A QUALITY IMPROVEMENT PROJECT TO IMPROVE ELECTROCARDIOGRAM COMPETENCY AND CONFIDENCE IN MEDICAL-SURGICAL CLINICAL STAFF

A Doctor of Nursing Practice Project Report

by

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This Doctor of Nursing Practice Project Report meets the standards for scope and quality of Texas A&M University-Corpus Christi College of Nursing and Health Sciences and is hereby approved.

Dr. Tammy McGarity, DNP
Chair

Dr. Dixie Andelman, DNP
Co-Chair or Committee Member

Dr. Don Melrose, PhD
Graduate Faculty Representative

August 2022

DEDICATION

I would like to dedicate this work to my family who have provided unending support. You have all encourage me to follow my dreams. To my father and sister, Rachel, although you are not here physically by my side you have been in my heart throughout this journey. I love and miss you so much and will continue to make you proud. To my mom, you are my inspiration to succeed. You have always been there for me, I love you.

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I would like to express my deepest appreciation to my chair, Dr. Tammy McGarity, who has provided guidance and support during this project. I appreciate all you have done to help develop me into a doctoral nurse leader. I would also like to thank my committee members, Dr. Dixie Andelman and Dr. Don Melrose, for providing constructive feedback and recommendations.

I would also like to thank the healthcare institution and staff. The medical-surgical clinical staff have been a great team to work with for this project. I greatly appreciate the nurse educators for their encouragement and support during this journey. To my mentor, thank you for assisting with the implementation of this project.

I would like to thank my family for their endless support and understanding while conducting my project. You have been there for me during my lowest and I am eternally grateful for all your love and support.

Lastly, I would like to thank God for giving me the strength to continue when I was at my lowest and questioned my faith. I know you will continue to guide me through the right path.

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ABSTRACT

Electrocardiogram (ECG) monitoring is used for early detection and recognition of cardiac arrhythmias. There has been an increase in hospitalized patients requiring ECG monitoring which is now a responsibility for medical-surgical nursing staff. Medical-surgical clinical staff (MSCS) must be competent to interpret and recognize ECG arrhythmias. The lack of ECG knowledge from the MSCS has resulted in multiple in-hospital cardiac arrests. The purpose of this DNP project was to determine if just-in-time training could improve ECG competence and confidence for MSCS and reduce adverse patient safety events. Just-in-time training is a teaching methodology that supports workplace training. The project design was a pre- and post-test design measuring the degree of change over time. A convenience sampling method was used. There were forty-three participants. A 3-month just-in-time ECG education program was implemented which included ECG just-in-time education and in-services. Overall results did not reveal increases in ECG competence or ECG confidence, however results show improved competency and confidence for many staff members and there was a 60% decrease in patient safety events. Participants with a bachelor's or master's degree and 18-34 years of age self-reported improved ECG confidence. Registered nurses, medical technicians, and continuous telemetry monitor technicians all had a significant increase in ECG competence. Based on the findings, MSCS need additional ECG education and training. It is recommended that MSCS participate in regular formal ECG education and use of just-in-time training to reinforce learning.

Keywords: medical surgical nursing, electrocardiogram (ECG), just-in-time training, education, competence, confidence

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A Quality Improvement Project to Improve Electrocardiogram Competency and Confidence in Medical-Surgical Clinical Staff

INTRODUCTION

More than 290,000 adults experience an in-hospital cardiac arrest annually (Cooper et al., 2010; Thomas et al., 2007) with post cardiac arrest hospitalization cost estimated to be $33 billion annually in the United States (Damluji et al., 2018). Cardiac arrhythmias are a main contributor to cardiac arrest (Allencherril et al., 2022) and occur in 24-30% of monitored cardiac patients and approximately 10% will experience a life threatening event (Fålun et al., 2020). Of those patients experiencing an in-hospital cardiac arrest (Andersen et al., 2019), approximately 80% of patients showed signs of deterioration within 24 hours prior to the cardiac arrest. Rapid and accurate interpretation of cardiac arrhythmias is vital (Hatchett, 2017) to ensure immediate and appropriate interventions to manage cardiac arrhythmia and prevent cardiac arrest (Bergum et al., 2015). Yet, clinical nursing staff working outside cardiac specialty units, such as medical-surgical clinical staff (MSCS), do not receive adequate education and training with ECG rhythm interpretation (Goodridge et al., 2013). Medical-surgical clinical staff (MSCS) have reported confusion and uncertainty with ECG rhythm interpretation and interventions due to their lack of knowledge (Nickasch et al., 2016). Although there has been an increase in ECG monitoring on medical-surgical units (Nickasch et al., 2016), the lack of staff education and accurate and timely ECG recognition has contributed to multiple in-hospital cardiac arrests.

Background

An ECG is a non-invasive technique that monitors a patient's electronic cardiac activity to identify and diagnose common heart conditions (Mayo Clinic, 2020). The most common reason for continuous ECG monitoring of hospitalized patients is to detect cardiac arrhythmias

(Sandau et al., 2017). Historically, continuous ECG monitoring has been a required nursing competency for clinical nursing staff working on monitored units such as intensive care and cardiac nursing units (Schultz, 2011). With the advancement of healthcare, the acuity level of hospitalized patients has resulted in increased usage of ECG monitoring outside of higher acuity units (Goodridge et al., 2013). It is expected that nurses caring for patients requiring ECG monitoring be competent with ECG interpretation and response (Brooks et al., 2016). The American Nurses Association (2014) defines competency as the expected level of performance which integrates knowledge, skills, and judgement into clinical practice therefore competency has a direct impact on quality improvement and patient care (Karami et al., 2017).

Medical-surgical clinical staff (MSCS) provide patient care to adults with a variety of medical issues and preparing for or recovering from surgery (Academy of Medical-Surgical Nursing, 2021). Today an additional responsibility for MSCS caring for multiple types of patients includes patients requiring ECG monitoring. Medical-surgical clinical staff (MSCS) lack competency in cardiac rhythm interpretation due to insufficient ECG education, training and practice (Goodridge et al., 2013). The lack of recognizing ECG dysrhythmias by medical-surgical clinical staff has significant consequences for hospitalized patients, making the management of this problem particularly important.

Review of Literature

There is a gap of evidence-based practice recommendations for nurses who do not have significant exposure to ECG monitoring (Nickasch et al., 2016). Goodridge et al. (2013) used a quasi experimental design to evaluate ECG knowledge of 32 medical-surgical nurses and reported a mean ECG rhythm analysis sccore of 48.5%. Nickasch et al. (2016) conducted a descriptive quality study to identify the nurses knowledge and ability to respond to dysrhythmias.

The study participants encompassed 11 registered nurses which included 6 medical-surgical nurses and found that nurses reported confusion and uncertainty with ECG monitoring due to analyzing ECG rhythms infrequently and relying on telemetry technicians for rhythm interpretation (Nickasch et al., 2016). A large randomized control trial by Funk et al. (2017) evaluated 3013 acute care nurses' knowledge after implementing the AHA practice standards for ECG monitoring. This study found ECG knowledge improved after intervention but knowledge was not sustained over time. Literature shows the need for regular and timely ECG education and training for MSCS.

Current literature states that just-in-time training has been effective in providing staff training with quality improvement (Helman et al., 2016). Just-in-time training is a teaching methodology that promotes workplace training without compromising staff time, resources or financial cost (Knutson et al., 2015). Peebles et al. (2020) conducted a quantitative research study on implementing and evaluating a just-in-time training program for medical-surgical nurses focusing on recognizing and responding to patient deterioration. There were 71 medical-surgical nurses who completed the just-in-time training program and questionnaire which was well received with results indicating 95.8% appreciated the education at the bedside and 98.6% wanted the program to be continued (Peebles et al., 2020). Pade et al. (2018) utilized a prospective cohort study to assess the retention of nursing knowledge with just-in-time training. The study results showed that there was limited decrease in cognitive knowledge over time when implementing just-in-time education with 70 pediatric emergency room nurses (Pade et al., 2017). Knutson et al. (2015) found that just-in-time training is an efficient quality improvement method for teaching a large number of clinical staff. The study encompassed over 300

multidisciplinary clinical staff to include nurses. Literature shows that just-in-time training is an effective teaching method for healthcare staff.

Problem Description in the Setting

The project setting occurred on a medical-surgical nursing unit and remote telemetry monitor room in a South Texas military hospital. Currently, the MSCS consist of registered nurses (RNs), licensed vocational/practical nurses (LVN/LPNs), medical technicians, and telemetry monitor technicians. All medical-surgical nursing units in this facility provide care for patients requiring continuous ECG monitoring. Medical-surgical clinical staff (MSCS) are required to demonstrate ECG competency annually by achieving 84% or higher on the facility ECG test per local hospital policy. The American Heart Association (AHA) recommends that adequate education is necessary to ensure the correct interpretation of cardiac rhythms and appropriate patient care (Sandau et al., 2017). This South Texas military hospital has provided ECG education for clinical staff but the MSCS continue to struggle to achieve a passing score of 84% on the ECG test. Historically, 57% of the MSCS have achieved a pass score on the ECG test with their first attempt.

The lack of timely ECG dysrhythmia interpretation by the MSCS has resulted in multiple adverse patient events within this South Texas military hospital. Electrocardiogram (ECG) monitoring is considered a high-risk low-volume competency for the MSCS. High-risk, low-volume competencies are therapies that are infrequently practiced, however carry an increased patient safety risk because of the complexity of the competency (Helman et al., 2016). The lack of exposure to ECG interpretation has resulted in unrecognized cardiac arrhythmias which have contributed to poor patient outcomes such as an in-hospital cardiac arrest. Fifty percent of in-hospital cardiac arrests occur in general inpatient wards (Bergum et al., 2015). Clinical nursing

staff are often the first responders for in-hospital cardiac arrest so it is imperative that nursing staff are competent in ECG recognition and interpretation (Chen et al., 2021). If the problem of early recognition and appropriate treatment of ECG abnormalities is not resolved, patients may experience an in-hospital cardiac arrest leading to further complex care, increased healthcare cost and/or death.

Project Purpose and Aims

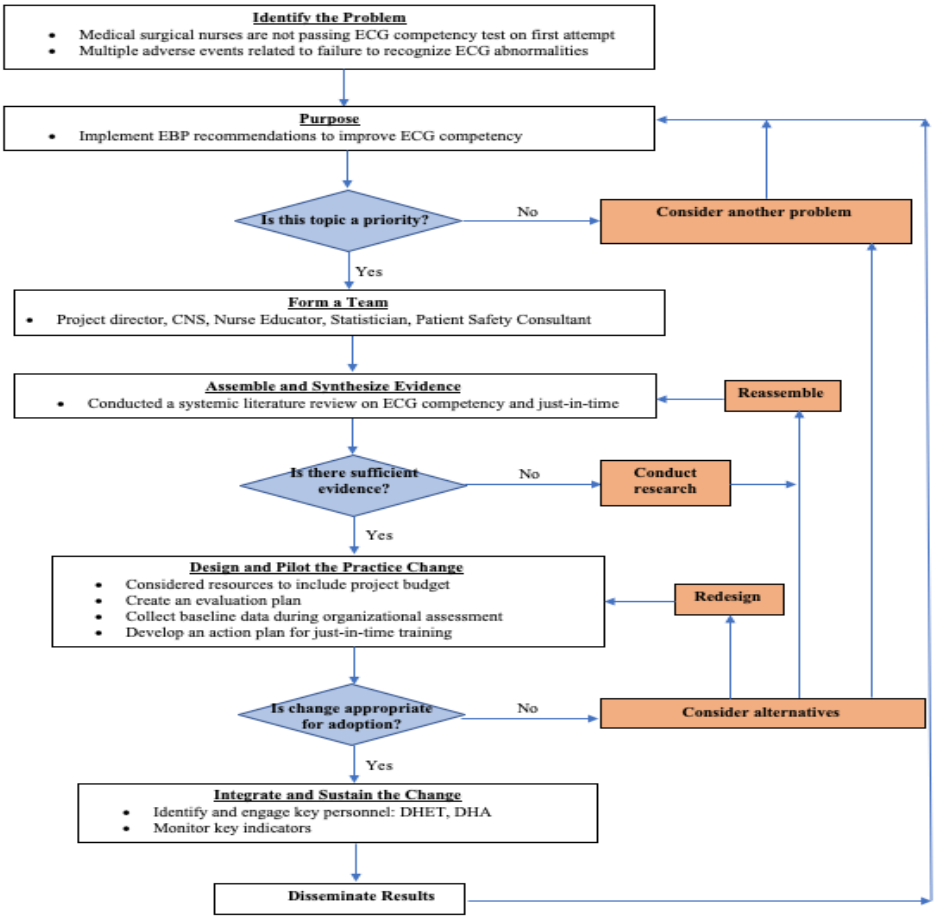
The purpose of this quality improvement project was to determine if just-in-time training could improve ECG competence and confidence for MSCS. The clinical question guiding this DNP project was: In a South Texas military hospital, does a three-month just-in-time training program, improve ECG competency, confidence, and reduce cardiac adverse events regarding medical-surgical clinical staff when compared to the initial ECG survey scores and cardiac adverse events? The first project aim was to increase ECG competency scores of MSCS by 20% after the implementation of just-in-time training. The second project aim was to improve ECG confidence for MSCS by staff self-reporting competent or somewhat competent on ECG survey. The third project aim was to reduce reported adverse patient safety events related to inappropriate ECG monitoring to zero after 12-weeks of just-in-time training. This evidence based-practice project aligned with DNP Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking by improving ECG competence, the project promoted quality healthcare and patient safety. The project also aligned with the AONL Nurse Executive Competencies: Clinical Practice Knowledge and Evidence-Based Practice/Outcomes Measurement and Research given that this evidence-based practice project facilitated ECG education for medical-surgical clinical staff to prevent adverse patient outcomes such as cardiac arrests.

Guiding Frameworks

The Iowa Model is a framework that guides implementation and sustainment of practice change (Iowa Model Collaborative, 2017). The Iowa Model developed at the University of Iowa provides a conceptual framework to identify the problem, define the purpose, appraise and synthesize evidence, design and pilot practice change, integrate and sustain the change, and disseminate results (see Figure 1). The Iowa Model begins with addressing the clinical problem of failure to recognize and respond to ECG dysrhythmias resulting in cardiac arrest. A just-in-time training ECG educational intervention was developed and implemented on a medical-surgical nursing unit and remote telemetry room. Just-in-time training was executed for 12-weeks and evaluated to determine whether the intervention should be integrated and sustained. The Iowa Model was used to guide this quality improvement initiative and a theoretical model was used to explain why these steps were taken.

Figure 1:

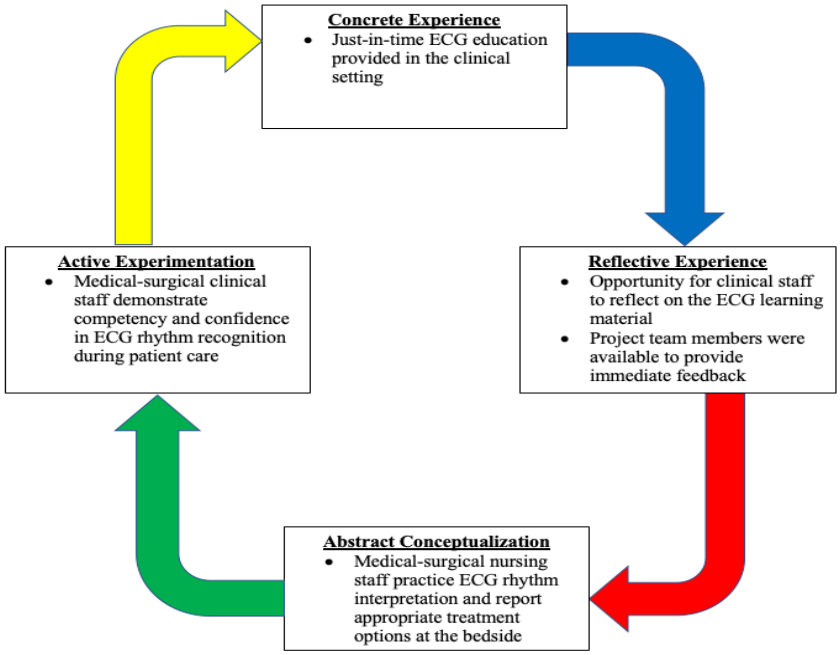
Conceptual Framework



Elements of Kolb's Experiential Learning Theory explain the actions taken by this project (Kolb, 1984). Kolb's theory states that learners need concrete learning experience with adequate support to observe, reflect, conceptualize, and alter practice to be effective learners (Kolb, 2014; Peebles et al., 2020). Kolb's Experiential Learning Theory supports just-in-time training (Peebles et al., 2020). Just-in-time training provides ECG education to the MSCS while promoting self-reflection and improved observation of the clinical experience (see Figure 2). The Iowa Model and Kolb's Experiential Learning theory have guided this DNP project.

Figure 2:

Theoretical Framework



METHODS

Ethical Considerations

This project plan was reviewed by the Texas A&M University-Corpus Christi Institutional Review Board (IRB) for project classification, and received a determination of "Exempt Research". Permission was given to proceed as a quality improvement project. (see Appendix A). This project did not collect Personal Health information, thus HIPAA permission was not required. No personal identifiers were collected from the study participants. Information provided from participants was protected by restricting access to only authorized personnel, data was stored in a password-protected computer and secure location. All research records will be retained for 3 years from study completion date. A letter of support was provided by the Chief of Hospital Education & Training agreeing to fully support the project. (see Appendix B).

Project Design

The project design for this quality improvement initiative, which used just-in-time training to improve ECG competence and confidence in a South Texas military hospital, was a pre- and post-test design measuring the degree of change over time. A pre- and post-comparison design was used to compare data at different points in time to determine the effectiveness of the intervention (Sylvia & Terharr, 2018). Providing continuous ECG education and competency validation was necessary to ensure the staff were providing safe clinical practices when caring for patients requiring ECG monitoring. There was a high turnover of clinical nursing staff due to military transitions and deployments. There was also a current nursing staffing shortage within this healthcare organization. The lack of nursing staffing was contributed to the decreased enrollment for classroom based training. Just-in-time training provided continuous ECG education at the nursing unit level which did not compromise patient care. See Table 1 for potential barriers and countermeasures to mitigate these risks.

Table 1:

Risk Assessment for DNP Project

Risk	Impact	Countermeasures	Resources	Barriers
Fear of being perceived as incompetent	Limit the participant sample	Educated staff participation is voluntarily and project promotes professional development. Ensured that pre and post ECG survey results remain confidential.	Met weekly with project team members to identify barriers with staff participation.	Scheduling constraints of project team members.
Competing priorities within the organization	Impede the implementation of this EBP initiative	Obtained approval for project from nurse leaders. Obtained support from Center for Nurse Science and Clinical Inquiry (CNSCI).	Communicated project updates to nurse leaders. Developed a partnership with CNSCI.	Implementation of new EHR has delayed project implementation.
Lack of support from nurse managers	Hinder project development, implementation, and participation from sample population	Presented project idea to the medical-surgical nurse managers and telemetry technician manager. Obtained stakeholder support to include managers, nursing staff, and telemetry technicians.	Provided updates weekly to nurse managers.	Potential change in nurse managers that do not support the DNP project.
Staffing shortage within medical-surgical nursing unit or telemetry technicians	Decrease number of participants in the study	Communicated project purpose and need for ECG training for the clinical staff. Emphasized the importance of providing safe patient care.	Include clinical nurse specialist and nurse educators as a part of the project team	Military personnel being deployed for military missions.

Participant and Recruitment

A convenience sampling method was used. The study participants were recruited from one medical-surgical nursing unit and the remote telemetry monitor room over a period of two weeks. Recruitment for the study occurred during unit change of shift huddles for the medical-surgical RNs, LVN/LPNs, and medical technicians. The telemetry monitor technicians were recruited during work shifts. Participants were included if they: (1) were 18 years or older; (2) identified as a medical-surgical clinical staff of selected nursing unit or telemetry monitor technician; (3) were a full-time employee which consist of working at minimum of 36 hours a

week on the nursing unit or remote telemetry room; and (4) interested in participating. Seventy medical-surgical clinical staff to include RNs, LVN/LPNs, and medical technicians and thirty telemetry monitor technicians met criteria for this project. It was estimated that 50% of MSCS would be interested, thus a sample size of 50 participants was expected.

Intervention

To address the gap in ECG knowledge, competency, and staff confidence, an ECG educational program was developed. This 3-month educational program encompassed 12-weeks of just-in-time training. Just-in-time training was implemented with the medical-surgical nursing staff and telemetry monitor technicians.

This quality improvement initiative implemented just-in-time training to educate MSCS on ECG rhythm concepts to include measurements, rhythm recognition, and nurse interventions. The use of just-in-time training to improve ECG competency was a key element in The Iowa Model which emphasized designing and piloting the practice change to improve patient care outcomes. At the time of recruitment, participants received written and verbal instruction on this project. See Figure 3 for a visual diagram of the project timeline.

Figure 3:

DNP Project Timeline

Project Phase	Milestone	Month of Completion								
		SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Initiation	Project Approved	→								
Planning	Project Planning Meeting	→	→	→						
	Project Planning Complete	→	→	→	→					
	Communication Plan Completed	→	→	→	→					
	IRB Approval	→	→	→	→	→				
Implementation	Intervention Completed	→	→	→	→	→	→	→	→	→
Monitoring	Pre-data collection	→	→	→	→	→	→			
	12-Weeks of Just-in-time ECG training	→	→	→	→	→	→	→	→	→
	Post-data collection	→	→	→	→	→	→	→	→	→
Closing	Project completion meeting	→	→	→	→	→	→	→	→	→

Participants completed the online pre-ECG survey through Qualtrics prior to the implementation of just-in-time training. Just-in-time training consisted of a two-step plan. During the first step, the project team member provided brief five to ten minute ECG education to the MSCS during change of shift huddles. The just-in-time ECG training consisted of 12 weekly ECG teaching topics as shown in Figure 4.

Figure 4:

ECG Education Topics

ECG Educational In-services/Huddles

Lesson 1: Policy, Documentation

Lesson 2: ECG Lead Placement and ECG paper

Lesson 3: Electrophysiology and Rates

Lesson 4: Wave Form and Measurements

Lesson 5: Analyzing ECG Strips

Lesson 6: Sinus Rhythms and Sinus Arrhythmia

Lesson 7: Atrial Arrhythmias

Lesson 8: SVT, Junctional Rhythms

Lesson 9: Atrioventricular Heart Blocks

Lesson 10: Ventricular Arrhythmias

Lesson 11: PEA, Asystole, IVR

Lesson 12: Pacemaker, Failure to Capture, Failure to Sense

The educational content was obtained from EKG for Nursing DeMystified (Clutter, 2015). Each topic was presented weekly to the MSCS. Electrocardiogram (ECG) education for medical surgical nursing staff was conducted three to four times per week and two to three times per week for the telemetry monitor technicians, but not every MSCS were at each training. An ECG teaching plan was used to provide ECG concepts, ECG rhythm identification, and nursing interventions to the MSCS. During ECG teaching, a computer monitor was used to display ECG rhythms and concepts. In addition to the above plan, the second step was to reinforce teaching with weekly ECG in-services. In-services occurred on the medical-surgical nursing unit and in the remote telemetry monitor room. During the in-services, staff measured and interpreted at minimum of three to five ECG practice rhythm strips weekly. The MSCS were provided 10-15 minutes to complete this activity. The participants received immediate feedback and reeducation

during the in-services by a project team member. After the completion of 12-weeks of just-in-time training, the MSCS completed the post ECG survey through Qualtrics.

Data Collection

The project team members provided the pre-ECG survey for two weeks before the implementation of just-in-time training. The participants were provided a QR code or weblink to complete the Qualtrics survey and were allotted two weeks to complete the post-ECG survey after the completion of just-in-time training. Data was collected from pre- and post-ECG surveys.

The pre- and post-ECG survey were used to collect descriptive data of participants, ECG competency and confidence levels. The participant demographics collected were age, gender, educational attainment, and hired position. The number of adverse patient safety events were collected from the patient safety reporting (PSR) system. Electrocardiogram (ECG) adverse events were collected from the Patient Safety Consultants pre and post just-in-time training. Baseline data of adverse events were collected for corresponding three months a year prior to the study and during the three months when just-in-time training was being conducted.

Measurement Tools

The online ECG survey developed by Keller et al. (2020) to evaluate ECG competence and confidence was used for this project to collect demographics and answer project aims one and two. (see Appendix C) The online ECG survey included patient demographics of age, gender, educational level, and hired position. (see Appendix C. Section 1: Demographics) The ECG competence survey reliability was assessed before the implementation of just-in-time training and after the implementation of just-in-time training. The instrument had a high level of internal consistency pre-intervention, Cronbach's alpha = 0.863, and post-intervention,

Cronbach's alpha = 0.869. The ECG confidence survey reliability was assessed before the implementation of just-in-time training and after the implementation of just-in-time training. The instrument had a high level of internal consistency pre-intervention, Cronbach's alpha = 0.967, and post-intervention, Cronbach's alpha = 0.964. The validity of the survey was confirmed by a research team of critical care nurses with expertise in cardiac nursing knowledge and a clinical bioscience expert (Chen et al., 2021). Approval was obtained from the authors to use the online ECG Survey tool for this quality improvement initiative.

ECG Competency

The ECG competence survey was composed using two subscales: seven ECG knowledge-based multiple-choice questions and 12 ECG interpretation-based free-text questions.

Knowledge. Each of the seven ECG knowledge questions had four options to select to assess questions, such as, "What does the P wave represent in an ECG?" (see Appendix C. Section 3: Knowledge). Responses were dichotomized (*correct response = 1, incorrect response = 0*).

ECG Interpretation. Each of the 12-item ECG interpretation were free-text for ECG rhythm interpretation. (see Appendix C. Section 4: ECG Interpretation). Responses were dichotomized (*correct interpretation = 1, incorrect interpretation = 0*).

ECG Confidence

The ECG confidence survey was composed using one overall confidence (AQ) item and 12 confidence of ECG interpretation Likert-type questions.

Overall Confidence (AQ). The overall confidence (AQ) question had five options to assess the statement, "Overall, I am confident in my knowledge about ECG rhythm interpretation" (see Appendix C. Section 4:ECG Interpretation). Responses were on a 5-point

Likert-type scale (*Strongly agree = 4, Agree = 3, Neither agree or disagree = 2, Disagree = 1, and Strongly Disagree = 0*).

Interpretation Confidence. Each of the 12 ECG interpretation questions had five options to select to assess their confidence in their ECG rhythm interpretation (see Appendix C. Section 4: ECG Interpretation). Responses were on a 5-point Likert-type scale (*Strongly agree = 4, Agree = 3, Neither agree or disagree = 2, Disagree = 1, and Strongly Disagree = 0*).

Data Analysis

The project outcomes measured were ECG competency, ECG confidence, and frequency of PSR events related to ECG recognition within the medical-surgical nursing unit. IBM SPSS Statistics 27 software was used for all descriptive calculations and data analysis. For the first two aims, data were aggregated to compare ECG competency and ECG confidence pre and post just-in-time ECG training. Proportions were created using participants' correct responses on items on the ECG Competence Survey. The correct responses were grouped and analyzed by gender, education, age, and hired position. Descriptive statistics were calculated using participants' responses on the items on the ECG confidence survey. Electrocardiogram confidence scores were analyzed and compared by gender, education, age, and hired position. For aim three, the number of PSR events was analyzed with a frequency distribution. The number of PSRs related to ECGs was measured by frequency. Comparing the pre and post PSR data will evaluate if the intervention of just-in-time ECG training was effective in reducing adverse patient safety events within the medical-surgical nursing unit at this South Texas military hospital.

Project Aims

AIM$_1$. The first project aim was to increase ECG competency scores of MSCS by 20% after the implementation of just-in-time training. Electrocardiogram (ECG) competence was analyzed from the ECG survey scores.

AIM$_2$. The second project aim was to improve ECG confidence for MSCS by staff self-reporting competent or somewhat competent on ECG survey. Electrocardiogram (ECG) confidence was analyzed using the pre and post ECG survey scores.

AIM$_3$. The third project aim was to reduce reported PSRs related ECGs to zero after 12-weeks of just-in-time training.

Supplemental Analyses

Supplemental analyses were conducted to assess ECG competency, ECG confidence before the implementation of just-in-time training and after the implementation of just-in-time training with the participants' demographics as covariates: gender (*Female = 1, Male = 0*), hired position, age group, and educational degree.

RESULTS

This quality improvement initative was delayed by two months from the initial plan due to the facility implementing a new electronic health record (EHR). The implementation of just-in-time training was delayed for an additional week since there were a minimual number of participants. Due to the recently implemented EHR system, the MSCS had limited time to complete the pre ECG suvey. The MSCS were reminded of the importance and purpose of this project and survey during huddles for an additional week. The MSCS were allowed two weeks to complete the pre ECG survey.

Implementation

Just-in-time training was implemented in this South Texas military hospital where, medical-surgical nursing staff received just-in-time training during change of shift huddles, three to four times per week. The telemetry monitor technicians did not receive just-in-time training during shift huddles as planned since the environment was not suitable for learning due to the presence of multiple staff members exchanging patient information. Just-in-time ECG training was provided to telemetry monitor technicians twice a week during each shift and at an agreed upon time between telemetry monitor technicians and project team. There were 12-weeks of ECG topics presented and staff received brief ECG education which took approximately five to 10 minutes.

The second step of the just-in-time training program included weekly ECG in-services where the MSCS would interpret three to five ECG practice rhythm strips weekly. The initial plan was to have staff sign up for a selected time slot, however, scheduling time during patient care was difficult for the MSCS and thus the project team altered the planned scheduling of ECG just-in-time training in-services to ECG just-in-time training in-service rounds. The ECG just-in-time training in-service rounds consisted of a project team member rounding on staff and providing two to three ECG practice strips for MSCS to measure and interpret. A project team member provided immediate feedback and re-education to MSCS during the ECG in-services.

Outcomes

Sample

A total of forty-three MSCS participated in the study with a majority of the sample reporting as female (67%). Almost half of the participants identified as having bachelor's degrees (49%), followed by associate degrees (26%), high school diplomas (21%), and master's

degrees (4%). Most of the participants were between the ages 25 to 34 years old (42%), followed by participants 18 to 24 years old (19%), participants 45 to 54 (19%), participants 35 to 44 years old (12%), and participants 55+ (9%). A majority of the participants were RNs (51%), followed by LVN/LPNs (23%), medical technicians (16%), and telemetry monitor technicians (10%).

Participant Attrition

Of the total forty-three MSCS who participated in the study, only thirty-eight participated in the initial assessment. Participants' demographics between before the implementation of just-in-time training and after the implementation of just-in-time training differed by hired position, in that more participants who completed the post assessments were LVN/LPNs and by education, more participants who completed the post assessments held associate degrees (see Table 2).

Table 2:

Participant Demographics

Counts & Percentages of Participants' Demographics Pre-Post Intervention

Intervention	Hired Position	*n*	%	Intervention	Hired Position	*n*	%
Pre	Telemetry Technician	14	37%	Post	Telemetry Technician	4	9%
	LVN/LPN	2	5%		LVN/LPN	10	23%
	Medical Technician	5	13%		Medical Technician	7	16%
	RN	17	45%		RN	22	51%
	Total	38	100%		Total	43	100%
Intervention	**Gender**	***n***	**%**	**Intervention**	**Gender**	***n***	**%**
Pre	Female	28	74%	Post	Female	29	67%
	Male	10	26%		Male	12	28%
					Non-bi	1	2%
					Prefer	1	2%
	Total	38	100%		Total	43	100%
Intervention	**Age Group**	***n***	**%**	**Intervention**	**Age Group**	***n***	**%**
Pre	18-24 years	6	16%	Post	18-24 years	8	19%
	25-34 years	13	34%		25-34 years	18	42%
	35-44 years	8	21%		35-44 years	5	12%
	45-54 years	7	18%		45-54 years	8	19%
	55 + years	4	11%		55 + years	4	9%
	Total	38	100%		Total	43	100%
Intervention	**Education**	***n***	**%**	**Intervention**	**Education**	***n***	**%**
Pre	Associate's degree	6	16%	Post	Associate's degree	11	26%
	Bachelor's degree	19	50%		Bachelor's degree	21	49%
	High school diploma	11	29%		High school diploma	9	21%
	Master's degree	2	5%		Master's degree	2	5%
	Total	38	100%		Total	43	100%

Data Analyses

AIM$_1$. There will be an increase ECG competency scores of MSCS by 20% after the implementation of just-in-time training, as measured by comparing the proportional differences of correct items on the ECG survey before the implementation of just-in-time training and after the implementation of just-in-time training (see Table 3). Project Aim one was not met.

Table 3:

ECG Competency Scores

	Pre Intervention $n = 38$			Post Intervention $n = 43$				
Item	**Response**	**Count**	**% by Item**	**Response**	**Count**	**% by Item**	**Δ**	**Δ%**
Knowledge Q1	Incorrect	6	15.8%	Incorrect	3	7.0%	Decrease	-8.8%
	Correct	32	84.2%	Correct	40	93.0%	Increase	8.8%
Knowledge Q2	Incorrect	7	18.4%	Incorrect	8	18.6%	Increase	0.2%
	Correct	31	81.6%	Correct	35	81.4%	Decrease	-0.2%
Knowledge Q3	Incorrect	12	31.6%	Incorrect	11	25.6%	Decrease	-6.0%
	Correct	26	68.4%	Correct	32	74.4%	Increase	6.0%
Knowledge Q4	Incorrect	13	31.6%	Incorrect	16	51.2%	Increase	19.6%
	Correct	25	68.4%	Correct	27	48.8%	Decrease	-19.6%
Knowledge Q5	Incorrect	15	39.5%	Incorrect	16	37.2%	Decrease	-2.3%
	Correct	23	60.5%	Correct	27	62.8%	Increase	2.3%
Knowledge Q6	Incorrect	2	5.3%	Incorrect	2	4.7%	Decrease	-0.6%
	Correct	36	94.7%	Correct	41	95.3%	Increase	0.6%
Rhythm Interpretation Q1	Incorrect	3	7.9%	Incorrect	8	18.6%	Increase	10.7%
	Correct	35	92.1%	Correct	35	81.4%	Decrease	-10.7%
Rhythm Interpretation Q2	Incorrect	3	7.9%	Incorrect	6	14.0%	Increase	6.1%
	Correct	35	92.1%	Correct	37	86.0%	Decrease	-6.1%
Rhythm Interpretation Q3	Incorrect	2	5.3%	Incorrect	4	9.3%	Increase	4.0%
	Correct	36	94.7%	Correct	39	90.7%	Decrease	-4.0%
Rhythm Interpretation Q4	Incorrect	17	44.7%	Incorrect	18	41.9%	Decrease	-2.8%
	Correct	21	55.3%	Correct	25	58.1%	Increase	2.8%
Rhythm Interpretation Q5	Incorrect	13	34.2%	Incorrect	16	37.2%	Increase	3.0%
	Correct	25	65.8%	Correct	27	62.8%	Decrease	-3.0%
Rhythm Interpretation Q6	Incorrect	6	15.8%	Incorrect	14	32.6%	Increase	16.8%
	Correct	32	84.2%	Correct	29	67.4%	Decrease	-16.8%
Rhythm Interpretation Q7	Incorrect	6	15.8%	Incorrect	11	25.6%	Increase	9.8%
	Correct	32	84.2%	Correct	32	74.4%	Decrease	-9.8%
Rhythm Interpretation Q8	Incorrect	10	26.3%	Incorrect	22	51.2%	Increase	24.9%
	Correct	28	73.7%	Correct	21	48.8%	Decrease	-24.9%
Rhythm Interpretation Q9	Incorrect	9	23.7%	Incorrect	15	34.9%	Increase	11.2%
	Correct	29	76.3%	Correct	28	65.1%	Decrease	-11.2%
Rhythm Interpretation Q10	Incorrect	22	57.9%	Incorrect	22	51.2%	Decrease	-6.7%
	Correct	16	42.1%	Correct	21	48.8%	Increase	6.7%
Rhythm Interpretation Q11	Incorrect	9	23.7%	Incorrect	12	27.9%	Increase	4.2%
	Correct	29	76.3%	Correct	31	72.1%	Decrease	-4.2%
Rhythm Interpretation Q12	Incorrect	18	47.4%	Incorrect	27	62.8%	Increase	15.4%
	Correct	20	52.6%	Correct	16	37.2%	Decrease	-15.4%
Total	Incorrect	173	25.3%	Incorrect	231	29.8%	Increase	4.6%
	Correct	511	74.7%	Correct	543	70.2%	Decrease	-4.6%

Results showed a slight decrease in the proportion of participants' correct responses on items on the ECG survey before the implementation of just-in-time training (74.7% of correctly

answered items) and after the implementation of just-in-time training (70.2% of correctly answered items). There was an increase in ECG competency scores for RNs (+6.3%), medical technicians (+8.3%), and telemetry technicians (+3.4%). The item with the largest decrease was on rhythm interpretation of "Ventricular fibrillation" (-24.9%). The item with the largest increase was on the question "What does the P wave represent in an ECG" (+8.8%).

AIM$_2$. There will be improved ECG confidence for MSCS by staff as measured by self-responses to items on the ECG confidence survey before and after the implementation of just-in-time training (see Table 4). Project aim two was not met.

Table 4:

ECG Confidence Scores

Descriptive Statistics of Pre/Post ECG Confidence for Medical-Surgical Clinical Staff

		Overall Confidence	Confidence Q1	Confidence Q2	Confidence Q3	Confidence Q4	Confidence Q5	Confidence Q6	Confidence Q7	Confidence Q8	Confidence Q9	Confidence Q10	Confidence Q11	Confidence Q12
Pre	*n*	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
	M	2.3	3.4	3.4	3.6	2.2	2.3	2.9	3.1	3.0	3.0	2.3	2.8	2.1
	Med	2.5	3.5	4.0	4.0	2.5	2.5	3.0	4.0	4.0	4.0	3.0	3.0	2.0
	Mode	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	SD	1.2	0.8	1.1	0.9	1.8	1.7	1.3	1.3	1.4	1.4	1.7	1.5	1.8
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Post	*n*	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	M	2.2	3.0	3.1	3.4	2.1	1.7	2.4	2.4	2.5	2.5	1.8	2.5	2.3
	Med	2.0	3.0	3.0	4.0	2.0	2.0	3.0	3.0	3.0	3.0	1.0	3.0	2.0
	Mode	3.0	4.0	4.0	4.0	3.0	0.0	4.0	4.0	4.0	4.0	0.0	4.0	4.0
	SD	1.2	1.2	1.1	1.2	1.5	1.5	1.6	1.5	1.5	1.5	1.6	1.6	1.5
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Results showed consistent marginal variation across the items on the ECG confidence survey. There was a marginal decrease in the participants' average rating on the ECG confidence

scores. Alternatively, the modes remained the same ($Mode_{pre}$ = 3 and $Mode_{post}$ = 3) which translates to the respondents' indicating that they agree with the statement. Across the 12 ECG interpretation questions, there was consistent decreases in the participants' reported confidence of their ECG rhythm interpretation before the implementation of just-in-time training and after the implementation of just-in-time training. The item with the largest average decrease in confidence was on the ECG rhythm interpretation of the "Ventricular Tachycardia" (-.64). The only item with an average increase in confidence was on the ECG rhythm interpretation of the "Junctional Rhythm" (+.18). Telemetry technicians and RNs had a 1-point increase on the Overall Confidence (AQ) item. There was no change on the Overall Confidence (AQ) item for LVN/LPNs and medical technicians.

AIM$_3$. There will be reduce PSR events related to failure to recognize ECG arrhythmias to zero after 12-weeks, as measured by the frequency of adverse patient safety events before the implementation of just-in-time training and after the implementation of just-in-time training. Project aim three was not met.

Results showed that of the frequency of PSR events before the intervention was five and the frequency of PSR events after the intervention was two. Although the goal for aim three was to reach zero PSR events after the intervention, results show a 60% decrease in frequency of PSR events.

Supplemental Analyses

ECG Confidence. There was a marginal variation in gender, with female participants reporting a 1-point average decrease in ECG confidence for MSCS by staff. However, modes in ECG confidence were similar before and after the implementation of just-in-time training between female and male participants (see Table 5).

Table 5:

ECG Confidence Scores By Gender

Means & Modes of Pre/Post ECG Confidence Scores Gender

	Female		Male		Female		Male	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	M	*M*	*M*	*M*	Mode	Mode	Mode	Mode
Overall Confidence	2	2	3	2	3	2	2	3
Confidence Q1	3	3	3	3	4	4	4	4
Confidence Q2	3	3	4	3	4	4	4	4
Confidence Q3	4	3	4	4	4	4	4	4
Confidence Q4	2	2	2	2	4	3	0	2a
Confidence Q5	2	2	2	2	4	0	4	0a
Confidence Q6	3	2	3	3	4	4	3	4
Confidence Q7	3	2	3	3	4	3a	4	4
Confidence Q8	3	2	3	3	4	3a	4	4
Confidence Q9	3	2	3	3	4	4	4	4
Confidence Q10	2	2	2	2	4	0	4	0a
Confidence Q11	3	2	3	3	4	4	2a	4
Confidence Q12	2	2	2	2	4	0	0	4

Note: a Multiple modes exist. The smallest value is shown

Participants with bachelor's and master's degrees had an increase in average ECG confidence scores compared to high school diplomas and associate degrees (see Table 6).

Table 6:

ECG Confidence Scores By Education

Means of Pre/Post ECG Confidence Scores By Education

	High School Diploma		Associate's Degree		Bachelor Degree		Master's Degree	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	M	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Overall Confidence	2	1	3	2	2	3	3	4
Confidence Q1	4	2	3	3	3	3	4	4
Confidence Q2	3	2	3	3	4	3	4	4
Confidence Q3	3	3	3	3	4	4	4	4
Confidence Q4	3	2	3	2	2	2	2	4
Confidence Q5	3	1	3	1	2	2	2	4
Confidence Q6	3	1	3	2	3	3	4	4
Confidence Q7	3	1	3	2	3	3	4	4
Confidence Q8	3	1	3	2	3	3	4	4
Confidence Q9	3	1	3	2	3	3	4	4
Confidence Q10	3	1	3	1	2	2	4	4
Confidence Q11	3	1	3	2	3	3	4	4
Confidence Q12	3	1	2	2	2	3	3	4

There was a 1-point increase on the Overall Confidence (AQ) item for bachelor's and master's degree participants. There was an increase in ECG confidence scores for participants for age groups 18 to 24 (31%) and 25 to 34 (31%) after implementation of just-in-time training (see Table 7).

Table 7:

ECG Confidence Scores By Age Group

Means of Pre/Post ECG Confidence Scores By Age Group

	18-24		25-34		35-44		45-54		55+	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	M	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Overall Confidence	1	2	2	3	2	2	3	2	4	3
Confidence Q1	3	2	3	3	3	3	4	4	4	3
Confidence Q2	2	2	3	3	3	3	4	4	4	4
Confidence Q3	3	3	4	4	4	3	4	4	4	4
Confidence Q4	1	2	1	2	2	1	4	2	4	3
Confidence Q5	1	1	2	2	3	1	4	2	4	3
Confidence Q6	2	2	3	3	3	2	4	2	4	3
Confidence Q7	2	2	3	3	3	2	4	2	4	3
Confidence Q8	1	2	3	3	3	3	4	2	4	3
Confidence Q9	2	2	3	3	3	3	4	2	4	3
Confidence Q10	1	1	2	2	2	1	4	2	4	3
Confidence Q11	1	2	3	3	3	2	4	2	4	3
Confidence Q12	0	1	1	3	2	2	4	2	4	3

Participants whose hired positions were telemetry technicians (7%), medical technicians (8%), and RNs (38%) increase in their ECG confidence scores (see Table 8).

Table 8:

ECG Confidence Scores By Hired Position

Means of Pre/Post ECG Confidence Scores By Hired Postion

	Telemetry Technician		LVN/LPN		Medical Technician		RN	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	M	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Overall Confidence	3	4	2	2	1	1	2	3
Confidence Q1	4	4	3	4	2	1	3	3
Confidence Q2	4	4	4	3	1	1	3	3
Confidence Q3	4	4	3	3	2	2	4	4
Confidence Q4	4	4	2	2	0	1	1	2
Confidence Q5	4	4	2	1	1	0	1	2
Confidence Q6	4	4	4	2	1	1	3	3
Confidence Q7	4	4	2	2	1	1	3	3
Confidence Q8	4	4	2	2	0	1	3	3
Confidence Q9	4	4	3	2	0	0	3	3
Confidence Q10	4	4	2	2	0	0	2	2
Confidence Q11	4	4	3	2	0	1	3	3
Confidence Q12	4	4	1	2	0	0	1	3

ECG Competency. There was no variation in ECG competency between genders. Both female and male participants reported a decrease (-4%) in the percentage of correct responses after the implementation of just-in-time training (see Table 9).

Table 9:

ECG Competence Scores By Gender

Counts of Pre/Post ECG Competence Survey Scores By Gender

	Female				Male			
	Pre		Post		Pre		Post	
Item	Response	Count	Response	Count	Response	Count	Response	Count
Knowledge Q1	Incorrect	5	Incorrect	3	Incorrect	1	Incorrect	0
	Correct	23	Correct	26	Correct	9	Correct	12
Knowledge Q2	Incorrect	7	Incorrect	6	Incorrect	0	Incorrect	2
	Correct	21	Correct	23	Correct	10	Correct	10
Knowledge Q3	Incorrect	9	Incorrect	8	Incorrect	3	Incorrect	2
	Correct	19	Correct	21	Correct	7	Correct	10
Knowledge Q4	Incorrect	10	Incorrect	12	Incorrect	3	Incorrect	3
	Correct	18	Correct	17	Correct	7	Correct	9
Knowledge Q5	Incorrect	14	Incorrect	13	Incorrect	1	Incorrect	3
	Correct	14	Correct	16	Correct	9	Correct	9
Knowledge Q6	Incorrect	2	Incorrect	1	Incorrect	0	Incorrect	1
	Correct	26	Correct	28	Correct	10	Correct	11
Rhythm Interpretation Q1	Incorrect	2	Incorrect	5	Incorrect	1	Incorrect	3
	Correct	26	Correct	24	Correct	9	Correct	9
Rhythm Interpretation Q2	Incorrect	3	Incorrect	6	Incorrect	0	Incorrect	0
	Correct	25	Correct	23	Correct	10	Correct	12
Rhythm Interpretation Q3	Incorrect	2	Incorrect	4	Incorrect	0	Incorrect	0
	Correct	26	Correct	25	Correct	10	Correct	12
Rhythm Interpretation Q4	Incorrect	13	Incorrect	11	Incorrect	4	Incorrect	5
	Correct	15	Correct	18	Correct	6	Correct	7
Rhythm Interpretation Q5	Incorrect	9	Incorrect	11	Incorrect	4	Incorrect	5
	Correct	19	Correct	18	Correct	6	Correct	7
Rhythm Interpretation Q6	Incorrect	5	Incorrect	10	Incorrect	1	Incorrect	4
	Correct	23	Correct	19	Correct	9	Correct	8
Rhythm Interpretation Q7	Incorrect	5	Incorrect	8	Incorrect	1	Incorrect	2
	Correct	23	Correct	21	Correct	9	Correct	10
Rhythm Interpretation Q8	Incorrect	8	Incorrect	14	Incorrect	2	Incorrect	7
	Correct	20	Correct	15	Correct	8	Correct	5
Rhythm Interpretation Q9	Incorrect	5	Incorrect	11	Incorrect	4	Incorrect	3
	Correct	23	Correct	18	Correct	6	Correct	9
Rhythm Interpretation Q10	Incorrect	14	Incorrect	14	Incorrect	8	Incorrect	6
	Correct	14	Correct	15	Correct	2	Correct	6
Rhythm Interpretation Q11	Incorrect	8	Incorrect	10	Incorrect	1	Incorrect	2
	Correct	20	Correct	19	Correct	9	Correct	10
Rhythm Interpretation Q12	Incorrect	13	Incorrect	17	Incorrect	5	Incorrect	8
	Correct	15	Correct	12	Correct	5	Correct	4
Total	Incorrect	134	Incorrect	164	Incorrect	39	Incorrect	56
	Correct	370	Correct	358	Correct	141	Correct	160

There was an increase in ECG competency scores for bachelor's degree (1.2%) and master's degree (2.84%) participants, all other education groups had a decrease in the percentages of correct responses after the implementation of just-in-time training (see Table 10).

Table 10:

ECG Competence Scores By Education

Counts of Pre/Post ECG Competence Survey Scores By Education

	High School Diploma				Associate's Degree				Bachelor's Degree				Master's Degree			
	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Item	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count
Knowledge Q1	Incorrect	1	Incorrect	0	Incorrect	1	Incorrect	2	Incorrect	4	Incorrect	1	Incorrect	0	Incorrect	0
	Correct	10	Correct	9	Correct	5	Correct	9	Correct	15	Correct	20	Correct	2	Correct	2
Knowledge Q2	Incorrect	3	Incorrect	4	Incorrect	1	Incorrect	2	Incorrect	3	Incorrect	2	Incorrect	0	Incorrect	0
	Correct	8	Correct	5	Correct	5	Correct	9	Correct	16	Correct	19	Correct	2	Correct	2
Knowledge Q3	Incorrect	5	Incorrect	4	Incorrect	3	Incorrect	2	Incorrect	4	Incorrect	5	Incorrect	0	Incorrect	0
	Correct	6	Correct	5	Correct	3	Correct	9	Correct	15	Correct	16	Correct	2	Correct	2
Knowledge Q4	Incorrect	2	Incorrect	2	Incorrect	3	Incorrect	5	Incorrect	8	Incorrect	8	Incorrect	0	Incorrect	1
	Correct	9	Correct	7	Correct	3	Correct	6	Correct	11	Correct	13	Correct	2	Correct	1
Knowledge Q5	Incorrect	5	Incorrect	4	Incorrect	2	Incorrect	3	Incorrect	8	Incorrect	9	Incorrect	0	Incorrect	0
	Correct	6	Correct	5	Correct	4	Correct	8	Correct	11	Correct	12	Correct	2	Correct	2
Knowledge Q6	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	0
	Correct	10	Correct	8	Correct	5	Correct	10	Correct	19	Correct	21	Correct	2	Correct	2
Rhythm Interpretation Q1	Incorrect	1	Incorrect	3	Incorrect	1	Incorrect	5	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0
	Correct	10	Correct	6	Correct	5	Correct	6	Correct	18	Correct	21	Correct	2	Correct	2
Rhythm Interpretation Q2	Incorrect	2	Incorrect	2	Incorrect	0	Incorrect	2	Incorrect	1	Incorrect	2	Incorrect	0	Incorrect	0
	Correct	9	Correct	7	Correct	6	Correct	9	Correct	18	Correct	19	Correct	2	Correct	2
Rhythm Interpretation Q3	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	2	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	0
	Correct	10	Correct	8	Correct	5	Correct	9	Correct	19	Correct	20	Correct	2	Correct	2
Rhythm Interpretation Q4	Incorrect	3	Incorrect	4	Incorrect	3	Incorrect	5	Incorrect	10	Incorrect	9	Incorrect	1	Incorrect	0
	Correct	8	Correct	5	Correct	3	Correct	6	Correct	9	Correct	12	Correct	1	Correct	2
Rhythm Interpretation Q5	Incorrect	3	Incorrect	6	Incorrect	2	Incorrect	5	Incorrect	7	Incorrect	5	Incorrect	1	Incorrect	0
	Correct	8	Correct	3	Correct	4	Correct	6	Correct	12	Correct	16	Correct	1	Correct	2
Rhythm Interpretation Q6	Incorrect	2	Incorrect	4	Incorrect	2	Incorrect	5	Incorrect	2	Incorrect	5	Incorrect	0	Incorrect	0
	Correct	9	Correct	5	Correct	4	Correct	6	Correct	17	Correct	16	Correct	2	Correct	2
Rhythm Interpretation Q7	Incorrect	2	Incorrect	4	Incorrect	3	Incorrect	2	Incorrect	1	Incorrect	5	Incorrect	0	Incorrect	0
	Correct	9	Correct	5	Correct	3	Correct	9	Correct	18	Correct	16	Correct	2	Correct	2
Rhythm Interpretation Q8	Incorrect	2	Incorrect	6	Incorrect	2	Incorrect	7	Incorrect	6	Incorrect	9	Incorrect	0	Incorrect	0
	Correct	9	Correct	3	Correct	4	Correct	4	Correct	13	Correct	12	Correct	2	Correct	2
Rhythm Interpretation Q9	Incorrect	2	Incorrect	3	Incorrect	2	Incorrect	4	Incorrect	5	Incorrect	7	Incorrect	0	Incorrect	1
	Correct	9	Correct	6	Correct	4	Correct	7	Correct	14	Correct	14	Correct	2	Correct	1
Rhythm Interpretation Q10	Incorrect	4	Incorrect	3	Incorrect	3	Incorrect	8	Incorrect	14	Incorrect	11	Incorrect	1	Incorrect	0
	Correct	7	Correct	6	Correct	3	Correct	3	Correct	5	Correct	10	Correct	1	Correct	2
Rhythm Interpretation Q11	Incorrect	3	Incorrect	4	Incorrect	2	Incorrect	4	Incorrect	4	Incorrect	4	Incorrect	0	Incorrect	0
	Correct	8	Correct	5	Correct	4	Correct	7	Correct	15	Correct	17	Correct	2	Correct	2
Rhythm Interpretation Q12	Incorrect	3	Incorrect	6	Incorrect	2	Incorrect	8	Incorrect	13	Incorrect	13	Incorrect	0	Incorrect	0
	Correct	8	Correct	3	Correct	4	Correct	3	Correct	6	Correct	8	Correct	2	Correct	2
Total	Incorrect	45	Incorrect	61	Incorrect	34	Incorrect	72	Incorrect	91	Incorrect	96	Incorrect	3	Incorrect	2
	Correct	153	Correct	101	Correct	74	Correct	126	Correct	251	Correct	282	Correct	33	Correct	34

Participants for age group of 18 to 24 had a twenty percent increase in ECG competency after implementation of just-in-time training (see Table 11).

Table 11:

ECG Competence Scores By Age Group

Counts of Pre/Post ECG Competence Survey Scores By Age Group

	18-24				25-34				35-44				45-54				55+			
	Pre		Post		Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Item	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count
Knowledge Q1	Incorrect	0	Incorrect	0	Incorrect	3	Incorrect	2	Incorrect	2	Incorrect	1	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0
	Correct	6	Correct	8	Correct	10	Correct	16	Correct	6	Correct	4	Correct	6	Correct	8	Correct	4	Correct	4
Knowledge Q2	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	3	Incorrect	1	Incorrect	1	Incorrect	3	Incorrect	3	Incorrect	1	Incorrect	0
	Correct	5	Correct	7	Correct	12	Correct	15	Correct	7	Correct	4	Correct	4	Correct	5	Correct	3	Correct	4
Knowledge Q3	Incorrect	2	Incorrect	1	Incorrect	4	Incorrect	6	Incorrect	3	Incorrect	1	Incorrect	2	Incorrect	3	Incorrect	1	Incorrect	0
	Correct	4	Correct	7	Correct	9	Correct	12	Correct	5	Correct	4	Correct	5	Correct	5	Correct	3	Correct	4
Knowledge Q4	Incorrect	2	Incorrect	4	Incorrect	3	Incorrect	8	Incorrect	2	Incorrect	2	Incorrect	4	Incorrect	1	Incorrect	2	Incorrect	1
	Correct	4	Correct	4	Correct	10	Correct	10	Correct	6	Correct	3	Correct	3	Correct	7	Correct	2	Correct	3
Knowledge Q5	Incorrect	6	Incorrect	6	Incorrect	3	Incorrect	5	Incorrect	2	Incorrect	1	Incorrect	1	Incorrect	3	Incorrect	3	Incorrect	1
	Correct	0	Correct	2	Correct	10	Correct	13	Correct	6	Correct	4	Correct	6	Correct	5	Correct	1	Correct	3
Knowledge Q6	Incorrect	1	Incorrect	1	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0
	Correct	5	Correct	7	Correct	13	Correct	17	Correct	8	Correct	5	Correct	6	Correct	8	Correct	4	Correct	4
Rhythm Interpretation Q1	Incorrect	1	Incorrect	2	Incorrect	2	Incorrect	4	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	2	Incorrect	0	Incorrect	0
	Correct	5	Correct	6	Correct	11	Correct	14	Correct	8	Correct	5	Correct	7	Correct	6	Correct	4	Correct	4
Rhythm Interpretation Q2	Incorrect	2	Incorrect	1	Incorrect	0	Incorrect	3	Incorrect	1	Incorrect	1	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	0
	Correct	4	Correct	7	Correct	13	Correct	15	Correct	7	Correct	4	Correct	7	Correct	7	Correct	4	Correct	4
Rhythm Interpretation Q3	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	2	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	0
	Correct	5	Correct	7	Correct	12	Correct	16	Correct	8	Correct	4	Correct	7	Correct	8	Correct	4	Correct	4
Rhythm Interpretation Q4	Incorrect	6	Incorrect	1	Incorrect	7	Incorrect	9	Incorrect	3	Incorrect	4	Incorrect	1	Incorrect	4	Incorrect	0	Incorrect	0
	Correct	0	Correct	7	Correct	6	Correct	9	Correct	5	Correct	1	Correct	6	Correct	4	Correct	4	Correct	4
Rhythm Interpretation Q5	Incorrect	4	Incorrect	4	Incorrect	5	Incorrect	4	Incorrect	3	Incorrect	3	Incorrect	1	Incorrect	4	Incorrect	0	Incorrect	1
	Correct	2	Correct	4	Correct	8	Correct	14	Correct	5	Correct	2	Correct	6	Correct	4	Correct	4	Correct	3
Rhythm Interpretation Q6	Incorrect	2	Incorrect	1	Incorrect	2	Incorrect	5	Incorrect	2	Incorrect	3	Incorrect	0	Incorrect	4	Incorrect	0	Incorrect	1
	Correct	4	Correct	7	Correct	11	Correct	13	Correct	6	Correct	2	Correct	7	Correct	4	Correct	4	Correct	3
Rhythm Interpretation Q7	Incorrect	3	Incorrect	1	Incorrect	2	Incorrect	4	Incorrect	0	Incorrect	3	Incorrect	1	Incorrect	3	Incorrect	0	Incorrect	0
	Correct	3	Correct	7	Correct	11	Correct	14	Correct	8	Correct	2	Correct	6	Correct	5	Correct	4	Correct	4
Rhythm Interpretation Q8	Incorrect	4	Incorrect	5	Incorrect	3	Incorrect	9	Incorrect	3	Incorrect	3	Incorrect	0	Incorrect	4	Incorrect	0	Incorrect	1
	Correct	2	Correct	3	Correct	10	Correct	9	Correct	5	Correct	2	Correct	7	Correct	4	Correct	4	Correct	3
Rhythm Interpretation Q9	Incorrect	2	Incorrect	1	Incorrect	6	Incorrect	8	Incorrect	1	Incorrect	2	Incorrect	0	Incorrect	3	Incorrect	0	Incorrect	1
	Correct	4	Correct	7	Correct	7	Correct	10	Correct	7	Correct	3	Correct	7	Correct	5	Correct	4	Correct	3
Rhythm Interpretation Q10	Incorrect	6	Incorrect	4	Incorrect	11	Incorrect	9	Incorrect	4	Incorrect	4	Incorrect	1	Incorrect	4	Incorrect	0	Incorrect	1
	Correct	0	Correct	4	Correct	2	Correct	9	Correct	4	Correct	1	Correct	6	Correct	4	Correct	4	Correct	3
Rhythm Interpretation Q11	Incorrect	4	Incorrect	2	Incorrect	2	Incorrect	5	Incorrect	3	Incorrect	2	Incorrect	0	Incorrect	2	Incorrect	0	Incorrect	1
	Correct	2	Correct	6	Correct	11	Correct	13	Correct	5	Correct	3	Correct	7	Correct	6	Correct	4	Correct	3
Rhythm Interpretation Q12	Incorrect	6	Incorrect	6	Incorrect	9	Incorrect	12	Incorrect	3	Incorrect	4	Incorrect	0	Incorrect	4	Incorrect	0	Incorrect	1
	Correct	0	Correct	2	Correct	4	Correct	6	Correct	5	Correct	1	Correct	7	Correct	4	Correct	4	Correct	3
Total	Incorrect	53	Incorrect	42	Incorrect	64	Incorrect	99	Incorrect	33	Incorrect	36	Incorrect	16	Incorrect	45	Incorrect	7	Incorrect	9
	Correct	55	Correct	102	Correct	170	Correct	225	Correct	111	Correct	54	Correct	110	Correct	99	Correct	65	Correct	63

There was an increase in ECG correct responses after just-in-time training for RNs (6.3%), telemetry technicians (3.4%), and medical technicians (8.3%) compared to an 18% decrease in the percentage of correct responses for LVN/LPNs (see Table 12).

Table 12:

ECG Competence Scores By Hired Position

Counts of Pre/Post ECG Competence Survey Scores By Hired Position

	Telemetry Technician				LVN/LPN				Medical Technician				RN			
	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Item	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count	Response	Count
Knowledge Q1	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	2	Incorrect	4	Incorrect	1
	Correct	13	Correct	4	Correct	2	Correct	10	Correct	4	Correct	5	Correct	13	Correct	21
Knowledge Q2	Incorrect	4	Incorrect	0	Incorrect	0	Incorrect	3	Incorrect	1	Incorrect	3	Incorrect	2	Incorrect	2
	Correct	10	Correct	4	Correct	2	Correct	7	Correct	4	Correct	4	Correct	15	Correct	20
Knowledge Q3	Incorrect	2	Incorrect	0	Incorrect	2	Incorrect	3	Incorrect	4	Incorrect	3	Incorrect	4	Incorrect	5
	Correct	12	Correct	4	Correct	0	Correct	7	Correct	1	Correct	4	Correct	13	Correct	17
Knowledge Q4	Incorrect	5	Incorrect	1	Incorrect	1	Incorrect	3	Incorrect	0	Incorrect	4	Incorrect	7	Incorrect	8
	Correct	9	Correct	3	Correct	1	Correct	7	Correct	5	Correct	3	Correct	10	Correct	14
Knowledge Q5	Incorrect	4	Incorrect	0	Incorrect	0	Incorrect	3	Incorrect	4	Incorrect	4	Incorrect	7	Incorrect	9
	Correct	10	Correct	4	Correct	2	Correct	7	Correct	1	Correct	3	Correct	10	Correct	13
Knowledge Q6	Incorrect	1	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	1	Incorrect	1	Incorrect	0	Incorrect	0
	Correct	13	Correct	4	Correct	2	Correct	9	Correct	4	Correct	6	Correct	17	Correct	22
Rhythm Interpretation Q1	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	3	Incorrect	2	Incorrect	5	Incorrect	1	Incorrect	0
	Correct	14	Correct	4	Correct	2	Correct	7	Correct	3	Correct	2	Correct	16	Correct	22
Rhythm Interpretation Q2	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	2	Incorrect	3	Incorrect	1	Incorrect	2
	Correct	14	Correct	4	Correct	2	Correct	9	Correct	3	Correct	4	Correct	16	Correct	20
Rhythm Interpretation Q3	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	2	Incorrect	3	Incorrect	0	Incorrect	1
	Correct	14	Correct	4	Correct	2	Correct	10	Correct	3	Correct	4	Correct	17	Correct	21
Rhythm Interpretation Q4	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	6	Incorrect	5	Incorrect	4	Incorrect	11	Incorrect	8
	Correct	14	Correct	4	Correct	1	Correct	4	Correct	0	Correct	3	Correct	6	Correct	14
Rhythm Interpretation Q5	Incorrect	2	Incorrect	0	Incorrect	0	Incorrect	5	Incorrect	3	Incorrect	6	Incorrect	8	Incorrect	5
	Correct	12	Correct	4	Correct	2	Correct	5	Correct	2	Correct	1	Correct	9	Correct	17
Rhythm Interpretation Q6	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	5	Incorrect	4	Incorrect	4	Incorrect	2	Incorrect	5
	Correct	14	Correct	4	Correct	2	Correct	5	Correct	1	Correct	3	Correct	15	Correct	17
Rhythm Interpretation Q7	Incorrect	0	Incorrect	0	Incorrect	1	Incorrect	3	Incorrect	4	Incorrect	3	Incorrect	1	Incorrect	5
	Correct	14	Correct	4	Correct	1	Correct	7	Correct	1	Correct	4	Correct	16	Correct	17
Rhythm Interpretation Q8	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	7	Incorrect	4	Incorrect	6	Incorrect	6	Incorrect	8
	Correct	14	Correct	3	Correct	2	Correct	3	Correct	1	Correct	1	Correct	11	Correct	14
Rhythm Interpretation Q9	Incorrect	0	Incorrect	1	Incorrect	0	Incorrect	4	Incorrect	4	Incorrect	3	Incorrect	5	Incorrect	7
	Correct	14	Correct	3	Correct	2	Correct	6	Correct	1	Correct	4	Correct	12	Correct	15
Rhythm Interpretation Q10	Incorrect	0	Incorrect	0	Incorrect	2	Incorrect	7	Incorrect	5	Incorrect	4	Incorrect	15	Incorrect	11
	Correct	14	Correct	4	Correct	0	Correct	3	Correct	0	Correct	3	Correct	2	Correct	11
Rhythm Interpretation Q11	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	4	Incorrect	5	Incorrect	4	Incorrect	4	Incorrect	4
	Correct	14	Correct	4	Correct	2	Correct	6	Correct	0	Correct	3	Correct	13	Correct	18
Rhythm Interpretation Q12	Incorrect	0	Incorrect	0	Incorrect	0	Incorrect	9	Incorrect	5	Incorrect	6	Incorrect	13	Incorrect	12
	Correct	14	Correct	4	Correct	2	Correct	1	Correct	0	Correct	1	Correct	4	Correct	10
Total	Incorrect	19	Incorrect	3	Incorrect	7	Incorrect	67	Incorrect	56	Incorrect	68	Incorrect	91	Incorrect	93
	Correct	233	Correct	69	Correct	29	Correct	113	Correct	34	Correct	58	Correct	215	Correct	303

DISCUSSION

In the 12-week just-in-time training project, the MSCS received ECG education. As a way of comparison, ECG competence, confidence and PSR events were evaluated before and after implementation of this intervention. The overall ECG knowledge scores decreased by 4.5% however there was an increase in scores for RNs (+6.3%), medical technicians (+8.3%), and

telemetry monitor technicians (3.4%). This finding suggests that there was an increase in participant knowledge after incorporating the just-in-time training program. The project aim to increase ECG competence by 20% was not achieved. There was a decrease in participation from the telemetry monitor technicians (-28.6%) which may have contributed to the decrease in overall ECG knowledge scores since the telemetry monitor technicians scoring an average of 92.4% on the initial assessment. Electrocardiogram (ECG) confidence scores from the MSCS reporting somewhat confident or confident with ECG rhtyhm interpretation decreased by 1-point after 12-weeks of just-in-time training. This finding indicates that overall MSCS self reported less confidence in analyzing ECG rhythms however participants with higher education levels, such as a bachelor's degree or master's degree and in the age of 18-34 years self-reported an increase in ECG confidence with ECG rhythm interpretation. The frequency of PSR events related to ECG rhythm identification or response decreased and there were zero sentinel events. The two PSR events reported were failure to monitor ECG patients and not related to failure to recognize ECG rhythms. This finding indicates that just-in-time ECG training improved patient safety by improving the medical-surgical staff's clinical practice with ECG rhythm recognition and response.

Limitations

Research Limitations

This study had several limitations. This quality improvement initiative was conducted at a large military hospital with several medical-surgical nursing units. A convenience sampling method was used to obtain participants from one medical-surgical nursing unit and remote telemetry monitor room. The study did not encompass all seven medical-surgical nursing units within this South Texas military hospital, which can limit generalizability about the medical-

surgical nursing population. Second, the sample size was small for this study. This study expected fifty participants, however only forty-three agreed to participate in this quality improvement initiative. The lack of inclusion of part-time staff and other medical-surgical nursing units limited the participation in this study as well. Third, the project was aimed at evaluating the effectiveness of just-in-time training on ECG interpretation, but this modality was not compared to other teaching strategies and lacked a control group. This South Texas military hospital provides a traditional ECG course and an eLearning ECG course and it would be beneficial to compare the three ECG teaching modalities to determine which method is most effective for the MSCS at this South Texas military hospital.

Data Limitation

The data collected had two major limitations. The first limitation is that analyses were descriptive in nature and cannot be generalized to the broader population. Inferential statistics were not used because matching participant data between survey before the implementation of just-in-time training and after the implementation of just-in-time training could not be achieved . There was no identifying information collected from the pre and post ECG survey to reduce possible risk of staff failing scores. Accordingly, data were aggregated to compare group statistics before the implementation of just-in-time training and after the implementation of just-in-time training on each survey. The second limitation is the difference sample sizes between initial assessment (n = 38) and post assessment (n = 43). Due to their being five participants who completed the post assessment but did not complete the initial assessment, generalizing the results of aims one and two scan only be done with caution.

Interpretation

This study showed that just-in-time training can be an effective teaching modality for ECG education with MSCS. Schultz (2011) conducted a systemic literature review to determine evidence-based teaching strategies for educating nursing staff about ECGs. This literature review evaluated different teaching modalites and supported the use of web based learning and unit based learning for ECG education (Schultz, 2011). The project finding support improved ECG competence in RNs, medical technicians, and telemetry monitor technicians but additional teaching methods may still be needed to improve competency and confidence.

Crimlisk et al. (2015) conducted a quantitative performance improvement study on implementing ECG education for all medical-surgical nursing staff in a level I trauma center. The ECG education included a dysrhythmia course, ECG rhythm measurements and interpretations, ECG testing, and clinical orientation (Crimlisk et al., 2015). The study population by Crimlisk et al. (2015) is similar to the MSCS at this South Texas military hospital. To ensure the nursing staff were competent with ECGs, education and training was provided in the classroom and included unit based training. This project revealed that unit based training such as just-in-time training along with classroom based training can be an effective teaching strategy for the MSCS population.

Kim & Kim (2020) conducted a quasi experimental quantative study to identify the effectiveness of ECG education. The study compared team based learning with weekly in-services and traditional lecture based learning and found that team based learning was more effective teaching strategy for early-stage learners (Kim & Kim, 2020). This study supports the use of weekly ECG in-services, such as just-in-time training. This project identified a significant

issues with ECG rhythm interpretation within this facility. Although there was a marginal increase in ECG competence and confidence for certain groups, additional education is needed.

The outcomes for this quality improvement initiative may be skewed due to multiple factors. First, there was a competeing priority with the implementation of a new EHR for this South Texas military hospital. The MSCS were adjusting to the new EHR which contributed to the lack of participation in this study. There were also, multiple PSR events for the new EHR which could have resulted in decreased reporting of ECG related PSRs. Another factor which could have contributed to decreased participation is associated with the transition of miliary personnel for military deployments and taskings. Not all military personnel completed the 12-weeks of just-in-time ECG training.

Theoretical Framework

Kolb's Experiential Learning Theory was used to provide a concrete learning experience to the MSCS. Just-in-time training provided ECG education on the medical-surgical nursing unit and remote telemetry room in the clinical setting. The MSCS were engaged in the learning and demonstrated understanding by interpreting practice ECG rhythm strips weekly. The participants reflected on the feedback provided from project team members on ECG interpretation. The participants also were able to apply ECG knowledge to clinical practice by interpreting ECG rhythms for their assigned patients. The participants encountered all four stages of Kolb's Experiential Learning Theory weekly with just-in-time ECG education.

Conceptual Framework

The Iowa Model was used to evaluate this quality improvement initiative. After conducting the just-in-time training program, the data was collected and analyzed to determine if this teaching modality was an effective approach for ECG education and training. The project

results do not support adoption and sustainment of only this intervention for the MSCS. According to the Iowa Model (2017), if the change is not appropriate for adoption, alternative teaching strategies must be explored. The project team will continue another cycle of the Iowa Model with the additional of formal lecture based learning to the just-in-time ECG program. The use of a lecture based learning will allow sufficient time to provide foundational learning of ECG rhythm concepts. Just-in-time teaching during shift change huddles will be adapted to educational huddles. Educational huddles will consist of a subject matter expert providing brief ECG education during every shift to reinforce ECG educational concepts presented during the lecture based learning and participants demonstrating understanding by practicing ECG rhythm interpretation and response.

Conclusion

This study showed that overall ECG survey scores for all MSCS participating in this intitive did not improve after just-in-time training. However, ECG competence improved for RNs, medical technicians and telemetry monitor technicians. Confidence with ECG rhythm interpretation improved with just-in-time training for MSCS with higher education levels and for those 34 years of age and younger. Eventhough ECG competence and confidence scores were complex in the analysis, patient safety outcomes improved. The reduction of PSR events related to ECG recognition proves that this intervention can be beneficial with additonal training. Additional research is needed to determine which alternative ECG teaching strategy is the most effective for this population. Future research should also evaluate individual ECG competence and confidence scores for improvement rather than group comparison.

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LIST OF APPENDICES

APPENDIX PAGE

APPENDIX A: IRB Determination for DNP Project

Date: January 18, 2022
To: Tammy McGarity
CC: Amanda Estrada
From: Office of Research Compliance
Subject: Exempt Determination

Dear Tammy McGarity, DNP,

On 01/18/2022, the Texas A&M University IRB - Corpus Christi Institutional Review Board reviewed the following submission:

Type of Review: Review Board Response Review Submission form
Title of Study: Just-in-Time Training to Improve Electrocardiogram Competency and Confidence in Medical-surgical Clinical Staff
Principal Investigator: Tammy McGarity
IRB Number: TAMU-CC-IRB-2021-0316

Texas A&M University IRB - Corpus Christi Institutional Review Board has reviewed the above-referenced submission and has determined the project is exempt. This submission was approved by the review process in accordance with the policies and procedures of the Human Research Protection Program. **Therefore, this project has been determined to be exempt under the following category:**

Exempt Category: Category 2: Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: i. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; ii. Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or iii. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by .111(a)(7).

You may proceed with this project.

APPENDIX B: DNP Letter of Support

DEPARTMENT OF THE ARMY
BROOKE army MEDICAL CENTER
3551 ROGER BROOKE DRIVE
JBSA FORT SAM HOUSTON, TEXAS 78234-4504

October 12, 2021

Dr. Tammy McGarity
DNP Program Coordinator
College of Nursing and Health Sciences Texas A&M University – Corpus Christi
6300 Ocean Drive
Corpus Christi, TX 78412

Dear Dr. McGarity:

The purpose of this letter is to provide Amanda Estrada, a Doctorate of Nursing Practice student at Texas A&M University College of Nursing and Health Sciences, support in conducting a quality improvement project at Brooke Army Medical Center. The project 'Just-in-Time Training to Improve ECG Competency and Confidence in Medical-Surgical Clinical Staff', provides ECG education and rhythm analysis as the project intervention to improve timely and appropriate ECG recognition and interventions.

This project is intended to improve ECG knowledge and confidence of the medical-surgical clinical staff to decrease adverse patient outcomes. Brooke Army Medical Center was selected for this project because this institution is a High Reliability Organization that aims to provide quality patient care and promote professional development. Amanda Estrada is employed at this institution and has an interest in improving care at this facility.

As the Department Chief of Hospital Education & Training at Brooke Army Medical Center, I fully support Amanda Estrada in the conduct of this quality improvement project, 'Just-in-Time Training to Improve ECG Competency and Confidence in Medical-Surgical Clinical Staff' at Brooke Army Medical Center.

Sincerely,

Gerry Sharp
Lieutenant Colonel, U.S. Army
Chief, Department of Hospital
Education & Training

APPENDIX C: ECG Survey

Section 1: Demographics

1. What is your hired position?
   a) Registered Nurse
   b) Licensed Practical/Vocational Nurse
   c) Medic
   d) Telemetry Technician

2. What is your age (years)?
   a) 18-24
   b) 25-34
   c) 35-44
   d) 45-54
   e) 55+

3. What is the highest level of education you currently hold?
   a) High school certificate/diploma
   b) Associate degree
   c) Bachelor degree
   d) Master degree
   e) Doctoral degree

4. What is your gender?
   a) Male
   b) Female

Section 2: Education, clinical experience, and perceptions

1. Have you had previous clinical experience in caring for a patient with some form of cardiac monitoring?
   a) Yes
   b) No

2. How often do you care for patients with some form of cardiac monitoring?
   a) Never
   b) Infrequently
   c) Every month
   d) Every week
   e) Daily

3. Have you had formal education or training around understanding and interpreting ECG rhythm?
   a) Yes
   b) No

4. Approximately how many hours of education or training (practical and theoretical) do you think you have received?
   a) Less than 3 hours
   b) 3-6 hours
   c) 7-10 hours
   d) 11-15 hours
   e) More than 15 hours
   f) Unsure

5. The following statements are about your perceptions of ECG interpretation.

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly Disagree
Education and training about cardiac arrhythmia interpretation are important					
ECG knowledge is useful in my career					
ECG is taught well in my facility					
I am interested in learning about cardiac arrhythmia interpretation					
ECGs are difficult to comprehend					

Section 3: Knowledge

1. Where have you experienced previous **theoretical** education or training in cardiac arrhythmia interpretation? (choose all that apply)
   a) Lectures
   b) Tutorials
   c) Clinical labs
   d) Simulation
   e) Online learning module
   f) Workplace in-service
   g) Other (free text box) _____

2. What does the P wave represent in an ECG?
   a) Atrial depolarization
   b) Atrial repolarization
   c) Ventricular depolarization
   d) Ventricular repolarization

3. What does the QRS wave represent in an ECG?
   a) Atrial depolarization
   b) Atrial repolarization
   c) Ventricular depolarization
   d) Ventricular repolarization

4. What does the T wave represent in an ECG?
   a) Atrial depolarization
   b) Atrial repolarization
   c) Ventricular depolarization
   d) Ventricular repolarization

5. What is a normal PR interval (assuming a normal speed of 25mm/sec)?
   a) 1-2 squares (0.04-0.08 sec)
   b) 1.5-2.5 squares (0.06-0.10 sec)
   c) 3-5 squares (0.12-0.2 sec)

6. What is a normal QRS interval (assuming a normal speed of 25mm/sec)?
   a) 1-2 squares (0.04-0.08 sec)
   b) 2-3 squares (0.08-0.12 sec)
   c) 3-5 squares (0.12-0.2 sec)

7. Which following describes a sinus rhythm?
   a) P-waves present, Normal PR interval, normal QRS complex, slow ventricular rate
   b) P-waves present, Normal PR interval, normal QRS complex, normal ventricular rate
   c) Absent p-waves, Absent PR interval, normal QRS complex, normal ventricular rate

Section 4: ECG interpretation

In this section, we will explore your knowledge and confidence in ECG interpretation.

1. Where have you experienced previous **applied** education or training in ECG rhythm interpretation? (choose all that apply)
   a) Lectures
   b) Tutorials
   c) Clinical labs
   d) Simulation
   e) Online learning module
   f) Workplace in-service
   g) Other (free text box) _____

2. The below statement is about your overall confidence in ECG interpretation.

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly Disagree
Overall, I am confident in my knowledge about ECG rhythm interpretation					

3.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

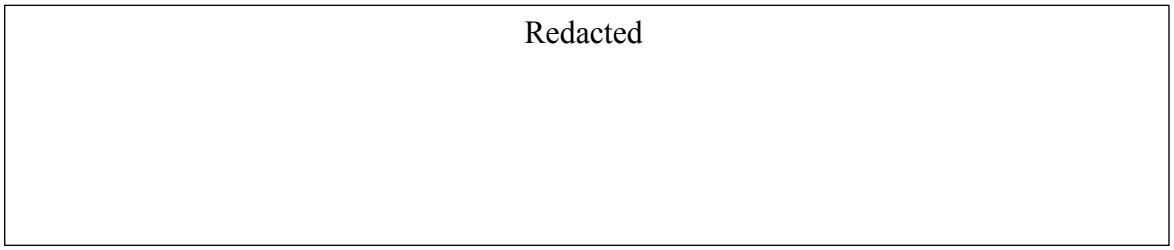
4.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

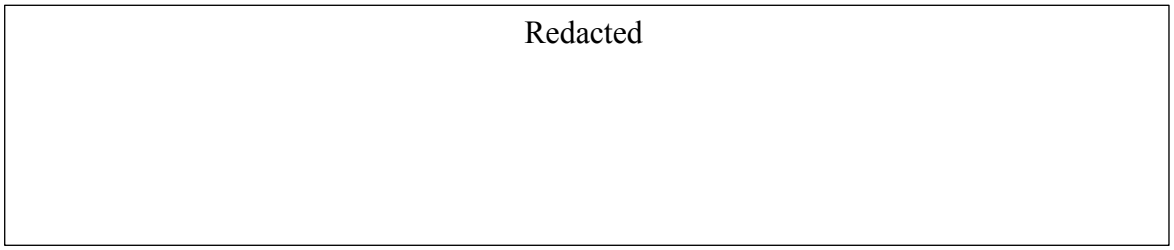
5.



A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

6.



A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

7.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

8.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

9.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

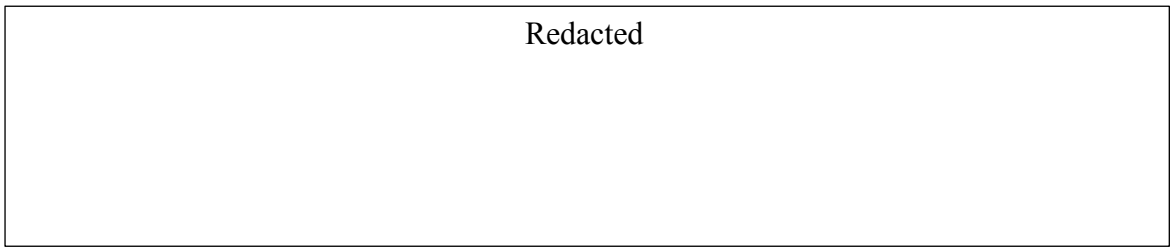
10.

Redacted

A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

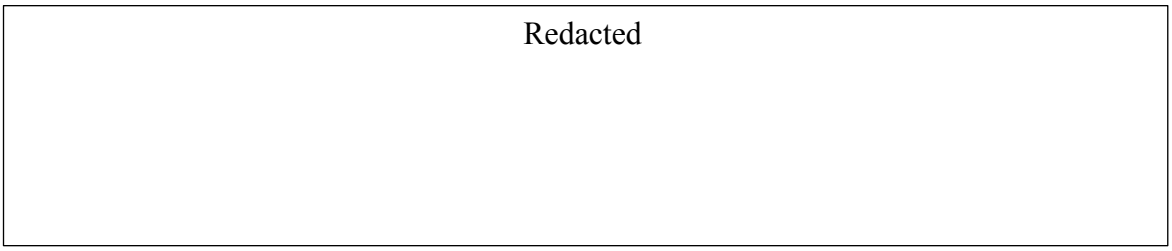
11.



A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

12.



A. Rhythm interpretation _____
B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

13.

Redacted

A. Rhythm interpretation _____

B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

14.

Redacted

A. Rhythm interpretation _____

B. How confident are you in this interpretation?

- Not confident
- Somewhat unconfident
- Neither confident nor unconfident
- Somewhat confident
- Confident

A free text section:

Is there anything you like to share with us about your experience or any thoughts about learning cardiac arrhythmia interpretation? We appreciate your input.