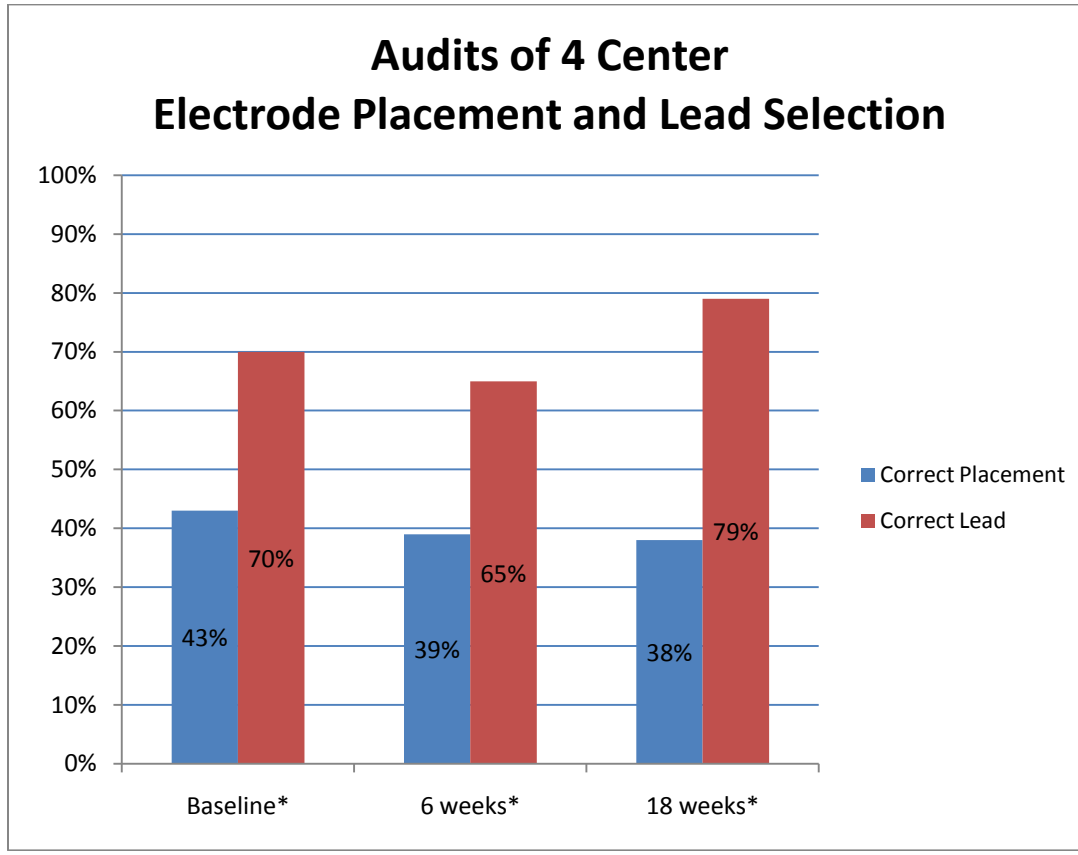
CASE	Correct placement?	Incorrect electrode	Correct Lead?	Actual lead	Recom Lead	Rhythm	Admitting Diagnosis	Age	Sex	LOS
1	N	V1	N	II	V1	Afib with IVCD	atrial fib	80	F	1
2	N	V1	Y	II	II	NSR	Malignant Hypertension, Hypokalemia	55	F	1
3	N	V1	N	V1	II	NSR	Acute renal failure, hypercalcemia	57	M	2
4	Y		Y	II	II	NSR	Salicylate toxicity	37	F	1
5	N	V1	Y	II	II	Atrial fib	Leukocytosis	58	M	3
6	N	V1	Y	II	II	NSR	Chest Pain (- ECG and enzymes)	36	F	2
7	N	V1	Y	II	II	NSR	Altered mental status	63	M	0
8	N	V1, RL, LL	Y	II	II	AV paced	COPD	81	M	4

CASE	Correct placement?	Incorrect electrode	Correct Lead?	Actual lead	Recom Lead	Rhythm	Admitting Diagnosis	Age	Sex	LOS
9	N	V1	N	II	V1	NSR with IVCD	Chest Pain (- ECG and enzymes), Pneumonia	52	M	2
10	Y		Y	V1	V1	ST with IVCD	Diarrhea, dehydration	71	F	20
11	N	V1	Y	II	II	ST	SOB	74	M	1
12	N	V1, LL	Y	II	II	A-Flutter (Classes Full)	Chest Pain (-ECG, enzymes), CHF	83	F	9
13	N	V1	Y	V1	V1	V paced	Pneumonia	89	M	2
14	Y		Y	II	II	NSR, (Classes Full)	CAD, SOB	64	F	1
15	Y		Y	II	II	NSR	GI Bleed, Abd pain	53	F	1
16	Y		N	II	V1	SB with IVCD	Hypoglycemia	86	M	5
17	Y		Y	II	II	NSR	Abd pain, Asthma	47	F	14
18	Y		Y	II	II	NSR	Dehydration, elevated LFT	36	F	5
19	Y		Y	II	II	NSR	Odontogenic infection	31	F	2
20	N	V1	Y	II	II	NSR	N/V Abd pain	59	F	1
21	N	V1	Y	II	II	NSR	CHF, Cirrhosis	47	F	1
22	N	V1	N	II	V1	NSR with PVC	Syncope, Periorbital Hematoma	75	F	8
23	N	V1	Y	II	II	Atrial Fib	Sepsis	66	F	9
24	Y		Y	V1	V1	A-paced	Left Shoulder pain	73	F	9

Appendix LL: Patient Audit Results

Item	Baseline	2-6 Weeks (by nurses)	6 Weeks	18 Weeks
Number included	30	20	23	24
Placement correct	13(43%)	6 (30%)	9 (39%)	9 (38%)
Placement Incorrect	17 (57%)	14 (70%)	14 (61%)	15 (63%)
V1 Incorrect Electrode	16/30 (53%) 16/17 (94%)	14/20 (70%) 14/14 (100%)	14/23 (61%) 14/14 (100%)	15/24 (63%) 15/15 (100%)
LL Incorrect Electrode	2/30 (6%) 2/17 (12%)	0	0	1/24 (4%) 1/15 (7%)
LA Incorrect Electrode	1/30 (3%) 1/17 (6%)	0	1/23 (4%) 1/14 (7%)	0
Monitored in Lead II	24 (80%)	N/A	18 (78%)	20(83%)
Monitored in V1	0 (0%)	N/A	5 (22%)	4 (17%)
Monitored in other leads	6 (20%)	N/A	0	0
Correct lead	21 (70%)	12 (60%)	15 (65%)	19 (79%)
Incorrect lead	9 (30%)	8 (40%)	8 (35%)	5 (21%)
Lead V1 used when indicated	0/3 (0%)	N/A	2/7 (29%)	3/7 (43%)
Lead II used when indicated	21/27 (78%)	N/A	13/16 (81%)	16/17 (94%)

Appendix MM: Audits of 4 CenterGraph



* no statistically significant differences between baseline/6 weeks, baseline/18 weeks, and 6 weeks/18 weeks ($p > 0.05$)

Appendix NN: Patient Demographics

Item	Baseline	6 Weeks	18 Weeks
Average Age	62.4	71.2	61
Age Range	24-97	34-95	31-89
Percent Male	40%	43%	33%
Percent Female	60%	57%	67%
Average Length of Stay	3.8	4.7	4.3
Range Length of Stay	0-29	0-19	0-20
Diagnosis			
Cardiovascular	50%	57%	29%
Pulmonary	16%	17%	25%
Gastrointestinal	7%	17%	29%
Diabetes	10%	4%	4%
Renal/Urinary	7%	9%	4%
Neurological	13%	4%	8%
Other (sepsis, drug overdose, leukocytosis, shoulder pain)	7%	9%	17%
Cardiac Rhythm			
Normal Sinus Rhythm, Sinus Bradycardia, or Sinus Tachycardia	57%	43%	71%
Bundle Branch Block or Intra-Ventricular Conduction Delay	3%	22%	17%
Premature Ventricular Contractions or Ventricular Tachycardia	3%	13%	4%
Atrial fibrillation or flutter	10%	17%	17%
Pacemaker	16%	22%	13%
First degree heart block	7%	22%	0

Appendix OO: Difference between Two Population Proportions

CorrectElectrode Placement

Item	Baseline	6 Weeks	18 Weeks	
x_i	13	9	9	
n	30	23	24	
Ṕroportion	43% (0.4333)	39% (0.3913)	38% (0.3750)	
Difference Between Proportions		Baseline and 6 Weeks	Baseline and 18 Weeks	6 Weeks / 18 Weeks
Test Statistic *Z*	-----	0.3078	0.4335	0.1149
p (two tailed)	-----	0.7583*	0.6646*	0.9085*

* no significant difference α= 0.05

Correct Lead Selection

Item	Baseline	6 Weeks	18 Weeks	
x_i	21	15	19	
n	30	23	24	
Ṕroportion	70% (0.7000)	65% (0.6522)	79% (0.7917)	
Difference Between Proportions		Baseline and 6 Weeks	Baseline and 18 Weeks	6 Weeks and 18 Weeks
Test Statistic *Z*	-----	0.3697	-0.7638	-1.0687
p (two tailed)	-----	0.7116*	0.4450*	0.2852*

* no significant difference α= 0.05

Lead VI Used when Indicated

Item	Baseline	6 Weeks	18 Weeks	
x_i	0	2	3	
n	3	7	7	
Ṕroportion	0%	29% (0.2857)	43% (0.4286)	
Difference Between Ṕroportions		Baseline/6 Weeks 0.29	Baseline/18 Weeks	6 Weeks/18 Weeks
Test Statistic *Z*	-----	-1.0351	-1.3553	-0.5578
p (two tailed)	-----	0.3006*	0.1753*	0.5770*

* no significant difference α= 0.05

Lead II Used when Indicated

Item	Baseline	6 Weeks	18 Weeks	
x_i	21	13	16	
n	27	16	17	
Ṕroportion	78% (0.7778)	81% (0.8125)	94% (0.9412)	
Difference Between Proportions		Baseline/6 Weeks	Baseline/18 Weeks	6 Weeks/18 Weeks
Test Statistic *Z*	-----	-0.2705	-1.4429	-1.1319
p (two tailed)	-----	0.7867*	0.1491*	0.2577*

* no significant difference α= 0.05

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SUMMARY OF QUALIFICATIONS

- Currently work as Professor of Nursing in A.S.N. and B.S.N programs at Florida State College at Jacksonville, teaching nursing students medical/surgical or critical care concepts and supervising their clinical performance.
- Completed Doctor of Nursing Practice program in December, 2010.
- Certified as Certified Nurse Educator, Critical Care Registered Nurse, and Online Professor
- Maintain clinical competency by working PRN as staff nurse on telemetry units
- Use creative teaching techniques and human patient simulators to stimulate learning and retention.

EDUCATION

2008 – 2010 **University of North Florida** Jacksonville, Florida
Doctor of Nursing Practice
- Administrator tract

1988-1992 **University of Florida** Gainesville, Florida
Master of Science in Nursing
- Emphasis on role of Educator in Adult Health Nursing with focus on cardiovascular diseases.
- Completed and published thesis on research about effectiveness of educational and behavioral strategies in cardiac risk factor modification

1987 or 1988 **Florida Community College** Jacksonville, Florida
- Statistics course required for MSN program

1978-1982 **Marycrest College** Davenport, Iowa
Bachelor of Science in Nursing and Music Minor (cum laude)

PROFESSIONAL EXPERIENCE

Florida State College at Jacksonville, Jacksonville, Florida

2004 – Present *Professor of Nursing*

- Teach B.S.N. students critical care concepts and procedures, and supervise their practicums since 2009
- Teach A.S.N. students medical/surgical concepts, nursing skills, and supervise their clinical performance.
- Utilize Human Patient Simulators and instruct other faculty how to integrate it in their curriculum.
- Chairperson of Nursing Curriculum Committee (A.S.N.)
- Chairperson for National League of Nursing Accrediting Commission self-study report for A.S.N. program
- Course Coordinator for 4th term (A.S.N.)

St. Vincent's Medical Center Jacksonville, Florida

2004 – present *Staff Nurse Telemetry Units PRN 4C/4E Telemetry*

- Deliver and manage quality care for team of 4-6 telemetry patients with variety of medical or surgical diagnoses PRN (two shifts per month)

1998 – 2004 *Nursing Clinical Educator, Telemetry/ Medical/Surgical Units*

- Developed, taught, and evaluated effectiveness of orientation, dysrhythmia, and internship courses
- Collaborated with multi-disciplinary teams to analyze fall and skin breakdown prevention programs and assisted with implementation and evaluation of new policies to improve patient safety and quality of care
- Developed new protocols with multi-disciplinary teams for monitoring patients on cardiac IV drips and educating patients before joint replacement surgery

1997 – 1998 *Critical Care Staff Nurse, CCU and 4 East ICU*

1992 – 1997 *Nursing Educator, Telemetry Units*

ACCREDITATIONS AND AWARDS

Certified Nurse Educator, by National League of Nursing, 2008 – present.

Critical Care Registered Nurse, by American Association of Critical-Care Nurses, 1998 – present

Online Professor Certification, Florida Community College at Jacksonville, Jacksonville, FL, anticipated completion December, 2008.

Innovative Excellence in Teaching, Learning, and Technology, Award Recipient April, 2008, at 19th International Conference on College Teaching and Learning, Florida Community College at Jacksonville, FL for development of songs and raps to stimulate learning, posted on faculty web page: www1.fccj.org/sschultz

Advanced Cardiac Life Support, by American Heart Association, Instructor: 2001-2003, Provider: 1992 – present

Basic Cardiac Life Support, by American Heart Association, Instructor: 1988-2003, Provider: 1982 – present

PRESENTATIONS AND PUBLICATIONS

"Dysrhythmia Monitoring Practices -- Research Proposal", poster presentation at JANIE conference, Jacksonville, FL, on March 12, 2010. Poster will also be presented at Sigma Theta Tau International, Lambda Rho Chapter-at-Large, Jacksonville, FL, on April 26, 2010.

"Stimulate when you Simulate", presented at Florida Community College, Jacksonville, FL on March 10 and 17, 2007 for 2 Contact Hours.

"*Make a Sensation with Medication Education",* presented three times: National Institute for Staff & Organizational Development (NISOD), Austin, TX in May 26, 2009; International Conference on College Teaching and Learning, Ponte Vedra, FL on April 5, 2007; and Florida Summit on Nursing Education, Valencia Community College, Orlando, FL on May 16, 2007 for 1.5 Contact Hours

"Rhythms, Rhymes, and Raps", Creative Solutions Poster Presentation at National Teaching Institute of Critical Care Nurses Association, 2002

"Who Knows the E.S.O.s?" (Emergency Standing Orders), Creative Solutions Poster Presentation at National Teaching Institute of Critical Care Nurses Association, 2001