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Use of Simulation to Reinforce Evidence-based Collection Processes

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Use of Simulation to Reinforce Evidence-based Collection Processes For Blood Cultures

by

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Dedication

I want to take this opportunity to thank Kathaleen C. Bloom, PhD, CNM, not only my committee chairperson, but my mentor. Dr. Bloom has furthered my professionalism with her guidance, wisdom, support, and encouragement throughout this educational journey at the University of North Florida. As a full time instructor for only two years, because of the education received from Dr. Bloom, I started an on-line program, simulation lab, and other achievements at Bethune Cookman University. Dr. Bloom has inspired and guided me through my transition to Florida. I wholeheartedly thank her and wish her the best in the future. Students under her supervision and guidance are lucky to have a person of such honorable character on their side.

I would like to thank Ernest and Carol Wheaton for accepting my husband Franklin, two daughters, Christine and Darlene and myself as family. Before moving to Florida, I lost my father and mother, Frank and Gloria Krawiec. Ernest and Carol Wheaton treated us as family, with pray, kindness, and togetherness. Ernest and Carol Wheaton will always be in our hearts.

To Mary N. Blasius, RN BSN CEN, no one could ever ask for a better friend. "The Wind Beneath My Wings" (Bette Midler, 1990)

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Abstract

Proper collection of blood cultures is needed to identify pathogens causing serious infections and direct appropriate antibiotic therapy. Blood culture contamination can lead to longer hospital stays, incorrect antibiotic treatment, additional testing, and overall increased costs for the patient and hospital. Blood culture collection technique is the most important factor affecting contamination rates.

The purpose of this project was to determine the effect of simulation reinforcement of blood culture collection processes on the rate of contamination of blood cultures drawn by nurses in a community medical center emergency department.

This one-group before-and-after cohort study utilized a convenience sample of 50 nurses who collect blood cultures on adult clients. Each participant completed a pretest, attended a simulation in-service class, and completed a posttest immediately after the simulation and again one-month later.

There was significant knowledge gained from pretest to immediate posttest, with no significant decrease in knowledge at 1-month post-intervention. The 3-month blood culture contamination rate was 3.26% prior to the intervention, 4% during the intervention period, 3.7% after the intervention, and 2% in months 4 and 5 post-intervention. The use of simulation in the professional development of practicing nurses has the potential to improve clinical practice performance and patient outcomes.

Chapter One: Introduction

Blood cultures are drawn by nurses on a daily basis for febrile incoming clients in the emergency department. Blood culture results are needed to determine appropriate antibiotic therapy for the identified pathogens. Blood culture contamination is a frequent problem for hospitals, accounting for up to 50% of positive cultures. The technique used in collecting blood cultures is the most important factor in contamination rates (Bekeris, Tworek, Walsh, & Valenstein, 2005).

Blood culture contaminations directly impact patient care outcomes, hospital staff, health care costs, and length of stay for patients. Misinterpretation of a patient's diagnosis, administration of antibiotics, and the need for additional therapy are negative outcomes of false positive blood cultures. (Bekeris et al.,2005).

Although it is impossible to eliminate all contaminations, interventions to reduce the rate of contamination can improve quality care for clients and reduce hospital costs. Among these interventions are adequate training of personnel in blood culture collection, blood collection from separate venipuncture sites, and tracking of blood culture contaminations in nursing units (Bekeris et al., 2005). Emergency rooms and units under pressure from staffing shortages are at greater risk for contamination (Bamber, Cunniffe, Nayar, Ganguly, & Falconer, 2009).

Current Practice

The hospital currently utilizes blood culture kits and tracks blood culture contaminations monthly. The preferred method for blood culture collection is venipuncture, although specimens from existing intravenous catheters are permissible

when it is impossible to obtain a specimen from another site. In response to a documented >3% contamination rate in the emergency department at a community hospital, a new policy for blood culture collection practices for the hospital was drafted based on an evidence-based clinical practice guideline and a review of the literature on interventions for reduction in blood culture contamination rates. This revised policy went into effect October 2009 (Alexander, Corrigan, Gorski, Hankins, & Perucca, 2009).

Practice Change

The previous policy on blood culture collections at the medical center stated that when collecting blood from a vascular intravenous catheter the first 5ml of blood withdrawn was to be discarded. Discarding 5-10ml of blood from severely ill clients each time a culture is needed can result in significant blood loss and anemia for the client. Based on the evidence indicating that discarding the first blood drawn does not reduce contamination rates (Dwivedi, Bhalla, Hoover, & Weinstein, 2009), the revised blood culture policy indicates that the initial blood obtained from a vascular intravenous catheter can be utilized for the blood culture.

Previous procedures for obtaining blood cultures utilized a syringe and needle to inoculate the blood culture bottles after obtaining the blood. This practice may lead to contamination by needle changing. Smart et al., (1993), revealed that changing of the needle after collection of the culture did not decrease contamination rates. Decreasing the exchange of blood from the client to the collection device has been revealed to decrease contamination rates. The emergency department now utilizes sterile transfer devices. The blood is drawn from the client and inoculated directly into the culture bottles lessening the chance of contamination by changing needles (Smart et al., 1993).

Implementing the Practice Change

Policy changes at the institution are implemented online and nurses are responsible for reviewing policy and procedure if unsure of correct procedures. Emergency department nurses with greater than five years of experience indicated verbally that they know the current procedure. Observation of practice and an informal survey of procedures, however, did not confirm this knowledge.

The facility does not have a formal in-service education class regarding collection of blood cultures. Special training in the skills required through educational one-on-one in-service classes' have been shown to lower blood culture contamination rates (Eskira et al., 2006). The use of simulation has been shown to improve clinical knowledge and enhance procedural skills in a variety of areas, including blood collections (Okuda et al., 2009). The evidence clearly suggests that simulation educational classes have the potential to improve quality care by decreasing the rate of contaminated cultures.

Purpose

The purpose of this project was to determine the effect of simulation reinforcement of collection processes on the rate of contamination of blood cultures drawn by nurses in a community hospital emergency department. It was hypothesized that there would be a decrease in the contamination rates of blood cultures after simulation education.

Definition of Terms

Blood Culture

A blood culture is the procedure used to identify organism growth in the bloodstream. Blood cultures are a tool for health care providers to detect the presence of dangerous living organisms in the client's blood stream.

Blood Culture Contamination

Also known as false-positive results, blood culture contamination occurs when organisms that are not actually present in a blood sample are grown in the culture. Blood culture contamination will be measured as the monthly rate of contaminated blood cultures divided by the total number of blood culture drawn in that month.

Simulation

Simulation is "the technique of imitating the behavior of some situation or process by means of a suitably analogous situation or apparatus, especially for the purpose of study or personnel training" (Bradley, 2006, p. 254). Simulators are utilized for training procedures such as: blood draws, surgery, and trauma care. Simulation provides a safe, educational environment that practitioners can utilize to observe that procedures are done correctly.

Chapter Two: Review of the Literature

This chapter begins with an overview of blood culture contamination, including statistics and ramifications. This is followed by a discussion of the factors associated with blood culture contamination in general, and in the emergency department in particular. The search strategies used to identify the best evidence for decreasing contamination are then presented, followed by an evaluation and synthesis of the evidence regarding best practices with respect to blood culture contamination. The chapter concludes with a presentation of search strategies used to identify the best evidence regarding simulation as a teaching-learning strategy, followed by an evaluation and synthesis of the evidence on the use of simulation in reinforcing learning and changing behavior.

Blood Culture Contamination

Blood culture contamination has been a significant problem in health care for many hospitals and laboratories, accounting for up to 50% of all positive cultures (Bamber et al, 2009). False-positive blood cultures and contaminated blood cultures, increase costs' for patients with unnecessary treatments and extended length of hospital stay up to 4.5 days (Gander et al., 2009; Hall & Lyman, 2006), adding as much as $4,100 to the cost of treatment and $8,000 to the patient's bill (Ernst, 2001; Gander et al., 2009). Unnecessary use of antimicrobials especially vancomycin, raises health care costs, causes antimicrobial resistant organisms, and exposes patients to adverse drug effects (Tokars, 2004). In addition, contaminated blood cultures can increase microbiology department overtime expenses by 30% (Ernst, 2001).

Evidence Regarding Reducing Blood Culture Contamination

Bibliographic databases for relevant studies on reducing blood culture contamination rates were CINAHL (2005 to 2010), Proquest, PubMed, and MEDLINE (2005 to 2010). Search terms included blood cultures, blood culture contaminations, emergency room and department contamination rates, strategies to reduce blood culture contamination rates, false-positive blood cultures, education and quality improvement with blood cultures. The combination of search terms resulted in a total of 20 unique studies. Studies included systematic reviews, prospective randomized clinical trials, controlled clinical trials, comparison, qualitative and quantitative studies. The evidence table may be found in Appendix A.

Determining Contamination

Blood cultures are the standard means of detecting bacteremia in a patient. False positive blood cultures occur from contamination of blood during the collection of the culture. If blood cultures are positive the practitioner has to determine whether the organism represents a significant infection or if the culture is a false-positive result, hence contaminated.

All institutions need to conduct surveillance of contaminations in blood cultures in order to evaluate the significance of positive blood cultures (Esel, Doganay, Alp, & Sumerkan, 2003). Target rates for blood culture contamination rates have been set at 2 to 3 % for all hospitals; actual contamination rates vary between 0.6% to 7% with an average rate of 3-4% (Chinniah, 2009). When blood culture contamination rates exceed the national average of 3-4%, hospitals must examine and correct the underlying factors (Weddle, Jackson, Cox, & Selvarangan , 2010). It is estimated that hospitals can avoid an

estimated cost of more than $400,000 annually through reduction of contamination rates. Trained personnel reduced contamination rates in the emergency department by $445,523.80 (Sheppard, Franks, Nolte, & Fantz, 2008).

Clinicians differentiate contaminated blood cultures from bacteremia primarily by the identity of the organism. Bates, Cook, Goldman, and Lee (1990) revealed that identity of the organism is an important factor in determining contaminations. Other factors that are assessed are the number of positive blood cultures, number of positive blood cultures within a set, time to growth, quantity of growth, clinical and laboratory data, source of culture, and automated classification using information technology (Hall & Lyman, 2006).

Coagulase-negative staphylococci (CoNS) are the pathogens that frequently represent contamination and are identified as false-positive blood cultures (Hall & Lyman 2006). CoNS are the most common contaminants and can account for almost 70-80% of all contaminated blood cultures. The sources of contamination of peripheral blood cultures can be found from the skin of the patient and the collection processes at the site of collection. Viagappan and Kelsey (1995) attempted to find the source of CoNS by isolating swabs of the patient and from the individual that collected the culture. The authors of this study revealed that from nineteen patients with contaminated blood cultures, six swabs were matched to the patient's skin flora, indicating that the most common source of contamination is inadequate skin preparation from CoNS. Inadequate skin preparation and technique were revealed to be barriers for preventing contaminations. Individuals who collect blood cultures may not have the knowledge on the skin preparation or may not allow for sufficient drying of the antiseptic utilized by

their institution. Trained phlebotomy or blood culture teams have been found to decrease contamination rates (Hall & Lyman 2006).

Other organisms that frequently represent contaminated blood cultures or false positive blood cultures are *Corynebacterium* species, *Bacillus* species other than *Bacillus anthracis*, *Propionibacterium acnes*, *Micrococcus* species, viridans group streptococcus, *Enterococci* , and *Clostridiuim perfringens* (Weinstein, 2003). Although these organisms are frequently a result of contamination, it is crucial that the possibility of true bacteremia be ruled out.

A set of blood cultures includes one aerobic bottle and one anaerobic bottle in an attempt to isolate the organism. If only one bottle exhibits growth within one set of bottles the contamination risk is greater. Increasing numbers of positive bottles indicate the likelihood of true bacteremia (Hall & Lyman, 2006). The number of positive cultures collected that grow organisms can differentiate contamination. If only one set is positive, often it is contaminated. Because CoNS represent true contaminants often they are present in both sets of cultures. If CoNS is grown in multiple bottles it truly represents contamination. Two sets of blood cultures from different sites should always be collected for this reason. When multiple blood cultures are collected, studies have revealed that true bacteremia has been identified. Another factor that determines contamination is the time it takes for the organism to grow. Several studies have shown that cultures that became positive more than 3-5 days after incubation have a higher rate of contamination. There is limited data to support quantity of organism growth per blood culture bottle in determining true contamination rates (Hall & Lyman, 2006).

Clinicians who diagnose infections should not only rely on lab results but also on clinical assessment of the patient. Schifman, Strand, Meier, and Howanitz (1998) found that when CoNS was isolated from only one of at least two sets of blood cultures, 84.3% of the cases were interpreted as contaminated by only utilizing laboratory results compared to 73.9% by using lab results and clinical assessment. When clinicians interpret blood culture results signs and symptoms of sepsis syndrome should also be evaluated. Clinical data, assessment of the patient and other lab results combined is necessary when determining blood culture contaminations (Hall & Lyman, 2006).

The source of the blood culture collection can also affect contamination. Percutaneous blood is the preferred method for collecting cultures, however when vascular catheters are utilized results can indicate several possibilities (Hall & Lyman, 2006). Blood collected from a vascular access can reveal true bacteremia, contamination, or catheter colonization. Catheter colonization is not the same as a contaminated blood culture, it occurs when microorganisms grow on the surface of the catheter. DesJardin et al. (1999) evaluated blood cultures assessed by infectious disease experts to determine bacteremia, catheter-drawn cultures had a sensitivity of 89% compared to 78% compared to peripheral cultures. The results of this study were similar to other studies which suggest that when obtaining blood cultures from a central vascular catheter device at least one set of cultures should be collected percutaneously (Hall & Lyman, 2006).

Health information technology improves quality care and has an important role in determining blood culture contaminations. With the use of surveillance and reporting systems, the tracking of blood culture contaminations has become possible. Automated classification of positive blood cultures assists clinicians in interpretations and decision

making in culture results. Technology provides a fast cost-effective approach to the surveillance of nosocomial and bloodstream infection rates throughout the hospital. Computer-based technology gives clinicians accessibility to information to make clinical judgments and assessments faster to determine appropriate treatments in septic patients. (Hall & Lyman 2006).

Factors Associated with Contamination

There are three major factors associated with blood culture contaminations. These include: contamination by skin-surface bacteria, non-laboratory personnel collecting blood, and collection of blood from a separate venipuncture site.

Contamination by skin-surface bacteria. Poor skin preparation is a common cause of blood culture contamination. In a retrospective, comparative, analyses of contamination rates in an emergency department, 48% of contaminated blood cultures were found to be due to skin contaminants. The use of proper aseptic skin cleansing and proper technique of collection of blood resulted in decreased contamination rates (Archibald, Pallangyo, Kazembe, & Reller, 2006). Proper technique and preparing the skin with chlorhexidine (Chloroprep) versus tincture of iodine has been shown to result in a savings of $875,000 per year as well as improving quality of care for the client (Tepus, Fleming, Cox, Hazelett, & Kropp, 2008).

Comparison of the effectiveness of different skin antiseptics for preparation of blood culture collections had no significant difference in contamination outcomes. Kiyoyama et al. (2009) found no difference in contamination rates with the use of isopropyl alcohol compared with isopropyl alcohol plus povidine-iodine as skin preparation. Similarly, Trautner, Clarrige, and Darouiche (2002) found no difference in

contamination rates when comparing chlorhexidine to tincture of iodine. Malani, Trimble Parekh, Chenoweth, Kaufman, and Saint (2007) found no difference when comparing various skin preparations, but did find a difference in contamination rates if blood culture kits were used. Bamber et al., (2008) found that switching to the use of blood culture kits reduced the contamination rates from 43% to 25%.

Non-laboratory personnel collecting blood. Blood cultures are the most important laboratory test done on patients to determine infectious disease processes. Many professionals do not adhere to aseptic techniques in collecting blood cultures, which leads to a delay in identifying the causative agent. Proper technique, training in the collection of blood culture collections, knowledge of optimal blood volume to be drawn, and aseptic technique are all factors that can lead to decreased contamination rates (Chinniah, 2009). In general, higher rates of blood culture contaminations are found in institutions that use non-laboratory personnel to collect blood and lower in those that have a dedicated phlebotomy team for blood cultures (Bekeris et al., 2005; Gander et al., 2009). In a prospective observational study comparing non-laboratory personnel to laboratory personnel collecting blood cultures in an emergency department, 5% of cultures drawn by non-laboratory persons were contaminated compared to 1.1% that were collected by laboratory personnel (Sheppard et al., 2008). Contamination rates may reflect high turnover rates of nursing personnel and the multitasking nature of emergency department nurses.

Collection of blood from a separate venipuncture site. Blood culture contamination rates are lower when collected from separate venipuncture sites compared to cultures drawn from newly inserted intravenous catheters (Ramsook, Childers, Cron, &

Nirken, 2000). Institution of a new policy requiring that blood cultures be obtained through a separate intravenous access has been shown to decrease contaminations from 9.1% to 2.8% (Norberg, Christopher, Ramundo, Bower, & Berman, 2003). Ehrenstein, Jarry, Linde, Scholmerich, and Gluck (2005), suggested that many blood cultures maybe over utilized in the emergency department, which can lead to contamination and increased costs for the patient and hospital.

Educational Interventions to Decrease Contamination

Proper collection of blood cultures is essential for quality care for the patient. Lack of knowledge in technique increases contamination rates. The volume of blood drawn for the blood culture is one of the most important factors in determining organism growth in cultures. In an anonymous survey of 355 hospital employees at an urban tertiary facility, qualified employees were asked the correct amount of blood volume needed for blood culture specimens. Forty-four percent responded that less than 5 mL of blood was acceptable, despite the fact that the minimum desirable amount is 5-10 mL of blood (Donnino et al., 2007).

A simple educational intervention given by an infectious disease nurse on a one-on-one basis compared with a sample that received no intervention, significantly reduced blood culture contamination rates in a busy 1000 bed tertiary hospital (Eskira et al., 2006). Strategies such as educational in-services with simulation can decrease blood culture contamination rates and have an impact on quality improvement that influences health care for a significant number of patients (Gander et al., 2009).

Evidence Regarding Simulation

Bibliographic databases for relevant studies on simulation as an educational strategy for quality improvement utilizing evidence-based practice were: CINAHL (2005 to 2010), ProQuest, PubMed, and MEDLINE (2005 to 2010). Search terms reviewed were: simulation, education with simulation, nursing education, simulation and blood cultures, strategies to reduce blood culture contamination rates, education and quality improvement with blood cultures. The combination of search terms resulted in a total of 8 unique studies. Studies included systematic reviews, quasi-experimental studies, randomize pre-test, post-test comparison studies, educational comparison studies, clinical trials, controlled clinical trials, comparison, qualitative and quantitative studies. The evidence table may be found in Appendix B.

History of Simulation

Historically, simulation has been used in the military for training purposes and represents one of the earliest usages of simulation. Simulation has also been used successfully in pilot training and gaming. Clinical simulation has a long-standing history as well (Bradley, 2006).

The use of models for learning about anatomy has been in place for centuries. CPR manikin use began in the 1960s with Åsmund Lærdal's 'Resusci-Anne' (Laerdal, Tjomsland, & Baskett, 2002). The first simulation man was developed in the late 1960s, specifically of for anesthesia training (Abrahamson, Denson, & Wolf, 2004), but was not widely accepted, primarily because of the cost (Bradley, 2006). Since then, there have been multiple changes and a variety of new developments in simulation.

Uses of Simulation

Simulators are used in the education of healthcare professionals to allow learners to gain competency in techniques and procedures and allow evaluation of the learner's competency in those skills in a teaching-learning environment rather than in a patient-care environment (Decker, Sportsman, Puetz, & Billings, 2008). The use of simulation as a teaching tool provides the learner with hands on experience and the educator's ability to know that the skill has been achieved. When a discussion-type teaching-learning situation was compared to a simulation instructional method, learners who engaged with simulation developed better decision making abilities (Brannan, White, & Bezanson, 2008).

The use of simulation should reflect the expected competencies of the nurse. Hands-on clinical training and acquisition of clinical skills has the ability to improve nursing care for the client. Simulation programs can reduce patient risks, improve patient safety, reduce medical errors and improve overall quality of care for the client. Although the use of simulation has been shown to increase knowledge and skills: the quality and quantity of the use of simulation in the medical field remains somewhat limited (Bradley, 2006; Brannan et al., 2008).

Simulation in Healthcare Education

Efficacy. Simulation has been used for many years in both nursing and medical education. There have been three systematic reviews of the use of high-fidelity simulation in healthcare education: one in nursing education and two in medical education. Kaakinen and Arwood's (2009) systematic review of the nursing simulation literature suggests the acquisition of skills is taught through "doing," and that most of the

learning actually occurs in the debriefing process. The use of simulation as a tool for learning, gives professionals an opportunity in clinical decision making, practice skills, and to observe outcomes from application.

Issenberg, McGaghie, Petrusa, Gordon, and Scalese (2005) found that simulation was an effective learning strategy in medical education. Results of the review of 109 studies concluded that educational feed-back was an important aspect of the simulation learning process. Simulation as a tool for learning clinical skills provides feedback during the learning experience, practice of skills in a safe environment, provides individualized teaching, and defines learning outcomes.

Okuda et al., (2009) found that simulation in medical training gave clinicians the ability to practice techniques, apply knowledge to skills, and learn in a safe environment with guidance from instructors. In this systematic review of 113 studies, medical educational practices utilizing simulation instruction were compared to classroom instruction. The use of simulation leads to clinical improvement for medical professionals.

Acceptability. Kardong-Edgren, Starkweather, and Ward (2008) examined student's and faculty's perspectives on simulation in a prospective descriptive repeated measures design using a convenience sample of 100 nursing students. Student's responses were positive, indicating that simulation provided an engaging learning opportunity. Faculty responses, however, were mixed. Faculty may view simulation as a technical tool that needs extensive training and requires intensive faculty time (Brannan et al., 2008; Kardon-Edgren et al., 2008). This concern is underscored by the results of a survey of nurse faculty measuring attitude toward and intent to use simulation as a

teaching tool, the results of which indicated that most of the faculty had little or no training with simulation (King, Moseley, Hindenlang, & Kuritz, 2008).

Simulation for Vascular Access

In a summary of simulation typology, simulation was recommended specifically for clinical skills such as phlebotomy and venipuncture, as well as tracking of practitioner's performances (Decker et al., 2008). Simulation of skills needed in clinical practice, such as collection of blood cultures, provides a risk-free environment where nurses can practice without fear of harming a client and can help nurses acquire the critical and reflective thinking skills that are needed for safe patient care.

Studies have shown the increased value of the virtual reality simulators over the use of the traditional simulation arms (Scerbo, Bliss, Schmidt, & Thompson, 2006; Scerbo et al., 2004). Radhakrishnan, Roche, and Cunningham (2007) found that nursing students who were learning phlebotomy and other skills were enhanced through the use of simulation and experienced fewer patient errors which improved patient safety. Tsai et al. (2008) conducted a pretest and posttest control group design to evaluate the use of simulation for novice nurses' learning Port-A-Catheter injections. There were fewer errors and increased selection of the correct equipment after the simulation intervention. The same was true in two studies with medical residents. Taniguchi, Matsui, Araki, and Kikawa (2008) found that simulation-based training programs for phlebotomy enhanced the learning process and skill development of 43 new medical residents. By connecting theory to practice medical professionals can improve patient care. Similarly, Dayal et al. (2004) found that simulator-training for novices in the placement of carotid stents

increased the accuracy of the procedure and decreased the total time for the procedure as well as the time under fluoroscopy.

Summary

This chapter discussed the evidence on blood culture contamination and simulation as an educational tool. Studies on blood culture contaminations revealed that technique and knowledge of collection was a clinical problem. Studies on simulation revealed that educational in-services using simulation can improve skills and quality improvement in the clinical area. The review of the literature focused on assessing the problem, blood culture contaminations, and improving the knowledge base for professionals regarding the use of simulation as an evidence-based technique to improve quality care.

Chapter Three: Methodology

This chapter presents a discussion of the design, setting, and sample for this study of simulation for reinforcing blood culture collection processes in the emergency department. This is followed by a detailed description of the procedures for data collection and the instrumentation for this study. Finally, discussion of proposed data analysis and the protection of human subjects are presented.

Design

This was a one-group before-and-after cohort study to determine the effects of simulation reinforcement of collection processes for blood cultures on the rate of contamination of blood cultures drawn by nurses in an emergency department.

Setting

The setting was a 764-bed community based Level II trauma medical center in the southeastern United States. The mission of the medical center is to meet the healthcare needs and exceed the service expectations of the community it serves and its vision is to be the provider of choice for healthcare services in the area and a leader for promoting optimal health for area residents. The 24-hours emergency department includes the area's only Level II Trauma Center and the only pediatric emergency department. The medical center also has "fast track" services for less critical injuries.

The emergency department consists of 60 beds and currently employs 92 nurses. The emergency department is divided into seven pods, each of which consists of twelve beds staffed by four nurses, a physician, and a secretary. Approximately 250 blood

cultures are drawn monthly in the emergency department. The only non-phlebotomist personnel who draw blood cultures in the emergency department are the nurses.

Table 3.1 presents information on blood culture draws and contamination rates obtained prior to simulation intervention. The collection period prior to simulation was August 2010 through October 2010.

Table 3.1
Blood Culture Contamination rates: 08/01/10-10/30/10

Collection Period	# of Blood Cultures Collected by Nurses	Contamination Rate
08/01/10 – 08/31/10	362	3.3%
09/01/10 – 09/30/10	379	2.9%
10/01/10 – 10/31/10	309	3.6%

Sample

A voluntary convenience sample of 50 nurses from the emergency department were recruited for the study. Inclusion criteria were nurses who collect blood cultures on adult clients. Nurses working in the psychiatric pod were excluded since these nurses do not collect blood cultures. Pediatric blood cultures were also not considered, because the protocol for blood collection differs for children. At the time of recruitment, there were approximately 92 nurses who worked in the emergency room, 75 of whom met the inclusion criteria. Therefore, 66.6% of the eligible nurses participated in the practice change.

Procedures

Recruitment and Consent of Nurses

Subjects were recruited for the study by email from the educational coordinator at the medical center and a memorandum in the nurses' lounge. The email invitation may be found in Appendix C and the memorandum may be found in Appendix D. The principal

investigator (PI), met individually with persons interested in participating in the study, explained the study in detail, solicited written informed consent (see Appendix E) to participate, and administered the pretest.

Participants were then scheduled at their convenience to attend simulation in-service classes. These classes were scheduled at various times of the day and on multiple days of the week in an effort to accommodate all interested nurses. The posttest was administered at the end of the simulation in-service class and again one-month later.

Data Collection Instruments

Data collection instruments included a pretest and posttest. The pretest (see Appendix F) was designed by the PI to collect demographic data and to evaluate the participant's knowledge of the current evidence-based blood culture collection procedures at the facility. Demographic data, included the gender, age, education, and experience of the participants. The knowledge test consisted of 15 questions on the medical center's current policy and procedure for blood culture collection. The knowledge questions were developed by the PI and reviewed for face and content validity by the nurse educator in the emergency department, quality assurance personnel at the medical center, and the PI's academic advisor.

The posttest (see Appendix G) consists of 20 questions. The first 15 questions are the same knowledge questions asked on the pretest. The last 5 questions were related to satisfaction with the simulation class. The satisfaction questions were developed by the PI and reviewed for face and content validity by the nurse educator in the emergency department, quality assurance personnel at the medical center, and the PI's academic advisor.

Blood Culture Contamination Rates

Blood cultures are collected and sent to the microbiology department. The blood culture is placed in the BACTEC™ 9240 system for 24 hours, which is an incubator to determine organism growth. After 24 hours, if the culture identifies an organism, the technician places the culture through a microscan procedure, which identifies the organism. If the organism identified is *coagulase- negative staphylococci* or *staphylococcus epidermidis* a false-positive culture is established.

The manager of microbiology uses a daily study worksheet to monitor blood culture collections. Specimen number, time, person collecting specimen and results of culture are recorded daily. Monthly statistics on blood culture contamination rates are retrieved from the MEDITECH, Bactec™ system at the hospital. This system calculates contamination rates throughout the hospital. The manager of microbiology differentiates this data to identify where, when, and by whom the cultures were collected. The contamination rates and area of the hospital where the culture was collected are then disseminated to the appropriate departments.

Intervention

Participants were scheduled at their convenience to attend a one on one 30-35-minute simulation in-service class. During the simulation in-service class, the PI reviewed the current policy and procedure for the collection of blood cultures peripherally and from a vacular catheter utilizing a Laerdal simulator, a blood collection simulator that allows for access to a vascular device, porta-A-cath, Pic line, and actual collection of simulated blood (red-colored water).

The participants then performed a return demonstration of the correct procedure utilizing the simulator. After the return demonstration the PI held a debriefing session on the participant's performance and repeated the demonstration if necessary. Each participant received a copy of the current policy (see Appendix G) on blood culture collection and was instructed on where to find the policy if needed. The posttest was administered one month after simulation classes to assess retention of knowledge on the correct policy and procedure for the collection of blood cultures.

Protection of Human Subjects

Institutional Review Board approval was granted by the University of North Florida Institutional Review Board. Permission to conduct this study at the medical center was obtained from the director of the emergency department, the head of cardiology, Liberty research, and oversight research committee. All participants provided written informed consent prior to participation, and each person in the study was given a study code number, which was recorded on each form completed (e.g., demographic form, pretest, and both posttests). A master list of study participants with their associated study code number was generated in order to be able to track study participants' data from one data collection point to the next. Aggregated blood culture contamination rates for the emergency department were retrieved from quality assurance personnel and reviewed by the PI and the nurse educator from the emergency department.

Chapter Four: Results

This chapter presents the results of this evidence-based practice change aimed at decreasing blood culture contamination rates in the emergency department. The chapter begins with a description of the sample. This is followed by discussion of the pretest and posttest data relative to scores on the knowledge test and the impact of the intervention on blood culture contamination rates.

Sample

There were 50 nurses who participated in the study, representing 66.67% of potential participants. The participants were primarily female registered nurses employed full-time in the emergency department. The average age of the participants was 42.26 (range 23 to 68; SD 11.19). Tables 4.1 and 4.2 depict the demographic and work-related characteristics of the sample.

Thirty-four nurses completed the study through the second post-intervention data collection point. There was one death and twelve others left the unit and were no longer available. Three nurses did not retake the posttest. The overall attrition rate was 32% .

Knowledge

Pretest and posttest Results

Fifty nurses completed the pretest and the first posttest given immediately after the simulation training. The average score on the pretest was 9.9 out of a possible 15 (66%). The range of scores was 7 to 13, with a standard deviation of 1.53. The average score on the posttest immediately following the simulation experience was 13.14 out of a

Table 4.1

Demographic Profile

Characteristic	N	%
Gender		
Female	47	94%
Male	3	6%
Title		
Registered Nurse	48	96%
Licensed Practical Nurse	2	2%
Nurse Practitioner	0	0
Highest Level of Education		
Some College	1	2%
Associate's Degree in Nursing	32	64%
Bachelor's Degree in Nursing	14	28%
Master's degree	0	0%
Other	3	6%
Employment Status		
Full-time	45	90%
Part-time	5	10%
Previous Experience with Simulation		
Yes	26	52%
No	24	48%

Table 4.2

Work-related Profile

Characteristic	Mean	Standard Deviation	Minimum	Maximum
Number of years of experience as a nurse	14.44	10.63	1	34
Years of experience as an emergency room nurse	9.4	8.52	1	30
Length of Employment in this emergency department	6.84	5.98	1	29

possible 15 (87.6%). The average ranges of scores were 10 to15, with a standard deviation of 1.33.

Thirty-four nurses completed the posttest one month following the simulation. There was one death and twelve others left the unit and were no longer available. Three other nurses did not take the second posttest and stated that they already did a posttest. The average score on the posttest one month following the simulation experience was 13.32 out of a possible 15 (88.8%). The range was 10 to 15, with a standard deviation of 1.32.

ANOVA revealed a significant difference in the scores, with $F = 7.843$ ($p = .001$). Post-hoc analysis using Scheffe revealed that there was a difference in scores between the pretest and posttest 1, but not between posttest 1 and posttest 2. Chi square analysis revealed a difference in scores by the nurse's title ($p < .05$) but not by gender, employment status, education, or length of experience.

Areas of Knowledge

Item-by-item analysis of knowledge gain showed that there was significant gain in knowledge from the pretest to the immediate posttest on 9 of the 15 items and on 1 of the 15 items from posttest 1 to posttest 2 (see Table 4.3). There was one area in which the scores were lower at posttest 1 than on the pretest: the time to wipe the end of the catheter prior to drawing the blood. There was also one area in which the posttest score at time two was lower than the posttest scores for time one: blood cultures should always be drawn first if other tests are required.

Table 4.3

Item-by-item Analysis of Knowledge Gain

Item	Percent Correct			McNemar	
	pretest N=50	post-1 N=50	post-2 N=36	pre/ post-1	post-1/ post-2
Blood specimens for culture should be obtained from two separate venipuncture sites.	94%	100%	100%	NS	NS
Peripheral unsuccessful attempts should be no greater than four.	50%	70%	90%	$p < .05$	NS
Complete set of blood culture bottles should be sent to lab all at the same time within 1 hour after specimen collection.	76%	100%	100%	$p < .05$	NS
Venipuncture sites used for collection of blood cultures should be scrubbed with chloroprep for 30 seconds.	26%	90%	94%	$p < .05$	NS
After prepping the site, you should allow it to dry for 15 minutes before attempting to collect blood.	90%	100%	100%	NS	NS
Blood for cultures may be removed from a vacutainer and injected into a blood-culture bottle.	46%	68%	88%	$p < .05$	$p < .05$
If blood cultures are ordered x2, an acceptable time limit between each culture is 15 minutes.	28%	82%	100%	$p < .05$	NS
Blood cultures may be obtained through a vascular catheter device.	86%	96%	100%	$p < .05$	NS
If collecting blood for cultures from a vascular catheter device a sterile cap is placed on the male end of the IV administration tubing and the female luer is vigorously scrubbed with an alcohol wipe.	68%	94%	96%	$p < .05$	NS
Thirty seconds is an acceptable amount of time to wipe the end of the vascular catheter for before collecting blood.	86%	74%	86%	$p < .05$	NS
The first blood drawn from the vascular catheter should be wasted.	40%	98%	98%	$p < .05$	NS
Blood may be drawn from a vascular catheter with a vacutainer.	50%	78%	90%	$p < .05$	NS
Four ml is an appropriate amount of blood to be drawn for each blood culture bottle.	52%	94%	100%	$p < .05$	NS
Blood cultures should always be drawn first if other tests are required.	96%	100%	96%	NS	NS
Nursing assistants or emergency room technicians are authorized to collect blood cultures.	94%	98%	100%	NS	NS

Blood Culture Contamination Rates

The blood culture contamination rates varied across the length of the study (see Table 4.4). The combined contamination rate for the three months prior to the intervention was 3.3%. During the two months that the intervention was being delivered, the overall contamination rate was 4.0%. The combined contamination rate for the three months subsequent to the intervention was 3.7%. The difference in contamination rates was not statistically significant. Data from the next two months showed a decrease in contamination rates for April to 2.8% and a further decrease in May to 1.2%.

Table 4.4

Blood Culture Contamination Rates 08/01/10-03/30/11

Collection Period	# of Blood Cultures Collected by ED Nurses	Contamination Rate
Pre-intervention Period (Average 3.3%)		
08/01-08/31	362	3.3%
09/01-09/30	379	2.9%
10/01-10/31	309	3.6%
Intervention Period (Average 4%)		
11/01-11/30	364	3.3%
12/01-12/31	446	4.7%
Post-intervention Period (Average 3.7%)		
01/01-01/31	550	3.8 %
02/01-02/28	534	3.6%
03/01-03/31	520	3.7%
Post-study Period (Average 1.5%)		
04/01-04/30	467	2.8%
05/01-05/31	432	1.2%

Participant Evaluation of Simulation Experience

Participants evaluated the simulation class as very helpful (1.16 out of a possible 3, with lower scores indicating a higher perception of the helpfulness of the class). All but one of the participants would recommend future simulation classes for emergency department personnel, and replication of this simulation class for other departments. The overall satisfaction with the class was 1.02 out of a possible 3, with lower scores indicating higher satisfaction.

There were nine responses to the fill-in-the-blank question "What improvements would you recommend for this class?" Four of the nurses responded "none," three responded "great job," one suggested "more time," and one recommended "snacks."

Chapter Five: Discussion

This chapter presents a discussion of results and recommendations related to the evidence-based practice changes needed for blood culture contaminations in the emergency department. The chapter begins with a discussion of the findings related to contamination rates and the impacts of the intervention. It is followed by suggested changes to the current nursing practice in the institution within and beyond the emergency department. Finally a discussion of future research and evidence-based practice are presented.

Findings

Knowledge

As a clinician working in the emergency department, observation of nurse's collecting blood cultures identified a researchable problem for this project. Many nurses did not know the correct procedure for the collection of blood cultures or where to look for the current policy. Working with the hospital nurse educators and laboratory personnel, evidence was identified and utilized to change the existing policy and procedure such that the initial aliquot of blood from vascular catheters should not be discarded (Dwivedi et al., 2009). The revised evidence-based policy for the collection of blood cultures, therefore, included: quarterly tracking of contaminations; use of a blood culture kit, sterile transfer devices, chloroprep skin preparations; collection of two sets of cultures; and use of the initial aliquot of blood from a central venous catheter.

Developing an effective educational intervention for clinicians was implemented to facilitate clinical practice with nationally accepted standards. A one-on-one simulation class was initiated in the emergency department with all willing participants. The use of simulation can improve skills, interventions and supports evidence-based practice (Kaakinen & Attwood, 2009). Educational interventions with the use of simulation can improve provider knowledge with interactive, problem-solving, opportunities to improve quality care in institutions. Using simulation to reinforce theory to practice has been shown to improve skills and critical thinking (Brannan et al. 2008; Radhakrishnan et al., 2007).

The results of this study revealed that the majority of nurses who collect blood cultures in the emergency department did not know the correct collection processes. The use of simulation as a teaching tool provided the learner with hands on experience and the educator's ability to know that the skill had been achieved. Findings regarding the use of simulation as an educational tool were consistent with Brannan et. al. (2008) who found that, learners who engaged with simulation developed better decision making abilities.

Nurses who participated in the educational simulation intervention demonstrated improvement in knowledge of the collection of blood cultures with return demonstrations of the procedure utilizing the simulator. There was a significant difference between the pretest and posttest scores after the use of simulation. A second posttest administered after one month of the simulation intervention revealed retention of knowledge with the procedure of blood culture collections.

The simulation classes were done on a one to one basis with each participant. The consent to participate and the pretest were distributed prior to the simulation class. Each participant was then given the same posttest. Fifty nurses participated in the project. Research findings were consistent with Eskira et al. (2006) who found that special training in skills required through educational one-on-one in-service classes have been shown to lower blood culture contamination rates. The simulation classes recreated a real work situation from which the participants enjoyed and learned. The simulation classes improved knowledge of patient safety and compliance with policy. The emergency department nurses revealed significant knowledge improvement on: complete sets of blood cultures to be sent to the lab within one hour, venipucture site scrubbed with chloroprep x 60 seconds, collection of two sets of blood cultures, not to discard first blood drawn from vascular catheter, amount of blood needed for a blood culture, and to always draw blood cultures first. Many nurses, answered question two wrong. The current policy states that peripheral attempts should be no greater than two, however in the emergency department only the nurses insert intravenous catheters and collect blood specimens. This means that if one nurse is unable to insert the catheter or collect the blood another nurse in the emergency department must attempt the collection.

Blood Culture Contamination Rates

Blood cultures are the best way to determine bacteremia in patients. Identifying the organism and administration of appropriate therapy reduces mortality (Chinniah, 2009). Blood culture contamination rates for the target institution have been over the national bench-mark for the past six years. Target rates for contaminations have been set at 2-3% nationwide. Monitoring contamination rates and education are the key factors in

improving performance (Bekeris et al. 2005). Similarly, Qamruddin, Khanna, and Orr (2008) suggested that the collection technique is the most important factor in contaminated blood cultures. Compliance with hospital policy on the collections of blood cultures has the potential to reduce contamination rates.

During the pre-intervention period of this study (August, September, and October) the mean number of blood cultures collected by emergency department nurses was 350 blood cultures with a mean contamination rate of 3.3%. Simulation classes started in November and ended the week of December 20th. The mean number of blood cultures collected by emergency department nurses' was 405 with a contamination rate of 4%. January, February, and March, 2011, post-intervention period, the mean number of blood cultures collected by emergency department nurses was 535 blood cultures with a contamination rate of 3.7%. The number of blood cultures collected almost doubled, however, the contamination rates remained the same after the simulation classes. Since it is possible that a higher volume of blood cultures could lead to more laxity in procedures, the fact that there was no significant increase in contamination rates with a doubling in volume might be seen as somewhat reassuring. The increase in contamination rates during both the intervention period and the 3 month post-intervention period as well as decrease in contamination rates for April and May (4 and 5 months after the intervention) are interesting to note. According to Bronwyn (2006), these changes are consistent with Kurt Lewin's change management model, which defines three stages: unfreezing, change, and freezing. Unfreezing occurs when there is motivation or an impetus for a change to occur. In this case, the motivation was the realization that the 2009 policy change had not been truly implemented in the organization. The change stage, also referred to as the

movement or transition stage, is actually the process of defining and implementing the change. This can be very uncomfortable, and supports should be in place during this time. It may well be that the initial, albeit small, increase in contaminations were a result of this transition stage of the process – nurses were vacillating between "the way we always did it" and the new policies. It is during the freezing stage that the change becomes stable, perhaps reflected by the decrease in contaminations in months four and five.

According to Chinniah (2009), although the target rates are set between 2-3%, actual blood culture contamination rates throughout most hospitals varies from 6-7%. Similarly, Hall and Lyman (2006) found that blood culture contamination rates have been increasing throughout the years. Blood culture contaminations require a multidisciplinary approach. Monitoring contamination rates, identity of the organism, the number of positive blood cultures in a set, clinical signs and symptoms, source of the culture collected, technology, skin preparation, blood culture collection kits, and most important the process of collection. Bekeris et al. (2005) revealed that hospitals that utilize dedicated phlebotomy teams had significantly lower contamination rates. It was hypothesized that contamination by skin flora was the main indicator for blood culture contaminations. Similarly, Eskira et al. (2006) performed staff education on a one-to-one basis with a full-time infection control nurse, which decreased contamination rates. Improved quality care and an estimated cost avoidance of more than 400,000 annually can be accomplished through education of staff, who collect blood cultures. High turnover rates in nursing personnel, poor skin preparation, and the multitasking of

emergency department nurses are variables that were similarly found in other studies that increased contamination rates (Sheppard et al. 2008; Tepus et al. 2008).

Satisfaction with Simulation

The use of simulation to reinforce the collection process for blood cultures with the emergency department nurses' was educational, interactive, and reinforcing. Utilizing the simulator with each nurse individually enhanced the learning experience by making it interactive. Direct observation of the technique of the nurse after demonstration revealed that the procedure was correct. The simulator was used to collect blood cultures from a peripheral and central vascular site. The nurses expressed that they felt more confident on how to collect cultures, and most important how contaminated blood cultures affect patient care outcomes. The use of the simulator allowed for repeated performances if necessary and actual hands on experience. Increasing the usage of simulation in the clinical area had a positive influence on attitudes, satisfaction, and changing behavior. Educational intervention with simulation is an innovative approach to bridge the gap between theory and reality (King, et. al, 2008). Similarly, Kardong-Edgren et al. (2008) found that simulation enhances problem-solving and decision making.

Radhakrishnan et al. (2007) found that the use of simulation practice improved nurses' performances with procedures. In addition Brannan et al. (2008) concluded that simulation enhances meaning to the practice of nursing by reinforcing behavior and confidence that the procedure is learned and practiced correctly.

The use of simulation to reinforce clinical practice and decision making brings theory to practice. Observation of the correct procedure and return demonstration helps to remember the correct way of performing a technique. Taniguchi et. al. (2007) developed

an educational, simulation program, for medical training on the collection of blood. The participants in this study were extremely satisfied with the use of simulation. The simulation program helped them with the practical skills and delivery of care in a controlled environment. The results of the study suggest that simulation education contributes to quality improvement and patient safety. Studies using simulation need further investigation to measure learning outcomes.

Limitations of the Study

The researcher identified four study limitations: sample, instrument, retention of nurses, and participation in the study. This study was a convenience sample, with data collected from adult patients in the emergency department. Because this study was a convenience sample, it cannot be generalized to the whole hospital. The PI is also a known colleague of all the participants which may have led to bias.

Fifty nurses agreed to participate in the study. Each simulation class including testing took approximately 35 minutes. The intervention with simulation started in November and lasted until the 3rd week of December. One month between the time of intervention and the 2nd posttest, thirteen nurses left the emergency department. The turnover rate and the fact that one-third of the nurses did not participate in the study may have influenced the results.

The pretest and posttest were developed by the principle investigator, nurse educator for the department, quality assurance personnel, manager of the emergency department, and the microbiology department. The test was consistent with the current policy of the hospital. Test-retest reliability was .55 (p = .001). Item analysis using Cronbach's Alpha was .432. Two of the questions may have confused the participants.

Question number four and question number ten were both related to the length of time to prep the site for collection of blood cultures. Question four was related to skin preparation time to cleanse the skin and question number ten was related to the amount of time to clean the vascular catheter site. The participant may have not read the question carefully or may have misunderstood the wording of the question.

One-on-one education with simulation was time consuming, and beyond what could be expected of the hospital nurse educators. Using small group sessions with five to six nurses could be more cost effective in terms of the nurse educator's time as well as that of the participants. Sharing of knowledge from the simulation classes may have occurred which decreased the contamination results in the post-intervention period in April and May.

Recommendations for Practice

The costs of this project were minimal. The simulator that was utilized for instruction belonged to the educational institution at which the researcher is employed and permission was granted for its use for this project. Sustainability of the use of simulation in the emergency department is probable since the researcher is an employee of both facilities. Based on the findings of this project, educational simulation classes on blood cultures and other clinical practices should be recommended as mandatory and continuous throughout the year. Evidence suggests that the cost of contaminated blood cultures can be as great as $400,000 annually for every 1% over the national benchmark. Trained personnel reduced contamination rates in the emergency department by $445,523.80 (Sheppard et al., 2008).Cost savings and improved patient care are priorities in health care.

Simulation as an intervention for verification of correct policy and procedures should be mandatory for all employees to help improve compliance and patient safety at the organizational level. Continuous quality assurance, best practices and patient-centered care is the philosophy of quality care. This study revealed problems with the current policy on blood culture collections. The order for two sets of blood cultures was not clear in the policy. The majority of nurses did not know the procedure and where to locate the policy. The simulation of the procedure reinforced the collection process for blood cultures. The interactive, involvement with simulation assisted the nurse in understanding and seeing the actual results of the problem. Follow-up simulation classes are recommended and the policy has been re-written for clarification of the procedure. The expansion of the simulation classes to other areas of the hospital in the collection of blood cultures is recommended.

Retention of nurses is also a problem for most hospitals, specifically in this institution. The recommendation for this institution is to place a greater emphasis on retaining their current staff. Nurses need support from administration and the opportunity to grow in their career. Offering RNs incentives to receive their bachelor of science in nursing can give them the opportunity to grow in their career. Professional, advancement opportunities, flexible hours, good pay, and opportunities to learn and develop their skills and problem solve, as with simulation has the potential to retain nurses. Strategies like simulation education may have the potential to improve the workplace and patient safety.

Recommendations for Future Studies

Bloodstream infections can cause death in patients. Blood cultures are the "Gold Standard" to identify septicemia. Further studies on the significance of blood culture

contaminations needs to be addressed. Preventative measures to detect contaminated blood cultures and follow-up care are critical to quality care. Effective implemented strategies are needed to decrease contaminated cultures. Research on useful tools, such as simulation, are needed in the clinical work environment. Special training, dedication, skills acquired with repeated practice can decrease contamination rates.

Further research utilizing simulation in the clinical area is needed. Based on this project, nurses were excited and participated fully with the simulation class. The study promoted the use of simulation in the collection of blood cultures. Expansion of this study has the potential to promote the use of this tool in other areas of this institution and other facilities. The continuation of this educational intervention and continuous quality improvement can decrease blood culture contamination rates. This study should be replicated throughout the hospital. Continuously evaluating compliance with the simulation classes and monitoring contamination rates will promote improved patient outcomes.

Conclusion

The results of this study revealed statistically significant improvements in blood culture collection procedures with the participating nurses as demonstrated in the simulations. Knowledge retention was also statistically significant as revealed by the 2nd posttest results. The same blood culture policy implemented in October of 2009 is still in practice. Incorporating simulation classes with all nurses and procedures routinely can improve quality care for the clients and decrease hospital costs.

Appendix A

Evidence Table for Reduction in Blood Culture Contamination

Author, Date	Design	Sample	Comparisons/Interventions	Results	Conclusions
Malani et al., 2007	Systematic review	3 RCTs 1 CT	Various combinations of povidone-iodine, 70% isopropyl alcohol, tincture of iodine in 47% ethyl alcohol, a preparation of povidone-iodine with 70% ethyl alcohol, chlorhexidine, iodine tincture	No clear evidence to suggest the ideal skin prep	Possible benefit from the use of prepackaged skin antiseptic kits and alcohol-containing antiseptics.
Hall & Lyman, 2006	Systematic Review	161 studies	Updated review of blood culture contaminations 640 institutions 497,134 blood culture specimens (CAP) Q-Probes tracking (quarterly data on blood culture results Reviewed significance, detection, identity, skin preps, overall factors in contaminated blood cultures	The median laboratory in the review had a contamination rate of 2.89% for all cultures. Interquartile range of 2.15% to 3.6% for all patient types.	Coagulase-negative staphylocci main source of contamination Proper aseptic technique and tracking of cultures can decrease contaminations
Chinniah, 2009	Systematic Review The College of American Pathologists (CAP) Q-Probes quality improvement study	Collected data from 40 studies	Reviewed 40 studies to determine identity of organism, proportion of positive blood cultures, number of positive blood cultures within a blood culture set,, time of growth, strategies to reduce contaminations, culture bottle preparation, vascular samples, blood culture kits, technique of collection, and optimal volume for collection	79% of laboratories cited that identifying the organism of growth was the most important factor in determining contamination 15-25% of cultures that identified CoNS were contaminated cultures Blood culture kits decreased contamination rates by 8%	Identifying organism and collection techniques are the most important factors in determining contamination Proper skin preparation, correct aseptic technique, blood culture kits, optimal volume of blood drawn and trained personnel are the most important factors in decreasing blood culture contaminations

Author, Date	Design	Sample	Comparisons/Interventions	Results	Conclusions
Tokars, 2004	Systematic review	Four studies were reviewed and compared	The model utilized 5 parameters to assess CoNS in blood culture collections. These four studies reported paired Blood cultures, one sample from peripheral vein and the other from a central vascular device.	78% of 189 contaminating organisms were CoNS False positive blood cultures from coagulase-negative staphylococcus	When multiple blood cultures are collected CoNS can be determined as the contaminant False-positive blood cultures have negative outcomes for patient and hospital
Archibald et al., 2006	Retrospective, comparative analyses	5 Emergency departments	Compared contamination rates with 5 emergency departments	Of 54 microorganisms isolated 26 (48%) were identified as skin contaminants	Aseptic skin cleansing and improved venipuncture techniques decreased contamination rates improved rates
Eskira et al., 2006	Comparative post-intervention educational intervention	1420 blood cultures obtained from 6 departments	The intervention was performed by an infectious disease nurse An educational in-service was initiated on a 1:1 basis	Base-line contamination rates were5.7%- 7.1% Post educational intervention reduced contamination rates ($p<0.001$)	Educational in-service reduced blood culture contaminations and was considered cost-effective All personnel collecting blood cultures should have up-dated educational classes on correct policy and procedure. Review of evidence-based research on collection processes to be implemented in practice

Author, Date	Design	Sample	Comparisons/Interventions	Results	Conclusions
Bekeris et al., 2005	Longitudinal cohort study	356 clinical laboratories	Measured blood culture contamination rates for practice patterns from 1999-2003. Compared dedicated phlebotomists to non-laboratory personnel collecting cultures	Participation in tracking contaminations reduced rates by the 5th year by 0.67% (p<.001) Blood culture contamination rates significantly higher with non-laboratory person collecting blood(p<.001), Longer participation in the Q-Tracks (Monitoring of contaminations) p< .001, decreased contamination rates	Experience in proper collection and long-term monitoring of culture rates associated with < contaminations
Sheppard et al., 2008	Base-line 2-arm intervention, prospective, observational study	A phlebotomist dedicated to the ED collected specimens for 3 months. TAT's (total turn-around time) compared(TAT) data was composed of 3 districts) 2,986 blood cultures collected	Compared phlebotomist to non-phlebotomists on blood culture collections and length of stay in the emergency department	Blood culture contamination significantly reduced from baseline p=.001 Blood culture contamination rates decreased from 5.0% to 1.1%	Trained personnel reduced contamination rates in the ED Reduced contaminations cost analysis $445,523.80.
Kiyouama et al., 2009	Prospective, nonrandomized partially blinded study	5,653 blood samples for culture	• Skin antisepsis performed with 70% isopropyl alcohol plus povidone-iodine on all inpatient wards • Skin antisepsis performed with 70% isopropyl alcohol in the emergency department.	No significant difference (p = .8)	The type of antiseptic used may not be as important as the use of proper technique
Dwivedi et al., 2009	Laboratory comparison	653 intravenous catheter-drawn blood culture pairs	• 1st 10 mL directly inoculated on aerobic culture medium (rather than discarded) • 2nd 10 mL inoculated on anaerobic culture medium • 3rd 10 mL inoculated on aerobic culture medium	No significant difference (p = .9)	No need to discard the initial blood

Author, Date	Design	Sample	Comparisons/Interventions	Results	Conclusions
Esel et al., 2003	Prospective, comparison study	567 blood cultures	Determine rate of contamination, compare contamination rates	The rate of true bacteremia was 12.1 %, 10.7% of the cultures were contaminated Coagulase-negative staphylocci common contaminant	Hospital contamination rates were too high Training of staff was indicated and utilization of blood culture kits
Tepus et al., 2008	Comparison study	Emergency department	Comparison of 2% chlorhexidine and 70% isopropanol	Significant decrease in contamination rates with 2% chlorhexidine	Poor skin preparation main cause of contamination expected savings per year $875000
Bamber et al., 2009	Comparison study	100 blood cultures were examined. Monthly tracking of blood culture contaminations in an emergency department	Compared before and after the utilization of introducing blood culture kits and a new tracking system (Bact/Alert) to reduce contaminations	Monthly tracking & blood culture kits reduced contamination rates from 43% to 25%	Blood culture kits reduced contamination rates Coagulase-negative staphylocci most common contaminant identified This study also revealed that units, such as the ED, where the nurses are under pressure revealed higher contamination rates
Gander et al., 2009	Prospective comparison trial	2, 642 patients 13 month collection in an emergency department 5,432 blood cultures collected	Contamination rates were compared between phlebotomists and non-phlebotomists collecting blood cultures	Contamination rates collected by phlebotomists significantly lower ($p<0.001$) than non-phlebotomists	Utilizing phlebotomists decreased contamination rates Projected costs reductions in patient charges approximately $4.1 million per year

Author, Date	Design	Sample	Comparisons/Interventions	Results	Conclusions
Norberg et al., 2003	Observational, comparison study	4108 blood cultures	All blood cultures drawn by emergency department registered nurses. Baseline phase, blood obtained simultaneously with intravenous catheter insertion. Post-intervention phase, blood collected from dedicated procedure, venipuncture.	False-positive rate decreased from 9.1% to 2.8% (p<.001)in the post-intervention phase	Blood culture contamination rates were lower when specimens were drawn from a separate site compared to newly inserted intravenous catheter
Traunter, et al., 2002	Prospective, blinded clinical trial	215 patients 430 blood cultures	Compared 2% chlorhexidine in one blood culture kit and 70% isopropyl alcohol.	No significant difference (p=.6)	Possible benefit from utilization of prepackaged blood culture kits
Donnino et al., 2007	Descriptive Anonymous Survey	360 employees whom collect blood cultures	Survey consisted of knowledge on policy and procedure of collection of blood cultures, volume of blood needed for culture	355 responded 44% answered less than 5ml. 79% did not know correct procedure	High percentage of health care professionals collecting blood do not know the correct procedure
Weddle et al., 2010	Descriptive	Nurses collecting blood cultures	Role of nursing units on performance of phlebotomy and blood culture contamination rates	Educational in-services when contamination rates are greater than 3%	When contamination rates are greater than 3% educational in-services should be implemented
Smart et al., 1993	Descriptive study	Emergency department	Effects of needle changing on blood culture contamination rates	Changing needles on transfer of blood to bottle had no significant change in contamination rates	Proper technique in collection and decreasing steps in transferring blood to bottles may decrease contamination rates
Ernest 2001	Descriptive analysis of 10 studies	N=10	Evidence on proper collection of blood cultures to decrease contamination rates	Evidence-based research on collection of blood cultures	Proper technique decreases contamination rates

Appendix B

Evidence Table Regarding Simulation as a Learning Tool

Author, date	Design	Sample	Comparisons/Interventions	Results	Conclusion
Kaakinen & Attwood, 2009	Systematic Review	120 articles retained from 650 articles, for analysis	The review of simulation had two purposes: one to determine if nurse educators view simulation as a learning opportunity and second was to determine how learning was used to design simulation	Two studies in the review revealed: Aliner et. al, 2004 utilized a pre-test, post-test, on 120 nursing students. Results indicated that student's scores improved by 6.7 %after simulation exercises, similarly Wong et. al, utilized simulation as a different learning environment with 20 nursing students and revealed that simulation was helpful in evaluating thinking and development skills	The Systematic analysis of nursing simulation examined teaching and learning as the focus of the review Teaching-is what the educator provides the student in terms of goals, methods, objectives, and outcomes Learning- refers to the process by which the student changes skills, knowledge, and dispositions through planned experience Learning based simulations enhances critical problem-solving

Author, date	Design	Sample	Comparisons/Interventions	Results	Conclusion
Issenberg et al., 2005	Systematic review	Systematic literature review on high-fidelity simulators 670 articles reviewed, 109 studies retained for analysis	Qualitative data synthesis, research methods, and outcomes were presented An eight step pilot phase was done to synthesis the research review *BEME invitation*: examined features of simulation that lead to effective learning. A topic review group was formed by experts in the field of simulation to review data Conceptual issues and effective learning were evaluated	Providing feedback was the most important feature of simulation (47%) followed by repetitive practice (39%), and curriculum integration (25%)	Simulation leads to effective learning Provides feedback, practice, controlled environment, and clearly defines outcomes
Brannon et al., 2008	Prospective, quasi-experimental, pre-test, pos-test comparison group	107 baccalaureate nursing students	Compared simulation classes to traditional teaching methods (lecture) The AMIQ-tool 20 item questionnaire measured cognitive skills and was developed by the faculty	Students that received simulation scored significantly higher bon the AMIQ post-test and had a higher (but not significantly higher) confidence level than students that received traditional teaching methods	The study revealed that actively engaging the participants may be useful for learning and retaining content Students that engaged in simulation exercises compared to traditional teaching methods scored significantly higher on the AMIQ
Radhakrishnan et al., 2007	Quai-experimental comparison pilot study	N=35 Senior BSN students	Compared simulation classes to traditional teaching methods (lecture) Faculty developed tool-CSET Clinical Simulation Evaluation Tool	Students in the simulation group scored higher on the CSET on safety($P<0.001$)and basic assessment scores ($P<0.009$)	Use of simulation practice was linked with better performance in clinical situations

Author, date	Design	Sample	Comparisons/Interventions	Results	Conclusion
Kardong-Edgren et al., 2008	Prospective, descriptive, repeated measures design	100 B SN students	Students experienced simulation classes EPQ- Educational Practices Questionnaire (measures best practices in simulation utilization) SDS-The Simulation Design Scale (evaluates the implementation of the best simulation design elements)	The EPQ revealed that students perceived that best practices, active learning with simulation scenarios was a collaborate and diverse way of learning. Problem-solving and feedback were rated high with the students using the SDS scale A creative environment was a positive feedback identified by the faculty Student satisfaction and self-confidence remained high throughout the semester Repetitive practice with simulation was a positive outcome with the use of simulation	Students supportive of simulation experiences Active learning, collaboration, diverse ways of learning, and high expectations were achieved with each scenario
Taniguchi et al., 2008	Comparison educational pilot study	Simulator exercise sessions compared to no simulation N=43 medical students	Educational program utilizing simulation on phlebotomy Survey 1-5 5 highly satisfied	Results of this study revealed that the participants were highly satisfied with the training program using simulation for phlebotomy	Simulation on phlebotomy enhanced skills and techniques

Author, date	Design	Sample	Comparisons/Interventions	Results	Conclusion
King et al., 2008	Two-phase study The theory of Planned Behavior	34 ADN faculty	Survey (47-item survey) faculty's intent to use simulation as a learning tool.	The results of this study had two hypothesis: The faculty identified that simulation is an effective educational tool and needs to incorporated into the learning system Secondly, what was the effect of simulation on intent to use The educational intervention had a positive significant effect ($p<0.5$) on all constructs (attitudes, intent to use, and opinions about simulation	Simulation had a positive influence on faculty and nurses
Tsai et al., 2006	Pre-test, post-test control group design	N=82 novice nurses	Computer-assisted protocol using virtual reality	Port-A catheter injection knowledge test (10 questions) $P < 0.001$	Simulation of technique increased knowledge in clinical skills

Appendix C

E-mail Invitation to Participate

E-mail invitation and vocera announcement

Vocera Announcement -A voluntary simulation class on the collection of blood cultures will be offered at HMC emergency room's classroom by Debbie Christeleit.

You are invited to participate in an evidence-based project entitled "The Use of Simulation to Reinforce Collection Processes for Blood Cultures: An Educational Model for Quality Improvement", supervised by Debbie Christeleit. The purpose of this study is for research and will take approximately 30 minutes of your time. A voluntary simulation class on the collection of blood cultures will be offered at HMC emergency room's classroom. All participants must be over the age of 18 to participate. The voluntary class and data collection will be conducted in the emergency room education classroom. A pre-test and post-test will be administered with the in-service. The class should take approximately 30 minutes. A second post test will be given one month after the simulation class. Classes will be conducted at your convenience. There is no compensation for participation in this research study, but your time is greatly appreciated. There are no foreseeable risks to you for participating in this research study. Thank-you, Debbie Christeleit.

Debbie Christeleit MSN

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Appendix D

Memorandum Nurses' Lounge

Attention Emergency Room Nurses

Be a Participant in a Quality Improvement Trial

The Medical Center Oversight Committee, Liberty IRB, & University of North Florida IRB Approved

Educational in-service utilizing simulation on blood culture collection policy and procedure

Confidential results and requires only 30 minutes

About the Trial: This is a voluntary quality improvement study to determine the effects of simulation reinforcement of collection processes for blood cultures on the rate of contamination of blood cultures drawn by nurses in an emergency room. The class and data collection will be conducted in the emergency room education classroom. There are no foreseeable risks to you for participating in this research study. All participants must be over the age of 18 to participate.

How to participate: All emergency room nurses that draw adult blood cultures are invited to participate. The purpose of this study is for research. The study will take approximately 30 minutes of your time. Employees will be provided information to sign up for simulation classes scheduled at their convenience. The process includes a simulation class on blood culture collection, a pretest and posttest. A second post-test will be given one month after simulation in-service class. There is no compensation for participation in this research study, but your time is greatly appreciated.

The class will be conducted by Deborah Christeleit, for additional information contact 386-481-2387 christeleitd@cookman.edu

Appendix E: Informed Consent

Study Title: The use of Simulation to Reinforce Collection Processes for Blood Cultures
Investigator: Deborah Christeleit, RN, BSN, MSN
University of North Florida (UNF) Doctoral Student

I am currently a student in the Doctor of Nursing Practice program at the University of North Florida under the direction of Dr. Kathaleen Bloom, my faculty advisor. As part of my studies at UNF, I am very interested in the use of simulation as an educational method of instruction for quality improvement in nursing practice. I have chosen to investigate whether the use of simulation in nursing in-service education programs on blood culture collection policies will improve blood contamination rates in the emergency department at the Medical Center.{This is a research study on the effects of simulation as an educational tool to improve quality care.}

If you choose to participate, you will be asked to complete a brief questionnaire including questions about yourself and your knowledge of blood culture collection procedures. Participants must be over the age of 18 years old to participate. It will take approximately 5-7 minutes to complete each questionnaire and approximately 10 minutes to participate in the simulation class}.You will be scheduled for the 30-minute in-service education class at your convenience. You will be asked to complete a questionnaire at the conclusion of the class and again one-month later. Information on overall blood culture contamination rates for the emergency department will be obtained from clinical laboratory quality assurance personnel.

Your participation in this study is voluntary, that is, you are under no obligation to participate. You can decide to stop participating in the study at any time. The benefits to you for participating in the study are an increase in knowledge and skill at collecting blood cultures that are usable in determining the course of treatment for your patients. There is no payment for participating in the study. {There are no foreseeable risks to you for participating in this study.} Participation in this study will not affect your employment, and declining to participate will have no penalty or loss of benefits at the medical center.

Your personal information will remain strictly confidential. Your name will not be associated with the results in any way. Each person in the study will be given a study code number, which will be recorded on each form completed. Deborah Christeleit and Dr. Bloom will be the only persons with access to that study code number. Once the study is finished, and information is analyzed, all forms will be destroyed. Information from this study may be presented at professional meetings and may be published in professional journals. However, your name and other identifying information will not be used.

If you have any questions or concerns regarding the study or your participation in the study, you may contact me, Deborah Christeleit, at (386) 675-7293 or Dr. Kathaleen Bloom, Professor of Nursing at UNF, at (904) 620-2684. If you have any questions regarding the rights of research subjects, you can contact Dr. Katherine Kasten, UNF Institutional Review Board at (904) 620-2498.

CONSENT TO PARTICIPATE

I acknowledge that I have been informed of the nature and purposes of this study by Deborah Christeleit; that I have read and understand the information presented above; and that I have received a copy of this form for my records. I give my voluntary consent to participate in this study.

Name of Participant	Signature of Participant	Date
Deborah Christeleit		
Name of Investigator	Signature of Investigator	Date

Appendix F

Pretest

The Use of Simulation to Reinforce Collection Processes for Blood Cultures Pretest

Investigator: Deborah Christeleit MSN

Date _____ Subject # _____

Demographic Data

Age: _____

Gender: ❑ Female ❑ Male

Title: ❑ LPN ❑ RN ❑ NP

Highest Level of Education:

❑ High School ❑ Some college but no degree

❑ Associate degree in nursing ❑ Bachelor's degree in nursing

❑ Master's degree in nursing ❑ Other _____

Employment Status: ❑ Part-time ❑ Full-time

Number of years of experience as a nurse _____

Years of experience as an emergency room nurse _____

Length of employment at this Medical Center's Emergency Department _____

Previous experience with simulation: ❑ Yes ❑ No

Blood Culture Collection

Please answer these True/False questions regarding blood culture collection policies.

1. Blood specimens for culture should be obtained from two separate venipuncture sites.
   ❑ True ❑ False

2. Peripheral unsuccessful attempts should be no greater than four.
   ❑ True ❑ False

3. Complete set of blood culture bottles should be sent to lab all at the same time within 1 hour after specimen collection.
   ❑ True ❑ False

4. Venipuncture sites used for collection of blood cultures should be scrubbed with chloroprep for 30 seconds.
   ❑ True ❑ False

5. After prepping the site, you should allow it to dry for 15 minutes before attempting to collect blood.
   ❑ True ❑ False

6. Blood for cultures may be removed from a vacutainer and injected into a blood-culture bottle.
   ❑ True ❑ False

7. If blood cultures are ordered x2, an acceptable time limit between each culture is 15 minutes.
   ❑ True ❑ False

8. Blood cultures may be obtained through a vascular catheter device.
   ❑ True ❑ False

9. If collecting blood for cultures from a vascular catheter device a sterile cap is placed on the male end of the IV administration tubing and the female luer is vigorously scrubbed with an alcohol wipe.
   ❑ True ❑ False

10. Thirty seconds is an acceptable amount of time to wipe the end of the vascular catheter for before collecting blood.
    ❑ True ❑ False

11. The first blood drawn from the vascular catheter should be wasted.
    ❑ True ❑ False

12. Blood may be drawn from a vascular catheter with a vacutainer?
    ❑ True ❑ False

13. Four ml is an appropriate amount of blood to be drawn for each blood culture bottle.
    ❑ True ❑ False

14. Blood cultures should always be drawn first if other tests are required.
    ❑ True ❑ False

15. Nursing assistants or emergency room technicians are authorized to collect blood cultures.
    ❑ True ❑ False

Appendix G

Posttest

The Use of Simulation to Reinforce Collection Processes for Blood Cultures Post-test

Investigator: Deborah Christeleit MSN

Date _____ Subject # _____

Blood Culture Collection

Please answer these True/False questions regarding blood culture collection policies.

1. Blood specimens for culture should be obtained from two separate venipuncture sites.
   ❑ True ❑ False

2. Peripheral unsuccessful attempts should be no greater than four.
   ❑ True ❑ False

3. Complete set of blood culture bottles should be sent to lab all at the same time within 1 hour after specimen collection.
   ❑ True ❑ False

4. Venipuncture sites used for collection of blood cultures should be scrubbed with chloroprep for 30 seconds.
   ❑ True ❑ False

5. After prepping the site, you should allow it to dry for 15 minutes before attempting to collect blood.
   ❑ True ❑ False

6. Blood for cultures may be removed from a vacutainer and injected into a blood-culture bottle.
   ❑ True ❑ False

7. If blood cultures are ordered x2, an acceptable time limit between each culture is 15 minutes.
   ❑ True ❑ False

8. Blood cultures may be obtained through a vascular catheter device.
   ❑ True ❑ False

9. If collecting blood for cultures from a vascular catheter device a sterile cap is placed on the male end of the IV administration tubing and the female luer is vigorously scrubbed with an alcohol wipe.
   ❑ True ❑ False

10. Thirty seconds is an acceptable amount of time to wipe the end of the vascular catheter for before collecting blood.
    ❑ True ❑ False

11. The first blood drawn from the vascular catheter should be wasted.
    ❑ True ❑ False

12. Blood may be drawn from a vascular catheter with a vacutainer?
    ❑ True ❑ False

13. Four ml is an appropriate amount of blood to be drawn for each blood culture bottle.
    ❑ True ❑ False

14. Blood cultures should always be drawn first if other tests are required.
    ❑ True ❑ False

15. Nursing assistants or emergency room technicians are authorized to collect blood cultures.
    ❑ True ❑ False

Simulation Learning Experience

16. How helpful do you believe that this simulation class on blood culture collection procedure was?
    ❑ Very helpful ❑Somewhat helpful ❑ A little helpful ❑Not helpful

17. Would you recommend future simulation classes for reinforcement of policy and procedures in clinical practice?
    ❑Yes ❑No

18. What improvement would you recommend for this class? _____
    _____

19. Would you recommend this class for other departments? ❑Yes ❑No

20. Overall satisfaction with this class. ❑Excellent ❑Good ❑Fair ❑Poor

Appendix H

Blood Culture Policy

Blood culture contamination is a frequent problem for hospitals, accounting for up to 50% of positive cultures. The technique used in collecting blood cultures is the most important factor in contamination rates. Blood culture contaminations directly impact patient care outcomes, hospital staff, health care costs, and length of stay for patients. Although it is impossible to eliminate all contamination, interventions to reduce the rate of contamination can improve quality care for clients and reduce hospital costs. Among these interventions are adequate training of personnel in blood culture collection, blood collection from separate venipuncture sites, and tracking of blood culture contamination in nursing units. Contaminations can add $4,100 to the cost of treatment and $8,000 to the patient's bill. Blood culture contamination rates >3% can cost the hospital over $400,000/year!

Peripheral Blood Culture Sites

1. Utilize blood culture kits
2. Chloroprep scub to site and scrub for 60 seconds
3. Allow to dry for 30 seconds
4. Perform stick and aspirate blood
5. Transfer blood into each bottle with transfer device and fill to line, 8-10 ml of blood is the recommended amount never less than 5ml blood
6. Blood cultures are always drawn first
7. Never remove blood from a vacutainer
8. Blood cultures are times 2 sites (2 sets of blood cultures are always to be drawn)
9. Blood specimens for culture should be obtained from blood draws from separate venipuncture sites. The sites are 5 minutes apart. If same site is used wait 30 min between specimens
10. Peripheral unsuccessful attempts no greater than 2.
11. Complete set of blood cultures will be sent to lab all at the same time within 1 hour after collection.

Vascular Catheter Blood Culture Aspiration

1. With an alcohol swab wipe vigorously for 5 seconds, female luer, white area, of positive pressure valve.
2. DO NOT WASTE first blood drawn
3. Attach empty syringe and aspirate 5 ml of blood
4. Transfer blood with transfer device into each culture bottle

Flush catheter with 5 ml normal saline followed by heparin

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Curriculum Vitae

Deborah Christeleit was born in Jersey City, New Jersey in 1962 and raised in North Bergen, New Jersey. She graduated from Christ Hospital School of Nursing in 1985, received her Bachelor of Science degree in 1995 from New Jersey City University with a major in nursing. In 1998, Mrs. Christeleit was awarded a Master of Nursing degree from New Jersey City University.

Mrs. Christeleit has been in clinical practice for 26 years and a nurse educator for 11 years. She worked in Christ Hospital as a medical surgical, critical care, emergency department nurse, and emergency department manager full-time. She was an adjuunct instructor at New Jersey City University teaching research, and Christ Hospital critical care clinicals, after graduating with her Masters degree while living in New Jersey. Mrs. Christeleit moved to Florida in 2005 and worked at Halifax Medical Center full-time as a trauma nurse. She currently works at Bethune Cookman University full-time as an instructor for Adult Health, Junior level coordinator, Director of simulaion lab, Director of RN-BSN on-line program, and teaches on-line classes. Mrs. Christeleit, her husband Franklin, two daughters, Christine and Darlene started a farm when they moved to Florida. She currently has 9 horses, 2 cows, 3 goats, 1 pig, 3 dogs, and 3 birds.