BLENDED VS. LECTURE LEARNING: OUTCOMES FOR STAFF DEVELOPMENT

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By

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ABSTRACT

BLENDED VS. LECTURE LEARNING: OUTCOMES FOR STAFF DEVELOPMENT

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Knowledge of pharmacology is crucial to safe patient management for nurses orienting to critical care areas. Traditionally this education has been offered as a classroom lecture for new nurses. However, adult learning theory identifies the benefit of self-directed, self-paced learning to build on individual knowledge and experience. A review of prior research indicates a lack of studies considering alternative teaching methods for nursing continuing education. The intent of this study was to provide experimentally derived evidence relating to the effectiveness of blended (online with discussion) vs. traditional lecture format education.

To examine learning outcomes, nurses new to critical care were randomized into a blended or lecture format with subsequent cognitive knowledge outcomes compared using a pretest, posttest design. Demographics were obtained from participants and analyzed to determine their impact related to the method of learning. In addition, effectiveness of each format was evaluated by the learner using a Likert scale survey and small focus group discussions.

Results indicate no statistically significant difference in learning outcomes between the blended and lecture formats. Further, test results were equivalent regardless of participant age, gender, nursing experience, degree or prior online learning experience.

A focus group comparison of satisfaction with teaching methods indicates overall positive findings for both blended and lecture learning. However, more positive themes were expressed by the blended group participants, especially relating to convenience, self-pacing and use of time.

Implications include the opportunity to provide effective staff development education in blended or lecture format based on class availability, student choice, learning style, prior experience, unit requirements and desire for flexibility. Further considerations include cost-effectiveness of the blended format relating to instructor salary and staff paid time. Alternative methods for critical care pharmacology education enhance the educator's options to provide learning in effective and timely formats.

CHAPTER 1: BACKGROUND AND RATIONALE FOR STUDY

Introduction

Registered nurses entering the critical care setting require continuing education regarding the management of intravenous infusions used for critically ill patients. These medications have a small therapeutic window (Coons & Seidl, 2007) and the effect of mismanagement due to lack of knowledge can be devastating to a patient. Compared to a general medical patient, a critically ill patient receives two times the medications due to their complex needs. Further, 78% of serious medical errors in ICU relate to use of medications (Camire, Moyen, & Stelfox, 2009).

Critical care pharmacology is a difficult and complex course requiring a significant amount of drug information to be presented. Knowledge of drug actions, dosages, side effects, nursing considerations and the ability to analyze patient situations for appropriate use are paramount. Inexperience and lack of drug knowledge are identified as potential risks for medication errors (Camire et al., 2009). Learning must occur in a timely manner for the nurse to be prepared to work in a critical care unit, and lecture has been a traditional method for imparting this knowledge.

A key component of safe practice for registered nurses orienting to critical care includes timely and effective education regarding pharmacology. It is also important to consider alternative methods of providing cost and time-effective education that can maintain or improve positive learning outcomes.

Garrison and Kanuka (2003) describe blended learning as "the thoughtful integration of classroom face-to-face learning experiences with online learning experiences" (p. 96). Studies indicate it is an effective alternative education method with

similar or better outcomes compared to lecture (Adams & Timmins, 2006; Pereira et al., 2007; Sheen, Chang, Chen, Chao, & Tseng, 2008; Sung, Kwon, & Ryu, 2008). However, according to O'Neil, Fisher and Newbold (2004) it is also important to design and develop content appropriate for online learning. Sections of the cognitive knowledge base necessary for a practical understanding of pharmacology are unambiguous and appropriate for interactive online learning. Yet, other pharmacology content is more appropriate for face-to-face discussion, review and practice.

Although research of blended learning is found in general education literature, very few nursing education studies exist examining outcomes of blending learning, particularly in the continuing education setting. Most research (nursing and non-nursing) has been accomplished in the university setting. Further, McCartney and Morin (2005) identify a lack of experimental research on nursing education topics in general, and discuss the importance of conducting experimental research adding to evidence-based teaching techniques. Provision of critical care pharmacology in the most effective format for learning ultimately impacts patient safety and care. It is therefore important to research alternative and potentially more effective methods of providing this education.

Purpose Statement

The purpose of this experimental research study is to identify learning outcomes and student satisfaction associated with blended versus traditional lecture classroom learning of critical care pharmacology nursing continuing education.

Justification of Study

This study is important for adding to the body of nursing research, particularly relating to nursing education and evidence-based teaching. It potentially offers immediate educational benefits to new nurses, ultimately impacting quality of patient care. If alternative teaching methods are effective, implications may include time-savings translating to cost-savings, increased flexibility and the option for the learner to choose education based on their preferred learning style. Offering educational options may increase nurse satisfaction, possibly impacting job satisfaction. Finally, learning alternative methods will be expanded to include other critical care topics if found to be effective.

Theoretical Framework

According to Polit and Beck (2008) the "relationship between theory and research is reciprocal and mutually beneficial" (p. 145). Theory is necessary as the framework for creating meaningful research. Concepts chosen to frame this study are from Alan Roger's (2002) theory on teaching adults. Rogers (2002) describes natural learning with two approaches to lifelong learning. One involves acquisition learning (task-conscious) where learning results from immediate tasks of daily living. The other approach is formalized learning (learning-conscious) and relies on transfer of information and facilitation or guidance from a teacher.

To further explain, acquisition learning is "contextualized, highly specific, and it uses the ordinary lifeworld as its context" (Rogers, 2002, p. 126). It occurs in an ongoing manner, and is usually concrete and task-oriented without addressing general principles. Tasks often follow each other continuously, and once learning is complete the next task is

undertaken. Further, acquisition learning is active and learner-centered. Rogers (2002) uses childhood language acquisition as an example.

On the other hand, the formalized approach uses learning as the task. Learning is episodic and "the formalized (educational) approach is that we learn first, then practice, and then use/perform" (Rogers, 2002, p. 133). Rather than an accumulation of task-related experience, it involves conscious education. Most adult learners expect the formalized approach and view themselves as students in this situation.

However, Rogers (2002) believes these approaches to learning can be used together to enhance and expand an active learning format to facilitate adult education. He believes participatory or active learning is necessary for effective education. The teacher may guide the process, but it is the student who completes the learning. Teaching should engage adults through "activities, study and practice, and encouraging and enabling the student participants to engage in it" (Rogers, 2002, p. 272). However, it is ultimately up to the learner to make learning changes, not the teacher.

Moreover, education should promote the concepts of lifelong learning and the desire for ongoing expansion of knowledge. According to Rogers (2002) adult learning may be used to enhance work knowledge, social interaction, self-determination and ultimately "enhanced adulthood" (p. 273). Teachers must balance their ability to teach or facilitate education while empowering the learner in the learning process.

More specifically, Rogers (2002) describes the need for adults to call upon existing knowledge and experience in finding learning solutions. Adults prefer to identify meaningful wholes to incorporate new education into existing knowledge and patterns. However, acquisition learning may be used for episodic, relevant information

as part of the whole. The learner can begin with short episodes of learning and weave them together to make more complete understanding of the whole (moving from concrete to general). Additionally, the learning must be relevant to the task at hand and should be problem-centered. There must be ongoing practice, feedback and reinforcement of learning to engage the student actively. Ultimately learning episodes should encourage the student to further lifelong learning.

McMillan, et al (2007) describe Roger's theory as an effective framework to target "learning activities in a way that support the achievement of short-term, course-based requirements, moderately short-term program requirements, and long-term career demands" (p. 89) to enhance motivation regarding professional goals.

These theoretical concepts provide the framework for developing content and facilitating learning for any educational format and are therefore appropriate as a guide to both blended and lecture learning. Online learning, in particular, lends itself to short-term acquisition approaches followed by the more formalized learning associated with face-to-face discussion.

Assumptions

1. Learning is a natural and lifelong process necessary for continued personal and professional growth (Rogers, 2002).
2. Nurses new to critical care areas require additional knowledge in pharmacology (Coons & Seidl, 2007).
3. Learners benefit from the provision of education in multiple formats.
4. Learning is enhanced by student participation, interaction, practice, feedback and reinforcement (Rogers, 2002).

Hypotheses

1. Null: There will be no significant difference in cognitive learning outcomes between nurses receiving critical care pharmacology education via blended versus lecture format. Alternate: There will be a significant difference in cognitive learning outcomes between nurses receiving critical care pharmacology education via blended versus lecture format.

2. Null: There will be no significant relationship between demographics and outcomes for blended versus lecture education. Alternate: There will be a significant relationship between demographics and outcomes for blended versus lecture education.

3. Null: There will be no significant difference in satisfaction of educational method between blended learning versus lecture format. Alternate: There will be a significant difference in satisfaction with educational method between blended learning versus lecture format.

Definition of Terms

Blended learning – a combination of educational formats including online and face-to-face education.

Lecture learning – educational format with instructor presenting learning material to a class of students.

Cognitive learning - knowledge recall and intellectual understanding including comprehension, analysis/synthesis and evaluation of information.

Critical care – healthcare provided to a critically ill patient during a medical emergency or crisis.

Critical care pharmacology – drugs used in critical care units to support patients' heart, blood pressure, and/or vital signs.

Acquisition learning – learning that occurs naturally through completion of tasks of daily living (Rogers, 2002).

Formalized learning – learning that occurs purposefully with the guidance of an instructor or facilitator (Rogers, 2002).

CHAPTER II: REVIEW OF LITERATURE

Critical Care Pharmacology

Registered nurses caring for critically ill patients manage medications that result in significant effects on heart rate, heart muscle and blood vessel function. According to Coons and Seidl (2007) their intended purpose is to alter blood pressure, cardiac and cardiovascular function to stabilize patient vital signs and to achieve clinical endpoints. However, these drugs often have a narrow therapeutic window and can unexpectedly produce deleterious responses, particularly without careful monitoring and nursing management. Many of these medications are considered high-alert drugs because errors may produce significant patient harm (Miller, 2007). In a study regarding patient safety in intensive care units, Valentin et al. (2006) found medication errors to be the second most common serious event in intensive care. Nurses working with these infusions require practical, working knowledge and education regarding pharmacotherapy for safe patient care (Coons & Seidl, 2007).

Blended Learning

In general, evidence-based methods for providing effective pharmacology or other nursing-related education are not well-documented. McCartney and Morin (2005) described a gap in evidence-based teaching (EBT) due to a lack of experimental research relating to general nursing education topics. There are, however, several studies related to the use of blended learning as an effective method for educating nursing students (Bata-Jones & Avery, 2004; Ireland et al., 2009; Jeffries, 2001; Sung et. al, 2008).

Research regarding blended learning identified many advantages compared to

traditional lecture. The vast majority of qualitative studies report increased student satisfaction as a common finding, whether in nursing or other related healthcare fields (Adams & Timmins, 2006; Ireland et al., 2009; Leski, 2009; So, 2009). Several common themes relating to student satisfaction with blended learning were outlined in the literature.

First, students appreciated the flexibility related to online education (Ireland et al., 2009; So, 2009). Several studies described flexibility in allowing more scheduling time for nursing practice and work (Burgess, Brooksby, & Asheworth, 2006; Sheen et al., 2008), enhanced quality time for higher learning activities and discussions (Jeffries, Woolf, & Linde, 2003) as well as more available time for practical or "hands-on" nursing education (Sung et al., 2008). The flexibility associated with self-pacing was an additional positive aspect. Self-paced learning empowered the student to accommodate for previous experience (Jeffries et al., 2003) and decreased frustration of too fast or slow course pace often associated with a lecture format (McCain, 2008). Finally, online learning allowed the student to return and review content as needed (Jeffries, 2001). Thus, the online format more readily permitted the student to individualize education based on their personal needs.

Further, studies related to blended learning identified its cost-effectiveness. McCain (2008) described the optimization of limited resources as important to nurse education for electronic medical record implementation. E-learning associated with blended learning also required less physical space (Wakefield, Carlisles, Hall & Attree, 2008). Berke and Wiseman (2003) discussed their survey findings; e-learning programs save 20-60% in time when compared to traditional classroom learning. A study by

Jeffries (2001) found a time decrease from 3 hours for lecture format to 2 hours for blended learning of oral medication administration, while McCain's (2008) study of electronic medical record education found a decrease in time between lecture and blended learning from 8 hours to 1.5 to 2 hours.

Perhaps the most important aspect of blended learning for pharmacology education was the ability to provide consistent, reliable content (McCain, 2008). There are critical components of pharmacology education that must be provided in a consistent format. An online education module provides the ability to educate utilizing standardized content.

However, studies also described the advantages of face-to-face interaction or lecture that cannot be provided by e-learning. Learners may prefer the face-to-face interaction and traditional student role associated with lecture. For example, in a study by Ireland et al. (2009) focus groups discussed several benefits of in-person interaction with an educator/facilitator. So (2009) described face-to-face discussion as important for sharing ideas and working collaboratively, and provided an opportunity for answering questions without delay (McCain, 2008). The instructor also benefited from face-to-face discussion with the ability to monitor visual cues to students understanding of educational content (Johnson, 2008). This allowed the instructor to provide support in response to student needs.

There are further disadvantages to e-learning associated with a blended learning format. Students may have computer skill deficiencies or insufficient knowledge of software requiring additional time and support from the instructor (Morrow, Phillips, & Bethune, 2007). These problems as well as issues associated with technical difficulties

can be a source of tremendous frustration for students (Sheen et al., 2008). Learning may be significantly impeded by technical problems not directly associated with instruction.

It is also important to review actual learning outcomes of a blended format. The vast majority of studies found blended learning for healthcare education provided equivalent or better learning outcomes than traditional lecture (Adams & Timmins, 2006; Bata-Jones & Avery, 2004; Margolis et al., 2009; Pereira et al., 2007; Sheen et al., 2008;). Jeffries (2001) completed a randomized experimental pretest-posttest study of oral medication administration education utilizing a blended learning versus lecture format, and later a similar study relating to 12 Lead ECG education (Jeffries et al., 2003). While the medication administration education research demonstrated better outcomes (cognitive testing) with blended learning, the education for 12 Lead ECG results showed no difference in learning outcomes. However, Bata-Jones and Avery (2004) identified student self-selection of the learning format as a possible limitation, perhaps allowing students with an inherent preference for computers to skew study results. Several of the cited studies allowed students to choose their learning format. Further, the majority of experimental studies used small sample sizes limiting the ability to generalize these findings. Regardless, an extensive literature review did not find any studies demonstrating lecture format to have better learning outcomes than blended.

Finally, the majority blended education studies occur in the university setting (Bata-Jones & Avery, 2004; Ireland et al., 2009; Jeffries, 2001; Jeffries et al., 2003; Leski, 2009; Wakefield et al., 2008). An extensive literature review found only three studies of in-hospital nursing education. McCain (2008) described the use of blended learning for registered nurse education of electronic medical record documentation. The

other two hospital-based studies took place in Korea and Taiwan. Sheen et al. (2008) researched outcomes for providing professional development topics to staff nurses via e-learning versus classroom, while Sung et al. (2008) studied similar learning methods and outcomes for medication administration. There was a gap of literature and research addressing effective teaching/learning methods for registered nurse staff development or continuing education, particularly in the United States.

Education Design

Much of the research relating to blended learning describes the critically important aspect of course design in success of the education (Adams & Timmins, 2006; Ausburn (2004); Burgess, Brooksby, & Ashworth, 2006; Leski, 2009; Long & Culshaw, 2005; So, 2009). The quality of content and ability of the instructor also impact the lecture format. It is important to know what material is effective in an online format versus that which lends itself to lecture of face-to-face (So, 2009). Therefore, content and presentation issues must be taken into account when preparing all education.

Regarding online learning, Dolezalek (2006) described delivery to be as important as content; "Good content just isn't enough – how it's delivered is the key" (p. 25). According to their book, *Developing an Online Course: Best Practices for Nurse Educators*, O'Neil, Fisher and Newbold (2004) defined instructional strategies and analysis as key to the development and subsequent effectiveness of online learning. They further described methods to create interactive, multimedia designs geared to specific populations and content as critical to effective learning.

Avery, Cohen and Walker (2008) created a model to identify best practices for online nursing programs through development of a quality evaluation tool. They

summarized four categories for evaluating a well-constructed online course with the first category identified as course mechanics. This described the need for clear goals and objectives appropriately associated to learning activities and assessment, technical requirements and time commitment. Course organization, the second category, identified the importance of learning material to evolve from simple to complex and include various activities for different learning styles. The third category defined the need for student support through availability of faculty and technical backing for learning activities. Finally, communication and interaction were deemed key to successful online course design (Avery et al., 2008).

Beyond the dazzling effects possible for online learning, there must be "substance, organization and integrity in the information as well as the "bells and whistles" (Bailey & Blythe, 1998, p. 2). The authors described specific steps to guide online learning development including the importance of creating content outlines through diagrams or storyboarding. Creating a course or presentation that is a balance between important information and interesting delivery requires pre-planning of graphics, links and fonts beyond simply developing content.

Principles of adult learning must be incorporated into education regardless of format. According to Knowles (1998) theory of adult learning, several concepts must be considered. Adults need to know the reason for education and prefer to be self-directed. They bring life experience to their learning and desire this experience be valued. Finally, learning related to occupational role competencies with a problem-solving approach is important to adult learning (Knowles, 1998). Rogers (2002) builds and supports these principles identifying the need for active involvement and tasks that meet immediate

learning needs. A research comparison of learning formats may define further how and whether these adult learning principles are incorporated effectively.

CHAPTER III: METHODOLOGY

Research Design

This study was a randomized controlled trial to provide evidence-based information regarding the effectiveness of blended versus lecture format for cognitive domain learning in the nursing staff development (hospital) setting (see Appendix A for protocol). Seventy consenting participants were randomized into an experimental group to receive education in a blended format or a control group to attend a traditional lecture. All participants completed a pretest and a survey of demographics prior to education. The blended study group was assigned 4.5 hours of interactive critical care pharmacology learning modules via the hospital's learning management system (M.C. Strategies®) and received a packet of information regarding the modules. They were also scheduled for a 2 hour discussion/review session following module completion. The control group attended the traditional 6.5 hour lecture offered to nurses new to critical care. Both study and control groups received pay for 6.5 hours of nursing education, and both received study workbooks usually given when attending the full day lecture class.

Following education, participants completed a critical care pharmacology test during their orientation time, similar to all nurses entering critical care. Tests were proctored during administration and blinded using numbers rather than names. An experienced registered nurse educator corrected the exams using a test rubric and answer form. Finally, both groups were invited to participate in a focus group relating to satisfaction with education and to determine total number of hours actually completed in class and/or studying. The design allowed for realistic and representative information regarding provision of education to new critical care nurses.

Setting

The final study timeframe occurred from July to early December, 2009. A large Western North Carolina community hospital (865 beds) with multiple critical care areas was chosen as the location for research. The setting is typical of like-size institutions hiring critical care nurses and provides nursing education in similar formats to other hospitals. Participants were recruited from nurses orienting to any of the critical care units, including intensive care and telemetry areas.

Sample

Staff registered nurses (RNs) or newly hired nurses planning to work in critical care were approached during orientation; this convenience sample enrollment continued through the summer/fall of 2009. All new nurses assigned to work in critical care areas were approached to participate regardless of prior experience or knowledge. Sample size was achieved early in the study, therefore a request was submitted to Mission Hospital and Western Carolina University Institutional Review Boards (IRB) for an increase in size to 70 (35 per learning group). Approval was received in August, 2009, so recruitment continued until 70 subjects were enrolled.

To randomize participants, names were listed, drawn from a box by an administrative assistant, and then alternately assigned to study or control group. The original sample size was deemed realistic due to the hospital's hiring plan and was similar to other similar studies in literature. As noted, original sample size was increased from 50 to 70 subjects.

Protection of Human Subjects

Nurses newly hired for critical care were approached to participate and introduced to the study through use of an informed consent information form and individual discussion (see Appendix B for consent form). Study procedures and forms/information for consent were approved by Mission Hospital's Institutional Review Board (IRB), IRB # 09-04-681 on April 30, 2009, and Western Carolina University's IRB on May 8, 2009, IRB # 09-233. As identified in the consent, study procedures, risks and benefits were described for subjects. Participation in the study was clearly described as voluntary with no adverse consequences for non-participation. Resources for contacting the researcher by phone or email were offered to all participants.

Instruments

The study utilized instruments to measure demographics, cognitive learning and education effectiveness. Once consent was obtained, basic demographic data was collected from each participant including age, gender, RN degree, prior online education experience and experience in healthcare (see Appendix C for demographic information). This allowed for a baseline determination of prior knowledge and whether this was inconsistent between study groups.

The posttest was a 46 item cognitive, written assessment test used to assess all critical care nurses employed in the hospital during orientation. The instrument, originally created be a staff development coordinator and revised by the researcher, consisted of a combination of multiple choice, true/false, short essay and calculation questions (see Appendix D for pharmacology posttest). Prior to initiation of the study, the test was given to 29 new critical staff members allowing for statistical analysis of test

reliability. A Kuder-Richardson 20 of 0.70 was determined from these compiled results. Test content was validated through expert review by four critical care nurse educator experts.

With the reliability and validity of the posttest established, a pretest was compiled by taking 10 questions from the critical care pharmacology posttest (see Appendix E for pharmacology pretest). All subjects completed this brief multiple choice pretest as a means to estimate prior knowledge before receiving pharmacology class content.

The critical care pharmacology educational class objectives were evaluated by both groups utilizing a Likert scale tool. Each objective for online modules, discussion session and lecture was ranked "excellent", "good", "fair" or "poor" immediately upon completion of the education. Finally, small and informal focus groups met to discuss general questions for feedback regarding educational methods, student experiences and time to complete modules for blended learning. The researcher developed questions for this purpose (see Appendix F for focus group questions).

The researcher, a Masters candidate as a Nurse Educator, prepared all online self-study materials and led the discussions, critical care pharmacology lectures and focus groups. Self-study modules were created using the interactive online authoring tool, Articulate©. Interactivity was important to maintain interest and focus for the online learning modules and consisted of imbedded games, interactive tabs and short quizzes. The online program included 5 modules, each requiring approximately 45 to 60 minutes to complete. Topics included "Antiarrhythmic Drugs", "Hemodynamic Concepts", "Vasoactive Drugs", "Emergency Drugs" and "Drug Calculations". Modules could be reviewed in any sequence with exit/reentry to the session at any time. A trial of online

education was performed by critical care educators to insure there were no computer technical issues with accessing or completing modules. Detailed instructions for technical support and access of computers were created and offered to blended learning participants.

Lecture education covered the same content and objectives as the online learning. Power Point®, whiteboard and class handouts were used to supplement the lecture and interactive student activities included discussions, drug calculation practice and case scenario review. Content of both blended and lecture classes were consistent with equivalency between methods confirmed by three critical care nurse educators.

Data Collection

Data was collected and compiled by the researcher throughout the study timeframe. Following the educational intervention participants were given approximately two to three weeks to study material prior to taking the posttest. Length of time between education and testing was determined by the participant's unit educator or Clinical Nurse Specialist (CNS) who scheduled the testing date. Participants completed the posttest in a proctored general critical care testing session or individually arranged and proctored by their unit educator/CNS. The tests were blinded, secured and sent to the educator designated to correct all study exams. Tests were corrected using a test rubric answer form. Once corrected they were returned to the researcher and complied in excel spreadsheets to track demographics, pretest and posttest results. Completed tests, demographic data and consents were secured in a locked cabinet located in the researcher's office. These records were only accessible by the researcher.

To determine participant satisfaction, participant feedback evaluation forms (as

described previously) were completed immediately following the class. The researcher then invited participants to focus groups approximate 2 to 4 weeks following completion of their posttest. These sessions were poorly attended regardless of time and location offered; only six participants attended the focus groups. To gather more qualitative data, the researcher approached participants on their unit during downtime to discuss questions and to request education feedback including amount of time to complete education. Information was gathered from a total of 11 participants.

Data Analysis

Demographic data, pretest and posttest results were entered into an excel spreadsheet. Data was assigned a "1" (yes/correct) or "2" (no/incorrect) for appropriate demographic and pretest questions. Each posttest question was assigned a percentage correct since partial credit could be given for essay questions. Final scores (in percentages) were logged for both pre- and posttests. This data was provided to the hospital Research Institute director and analyzed using the SAS/STAT® computer program. Demographics were compiled and compared using Fisher's exact test or pooled t-test. Pretest and posttest results were analyzed for central tendencies (means) and standard deviation. They were then compared between groups utilizing paired t-test analysis. Further, actual changes in scores between groups were measured and group means were adjusted between pretest and posttest change in scores. Finally, the Analysis of Variance (ANOVA) procedure was used to compare demographics to posttest scores for analysis. All data was entered into table formats to easily compare results. A threshold level of 0.05 p-value was used for the purpose of the study.

To analyze participant satisfaction participant feedback tool results were compiled

by an office specialist with percentages designated for each ranking. Finally, all results were combined for each learning format (blended, discussion and lecture) and averaged for percentage based on ranking. Although limited data was obtained, focus group discussions and responses were reviewed and general themes considered.

Limitations

Although a sample size of 70 is comparable to similar studies, it is not sufficient for the study to be generalizable to all settings. Additionally, the study used a convenience sample in a critical care setting and needs to be replicated for other nursing areas.

Prior to this study, critical care pharmacology posttest scores were significantly lower than those found in current study results. The improved scores for this study may be due to a Hawthorne effect or differences in instructors and learning content. In addition, the variable time between participant education and testing, although consistent with past education practices, could have impacted posttest results. Clearly, the lack of participation in focus groups does not necessarily provide a representative sample of participant responses.

CHAPTER IV: RESULTS

Sample Characteristics

The original sample size designated for the study was 70, however the number of participants completing the study was 68. Thirty-five enrolled and completed the blended learning and 33 the lecture. Two subjects dropped from the lecture learning group; one resigned employment with the hospital and the other did not complete the posttest in the designated timeframe.

Demographics of the blended and the lecture group participants were very similar as outlined in Table 1. A calculation to determine p-values was derived from Fisher's exact test or pooled t-tests and found no significant differences between groups relating to gender, age, RN experience, education or online experience. P-values comparing learning groups ranged from 0.3312 to 1.000.

Table 1

Demographics of Blended and Lecture Participants

Demographics	Blended n (SD)	Lecture n (SD)	p
Gender Male Female	 6 (17.1%) 29 (82.9%)	 5 (15.2%) 28 (84.9%)	 1.000
Age (M/years)	32.6	34.8	0.3312
Experience New grad Exp. RN years (M)	 20 (57.1%) 5.5	 15 (45.4%) 6.7	 0.4668 0.5754
Education Associate degree Diploma BSN	 20 (57.1%) 1 (2.9%) 14 (40%)	 22 (66.7%) 0 11 (33.3%)	 0.5345
Online education experience	28 (80%)	23 (69.7%)	0.4055

Overall demographics indicated a relatively high percentage of men (17.1%) compared to an overall hospital male percentage of 12%. The average participant age was 33.7 (SD 9.58) with a range of 21 to 56 years. This compares to an average age of 44.5 for all hospital RN staff. New graduates comprised 51.5% of the study population. The remainder of the experienced RNs indicated an average of 6.1 (SD 6.14) years of experience with a range of 1 to 24 years. One participant indicated prior experience as a paramedic and 10 had prior experience as an LPN. The analysis of participant nursing degrees determined 61.8% with an Associate Degree (n=42), 1.5% Diploma (n=1), 36.8% BSN (n=25) and no participant with an MSN. Finally, 75% (n=51) of participants reported previous experience with online computerized learning.

Major Findings

Pretest scores between groups were compared to determine participant prior knowledge. Average pretest score for the blended group was 62.6 and for lecture 60.9 with a resulting p-value of 0.6808. The group test scores were comparable prior to the implementation of the education as identified in Table 2.

Table 2

Pretest Result Blended vs. Lecture Comparison

Pre-test	Blended	Lecture	p
M (SD)	62.6 (15.59)	60.9 (17.56)	0.6808
Range	30-90	20-100	

Hypothesis 1. Hypothesis 1: There will be no significant difference in cognitive learning outcomes between nurses receiving critical care pharmacology education via blended versus lecture format. Alternate: There will be a significant difference in cognitive learning outcomes between nurses receiving critical care pharmacology education via blended versus lecture format.

Analysis of posttest results showed very similar outcomes between groups as noted in Table 3.

Table 3

Posttest Result Blended vs. Lecture Comparison

Posttest	Blended	Lecture	p
M (SD) Range	89.7 (5.16) 78-98	88.3 (6.79) 76-99	0.3378
Mean adjusted for pre-test scores	89.7	88.3	0.5771
Change in score pre-test to post-test (SD)	27.2 +/- 16.65	27.4 +/- 18.09	0.9592

Findings indicated the blended and lecture group posttest results were within 2 percentage points. A non-significant p-value of 0.3378 was determined by t-test procedure. Of note, standard deviations for the groups were similar and smaller than found in the pretest. The range of posttest scores was comparable with results ranging from 78-98 for the blended group and 76-99 for lecture. When adjusted for initial pretest scores, again a p-value of 0.5771 demonstrated no significant differences between groups. Finally, the overall change in scores from pretest to posttest resulted in nearly identical values. The blended group pretest to posttest change was 27.2 while the lecture

increased by a percentage of 27.4 leading to a non-significant p-value of 0.9592. Therefore, the null hypothesis is accepted for differences in cognitive learning outcomes between blended and lecture learning; the alternate hypothesis is rejected.

Hypothesis 2. Hypothesis 2: Null: There will be no significant relationship between demographics and outcomes for blended versus lecture education. Alternate: There will be a significant relationship between demographics and outcomes for blended versus lecture education.

An analysis using Fisher's exact test and t-test procedure compared learning groups to assess the impact of demographic differences on posttest scores. In each category measured, no statistically significant difference was found (Table 4).

Table 4

Overall Demographic and Posttest Result Comparison

Demographic	Post-test score %	SD	p
Gender			
Male	90.4	6.17	0.4620
Female	88.8	5.99	
New grad			
Yes	89.5	6.31	0.5124
No	88.6	5.71	
RN years experience			
0-3	89.6	6.07	0.2284
4+	87.5	5.64	
Age			
30 or younger	90.1	5.66	0.1876
31 or older	88.2	6.20	
Education			
Associate degree	88.2	6.01	0.1907
Bachelor's degree	90.2	5.95	
On-line Experience			
Yes	89.6	5.85	0.1935
No	87.4	6.29	

A closer analysis identified men scored slightly higher on the posttest than women (90.4 and 88.8 respectively), but a p-value of 0.4620 indicated this difference does not approach significance. Nurses with prior experience actually scored lower (88.6) than those who were new graduates (89.5), possibly a reflection of experienced nurses' confidence in prior knowledge or lack of recent test-taking experience. A closer inquiry relating to experience determined no significant difference ($p = 0.2284$) between nurses with 0-3 years in nursing versus those with 4 or more years. Age also was apparently not a factor in test score results. Participants 30 years old or younger scored an average of 89.6 on the posttest while nurses older than 30 scored 87.5. Although younger nurses' results were slightly higher, this did not approach significance (p-value = 0.1876).

Only one study participant was a diploma graduate, so this degree was not included in the analysis of education demographics. Nurses with a bachelor's degree in nursing (BSN) scored 90.2 on the post-test compared to those with an associate degree (ADN) who scored an average of 88.2. Again, the p-value of 0.1907 did not find significance in these differences. Finally, although the majority of participants indicated prior experience with online learning, this did not demonstrate an advantage for test results. Those with previous online experience scored an average of 89.6 while those without computer learning experience scored 87.4 ($p=0.1935$). As a result of these findings, the null hypothesis is accepted and alternate hypothesis rejected. The gender, age, nursing experience, degree or online learning experience of participants did not impact the effectiveness of the learning method and posttest score based on these results.

Hypothesis 3. Hypothesis 3: Null: There will be no significant difference in satisfaction of educational method between blended learning versus lecture format.

Alternate: There will be a significant difference in satisfaction with educational method between blended learning versus lecture format.

A compilation of all Likert scale participant feedback tools indicated some differences in participant responses to effectiveness of education. The discussion group received the highest percentage of "excellent" responses to the education (97.1%) followed by the computerized learning modules (91.4%) and lecture (87.9%). The remainder of responses for all learning formats indicated "good" rankings; none of the methods received "fair" or "poor" responses. However, although there were differences these did not reach statistical significance with a p-value of 0.3476.

Table 5

Participant Evaluation of Class Effectiveness

Class effectiveness	"Excellent"	"Good", "Fair", "Poor"	Total
Lecture	29 (87.9%)	4 (12.1%)	33 (100%)
Computer	32 (91.4%)	3 (8.6%)	35 (100%)
Discussion	34 (97.1%)	1 (2.9%)	35 (100%)

Focus group participation for student feedback on learning proved to be problematic. Although several sessions were planned only 6 students participated in the group sessions. The researcher therefore approached participants on their units to discuss focus group questions. Ultimately feedback was received from 11 students.

Satisfaction with the method of education was requested by the first question: "Please share your thoughts regarding the method of critical care pharmacology education you received." Blended learning participants responded very positively

indicating the format was beneficial allowing for self-pacing and flexibility, interaction, and repeated access to material. Participants also indicated pharmacology discussion sessions were valuable for material clarification and to answer questions. Short case studies associated with the discussion allowed the nurses to apply their knowledge. Examples of responses: “It was easier for me to study at my pace than just sit through a lecture.” “With the blended learning it made more sense – you have an introduction and a discussion reinforcement of the material.” “It was good to study on my own time since I work night shift.”

Responses provided by lecture learners were also positive, but less detailed than those of the blended learners. Advantages of lecture primarily related to the interaction accorded by the format; the ability to ask questions and interact with the instructor. Two responses include; “I felt the classroom experience was helpful. Questions could be asked.” “I like the classroom environment for learning, especially when the material is all pretty new.”

The second question requested more specific information about the education: “What did you like or dislike about the method?”. Response themes were similar to the first question with generally positive feedback. One blended learner felt the modules were very thorough and appreciated the reinforcement offered with the discussion. Others responded the ability to self-pace was helpful, particularly for nurses working the night shift. They were not required to stay awake through a daytime lecture and modules were available at all times. Lecture learners responded positively to the organization of the class lecture and to the workbooks provided to supplement the class content. However, one lecture participant indicated the drug calculation section was confusing and

another felt the pace of the class was too rapid.

The next question requested information to improve the format: “Do you have any suggestions or recommendations for improving this learning process? The majority of responses from both groups indicated suggestions unrelated to format. For example, a lecture participant suggested an overview sheet of the drugs would be beneficial. One nurse also felt experience with the medications prior to the class would allow for “more of a connection” between knowledge and practice. Recommendations for ordering of the content were also described. An example indicated drug calculations should be provided as the initial material. A suggestion to “offer it to everyone!” was expressed for the blended format.

Finally, blended learning participants were queried regarding the number of hours to complete computer education modules. This information was obtained partially from discussion sessions as well as the focus group meetings. Eleven blended learning participants responded with time completion responses ranging from 1 to 8 hours. A calculation of an average time determined a mean of 3.3 hours, less than the 4.5 hours originally estimated and allocated for module completion. When added to the 2 hour discussion time, the total blended learning format required an average of 5.3 hours as compared to the 6.5 hour lecture.

Satisfaction therefore was similar between lecture and blended learning groups, although more detailed and positive themes were indicated for the blended format. The flexibility of self-pacing for blended learning and the ability to provide interaction for lecture learning were predominant themes. Finally, time to complete the lecture learning (6.5 hours) was greater than needed to complete blended learning (5.3 hours).

CHAPTER V: DISCUSSION

Conclusions

A comprehensive knowledge of critical care pharmacology is crucial to nurses' safe management of acutely ill patients. Additionally, the topic of critical care pharmacology is challenging to teach and for students to master. The ability to provide education through different methods offers opportunities for learning adapted to varying nurse and hospital needs.

Few previous research studies regarding nursing education using blended learning were noted in the literature (Bata-Jones and Avery, 2004; Ireland et al., 2009; Jeffries, 2001; Sung et al., 2008) and very few occurred in the staff development setting. This study was intended to address this gap in research regarding effectiveness of critical care pharmacology education presented in a blended format versus a traditional lecture setting. Research examined differences in cognitive outcomes of education through pretest and posttest scores. Test results were also analyzed with participant demographics to assess the impact of age, gender, nursing experience, computer online experience and education on learning method effectiveness.

A randomized controlled trial design was completed using a convenience sample of nurses entering the critical care setting. Each participant was enrolled and randomized to an interventional group for blended learning or the comparison group for lecture learning. A pretest and posttest were completed by participants to examine differences in cognitive learning outcomes initially and upon completion of the education. The blended learning group received 4.5 hours of computerized learning modules and a 2 hour discussion session, while the lecture group attended the traditional 6.5 hour class

presented to all new critical care nurses. The instruments used for testing were validated by critical care nurse experts and the test reliability was determined to be acceptable (Kuder-Richardson 20 of 0.70). To insure standard content and consistency all educational materials were created and presented by the researcher.

Analysis of data from pretests, posttests and a comparison of testing differences revealed no statistically significant test score outcomes, yet both methods resulted in cognitive knowledge gain. Demographics of the participants were very closely matched ($p = 1.000$) decreasing the likelihood of results based on group characteristics such as age or gender. Reasons for demographic differences in gender and age ratio of study participants compared to that of the institution as a whole are unclear. Pretest scores of the blended and lecture groups were very similar indicating prior and baseline knowledge of the material was equivalent. Posttest analysis found no statistically significant differences in scores between blended and learning groups. The scores were, in fact, extremely similar between groups for pretest and posttests as well as when adjusted for original pretest scores. Results indicate education offered in either a blended or lecture format achieve similar learning outcomes and both equally improve cognitive knowledge of critical care pharmacology. These findings are consistent with previous studies indicating no differences in cognitive outcomes from blended versus traditional formats, although not all are nursing research (Adams & Timmins, 2006; Pereira et al., 2007; Sheen et al., 2008; Sung et al., 2008).

This research further compared posttest scores with participant demographics to identify whether certain populations benefit more from lecture or blended learning. Results indicate there were no significant differences in posttest scores associated with

participant age, gender, education, nursing experience or computer learning experience. A common perception persists that computerized education is more difficult for older learners; this did not hold true in this study. Mean scores were similar for participants over age 30 as compared to those under 30 with an age range of 21 to 56 years.

The majority (75%) of participants indicated prior experience with online learning. However, study results indicate this experience with computer online learning was not a factor in posttest scores. Participants indicating no prior experience had posttest scores only slightly lower than those with experience. Technical and access problems with computers have been identified as a significant barrier to satisfaction and learning in studies of computerized education (Sheen et al., 2008). Therefore, to assist participants without prior online experience, the researcher took significant steps to address technical issues prior to assigning modules. Extensive instructions and phone resources prevented the frustration often associated with computerized learning. Thus, the trial of the modules in the system may have alleviated some potential problems for those without computer learning experience.

Finally, prior participant education (degree or experience) did not significantly impact cognitive learning outcomes in this study. Of note, new graduate nurses scored higher than nurses with experience. Perhaps new graduates were comfortable with testing due to recent educational experiences, or possibly experienced nurses had confidence regarding their drug knowledge from prior practice and therefore studied less. Although nurses with a BSN scored slightly higher than ADN nurse scores, statistical significance was not reached.

Scores compiled from the Likert scale ranking of education effectiveness indicate

highest satisfaction with the 2 hour discussion sessions associated with blended learning. These discussion groups were generally small (4-8 participants) and allowed for review and reinforcement of computer learning as well as knowledge application through case studies. The computerized learning modules ranked closely behind in effectiveness followed by lecture learning. However, all received very positive rankings (predominantly excellent) and differences were not found to be statistically significant. Satisfaction with learning is a subjective measurement that is similarly ranked in this study whether education is provided in a lecture or blended format.

Focus study groups were problematic due to low attendance at sessions offered. Although several times and locations were scheduled they were poorly attended. To compensate, several discussions occurred with individual nurses on their units. A total of 11 nurses offered discussion feedback as outlined by the focus group questions. However, due to the low response it is difficult to insure these findings are representative of the entire study group.

The researcher compiled and analyzed themes of the focus group responses and found positive feedback for both blended and lecture learning formats. The nurses participating in the blended learning identified the advantages of self-pacing, flexibility and interactivity as favorable aspects of this format. This is again consistent with other blended learning research studies regarding student satisfaction (Burgess et al., 2006; Sheen et al., 2008). Self-pacing allows the experienced nurse to move quickly through the material while the new nurse may take more time to comprehend and assimilate the content. Time is not wasted on information the learner already knows; they can focus effort on new concepts and knowledge. Flexibility is particularly important for nursing

staff working weekends or nights. A daytime lecture can be difficult for a night nurse to schedule and to remain alert and present. Nursing unit staffing is also impacted by the need to find coverage for the learner's class time. Computerized modules are available during unit downtime allowing the nurse to access and study during quiet time at work. The interactivity of the modules further requires the participant to concentrate and participate in the education. In addition, following completion of the education reinforcement is available at any time.

The blended two hour discussion sessions are easier to accommodate, both for the learner and their work unit. This face-to-face interaction encourages questions, clarification and reinforcement of module content. The shorter sessions improve attentiveness and smaller groups encourage learner participation. Applying knowledge through use of case scenarios enhances critical thinking and analysis related to actual use of the drugs. All blended learning responses indicated these follow-up discussions are very important to understanding of the critical care pharmacology education.

Lecture learning was also positively received, with many participants indicating the advantages of discussion and interaction with the instructor. Lecture also provided the instructor an opportunity to interpret facial expressions and physical cues to learner's understanding of the educational content. A formative evaluation based on real-time learner responses was possible due to these interactions. In addition, since this is the predominant format used in hospital education it was familiar and comfortable to most of the learners. Several study participants expressed a fear of computerized learning and were relieved to be randomized to the lecture group. Further feedback indicated two participants had some difficulty with the pace of the lecture feeling it was too fast.

However, lecture learners also appreciated the inclusion of case studies although the pharmacology knowledge was so new it was somewhat difficult to apply.

The lecture learners were provided 6.5 hours of education in one class day. Blended learners were allocated 4.5 hours, but a self-reported survey of hours to complete the modules found a mean of 3.3 hours actually taken. Again, this may relate to self-pacing allowing more experienced nurses to move quickly through the information. When combined with the 2 hour discussion session, an average total of 5.3 hours were used to complete the blended format. This difference indicates 1.2 hours less to complete the blended learning components compared to lecture, and could imply an economic benefit to the institution if participants are paid for actual education time.

The researcher noted a few study participants, particularly those who were older and with less online experience, requested a change from blended to lecture learning while some of younger learners indicated they would prefer blended. Due to study design, these requests were not accommodated. However, according to study results outcomes of learning were equivalent regardless of the learner's perceived preference.

Limitations

Limitations include potential threats to internal and external validity. A sample size of 70 limits ability to generalize study conclusions. Although this sample is typical of similar studies, it does not provide sufficient data to insure these findings will occur in other situations and settings. Furthermore, learner satisfaction results may have been impacted by low attendance at focus groups. Although those who attended offered helpful feedback, the small response may not reflect impressions of the entire study group.

Study participants were openly enrolled and aware of the research study; this could have altered their study and testing practices. The researcher noted generally higher posttest scores for the critical care pharmacology test than in previous years. The impact of the Hawthorne effect on these nurses is unknown, but certainly a possibility.

Regarding development of education and testing, the use of posttest questions for the study pretest may threaten internal validity even though questions were sequenced in different order. Furthermore, the ability to create effective computerized learning modules or to capably present lectures may impact outcomes in other settings. Effective education in either format requires knowledge, experience, and practice. Technical problems or poor quality modules for online learning or an unprepared or inexperienced lecturer will impact the effectiveness and results. Finally, the specific topic of critical care pharmacology may lend itself to blended learning while other content may not be as appropriate.

Implications

Critical care pharmacology is one of the most important topics presented to nurses entering the critical care arena. Safety of the patient is dependent on the nurse's knowledge regarding management and use of these medications. Traditionally, critical care pharmacology information has been presented in lecture format. However, adult learning theories identify the benefits of providing education that is relevant, interactive, problem-centered and lifelong (Knowles, 1998; Rogers, 2002). Methods to achieve learning goals should include provision of education in various methods and with increased interactivity and independence. Yet, nursing education research, particularly in the staff development setting, has been slow to study effectiveness of education in the

blended learning format.

Implications of this study therefore include adding to the body of research knowledge for nursing education and staff development. Specifically, the study provided a randomized, controlled method to assess effectiveness of education provided in a blended format compared to that of a lecture learning experience. Findings indicate both are effective for teaching cognitive knowledge content. Regardless of learner age, experience, degree, or preference the learning outcomes are equivalent.

Although sample size and topic may limit generalizability of this research, the study provides data that can encourage alternate teaching methods to achieve learning goals. By doing so, options for instructors and institutions are expanded with knowledge that a blended learning format is an acceptable alternative to traditional lecture. Either teaching method increased the nurses' knowledge base as demonstrated by differences in pretest and posttest results. These findings imply that a blended learning format may take the place of lectures based on student preference, instructor availability, scheduling or institutional issues. Further, online education insures consistency in content and presentation of key points and information.

The flexibility and self-pacing of blended learning has implications for learner satisfaction. According to this study, students appreciate the ability to self-pace and learn at their own speed and on their own time. They also enjoy short, scenario based discussions associated with blended learning. Since recruitment and retention of nurses is an ongoing challenge, any improvements that enhance nursing satisfaction are significant.

Use of alternative teaching methods has economic implications for hospitals

(McCain, 2008). Planning for class time is less a problem, particularly the difficulties associated with expense and staff coverage for a night shift nurse to attend a day lecture. The two hour discussion sessions associated with the blended learning are less costly and easier for staff scheduling. Finally, associated economic benefits may include overall decreased time to complete education as indicated by the 1.2 hour decline in learning time by the blended versus the lecture group. This decreased completion time is consistent with prior research (Jeffries, 2001). Although development of computerized modules is very time consuming, the cost of instructor salary ultimately decreases with online education versus regularly schedule lecture classes.

Finally, implications regarding limited educational resources may also be impacted by study findings. Lecture requires the reservation of limited classroom space and audio-visual resources. If computerized learning occurs, these resources are available for more interactive and higher level learning opportunities.

Recommendations

There are several opportunities for future research resulting from study conclusions. This research involved a relatively small sample of nurses educated on a very specific topic. It would be beneficial to replicate a similar study in different hospitals and settings using a variety of learning content. Qualitative and non-randomized research regarding blended learning are more available in the literature than randomized controlled trials, so it would be particularly beneficial to repeat an experimental randomized study analysis.

Although this study indicates accomplishment of cognitive nursing knowledge, it does not measure application of the learning. A subsequent measurement of practice

application in the clinical setting could provide data on whether patient management is ultimately impacted by the type of learning format. Following the pharmacology education a measure of medication errors or a qualitative study interviewing nursing supervisors or nurse preceptors regarding participant practice could add to research information regarding actual patient care implications. Finally, collection of data for the economic impact associated with learning methods may provide beneficial information to support nursing education. This is particularly meaningful during challenging economic times for hospitals.

Based on results of this study as well as others in literature, blended learning may be adopted as an effective method to present staff development education. Ideally, adult learning theory suggests students choose a blended or lecture format based on their preference. However, if necessary, data indicates the blended format may be adopted for all students regardless of age, nursing or online learning experience. This enhances the ability to provide timely education if an instructor or classroom is unavailable or if there are not sufficient participants to justify a lecture experience.

The ultimate goal of nursing education is to insure and enhance safe nursing patient care management. Effective methods to improve the learning environment and provide cognitive knowledge as a basis for safe practice subsequently impacts patient care. This study considers the effectiveness of nursing education in different formats to determine best educational methods to achieve learning outcomes. Results offer the nurse educator data to support effective provision of cognitive learning while enhancing ability of the learner to choose a method of education based on individual preferences.

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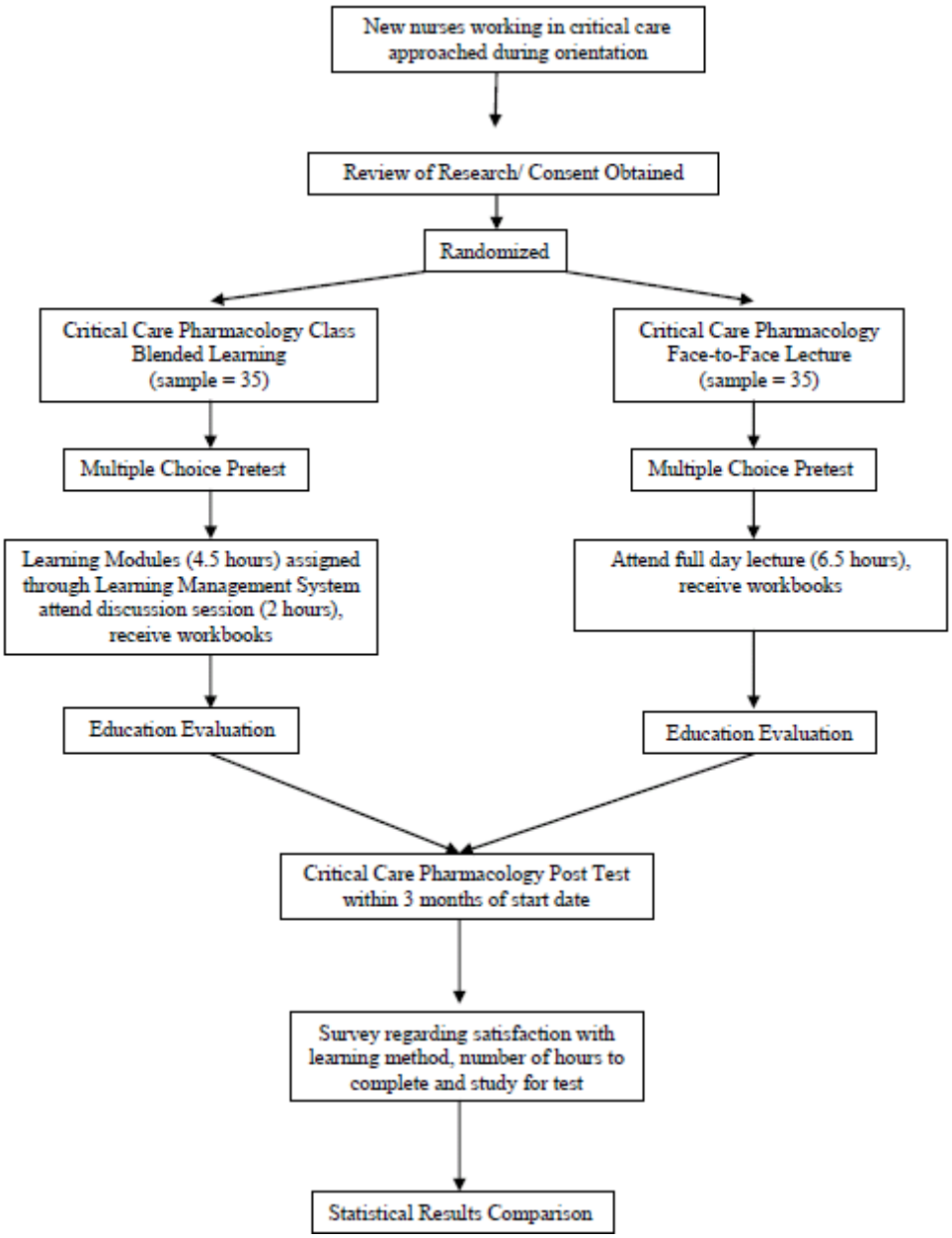
Appendix A

Research Protocol



Appendix B

Informed Consent

Consent to Participate in a Research Study

Protocol Title: Blended vs. Lecture Learning: Outcomes for Staff Development.

Researcher Name and Contact Information: Heidi Sherman, BSN, RN-BC, CCRN
heidi.sherman@msj.org
828-213-1870 (w) 828-275-8068 (c)

What is the study about and why are you doing it?
This research is being conducted to compare methods of providing education for Mission Hospital's Critical Care Pharmacology class.

What are you asking me to do if I agree to be in the study?
If you agree to participate in the study, you will take a brief pretest to determine your baseline knowledge of the subject material. Demographic data to include sex, age, and years of experience in healthcare will be collected. You'll then be randomized into a control group and registered for a traditional lecture format class, or to a study group to receive education through online or computerized learning followed by a 2 hour discussion session. The online learning will be available 24 hours a day and can be accessed from home or work. Discussion sessions will be offered throughout the summer and you can work with your educator to arrange the best time to attend. Following completion of education, both groups will take a Critical Care Pharmacology test (required by all new critical nurses, even those not included in the study). Both groups will also evaluate learning methods and objectives as with all Mission classes, and will be asked to indicate number of total hours studying pharmacology. A comparison of the test results will be used to determine effectiveness of the teaching methods. Both groups will receive the same amount of pay for the learning day or time, and those participating in the study will be entered into a drawing for a $50 gift card. A name from those who provided consent will be drawn for the gift card.

How will this study help me?
The information obtained from this study may help you by considering effectiveness of your learning using various methods. It will also help others by making recommendations to allow for various learning opportunities and methods in the future.

Are there any risks involved with being in the study?
There are no anticipated mental, social or physical risks or harms to you as a result of your participation in the study. The decision whether or not to participate in the study will not affect employment status in any way.

What steps have been taken to minimize participant risk?
Any individual demographic data will be kept confidential. Your test will be assigned a

study ID number for objective grading. Your results will be shared only with your Clinical Nurse Specialist or Clinician (as is typical of all critical care testing) for you to review in their presence. Only aggregate data will be presented upon study completion.

Will it cost anything to participate?
No. Participants will be entered into a drawing for a $50 gift certificate in appreciation for your time and effort.

What else do I need to know?
Your decision to participate in this study is voluntary. If at any time during this study you wish not to participate, you may withdraw from the study without any consequence.

Whom can I contact with questions or concerns?
Contact me, Heidi Sherman (828)-213-1870 or my advisor Dr. Linda Comer (828) 670-8810. If you have concerns about the study, please contact the Institutional Review Board at Mission Hospitals at (828) 213-1105.

For a copy of the completed study, contact Heidi Sherman at 828-213-1870. Results will be available after March, 2010.

Participant's Agreement: I have read the above information. The study has been explained to me and any questions have been answered. I voluntarily agree to be in this study.

Name: (printed)	
Signature:	Date:

Person providing informed consent discussion.

Name: (printed)	
Signature:	Date:

Appendix C

Demographics

Blended vs. Lecture Learning – Participant Demographics:

Please **mark or complete the blank as listed**. All information will remain confidential.

1. Gender M ____ F____

2. Age _____

3. Prior experience in Healthcare/number of years if appropriate:

   New Graduate _____

   RN: _____ years

   Paramedic: _____ years

   LPN: _____ years

   Other (please explain) _____

4. Educational degree in nursing:

   ADN _____

   Diploma _____

   BSN _____

   MSN _____

5. Prior experience completing online (computerized) education:

   Yes _____ No _____

   If yes, please describe:

Thank-you for your participation!

Appendix D

Pharmcology Posttest

CRITICAL CARE PHARMACOLOGY TEST

Name:_____
Unit: _____
Date: _____

Select the best answer for the following multiple choice questions.

1. The patient has a pulse, is alert and oriented, skin warm and dry, and denies chest pain or dyspnea. ECG rhythm is **Ventricular Tachycardia**:

Treatment should include:

A. Atropine 1 mg slow IV push
B. Lidocaine 10 mg rapid IV push
C. Synchronized cardioversion
D. Amiodarone 150 mg/100 ml D5W over 10 minutes

2. The initial rhythm after a code blue is initiated is asystole. The best rationale for administering Epinephrine is:

A. Decrease vasoconstriction
B. Decrease defibrillation threshold
C. Increase myocardial oxygen consumption
D. Improve cerebral and coronary perfusion

3. Moderate does (5mcg/kg/min-10mcg/kg/min) DOPamine results in which of the following responses:

A. Increased urine output
B. Peripheral vasoconstriction
C. Increased heart rate and contractility
D. Decreased heart rate and contractility

4. A patient admitted four hours ago with an anterior myocardial infarction suddenly becomes pulseless and has the following ECG rhythm: This is **Ventricular Fibrillation**

The best sequence for initial treatment should be:

A. CPR, Defib 120 J, CPR, Vasopressin 40 units IV
B. Defib 120 J, Defib 150 J, Defib 200 J, Epinephrine 1 mg
C. CPR, Epinephrine 1 mg IV, Defib 120 J, CPR
D. Defib 120 J, Amiodarone 150 mg IV, CPR, Defib 120 J

5. Treatment of pulseless electrical activity per the Emergency Treatment Protocol includes:

A. Epinephrine 1mg (1:10,000) IV
B. Normal saline 500 ml IV bolus
C. Atropine 1 mg IV with heart rate < 60
D. All of the above

6. Which of the following medications is appropriate for the treatment of supraventricular tachycardia (SVT)?

A. Sodium Bicarbonate
B. Epinephrine
C. Adenosine
D. Nitroglycerin

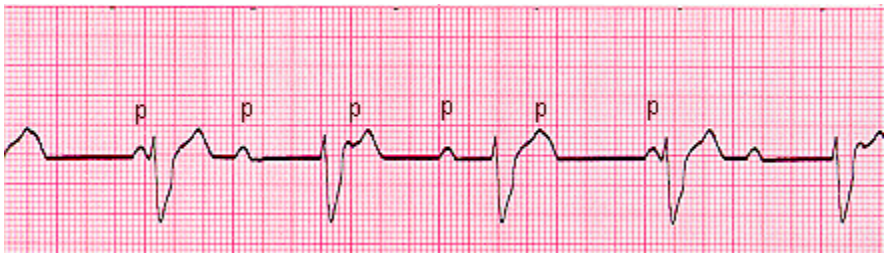
7. As essential treatment element for polymorphic ventricular tachycardia (Torsades de pointes) is:

A. Calcium
B. Potassium
C. Magnesium
D. Heparin

8. The monitor technician reports that the patient has developed new onset PVC's that are increasing in frequency. What initial action should be taken?

A. Amiodarone 300 mg IV push
B. Amiodarone 150 mg IV push
C. Assess patient for hypoxia and electrolyte imbalance
D. Have the patient cough vigorously

9. The patient has new onset confusion, blood pressure 70/40, heart rate 45, skin cool and clammy and the following ECG rhythm: This is **Third Degree Heart Block.**



Treatment may include:

A. Transcutaneous pacemaker
B. Atropine 0.5 mg IV while awaiting pacer
C. DOPamine 5 mcg/kg/min if B/P remains less than 80 after pacer is on
D. A and C only

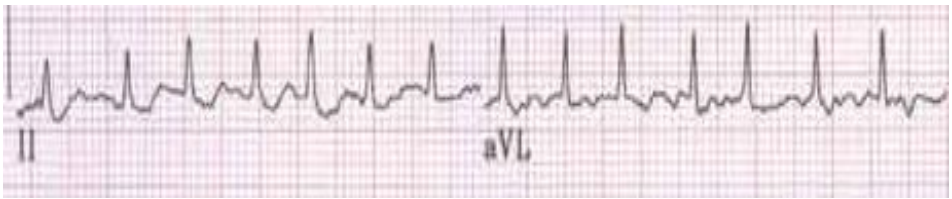
10. Dobutamine would be an appropriate treatment consideration for which of the following patients?

A. 79 year-old male with cardiogenic shock
B. 56 year-old female with severe aortic Stenosis
C. 60 year-old male with hypovolemia
D. 50 year-old female with constrictive cardiomyopathy

11. The patient is 6 hours post op and has an epidural infusion, blood pressure 68/42, heart rate 110. Which of the following may be used to treat the hypotension?

A. Milrinone 0.375 mcg/kg/min
B. Diltiazem 10 mg/min
C. Neo-Synephrine 30 mcg/min
D. DOPamine 2 mcg/kg/min

12. The following rhythm is noted on the monitor; the patient is alert and oriented, skin warm and dry, blood pressure is 90/60, heart rate 150. This is **Atrial Fibrillation.**



Which of the following medications would be indicated?

A. Diltiazem (Cardizem)
B. DOPamine
C. Atropine
D. Epinephrine

13. The treatment of Ventricular Fibrillation includes which of the following:
    A. Amiodarone 300 mg IV
    B. Amiodarone 100 mg IV
    C. Vasopressin 40 units IV every 3 minutes
    D. Lidocaine 150 mg rapid IV push

14. If IV access can not be established, which of the following may be administered via the endotracheal tube?
    A. Epinephrine
    B. Atropine
    C. Lidocaine
    D. All of the above

Please select True or False for the following statements.

True **False** 15. Morphine sulfate is effective in reducing preload by vasoconstricting the venous system.

True **False** 16. When used in the treatment of ventricular fibrillation, Amiodarone 300 mg IV should be administered over 10 minutes.

True **False** 17. The initial dose of Atropine for symptomatic bradycardia is 2 mg rapid IV push.

True **False** 18. Volume status should be optimized prior to starting a vasoactive agent in the treatment of decreased cardiac output and hypotension.

True **False** 19. Milrinone can decrease platelet count.

True **False** 20. Sodium Bicarbonate may worsen acidosis intracellularly if given without a patent airway.

True **False** 21. Transient hypotension may occur following Diltiazem (Cardizem) bolus dose.

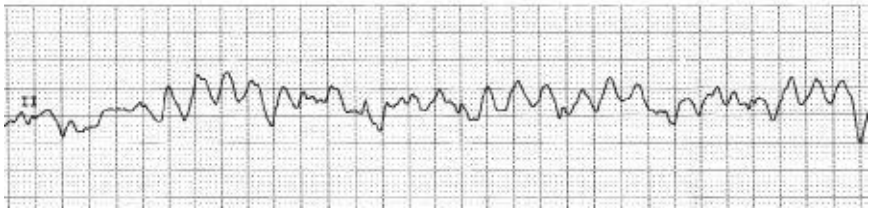
True **False** 22. Patients that have an iodine allergy should not receive Amiodarone.

True **False** 23. Adenosine used in the treatment of SVT should be administered over 1-2 seconds.

True **False** 24. Vagal nerve stimulation will produce tachycardia.

Answer the following short essay questions:

25. The patient has the following rhythm, describe initial actions and any pharmacological and non-pharmacological treatment options. This is **Ventricular Fibrillation.**



26. Describe the **location** and **effect** on receptor sites for Beta 1, Beta 2, and Alpha stimulation.

27. The patient has the following rhythm that has been sustained for 1 minute; describe initial actions and any pharmacological and non-pharmacological treatment options. This is **Supraventricular Tachycardia (SVT).**

DRUG CALCULATIONS:

The patient has an admitting diagnosis of decompensated heart failure. An order is written to start Dobutrex at 2 mcg/kg/min. The drip is mixed 1000 mg Dobutamine in 250 ml D5W. The patient weighs 220 pounds and is 68 inches tall.

28. What is the rate for this infusion?

29. If the Dobutamine infusion is titrated up to 5 mcg/kg/min, what is the rate?

Upon returning to assess the patient, the Dobutamine is infusing at 50 ml/hr. The patient's blood pressure is 70/40, heart rate is 130.

30. What dose is being delivered at 50 ml/hr?

31. What initial actions should be taken?

The patient has sudden onset of dyspnea, respiratory rate 50, heart rate 120, B/P 130/70, frothy sputum and crackles bilaterally. The patient has been placed in high fowlers position and has received Lasix 40 mg IV. Treating per the Emergency Treatment Protocol, a Nitroglycerin infusion needs to be started at 10 mcg/min. The infusion is mixed 25 mg in 250 ml D5W (100 mcg/ml).

32. What is the rate?

33. If the infusion is increased to 30 mcg/min, what is the rate?

The patient's blood pressure is now 90/50 and the rate is decreased to 9 ml/hr.

34. What dose is being delivered at 9 ml/hr?

The patient goes into atrial fibrillation with rapid ventricular response. The order is received to administer a Diltiazem (Cardizem) bolus and start an infusion (the infusion is mixed 125 mg/125 ml). The patient weight is 100 kg and 62 inches.

35. What is the initial bolus?

36. The infusion is started at 5 mg/hr. What is the rate?

The Diltiazem is titrated up to 15 ml/hr and has been infusing four hours, the patient remains in atrial fibrillation, heart rate is 50, and blood pressure is 80/50.

37. The Dilitiazem (Cardizem) infusion should be **increased/decreased/stopped**. (*Circle correct answe*r).

You are caring for a 60-year-old-male, admitting diagnosis of ischemic stroke. The patient's blood pressure is 70/40; heart rate is 110, resp rate 32. He has received a fluid challenge. An order is written to start DOPamine at 5 mcg/kg/min. The infusion is mixed 800 mg in 500 ml of D5W. The patient weighs 90 kg and is 72 inches.

38. What is the rate for 5 mcg/kg/min?

39. The DOPamine is increased to 8 mcg/kg/min, what is the rate for this dose?

The next day during report while checking the infusion dose/rate with the night nurse, the DOPamine is noted to be infusing at 40.5 ml/hr.

40. What dose is being delivered at this rate?

41. DOPamine infusing at this dose/rate is in the **beta/alpha** range. (*Circle the correct answer*).

A 50 year-old-female is in sustained ventricular tachycardia, heart rate 150, blood pressure 100/50. She denies chest pain or dyspnea. A decision is made to treat this dysrhythmia by administering an Amiodarone bolus and start an infusion. The infusion is mixed 450 mg/250 ml D5W.

42. What is the bolus dose?

43. If the infusion is started at 1 mg/min, what is the rate?

8 hours after starting the infusion, the rate is 17 ml/hr.

44. What dose is being delivered at this rate?

45. Amiodarone has been infusing for 15 hours, the patient starts having short runs of V Tach. What action can be taken at this point?

46. The patient goes into complete heart block, the Amiodarone infusion should be **titrated up, turned off immediately, titrated down**. (*Circle the correct answer*)

Appendix E

Pharmcology Pretest

Critical Care Pharmacology Pretest:

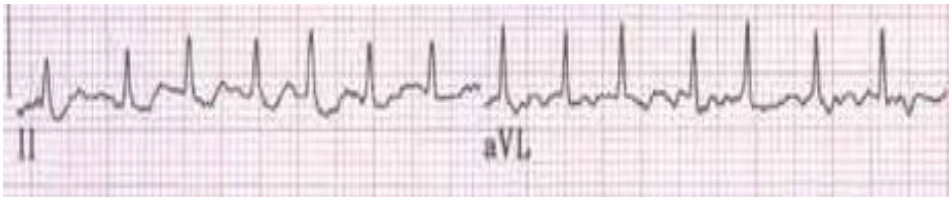
1. The treatment of Ventricular Fibrillation includes which of the following:
   A. Amiodarone 300 mg IV
   B. Amiodarone 100 mg IV
   C. Vasopressin 40 units IV every 3 minutes
   D. Lidocaine 150 mg rapid IV push

2. Moderate does (5mcg/kg/min-10mcg/kg/min) DOPamine results in which of the following responses:
   A. Increased urine output
   B. Peripheral vasoconstriction
   C. Increased heart rate and contractility
   D. Decreased heart rate and contractility

3. Dobutamine would be an appropriate treatment consideration for which of the following patients?
   A. 79 year-old male with cardiogenic shock
   B. 56 year-old female with severe aortic Stenosis
   C. 60 year-old male with hypovolemia
   D. 50 year-old female with constrictive cardiomyopathy

4. The monitor technician reports that the patient has developed new onset PVC's that are increasing in frequency. What initial action should be taken?
   A. Amiodarone 300 mg IV push
   B. Amiodarone 150 mg IV push
   C. Assess patient for hypoxia and electrolyte imbalance
   D. Have the patient cough vigorously

5. The following rhythm is noted on the monitor; the patient is alert and oriented, skin warm and dry, blood pressure is 90/60, heart rate 150. This is Atrial Fibrillation.



Which of the following medications would be indicated?

A Cardizem
B. DOPamine
C. Atropine
D. Epinephrine

6. The patient is 6 hours post op and has an epidural infusion, blood pressure 68/42, heart rate 110. Which of the following may be used to treat the hypotension?

A. Milrinone 0.375 mcg/kg/min
B. Cardizem 10 mg/min
C. Neo-Synephrine 30 mcg/min
D. DOPamine 2 mcg/kg/min

True False 7. Volume status should be optimized prior to starting a vasoactive agent in the treatment of decreased cardiac output and hypotension.

True False 8. When used in the treatment of ventricular fibrillation, Amiodarone 300 mg IV should be administered over 10 minutes.

True False 9. Adenosine used in the treatment of SVT should be administered over 1-2 seconds.

True False 10. The initial dose of Atropine for symptomatic bradycardia is 2 mg rapid IV push.

Appendix F

Focus Group Questions

Blended vs. Lecture Learning - Focus Group Follow-Up Questions

Please share your thoughts regarding the method of critical care pharmacology education you received.

What did you like or dislike about the method?

Do you have any suggestions or recommendations for improving this learning process?