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Abstract

Purpose: The purpose of this project was to implement a quality improvement project to improve blood specimen acceptance rates at a specific Emergency Department (ED) using strategies to enhance knowledge, improve motivation, and reinforce skill.

Background: Specimen acceptance rates continue to fall outside of the recommended target rate of 98% or higher at a specific ED. In this particular ED, the responsibility for specimen collection has shifted away from phlebotomists and towards nurses, many of whom have received little to no phlebotomy training. Without proper blood collection techniques, specimens are more likely to be rejected, and re-collection of rejected blood specimens delays patient care and decreases overall ED efficiency. While much research is available regarding evidence-based practices, blood specimen acceptance rates continue to fall out of the recommended target range. The project leader hypothesizes that the implementation of passive educational strategies could be one of several factors related to low specimen acceptance rates.

Methods: The scholarly project was a quasi-experimental project with a pre/posttest design using the Informational-Motivational-Behavioral (IMB) Model as its theoretical foundation. Thirty-eight staff members' knowledge and motivation regarding blood specimen collection were compared before and after the implementation of an educational module. Motivational and reinforcement strategies were provided to the intervention group. Pre/posttest scores were then analyzed and compared using Mann Whitney-U and Friedman's ANOVA by Rank tests.

Results: Despite the implementation of this scholarly project, acceptance rates remained out of the recommended target goal of 98% or higher in this specific ED. Statistical analysis revealed a significant difference in one-month posttest knowledge scores between the treatment and control groups. Although the mean rank knowledge score was higher in the treatment group as opposed

to the control group, post-hoc analysis revealed a statistical difference in the control groups' specimen acceptance rates. However, a significant difference was not discovered in the treatment groups' specimen acceptance rates.

Conclusion: The combination of enhanced knowledge, increased motivation, with reinforcement of blood specimen collection skills did not improve overall blood specimen acceptance rates in this ED. These results are not consistent with existing literature regarding the application of the IMB model, but ineffective implementation of the IMB model's components may have contributed to the results. Results of this project substantiate the need for periodic venipuncture training among ED staff members due to knowledge degradation over time. Furthermore, adoption of standardized guidelines in this particular ED may improve blood specimen acceptance rates, which could ultimately improve the timeliness of patient care and ED staff efficiency.

Keywords: behavior, blood specimen collection, education, Emergency Department, hemolysis, information, knowledge, motivation, nurse

A Quality Improvement Project to Improve Blood Specimen Acceptance Rates in an Emergency Department

Venous blood specimen collection is one of the most common procedures in the Emergency Department (ED) (Bolenius et al., 2013; Bowe-Geddes, 2011; Fang, Fang, Chung, & Chien, 2008). Accurate and timely lab results are essential in the fast-paced environment of EDs, especially since approximately 80% of patient diagnoses are based on the result of laboratory tests (Bowe-Geddes, 2011). Errors in venous blood specimen collection may lead to patient suffering and jeopardize patient safety (Bolenius et al., 2013). The majority of errors within the blood collection process occur in the preanalytical phase, before the sample is analyzed in the laboratory (Bolenius et al., 2013; Bostic et al., 2015; Fang et al.,2008; Hawkins, 2010; Heyer et al., 2012; Lippi et al., 2007; Lippi et al., 2008; Pretlow, Gandy, Leibach, Russell, & Kraj, 2008; Soderberg, Wallin, Grankvist, & Brulin, 2009).

Preanalytical errors are largely attributed to human mistakes and account for up to 84.5% of all laboratory errors (Hawkins, 2010; Soderberg et al., 2009; Wallin et al., 2009). The leading causes of preanalytical errors are due to: (1) misidentification; (2) quantity (insufficient volume to perform the analysis, inadequate blood/anticoagulant ratio); and (3) quality issues (hemolytic, clotted, contaminated specimens, or samples collected in the wrong container) (Bostic et al., 2015; Lippi et al., 2007). Of these causes, hemolysis is the most common type of preanalytical error leading to sample rejection (Hawkins, 2010). The influence of hemolysis on sample quality and laboratory results has encouraged health care institutions to undertake quality improvement projects, particularly in the ED (Bostic et al., 2015; Damato & Rickard, 2015; McGrath, Rankin, & Schendel, 2012).

Hemolysis, breakdown of red blood cells resulting in leakage of intracellular contents into the plasma, accounts for 40%-70% of lab-rejected specimens (Damato & Rickard, 2015, Dugan, Leech, Speroni, & Corriher, 2005; Fang et al., 2008; Lippi et al., 2008; Makhumula-Nkhoma, Whittaker, & McSherry, 2014). Makhumula-Nkhoma et al. (2014) reported poor technique and mishandling of specimens are common causes of hemolysis. While the American Society of Clinical Pathology states the benchmark hemolysis rate is 2% or less (which translates to a 98% acceptance rate), many EDs fail to meet this recommended target rate, and some report hemolysis rates as high as 61% (Dietrich, 2014; Heyer et al., 2012; Lowe et al., 2008; McGrath et al., 2012; Tanabe, Kyriacou, & Garland, 2003).

The Centers for Disease Control (2012), Emergency Nurses Association (2012), and the World Health Organization (2010) have published guidelines on blood specimen collection techniques in an attempt to improve blood specimen acceptance rates. However, while much research is available regarding evidence-based practices for blood specimen collection, acceptance rates in a specific ED are below the recommended target (ENA, 2012; Grant, 2003; Heyer et al., 2012; Makhumla-Nkhoma et al., 2014; Ong, Chan, & Lim, 2009; Tanabe et al., 2003). Therefore, the objective of this project was to improve blood specimen acceptance rates at a specific ED by using strategies to enhance knowledge, improve motivation, and reinforce skill. The Informational-Motivational-Behavioral (IMB) Model was used as the basis for the development, implementation, and evaluation of these various strategies to facilitate information, motivation, and behavioral skills among ED staff members in order to improve their acceptance rates.

Problem Statement

The project leader of this scholarly project obtained retrospective quantitative data reporting low blood specimen acceptance rates in a specific ED. The project leader hypothesized that deficient knowledge, lack of motivation, and poor techniques have contributed to these low acceptance rates. Despite ample evidence detailing practices that will improve blood specimen acceptance rates, hemolysis rates continued to exceed the recommended hemolysis rate of 2% or less (CDC, 2012; Corkill, 2012; Damato & Rickard, 2015; Dugan et al., 2005; ENA, 2012; Fang et al., 2008; Heyer et al., 2012; Lowe et al., 2008; Makhumula-Nkhoma et al., 2014; Ong et al., 2009; Pretlow et al., 2008; Tanabe et al., 2003; WHO, 2010). The project leader posited that the poor specimen acceptance rates resulted from use of passive educational strategies when instructing ED staff members about proper blood specimen collection techniques. This scholarly project's interventions attempted to improve blood specimen acceptance rates at a specific ED, by using strategies to enhance knowledge, improve motivation, and reinforce skill. Knowledge, motivation, and skills may combine to improve blood specimen acceptance rates. If successful, the improved blood specimen acceptance rates could improve timeliness of patient care and ED efficiency.

Purpose

The purpose of this project was to implement a quality improvement project to improve blood specimen acceptance rates at a specific ED by using strategies to enhance knowledge, improve motivation, and reinforce skill.

Review of Literature

Literature suggests that hemolysis rates tend to be higher in EDs when compared to other areas of the hospital due to poor technique and lack of knowledge (CDC, 2012; Corkill, 2012;

Damato & Rickard, 2015; Dugan et al., 2005; ENA, 2012; Fang et al., 2008; Heyer et al., 2012; Lowe et al., 2008; Makhumula-Nkhoma et al., 2014; Ong et al., 2009; Pretlow et al., 2008; Tanabe et al., 2003; WHO, 2010). Makhumula-Nkhoma et al. (2014) reported a higher hemolysis rate of 12.4 percent in the ED when compared to 1.6 percent in other areas of the hospital. Blood specimens are more likely rejected without proper blood specimen collection techniques (Bowe-Geddes, 2011). Although a myriad of factors and causes have been identified in the literature, the project leader chose to focus on the factors and causes reported by the esteemed organizations of the ENA, CDC, and WHO.

Time, an important factor in the ED, includes collecting laboratory specimens expeditiously (Cox, Dages, Jarjoura, & Hazelett, 2004). Nurses often collect blood specimens from peripheral intravenous (IV) catheters when an IV is initiated to save time and to avoid discomfort to patients (Cox et al., 2004; Damato & Rickard, 2015; Fang et al., 2008; Grant 2003; Heyer et al., 2012; Lowe et al., 2008; Makhumula-Nkhoma et al., 2014; Ong et al., 2009; Straus et al., 2012). However, "Clinical Practice Guidelines" and "Laboratory Medicine Best Practice Workgroup" recommend direct venipuncture with straight needles as opposed to blood collection through IV catheters because the soft plastic of IV catheters could potentially collapse under negative pressure, causing turbulence and hemolysis (ENA, 2012; CDC, 2012; Grant, 2003; Heyer et al., 2012; Makhumla-Nkhoma et al., 2014; Ong et al., 2009; Tanabe et al., 2003; WHO, 2010). If an IV catheter is going to be used to obtain blood specimens, use of a larger gauge needle is recommended to avoid stress and/or turbulence of the red blood cells during collection (ENA, 2012; CDC, 2012; Grant, 2003; Heyer et al., 2012; Makhumla-Nkhoma et al., 2014; Ong et al., 2009; Tanabe et al., 2003; WHO, 2010). Nurses should also avoid drawing blood from

venipuncture sites other than the antecubital fossa (AC) because sites other than the AC are more frequently associated with hemolysis (ENA, 2012; CDC, 2012; WHO, 2010).

The level of vacuum applied to the needle of IV catheters may impact hemolysis (Heyer et al., 2012). Staff member control of the vacuum level when using a syringe is preferable to the fixed pressure utilized in a vacuum tube; therefore, "Clinical Practice Guidelines" recommend syringes instead of vacuum tubes when collecting blood specimens (ENA, 2012; CDC, 2012; Heyer et al., 2012; WHO, 2010). If a vacuum tube must be used, ED staff members are advised to use full vacuum tubes because these result in less hemolysis than partial vacuum tubes (CDC, 2012; ENA, 2012; Heyer et al., 2012, WHO, 2010). Guidelines also suggest that tourniquets should not be applied for more than a minute when collecting blood specimens because tourniquets constrict blood vessels, resulting in an increased risk of hemolysis (CDC, 2012; Fang et al., 2008; Heyer et al., 2012; Makhumula-Nkhoma et al., 2014; WHO, 2010).

In many EDs, practices vary when collecting blood specimens, and laboratory oversight of training and competency of the staff is inconsistent from one hospital to another (Bowe-Geddes, 2011; Heyer et al., 2012; Lima-Oliveira et al., 2012). Accreditation of clinical laboratories often regulates the collection of blood specimens and assists laboratory staff in adhering to blood specimen collection techniques according to published guidelines (Bowe-Geddes, 2011; Wallin et al., 2009; WHO, 2010). In the ED, the practices used in blood specimen collection are dependent upon the personal preferences of staff members rather than the adoption of standardized protocols (Bolenius et al., 2013). Wallin et al. (2009) reported that blood specimen collection performed by laboratory staff is associated with higher acceptance rates compared to blood specimen collection by ED staff members. Many hospitals no longer utilize laboratory staff in the ED, and blood specimen collections are performed by non-laboratory

professionals (e.g., nurses and non-technician personnel) (Bowe-Geddes, 2011; Lima-Oliveira et al., 2012). Therefore, the responsibility of blood specimen collection has shifted to ED staff members, who may lack the knowledge of proper blood specimen collection techniques according to evidence-based guidelines (Bowe-Geddes, 2011; Heyer et al., 2012). Pretlow et al. (2008) stated supplying additional training, as well as performing periodic proficiency evaluations of ED staff members, could be a possible long-term solution to increasing blood specimen acceptance rates. However, in many hospitals, a structured program or periodic training related to blood sample collection is minimal or non-existent (Bowe-Geddes, 2011; Heyer et al., 2012). This lack of education may contribute to low acceptance rates as improper specimen collection techniques can be influenced by variability and inconsistency in phlebotomy training.

Blood specimens have to be re-drawn when hemolysis occurs (Cox et al., 2004; Ong et al., 2009). Furthermore, the pain and inconvenience associated with blood sample collection are rated among the most important concerns regarding the quality of patient care (Bowe-Geddes, 2011). Emergency departments are fast-paced environments; therefore, it is important for staff members to be efficient with their time. However, more time and resources are required to obtain a new specimen from the patient, causing a decrease in overall staff efficiency (McGrath et al., 2012). The re-collection of blood specimens in the ED may contribute to delays in patients' diagnosis and treatment and may potentially increase patients' length of stay (Damato & Rickard, 2015; Fang et al., 2008; Makhumula-Nkhoma et al., 2014; Ong et al., 2009).

The project leader hypothesized that that the implementation of passive educational strategies could be one of several factors related to low specimen acceptance rates. Mayer-Mihalski and DeLuca (2009) reported continuing medical education programs with little

interaction improve knowledge and skills but do not change behavior, and therefore, active learning methodologies should be incorporated into curriculum. Furthermore, multiple interactive teaching strategies should be used because individuals obtain knowledge in a variety of ways (Dusaj, 2013). For example, a Power Point presentation may facilitate an interactive learning environment as opposed to an independently-completed online module. Practical demonstration is considered to be active participation and is an example of interactive learning (Participatory Learning Techniques, 1994). Reinforcement strategies are various interventions used to enhance learning effectiveness and promote adherence behavior (Mayer-Mihalski & DeLuca, 2009). The implementation of various strategies may facilitate active learning and increase the likelihood of active participation in the learning process (Dusaj, 2013).

Bloom's *Taxonomy of Educational Objectives* is one of the most prominent taxonomies used in education, associating active learning with higher levels of achievement (Rahn & Moraga, 2007). As higher levels of Bloom's *Taxonomy* are achieved, such as synthesis and evaluation, there is a deeper understanding of the knowledge, which leads to greater application (Rahn & Moraga, 2007). Therefore, emphasis on active learning throughout curriculum is encouraged because it fosters knowledge retention (Rosenshine, 2012). For example, Sjarif et al. (2016) stated clinical teaching by a skill tutorial or simulation showed improvement in knowledge retention by 90%. Mayer-Mihalski & DeLuca (2009) also found active participation resulted in a 90% retention rate as opposed to a 10% retention rate associated with passive participation two weeks after implementation of an educational program. Furthermore, in order to promote knowledge retention, students should be engaged in weekly and monthly reviews of learned material (Rosenshine, 2012).

Passive educational strategies have been unsuccessful in sustaining hemolysis incidence within the recommended target. However, one study successfully sustained hemolysis incidence within the recommended target by using a combination of educational and motivation. According to McGrath et al. (2012), hemolysis rates were not sustained when ED staff members were merely provided information and educational reminders about blood specimen collection techniques and ways to decrease hemolysis. In contrast, when motivation was used in conjunction with information and educational reminders, hemolysis rates were sustained within the recommended target rate. Motivation was provided by posting individual hemolysis rates for all to see, resulting in many ED staff members becoming motivated and vocalizing the desire to reduce hemolysis rates in their respective EDs (McGrath et al., 2012). Therefore, providing information along with educational reminders and motivation facilitated the achievement and sustainment of hemolysis rates within the recommended target rate. Mayer-Mihalski & DeLuca (2009) stated behavioral change is a dynamic process resulting from information about blood specimen collection techniques and implementation of effective teaching strategies (Mayer-Mihalski & DeLuca, 2009). Furthermore, according to Corace & Garber (2014) in order to facilitate a behavior change, movement beyond education and knowledge acquisition requires application of well-validated behavior change theories.

Theoretical Model

The IMB model, proposed by Fisher and Fisher in 1992, served as the theoretical framework for the scholarly project and was used initially to explain human immunodeficiency virus (HIV)-related risk behaviors. The IMB model includes three primary constructs that influence behavior changes: information and knowledge about the behavior, the individual's motivation to perform the behavior, and the behavioral skills necessary to perform the behavior

(Fisher & Fisher, 1992). Information is the basic knowledge about a medical condition that could include how the disease develops, its expected course, and effective strategies for its management. Motivation is composed of two factors: personal motivation, which includes beliefs about the intervention's outcomes and attitudes toward a particular health behavior; and social motivation, which indicates the perceived social support or social norm for engaging in a particular behavior. Behavioral skills include ensuring that the patient has specific behavioral tools or strategies necessary for adherence to behavior (Fisher & Fisher, 1992). Information and motivation have direct effects on both behavioral skills and health behavior (Fisher & Fisher, 1992). Additionally, behavioral skills exert direct effects on health behavior (Fisher & Fisher, 1992). Therefore, all three constructs are essential to facilitate a behavioral change (see Figure 1).

The IMB model has been used as a theoretical framework for behavioral intervention studies across a variety of health behaviors (Chang, Choi, Kim, & Song, 2014; Fisher, Fisher, Bryan, & Misovich, 2002; Zarani, Besharat, Sarami, & Sadeghian, 2011). Since the model is parsimonious, the model is appropriate for the scholarly project because it is considered generalizable. For example, in one article, researchers reported sustained changes in HIV prevention behavior at 12 months post-intervention using the IMB model as their theoretical framework (Fisher et al., 2002). Additionally, Zarani et al. (2011) reported evidence for the effectiveness of IMB-based interventions by supporting the importance of these constructs to improve adherence to medical recommendations by healthcare professionals and promotion of a healthier lifestyle of patients who received a coronary artery bypass graft. Therefore, the IMB Model should be transferrable to another population based on its successful use in various other populations.

Although the IMB model demonstrates that information is a prerequisite for changing behavior, information in itself is insufficient to achieve change (Chang et al., 2014). Therefore, the project leader believed a combination of knowledge, motivation, and skills may improve blood specimen acceptance rates in the ED. With regard to the information construct, blood specimen collection techniques established by published guidelines, such as the "Clinical Practice Guidelines," "Laboratory Medicine Best Practice Workgroup," and the World Health Organization, were presented to the participants (CDC, 2012; ENA, 2012; WHO, 2010). The project leader promoted social motivation by illustrating the positive impact of improved acceptance rates on the timeliness of patient care and ED efficiency. Personal motivation was assessed by adding a question about how motivated the participants were to see an improvement in lab acceptance rates in the ED. Reinforcement strategies, such as practical demonstration and a handout on blood specimen collection techniques and ways to decrease hemolysis, provided the behavioral skills necessary to facilitate a behavioral change. The project leader did not directly measure behavioral changes, but determined whether ED staff members adhered to the published blood specimen guidelines by measuring acceptance rates as a proxy for improved behavior.

Project Design

The scholarly project was a quasi-experimental quality improvement project with a pre-test/post-test design. The independent variables in the project were an educational module, motivational strategies, and demonstrations; the dependent variables were blood specimen acceptance rates and staff's knowledge of blood specimen collection techniques. Personal motivation was measured at the ordinal level; staff's knowledge was measured at the interval level; and acceptance rates were measured at the ratio level (Kellar & Kelvin, 2013). Permission to conduct the project at Tennova Medical Center ED was granted to the project leader by the

ED director. The scholarly project exemption was verified by Belmont University's Institutional Review Board.

Clinical Setting

Clarksville, Tennessee is an urban city located 45 miles northwest of Nashville. The scholarly project took place in a 40-bed ED, which serves approximately 200,000 people in Clarksville and the surrounding area. The ED staff size of approximately 100 employees consists of 54 Registered Nurses (RN), two Licensed Practical Nurses (LPN), 30 Certified Nursing Assistants (CNA), and three licensed phlebotomists who are employed as CNAs rather than phlebotomists. Currently, there were also seven travel nurses who signed eight week contracts with the ED. The ED staff collects approximately 150 blood specimens per day.

Project Population

A convenience sampling method was used to recruit potential participants at a staff meeting on October 19, 2016. Inclusion criteria consisted of licensed RNs, LPNs, CNAs, and phlebotomists at Tennova Medical Center ED, all of whom provided direct patient care that included collecting blood specimens. Exclusion criteria consisted of licensed personnel in the ED who were not an RN, LPN, phlebotomist, or CNA, and who did not provide direct patient care, which included the collection of blood specimens. Additionally, exclusion criteria included float personnel. The maximum number of eligible participants recruited for the project was 100.

Sources of Data/Data Collection Instruments

Regarding the construct of information, the educational module was implemented in the form of a Power Point presentation and contained evidence-based information about blood specimen collection and hemolysis reduction techniques (CDC, 2012; ENA, 2012; WHO, 2010) (see Appendix C). A Likert scale was used on the questionnaire and inquired about participants'

motivational status to see an improvement in specimen acceptance rates in the ED. Additionally, the project leader motivated participants' adherence to published guidelines by illustrating the positive impact of improved specimen acceptance rates on the timeliness of patient care and ED efficiency. Reinforcement strategies, such as practical demonstration, a handout consisting of blood specimen collection and hemolysis reduction techniques, as well as a huddle script, provided the behavioral skills necessary to facilitate a behavioral change. The huddle script reinforced what had been taught by the project leader in the educational module, used practical demonstration, and provided the participants with social motivation (see Appendix D). Practical demonstration with the participants facilitated the application and reinforcement of accurate skills based on the 16 best practices in phlebotomy (WHO, 2010). A pocket-size laminated handout, which had the 16 best practices in phlebotomy on one side and hemolysis reduction techniques on the other side, was given to all of the participants as a means of reinforcement (CDC, 2012; ENA, 2012; WHO, 2010) (see Appendices E and F). The project leader did not directly measure behavioral changes, but determined whether ED staff members adhered to the published blood specimen guidelines by measuring blood specimen acceptance rates as a proxy for improved behavior.

The project leader obtained quantitative data from the laboratory director and monitored ED staff members' monthly acceptance rates. The project leader used an adapted questionnaire designed through Bristol Online which assessed participants' knowledge about blood specimen collection techniques. Makhumula-Nkhoma et al. (2014) hypothesized that participants' level of confidence correlated with their success in collecting accepted blood specimens. However, the project leader hypothesized that information, motivation, and behavioral skills correlated with an improvement in blood specimen acceptance rates. Therefore, the questionnaire was modified

based on the IMB model because of its success in facilitating behavioral changes throughout a range of disciplines (Chang et al., 2014; Fisher et al., 2002; Zarani et al., 2011).

The original questionnaire had a total of 18 questions: seven of which were demographic in nature; one which assessed level of confidence in performing venipuncture; and ten were knowledge-based questions pertaining to the causes of hemolysis (Makhumula-Nkhoma et al., 2014). The adapted questionnaire had a total of 14 questions: three of which were demographic in nature; one that assessed personal motivation of the participants; and ten that had a mixture of the 16 best practices in phlebotomy and ways to decrease hemolysis based on published guidelines (CDC, 2012; ENA, 2012; WHO, 2010) (see Appendix B). Based on the IMB model, a question was added to the questionnaire that inquired about participants' personal motivation to improve acceptance rates in the ED. The adapted questionnaire contained five of the original knowledge-based questions. The project leader narrowed the scope of the content on the knowledge-based questions based on information taught in the educational module that focused on evidence-based published guidelines (CDC, 2012; ENA, 2012; WHO, 2010).

The project leader's advisors, two experts in the field of nursing, and an expert in statistics, all examined and provided feedback about the adapted questionnaire. Prior to administering the adapted questionnaire to participants, the project leader received feedback on the questionnaire from six experts in the field of nursing. However, finalization of the questionnaire was complete before the project leader obtained the feedback.

Data Collection Process/Procedures

The scholarly project recruitment and data collection started on October 10, 2016 and ended December 19, 2016. Participants' contact information was obtained from the ED office manager and a recruitment email was sent out on October 10, 2016 (see Appendix A). A unique

code was assigned to each participant prior to the meeting on October 19, 2016. The unique code granted confidentiality of participants and allowed for feasibility in matching their pre and posttests. Participants were divided into three groups based on their roles. For example, RNs started in the 100 series, LPNs were in the 200 series, and CNAs were in the 300 series. After participants were divided into their prospective groups, a folder was assigned to each consisting of an informed consent and a pre and posttest. On the day of October 19, 2016, the project leader had the participants' folders organized into the three groups with two labels that consisted of their unique code paper clipped to each folder. Participants chose their folder and put their name on both labels; they kept one label for their one month post-test and placed the other one in a box. The label box allowed the project leader to quickly identify participants in the project as well as randomly select a participant who completed all three of the questionnaires (pretest, posttest, one month posttest) to win a $100 VISA gift-card.

On the morning of October 19, 2016, participants signed an informed consent, completed a written pretest, listened to an educational module in the form of a Power Point presentation about blood specimen collection and hemolysis reduction techniques, and completed the written posttest. The project leader provided all of the participants with a pocket-size laminated handout with the16 best practices in phlebotomy on one side and hemolysis reduction techniques on the other side for reinforcement (CDC, 2012; ENA, 2012; WHO, 2010). Participants' knowledge on blood specimen collection techniques and was assessed by using the adapted questionnaire (Makhumula-Nkhoma et al., 2014). A motivational question was added to the adapted questionnaire and assessed participant's personal motivation using a Likert scale. A month later, participants took the same written posttest. The project leader evaluated the impact of the quality improvement project on blood specimen acceptance rates by acquiring quantitative data from the

lab director. Retrospective data was obtained from August and September and was compared to the data during the two months of the project (October 19th through December 19th). Since not all of the staff members were able to attend the meeting on the morning of October 19, 2016, the project leader returned to the ED on the night of October 19, 2016, and the morning and night of October 20, 2016 to give all staff members an opportunity to participate in the project. The project leader recruited 41 of the eligible 100 participants for the scholarly project.

After enrollment, participants were randomly divided into two groups (control and treatment) based on their work schedules. There were 20 participants in the treatment group and 21 participants in the control group. The treatment group was further divided into sub-groups based on work schedules. The IMB-model-based interventions consisted of five-minute teaching-learning sessions for treatment group participants on two separate occasions. However, the project leader was only allotted approximately two-to-three minutes to converse with treatment group participants with the huddle script. The huddle script reinforced information taught in the educational module, used practical demonstration, and provided social motivation to participants by illustrating the positive impact of improved acceptance rates on the timeliness of patient care and ED efficiency. Quality and consistency was achieved by using the same huddle script at each motivation session. The first huddle script was implemented approximately one week after the initial meeting on October 19, 2016 as follows: eight participants in the group on the night of October 23, 2016; eight participants in the group on the morning of October 25, 2016; and four participants in the group on the morning of October 27, 2016. Additionally, the second huddle script was implemented approximately one month after the initial meeting on October 19, 2016 and was provided as follows: six participants in the group on the night of November 13, 2016; six participants in the group on the night of November 17, 2016; and seven

in the group on the night of November 18, 2016. The posttest was implemented on the night of November 28, 2016, the day of November 29, 2016 and November 30, 2016, and on the day and night of December 1, 2016 (see Table 1).

Study participants signed an informed consent with the understanding that they could withdraw from the project at any time. Participants' data was protected by being stored in a locked container with the project leader having sole access. All records were de-identified following data analysis and will be destroyed after three years.

The Statistical Package for Social Sciences (SPSS) version 23 software was used to perform data analysis. Descriptive statistics and frequencies were obtained for each of the control and treatment groups' knowledge scores and acceptance rates. Mann-Whitney U and Friedman's ANOVA by rank was used to analyze the data because the Sharpio-Wilks test determined deviations from normality (Kellar & Kelvin, 2013). Additionally, a post-hoc analysis was performed.

Results

Demographics

Sociodemographic characteristics for this project's participants are presented in Tables 2 and 3. Although 41 participants were recruited into the project, 38 completed all project components. Among the 38 participants, one participant failed to complete a significant portion of the pretest and posttest one and was dropped as an outlier for the analysis of the pretest, posttest, and one-month posttests. August specimen acceptance rates were not reported on two of the participants and they were dropped as outliers for the analysis of the acceptance rates. The control and treatment groups each had 19 participants. The majority of participants 65.8% (n=25)

identified as RNs and 18.4% (n=7) as phlebotomists, while the remaining participants were either LPNs or CNAs.

Control Group

Among the 19 participants in the control group, 63.2% (n=12) were RNs and 15.8% (n=3) were phlebotomists. The majority of participants in the control group reported formal venipuncture training (73.7%, n=14), while the remaining participants reported informal venipuncture training (26.3%, n=5). Among the control participants, 47.4% (n=9) reported completion of venipuncture refresher training and 52.6% (n=10) reported they had not received venipuncture refresher training. The majority of control participants reported high motivation to improve specimen acceptance rates in the ED (73.7%, n=14), while the remaining participants reported that they were only somewhat motivated (26.3%, n=5). The control participants received a mean score 63.16% on their pretest, a mean score of 85.26% on their posttest, and mean score of 77.89% on their one-month posttest. Control participants' mean specimen acceptance rates were: August = 94%, September =96%, November = 96% and December = 94%.

Treatment Group

Among the 19 treatment participants, 68.4% (n=13) were RNs and 21.1% (n=4) were phlebotomists. The majority of treatment participants reported formal venipuncture training (68.4%, n=13), while the remaining participants reported informal venipuncture training (15.8%, n=6). Among the treatment participants, 47.4% (n=9) reported completion of venipuncture refresher training and 52.6% (n=10) reported no venipuncture refresher training. All of the treatment participants reported either high or somewhat high motivation to improve specimen acceptance rates. The treatment participants earned a mean score of 71.58% on their pretest, a

mean score of 91.05% on their posttest, and mean score of 83.16% on their one-month posttest. Treatment participants' mean specimen acceptance rates were: August = 94%, September = 95%, November = 95% and December =94%.

Mann-Whitney U Scores

The Mann-Whitney U test was employed since the Sharpio-Wilks test demonstrated deviations from normal distribution (Kellar & Kelvin, 2013). Statistical analysis results for the Mann-Whitney U knowledge test and specimen acceptance rates are presented in Tables 4 and 5. A median split of the summed groups' scores and acceptance rates dichotomized the variable into control and treatment scores and rates (Kellar & Kelvin, 2013). In computing the pretest knowledge scores, the control mean rank was 16.11 (n=19), while the treatment mean rank was 22.06 (n=18); no significant difference was found between the groups' pretest scores (p=0.086). In computing the posttest knowledge scores, the control mean rank was 16.68 (n=19), while the treatment group mean rank was 21.44 (n=18); no significant difference was found between the groups' posttest scores (p=0.154). Lastly, in computing the one-month posttest knowledge scores, the control mean rank was 15.08 (n=19), while the treatment group mean rank was 23.14 (n=18), revealing a significant difference between the groups (p=0.020).

In computing specimen acceptance rates, the control mean rank for August was 19.17 (n=18), while the treatment mean rank was 17.83 (n=18); no significance was found between the groups (p=0.704). For September, the control mean rank was 20.33 (n=18), while the treatment mean rank was 16.67 (n=18); no significance was found between the groups (p= 0.296). A control mean rank of 21.67 (n=18) was computed for the November acceptance rates, while the treatment mean rank was 15.33 (n=18); this analysis revealed moderate significance between the groups (p=0.071). Lastly, December acceptance rates revealed a control mean rank of 20.56

(n=18), while the treatment mean rank was 16.44 (n=18); no significance was found between the groups (p=0.242).

Friedman's ANOVA by Rank

Friedman's ANOVA by rank was used to analyze the data because the Sharpio-Wilks test determined deviations from normality (Kellar & Kelvin, 2013). Statistical analysis results for Friedman's ANOVA by rank for the knowledge test and specimen acceptance rates are presented in Tables 6 through 9. A median split of the summed groups' scores and acceptance rates dichotomized the variable into control and treatment scores and rates (Kellar & Kelvin, 2013). The control group (n=19) reported a mean rank of 1.29 on the pretest, 2.55 on the posttest, and 2.16 on the one-month posttest. A significant difference was revealed between the control group's pretest, posttest, and one-month posttest ($p<0.001$). Post-hoc analysis revealed a significant difference between the control group's pretest/posttest (q=5.506, CV=3.314); a significant difference was also found between the control group's pretest/one-month posttest (q=5.353, CV=2.772); however, no significance was found between the control group's posttest and one-month posttest (q=2.422, CV=2.772).

The treatment group (n=18) reported a mean rank of 1.28 on the pretest, 2.47 on the posttest, and 2.25 on the one-month posttest. A significant difference was revealed between the treatment group's prettest, posttest, and one-month posttest ($p<0.001$). Post-hoc analysis revealed a significant difference between the treatment group's pretest/posttest (q=5.068, CV=3.314); a significant difference was also found between the treatment group's pretest/one-month posttest (q=5.833, CV=2.772); however, no significance was identified between the treatment group's posttest and one-month posttest (q=1.333, CV=2.772).

The mean ranks for the control group's specimen acceptance rates were: August=1.83, September= 2.69, November= 3.03 and December=2.44. A significant difference was revealed between the control group's acceptance rates (p=0.037). Post-hoc analysis for the control group revealed a significant difference between the month of August/September (q=5.16, CV=3.314), August/November (q=5.09, CV=3.63), August/December (q=3.66, CV=2.722), and November/December (q=3.54, CV=3.314). However, no significance was identified between September/November (q=2.04, CV-2.772) and September/December (q=1.50, CV=2.772). The mean ranks for the treatment group's specimen acceptance rates were: August=2.28, September= 2.83, November=2.83 and 4) December=2.06. No significance was found between the treatment group's acceptance rates (p=0.167). Post-hoc analysis for the treatment group revealed a significant difference between the month of August/September (q=3.30, CV=2.772). However, no significance was ascertained between August/November (q=2.33, CV=3.314), August/December (q=1.32, CV=2.772), September/November (q=0.00, CV=2.772), September/December (q=3.27, CV=3.314), and November/December (q=3.27, CV=3.63).

Discussion

Results identified through data analysis indicate an ongoing problem with low blood specimen acceptance rates in this ED. Although there was moderate significance between the control and treatment groups' specimen acceptance rates for November, neither group met the 98% recommended target rate. There was also a significant difference in the control group's overall blood specimen acceptance rates, while no significant difference was revealed in the treatment group. Therefore, the combination of enhanced knowledge and increased motivation, as well as reinforcement of blood specimen collection skills did not improve overall blood specimen acceptance rates in this ED. These results are not consistent with existing literature

regarding the application of the IMB model, but ineffective implementation of the IMB model's components may have contributed to the results.

The IMB-model-based interventions consisted of five-minute teaching-learning sessions for treatment group participants. However, the project leader was allotted approximately two-to-three minutes to converse with treatment group participants. Therefore, the motivational and behavioral skills necessary for improvement of specimen acceptance rates was limited due to time constraints. According to Zarani et al. (2011), behavior change interventions should allocate more time and provide follow-up or multi-session interventions to improve behavioral skills. Thus, an insufficient amount of time allocated for the promotion of motivation and behavioral skills may be a factor in the treatment group's lack of specimen acceptance rate improvement.

Active learning is considered to be a powerful strategy for fostering behavioral skills (Rosenshine, 2012). Chang et al. (2014) identified that the behavioral constructs perceived self-efficacy and objective skills could be translated into behavioral interventions. For example, role-playing can provide opportunities for learning or improving upon identified skills via a "hands-on" approach. Although the project leader provided treatment group participants with motivation and reinforcement skills, perceived self-efficacy was not identified. Therefore, self-efficacy could be an impactful component in increasing specimen acceptance rates.

Results of this study indicated that participants who were exposed to the IMB-based interventions demonstrated an improvement in their one-month posttests in information acquisition as opposed to participants who were not exposed. These results are not consistent with existing literature regarding the application of the IMB model. Chang et al. (2014) reported that brief interventions that are theory-based with effective delivery of the critical elements (i.e., information, motivation, and behavioral skills) should facilitate a behavioral change. Therefore,

theoretically, implementing the three constructs of the IMB model should have resulted in an increase in specimen acceptance rates in the treatment group rather than the control group. Since the project leader did not use a valid and reliable tool to measure personal and social motivation, it is not evident whether personal and social motivations were accurately measured. The lack of a valid and reliable tool to measure motivation could be a contributing factor in the treatment group's specimen acceptance rates not improving.

Though these explanations could provide the rationale of the lack of improvement in the treatment group's specimen acceptance rates, the explanations are not sufficient to address why the control group's acceptance rates improved. According to the IMB model, all three constructs are essential to facilitate a behavioral change (Fisher & Fisher, 1992). The findings in this project are not consistent with existing literature because the control group improved their acceptance rates without receiving all three constructs of the IMB model. Therefore, results of this project may warrant additional research regarding process refinement of the IMB model. Additionally, adoption of standardized protocols for blood specimen collection in this specific ED could potentially increase acceptance rates. Standardized guidelines may improve specimen acceptance rates, which could ultimately improve the timeliness of patient care and staff efficiency.

The project leader implemented various strategies to facilitate an active learning environment for the treatment group. However, no significant difference was identified between the treatment group's posttest and one-month posttest scores. While this finding is inconsistent with literature stating that active learning is thought to foster knowledge retention, it is consistent with literature reporting that knowledge and skills can be forgotten with the passage of time, resulting in decreased performance (Kim, Koubek, & Ritter, 2007).

Knowledge degradation over time may have been a possible component in the treatment group's declining scores and further contributed to their specimen acceptance rates not improving. Results of this project substantiate the need for periodic venipuncture training among ED staff members due to knowledge degradation. Donabedian's model provides a conceptual framework for examining health services and evaluating quality of health care using three categories: "structure," "process," and "outcomes" (Hickey & Brosnan, 2012). This model could be employed to ensure the utilization of published guidelines in venipuncture training programs by including content on prevention of hemolysis as well as a clear structure. Additionally, deployment of phlebotomists throughout the 24-hour period could facilitate an increase in acceptance rates. Staff members take on various roles in the ED, while venipuncture is phlebotomists' primary role. Therefore, collaboration among departments, to include allocating ED staff members to shadow phlebotomists, may promote a knowledge base and facilitate an increase in acceptance rates.

Demographic variables for the participants should be taken into consideration when explaining the results of this project. Staff category (RN, LPN, CNA, or phlebotomist), venipuncture training, and refresher training have all been mentioned in literature as contributing factors to low acceptance rates in EDs (Bowe-Geddes, 2011; Heyer et al., 2012; Lima-Oliveira et al., 2012; Pretlow et al., 2008). There was no significant difference ascertained in staff category, venipuncture training, and refresher training between the control and treatment groups. This project did not assess the years of experience, age, or gender of the participants; however, these demographic variables could have contributed to the unexpected results of the project. It may be worthwhile for future studies to consider associations between experience, age, or gender and their influence on acceptance rates in EDs.

Strengths/Limitations

The project leader acknowledges that this scholarly project has several strengths. The scholarly project was a quasi-experimental quality improvement project with a pretest/posttest design. Quasi-experimental designs are thought to have better validity than purely observational study designs (Kellar & Kelvin, 2013). While convenient sampling of the participants in the scholarly project did occur, the participants were randomly assigned to either the treatment or control group based on their work schedules. Targeting potential participants via email gave all eligible staff members an equal opportunity of enrolling into the project. According to Dillman (2007), giving all eligible staff members an equal opportunity to participate, helps minimize coverage error that may occur when the sample drawn does not include all elements of the available population. Recruitment of staff from different disciplines strengthened ecological validity and the extent to which study design and meaning have relevance to real-world contexts (Polit & Beck, 2008). Additionally, a pretest/posttest design increased the reliability of the scholarly project (Kellar & Kelvin, 2013).

The project leader also acknowledges that this scholarly project has several limitations. The internal/external validity and reliability of the results were compromised in this scholarly project. While the project leader used a reliable tool from a previous study, more than half of the questions on the original questionnaire were changed (Makhumula-Nkhoma et al., 2014). As previously discussed, the project leader also added a motivational question in the questionnaire to assess personal motivation and implemented a motivational intervention to provide social motivation, but neither were retrieved from a reliable or validated resource. Therefore, the project leader cannot accurately reject the hypotheses of the scholarly project because it is uncertain whether the motivational question and intervention accurately measured personal and

social motivation due to lack of validation and reliability. Future studies should find a reliable and valid motivational tool and intervention to accurately assess the motivational construct of the IMB model.

The internal/external validity and reliability of the results may have also been compromised due to ineffective implementation of the IMB model components. Self-efficacy has been identified in the behavioral construct, along with objective skills, to help facilitate a behavioral change (Chang et al., 2014). While the project leader provided participants in the treatment group with motivation and reinforcement skills, perceived self-efficacy was not identified. Additionally, the project leader was allotted approximately two-to-three minutes to converse with treatment group participants with the huddle script. Therefore, the motivational and behavioral skills necessary for improvement of specimen acceptance rates was limited due to time constraints. Future studies that implement the IMB-based model should implement self-efficacy and allow for a sufficient amount of time for the implementation of interventions.

Due to unavailability of a sample frame, the population size was based on estimation, and this could have affected the effect size of the sample. A project that is underpowered is at risking of committing a type II error (Kellar & Kelvin, 2013). The results obtained may not be a true presentation of the population's knowledge in venipuncture, technique, and motivation affecting generalizability. The fact that the project sample only included participants who were currently working at Tennova Medical Center ED in Clarksville, Tennessee, could have had a profound impact on the results that were gathered. The project sample was not particularly diverse, as a majority of the participants were RNs. Replication of this project in a different region with a more diverse sample could yield significantly different results. Future studies should conduct a power analysis before recruiting eligible participants to minimize the risk of type I or II errors in

the project. Additionally, a more accurate representation of the population should be achieved to make the project more generalizable.

The implementation of an educational module during a mandatory meeting was another challenge that may have impacted the integrity of the results. The project leader had the advantage of having eligible participants at the mandatory meeting, but the disadvantage of the meeting was that too much was scheduled for one setting. The implementation of the educational module was the second presentation that the eligible participants heard. The first presentation lasted approximately an hour longer than originally scheduled, therefore, some of the participants left before the project leader presented the educational module. Practical demonstration was originally included for all of the eligible participants at the meeting, but the project leader was unable to implement practical demonstration the day of the meeting due to time constraints.

The project leader distributed the handouts with the 16 steps of phlebotomy on one side and ways to decrease hemolysis on the other side to all of the eligible participants before the implementation of the educational module. The project leader instructed the eligible participants to not look at their handouts while taking their pretest and posttest. However, the answers to the pretest and posttest were on the handouts, and it is difficult to assess whether the eligible participants used the handout to answer pretest questions.

Lastly, the project leader is uncertain if a sufficient amount of time was allotted for the implementation of reinforcement strategies. The project leader met the participants in the treatment group before their shift started. Due to time constraints, only two-to -three minutes were allotted for the behavioral skills necessary for blood specimen collection that may have resulted in an improvement in specimen acceptance rates. Therefore, this compressed timeframe

could have impacted the integrity of the results because the project leader was cognizant of the participants' work commitment and rushed through the planned behavioral skills material.

Conclusion

Even with the implementation of this scholarly project, acceptance rates fell out of the target range of 98% or higher in this specific ED. The combination of enhanced knowledge and increased motivation, as well as reinforcement of blood specimen collection skills did not improve overall blood specimen acceptance rates in this ED. These results are not consistent with existing literature regarding the application of the IMB model, but ineffective implementation of the IMB model's components may have contributed to the results. However, adoption of a standardized protocol in this specific ED could enhance consistency in blood specimen collection techniques and could ultimately increase specimen acceptance rates. Although use of a protocol in a busy ED environment can be challenging, conducting venipuncture without established guidelines can impact patients' and staff members' safety and quality of care. The decrease in both the control and treatment groups' posttest and one-month posttest scores indicate knowledge degradation. Therefore, results of this project substantiate the need for periodic venipuncture training among ED staff member due to knowledge degradation over time. A strategy to ensure the development of guidelines in venipuncture training programs could improve staff members' overall knowledge retention. In this specific ED, standardized guidelines and periodic venipuncture training may improve blood specimen acceptance rates, which could ultimately improve the timeliness of patient care and ED staff efficiency.

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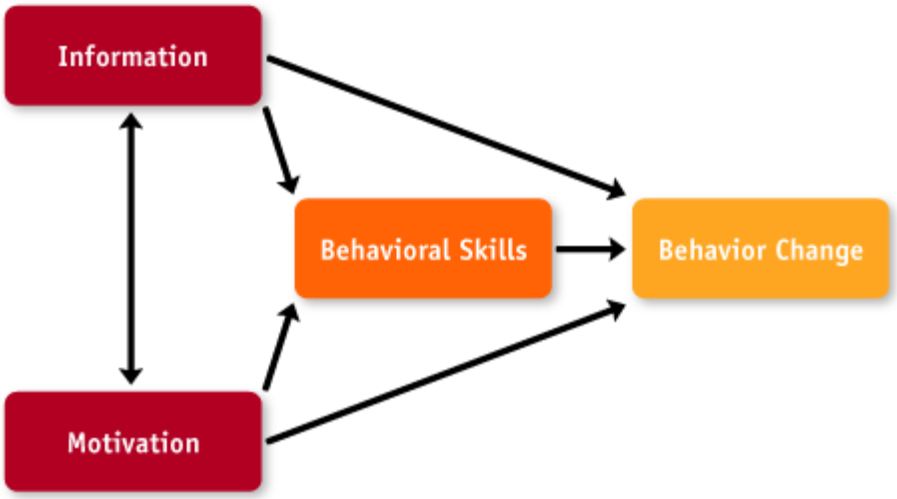


Source: World Health Organization, 2003

[taken from http://www.adultmeducation.com/patientrelatedfactors_2.html]

Figure 1. Information-Motivational-Behavioral Model.

Table 1: Implementation of pre/posttest and huddle script

Pretest	Huddle #1	Huddle #2	Posttest
10/19/2016	10/23/2016	11/13/2016	11/28/2016
10/20/2016	10/25/2016	11/17/2016	11/29/2016
	10/27/2016	11/18/2016	11/30/2016
			12/01/2016

Table 2: Descriptive Statistics

	Control (n=19)		Treatment (n=19)	
	Mean(SD)	n (%)	Mean(SD	n (%)
Staff Category	1.89 (1.24)		1.79(0.273)	
Registered Nurse (RN)		12 (63.2%)		13 (68.4%)
Licensed Practice Nurse (LPN)		0		1 (5.3%)
Certified Nursing Assistant (CNA)		4 (21.1%)		1 (5.3%)
Phlebotomist		3 (15.8%)		4 (21.1%)
Venipuncture Training	1.26(0.452)		1.32(0.478)	
Formal Training		14 (73.7%)		13 (68.4%)
Informal Training		5 (26.3%)		6 (15.8%)
Refresher Training	1.53(0.513)		1.53(0.513)	
Refresher Training		9 (47.4%)		9 (47.4%)
No Refresher Training		10 (52.6%)		10 (52.6%)
Motivation	1.26(0.452)		1.11(0.315)	
Highly Motivated		14 (73.7%)		17 (89.5%)
Somewhat Motivated		5 (26.3%)		2 (10.5%)

Table 3: Descriptive Statistics (cont.)

	Control (n=19)		Treatment (n=19)	
	Mean(SD)	# Correct(%)	Mean(SD)	# Correct(%)
Pretest	63.16(17.01)		71.58(17.08)	
Q1- Correct Filling Order	0.68(0.478)	13(68.4%)	0.79(0.419)	15(78.9%)
Q2- Tube Inversion	0.47(0.513)	9(47.4%)	0.53(0.513)	10(52.6%)
Q3- Vein Angle	0.37(0.496)	7(36.8%)	0.84(0.375)	16(84.2%)
Q4- Culture Bottles	1(0)	19(100%)	1(0)	19(100%)
Q5- Vacutainer	0.32(0.478)	6(31.6%)	0.26(0.452)	5(26.3%)
Q6- Tourniquet	0.74(0.452)	14(73.7%)	0.79(0.419)	15(78.9%)
Q7- IV Catheter Gauge	0.63(0.496)	12(63.2%)	0.79(0.419)	15(78.9%)
Q8- Blood Flow	0.68(0.478)	13(68.4%)	0.95(0.229)	18(94.7%)
Q9- Antecubital Fossa	0.68(0.478)	13(68.4%)	0.58(0.507)	11(57.9%)
Q10- Straight Needle	0.74(0.452)	14(73.7%)	0.63(0.496)	12(63.2%)
Posttest	85.26(17.12)		91.05(13.70)	
Q1- Correct Filling Order	1(0)	19(100%)	0.95(0.229)	18(94.7%)
Q2- Tube Inversion	0.89(0.315)	17(89.5%)	0.95(0.229)	18(94.7%)
Q3- Vein Angle	0.84(0.375)	16(84.2%)	0.95(0.229)	18(94.7%)
Q4- Culture Bottles	1(0)	19(100%)	1(0)	19(100%)
Q5- Vacutainer	0.58(0.507)	11(57.8%)	0.68(0.478)	13(68.4%)
Q6- Tourniquet	0.79(0.419)	15(78.9%)	0.95(0.229)	18(94.7%)
Q7- IV Catheter Gauge	0.84(0.375)	16(84.2%)	0.95(0.229)	18(94.7%)
Q8- Blood Flow	0.84(0.375)	16(84.2%)	0.95(0.229)	18(94.7%)
Q9- Antecubital Fossa	0.84(0.375)	16(84.2%)	0.89(0.315)	17(89.5%)
Q10- Straight Needle	0.89(0.315)	17(89.5%)	0.84(0.375)	16(84.2%)
One-Month Posttest	77.89(11.34)		83.16(20.29)	
Q1- Correct Filling Order	0.79(0.419)	15(78.9%)	1(0)	19(100%)
Q2- Tube Inversion	0.74(0.452)	14(73.3%)	0.89(0.315)	17(89.5%)
Q3- Vein Angle	0.47(0.513)	9(47.4%)	0.63(0.496)	12(63.2%)
Q4- Culture Bottles	1(0)	19(100%)	1(0)	19(100%)
Q5- Vacutainer	0.32(0.478)	6(31.6%)	0.68(0.478)	13(68.4%)
Q6- Tourniquet	1(0)	19(100%)	0.84(0.375)	16(84.2%)
Q7- IV Catheter Gauge	0.79(0.419)	15(78.9%)	0.84(0.375)	16(84.2%)
Q8- Blood Flow	0.95(0.229)	18(94.7%)	0.89(0.315)	17(89.5%)
Q9- Antecubital Fossa	0.89(0.315)	17(89.5%)	0.84(0.375)	16(84.2%)
Q10- Straight Needle	0.84(0.375)	16(84.2%)	0.68(0.478)	13(68.4%)
Aug Acceptance Rates	0.9447(0.039)		0.9485(0.021)	
Sept Acceptance Rates	0.9613(0.031)		0.9536(0.026)	
Nov Acceptance Rates	0.9646(0.034)		0.9547(0.026)	
Dec Acceptance Rates	0.9448(0.54)		0.9434(0.018)	

Table 4: Mann-Whitney U Knowledge Scores

Test	*n*		Mean Rank		*z*	*P value*
	Control	Treatment	Control	Treatment		
Pretest	19	18	16.11	22.06	-1.717	.086
Posttest	19	18	16.68	21.44	-1.427	.154
One-month posttest	19	18	15.08	23.14	-2.336	.020*

*Significant at p<0.10; ** t p<0.05; *** p<0.01

Table 5: Mann-Whitney U Acceptance Rates

Month	*n*		Mean Rank		*z*	*P value*
	Control	Treatment	Control	Treatment		
August	18	18	19.17	17.83	-.380	.704
September	18	18	20.33	16.67	-1.044	.296
November	18	18	21.67	15.33	-1.804	.071*
December	18	18	20.56	16.44	-1.171	.242

*Significant at p<0.10; ** t p<0.05; *** p<0.01

Table 6: Friedman ANOVA by Rank- Control Group Knowledge Scores

Test	Mean	Mean Rank
Pretest	63.19(17.01)	1.29
Posttest	85.26(17.12)	2.55
One-month posttest	77.89(11.24)	2.16

Test	*n*	*df*	χ^2	p	Q	CV
Friedman's	19	2	17.4789	<0.001***		
Pretest Posttest					5.506**	3.314
Pretest One-month Posttest					5.353**	2.772
Posttest One-month Posttest					2.422**	2.772

*Significant at p<0.10; ** p<0.05; *** p<0.01

Table 7: Friedman ANOVA by Rank -Treatment Group Knowledge Scores

Test	Mean	Mean Rank
Pretest	73.33(15.72)	1.28
Posttest	93.89(6.18)	2.47
One-month posttest	85.00(19.17)	2.25

Test	*n*	*df*	χ^2	p	Q	CV
Friedman's	18	2	16.871	<0.001***		
Pretest Posttest					5.068**	3.314
Pretest One-month Posttest					5.833**	2.772
Posttest One-month Posttest					1.333	2.772

*Significant at p<0.10; ** t p<0.05; *** p<0.01

Table 8: Friedman ANOVA by Rank-Control Group Acceptance Rates

Test	Mean	Mean Rank
August	0.9447(0.039)	1.83
September	0.9613(0.031)	2.69
November	0.9646(0.034)	3.03
December	0.9448(0.54)	2.44

Test	*n*	*df*	χ^2	p	Q	CV
Friedman's	18	3	8.486	<0.037**		
August - September					5.16**	3.314
August -November					5.09**	3.63
August - December					3.66**	2.772
September - November					3.54**	3.314
September - December					2.04	2.772
November - December					1.50	2.772

*Significant at p<0.10; ** p<0.05; *** p<0.01

Table 9: Friedman ANOVA by Rank Treatment Group Acceptance Rates

Test	Mean	Mean Rank
August	0.9485(0.021)	2.28
September	0.9536(0.026)	2.83
November	0.9547(0.026)	2.83
December	0.9434(0.018)	2.06

Test	*n*	*df*	χ^2	p	Q	CV
Friedman's	18	3	5.067	<0.167		
August - September					3.30	2.772
August - November					2.33	3.314
August - December					1.32	2.772
September - November					0	2.772
September - December					3.37	3.314
November - December					3.27	3.63

*Significant at p<0.10; ** p<0.05; *** p<0.01

Appendix A: Recruitment Email

Hello Tennova Staff Members!

I wanted to let you know about a learning opportunity at the October staff meeting (10/19/2016 at 7:15 a.m.). During the meeting, we'll have a presentation on blood specimen collection and ways to increase blood specimen acceptance rates. The same information will be presented that night at 6:30 p.m. in the break room in order to allow the staff that worked that day and anyone else that could not make the meeting an opportunity to participate. You'll also have the chance to participate in up to three questionnaires. Sounds fun, right?

So let's make it a little more interesting: if you attend the presentation, complete all three questionnaires, then you'll be entered for a chance to WIN A $100 VISA GIFT CARD! (You have to complete all the steps to qualify: a pre-presentation questionnaire, a post-presentation questionnaire, and the final questionnaire one month after the presentation).

Not only will you have a shot at winning a hundred dollar gift-card, but also you'll be helping to improve collection techniques, increase blood specimen acceptance rates, decrease delay of patient care, and increase your work efficiency. Everybody wins!

I'm looking forward to seeing you at the October staff meeting or at the evening session and greatly appreciate your participation. Let me know if you have questions. Thank You!

Sincerely,

Christian Hankins

Appendix B: Questionnaire

A Quality Improvement Project to Improve Blood Specimen Acceptance Rates in an Emergency Department

Instructions: Please circle the letter of the appropriate answer for each question. ID # _____

_____

1. Which staff category do you fall under?

A. Registered Nurse (RN)

B. Licensed Practice Nurse (LPN)

C. Certified Nursing Assistant (CNA)

D. Phlebotomist

_____

2. Was your venipuncture training:

A. Formal

B. Informal

_____

3. Have you received any refresher training on venipuncture?

A. Yes

B. No

_____

4. How motivated are you to see improved lab acceptance rates in our Emergency Department?

A. Very motivated

B. Somewhat motivated

C. Not very motivated

D. Not at all motivated

_____

5. Which order is the correct way to fill collection tubes?

A. Culture bottles, light blue, gold, red, green, lavender, grey

B. Lavender, light blue, green, gold, red, culture bottles, grey

C. Light blue, gold, red, green, lavender, grey, culture bottles

_____

6. After the collection tubes are filled, how many times should they be inverted to prevent hemolysis?

A. 6-8 times

B. 3-5 times

C. None

_____

7. According to the Best Practices in Phlebotomy, at what degree angle should the staff member enter the vein?

A. 15 degrees

B. 30 degrees

C. 45 degrees

_____

8. When collecting an aerobic and anaerobic adult blood culture set, how many milliliters should be injected into each culture bottle?

A. 2 milliliters

B. 3 milliliters

C. 5 milliliters

_____

9. Which blood collection method most likely causes blood sample hemolysis?

A. Syringe and needle

B. Cannula and syringe

C. Cannula and vacutainer

_____

10. What length of tourniquet time causes hemolysis?

A. When it is applied less than one minute

B. When it is applied more than one minute

C. None of the above

_____

11. Which needle and cannula gauge predisposes blood specimen hemolysis?

A. 16

B. 18

C. 20

_____

12. When is blood flow into the collection tube most likely to be vulnerable to hemolysis?

A. When the flow is turbulent

B. When the flow is smooth

C. None of the above

13. Blood samples collected from which site are most likely to NOT hemolyze?

A. Antecubital fossa (AC)

B. Cephalic Vein (CV)

C. External Jugular Vein (EJ)

---

14. Which one of these factors does NOT contribute to hemolysis?

A. Blood that is forced into a collection tube

B. Direct venipuncture with a straight needle

C. The collection tube is less than half full

Appendix C: Educational Module

- Tennova Emergency Department
- A Quality Improvement Project to Improve Blood Specimen Acceptance Rates in an Emergency Department
- By: Christian Hankins
- Objectives

The staff member will:

- Demonstrate venipuncture and blood specimen collection techniques that are consistent with the "Clinical Practice Guideline- Prevention of Blood Specimen Hemolysis in Peripherally-Collected Venous Specimens"
- Restate the definition and causes of hemolysis
- Discuss how blood specimen collection technique can affect patient care and is less efficient on the staff.
- Patient Identification
- Proper identification should always be determined before drawing blood by using at least 2 identifiers
- Utilize the hospital armband
- Ask patient to state their full name and date of birth
- Labeling Specimens
- Date and time
- Collector's full login
- The specimen MUST be labeled in the presence of the patient.
- Must have two verifiers of patient's name and date of birth

- Place the patient's label over the tube's label
- Labeling Specimens (cont.)
- Steps for Best Practices in Phlebotomy
- Step 1: Assemble equipment
- Step 2: Perform hand hygiene
- Step 3: Identify and prepare the patient
- Step 4: Select the site
- Step 5: Apply the tourniquet
- Step 6: Ask the patient to form a fist
- Step 7: Put on gloves
- Step 8: Disinfect the site
- Steps for Best Practices in Phlebotomy (cont.)
- Step 9: Anchor the vein by holding the patient's arm down
- Step 10: Enter the vein at a 30 degree angle
- Step 11: Release the tourniquet
- Step 12: Withdraw the needle gently
- Step 13: Discard the used needle and syringe
- Step 14: Check the label and forms for accuracy
- Step 15: Discard sharps and broken glass
- Step 16: Remove gloves, perform hand hygiene
- Order of Blood draw
- Culture bottles
- (Light Blue Top) Sodium Citrate

- (Red top) Provides Serum
- (Gold Top) Clot activator/Serum Separator
- (Green Top) Lithium Heparin
- (Purple Top) EDTA
- Grey
- Blood Cultures
- Light Blue
- Sodium Citrate tube (light blue top)
    - Provides sodium citrate plasma
    - Used for coagulation testing
    - Must not be clotted or hemolyzed
    - Must be completely full
- Red and Gold
- No additive tube (red top)
    - Provides serum
    - Used for tests such as (RPR, Send-out tests)
    - Serum separator (gold top)
    - Provides serum
    - Contains a gel barrier and a clot activator
    - Used for chemistry testing (BMP, Hepatic)
    - Must not be hemolyzed.
- Green
- Lithium Heparin tube (green top)

    - Provides lithium heparin plasma
    - Used for testing in chemistry
    - Use for venous pH and Carboxy Hemoglobin
    - Must not be hemolyzed
    - Must be at least ½ full.
- Purple and Grey
- EDTA (purple top)
    - Provides EDTA plasma
    - Used for testing in hematology and blood bank
    - Must not be clotted
    - The tube must be at least ½ full
- Lactic Acid (grey top)
    - Collected last and must be on ice
- Clotting
- All tubes should be gently inverted 6-8 times after filling
- Blood collected with a syringe should be placed into the blood tubes immediately after collection.
- Blood that is difficult to obtain may clot or hemolyze.
- Hemolysis
- Defined as the breakdown of red blood cells leading to the leakage of intracellular contents into the plasma
- Techniques to decrease hemolysis according to *The Clinical Practice Guidelines* will be discussed

- Intravenous catheters (IV) versus straight needle sticks
- Direct venipuncture with straight needles is less likely to cause hemolysis
- Rationale for recommendation
- Antecubital Fossa
- Hemolysis is less likely when blood is drawn from the AC
- Studies have contrasted hemolysis rates using the antecubital fossa (AC) versus more distal sites
- The antecubital fossa site provides access to a large vein and allows easier access
- Catheter Size
- There is conflicting evidence on catheter size
- Studies have shown an increase in blood specimen hemolysis drawn from smaller gauge catheters such as (20, 22, and 24).
- Rationale for recommendation
- Syringes versus vacuum tubes
- There is conflicting evidence when it comes to syringes versus vacuum tubes
- Syringes allow the medical staff collecting the blood samples to control the amount of vacuum
- Recommendation if vacuum tubes are going to be used
- Tourniquet time
- Tourniquets constrict blood vessels and can themselves, result in hemolysis
- Tourniquets should not be applied for more one minute when collecting blood specimens
- Other contributing factors
- More than one venipuncture attempt

- Sample tube is less than half full
- When the collection tube is vigorously shaken horizontally
- Blood that is forced into a collection tube
- Years of experience
- Training
- Specimen transport
- Outcomes
- Patients face discomfort of additional blood draws
- Impacts patient satisfaction
- Delay of patient care
- Produces unreliable lab results
- Decrease in work efficiency
- Not cost-effective
- Questions?
- Does anyone have any questions?

Appendix D: Huddle Script

The project leader will bring donuts to each visit.

Hello everyone. Thank you for allowing me to come speak to you before your shift begins. I would like to highlight the 16 steps used in phlebotomy, the order of blood draw (blood culture, blue, red, gold, green, purple, and grey tops), and some different techniques that cause hemolysis (drawing blood while starting intravenous catheters, using sites other than the antecubital fossa, using vacuum tubes rather than a syringe when collecting, using intravenous catheters less than an 18 gauge, and leaving the tourniquet on for longer than a minute). Our mission is to improve patient care. By following the 16 steps of phlebotomy, order of blood draw, and using techniques that decrease hemolysis, we can increase acceptance rates. Increased acceptance rates will lead to overall work efficiency for everyone and decrease delay of patient care. I know that as a team, we can make this happen!

Appendix E: Handout

Best Practices in Phlebotomy

1. Assemble equipment
2. Perform hand hygiene
3. Identify patient using two identifiers
4. Select the site
5. Apply a tourniquet
6. Ask the patient to make a fist
7. Put on gloves
8. Disinfect the site and allow it to dry completely
9. Anchor the vein by holding the patient's arm and placing a thumb below the site
10. Enter the vein swiftly at a 30-degree angle
11. Release the tourniquet
12. Withdraw the needle gently and place a gauze over the site
13. Discard the needle
14. Check the label and forms for accuracy
15. Discard the sharps and broken glass
16. Remove gloves and perform hand hygiene

Appendix F: Handout

The Joint Commission Journal on Quality and Patient Safety

Online Only Content

Appendix 1. A "Tip Sheet" for Preventing Hemolysis

Tips to Prevent HEMOLYSIS

Drawing Blood from an IV
Blood drawing from peripheral lines is ***ONLY*** to be done ***at the time of insertion.*** Use a peripheral vein to re-collect an unacceptable sample or to draw additional tubes of blood. Use the luer-lok adapter to fill Vacutainer tubes from IV site.

Drawing Blood by Venipuncture
Best way to prevent hemolysis; least amount of trauma to the red blood cells

Syringe or Butterfly Draw with syringe
Pulling the plunger back too far during blood collection while using a large bore needle, may create enough pressure to cause hemolysis.
Pushing the plunger too forcefully when transferring blood from a syringe into a tube may also cause hemolysis. Use blood transfer device.

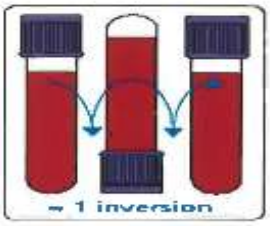
Alcohol and/or Chloraprep® Drying Time
Allow the cleansed site to ***dry thoroughly*** (~30 seconds).

Tourniquet Time
Do not leave the tourniquet on for more than 1 minute. Longer tourniquet time causes the interstitial fluid to leak into tissue, causing hemolysis.

Order of Draw for Multiple Tube Collections
To prevent cross contamination of anticoagulant or other tube additive, ***collect tubes following the order of draw.*** Blood culture blue then purple (See image to the right—order is top to bottom.)

Volume per Tube
Fill each tube with the ***correct blood volume*** to ensure sufficient specimen is available for testing and to ensure the proper ratio of tube additive to blood. Fill volume is especially critical for the blue-top Citrate tubes used for coagulation studies.

Mixing Tubes
Gently rotate each tube 6–8 times as they are removed from the Vacutainer holder and before engaging the next tube. Vigorous mixing or shaking of the tubes may cause hemolysis.



Specimen Transport
Mechanical trauma during transport may occur in a pneumatic tube system, resulting in hemolysis. Tubes not filled with enough blood have more air space within the tube for blood to move back and forth during tube transport.

This comprehensive tip sheet, which was disseminated to all units, highlighted the process and method required to ensure a quality blood collection. The sheet included factors that contribute to hemolyzed specimens, such as prolonged tourniquet time and vigorous mixing.

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