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A Quality Improvement Initiative to Bridge the Gap of Pharmacology Knowledge among Associate Degree Nursing Students

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**A Quality Improvement Initiative to Bridge the Gap of Pharmacology Knowledge among
Associate Degree Nursing Students**

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I have no conflicts of interest to disclose.

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Abstract

The purpose of this project was to determine if a formal pharmacology course in associate degree nursing (ADN) programs would increase the new graduate registered nurses' (NGRN's) knowledge of pharmacology content in an effort to decrease medication errors in practice. Disparities exist among nursing ADN program curriculums and the delivery of pharmacology content. Some ADN programs consist of a formal pharmacology course while others disperse the information throughout the program, often omitting pertinent content for students to apply the basic pharmacology knowledge to patient care. Despite the differences in nursing program curriculum, all NGRNs are expected and held to the same practice standards upon successful completion of the National Council Licensure Examination (NCLEX), and immediately entering the workforce as a nurse.

A 25-question exam was administered to two groups of ADN students using test items from Assessment Technology Institute's (ATI's) private reserve test bank. The exam consisted of 20 questions pertaining to basic pharmacology content, 5 dosage calculation questions, and high-risk medications such as; beta blockers, antidiabetic medication, insulin, epinephrine, emergency medications, and anticoagulants.

The pre and post test results revealed a statistically higher difference for the ADN students who received pharmacology content dispersed throughout the 4-semester curriculum than the students who received the majority of pharmacology content within a 2-credit, one semester course. The results of this project were opposite of this author's hypothesis. The statistical data gained from this study can be implemented in educational practice to elevate the rigor of pharmacology content currently taught within ADN programs that do not offer a formal course.

A Quality Improvement Initiative to Bridge the Gap of Pharmacology Knowledge among Associate Degree Nursing Students

The administration of medication is considered a nursing task that NGRNs are expected to be knowledgeable in performing accurately despite the level or degree nursing program completed (Wondermieneh et al., 2020). Medication administration is a critical component of nursing as well as one of the highest risk skills a nurse performs, therefore students should be well prepared for the task (Lee & Quinn, 2019). Over 40% of a nurses' time performing patient care is spent administering medication and evaluating the effectiveness after administration (Wondermieneh et al., 2020). Education and preparation should be of importance for nursing students to master the skill of safe medication administration. Unfortunately, as Khan and Hood (2018) noted, "The presence of pharmacology education in nursing curricula varies" (p. 546), and these variations can contribute to the occurrence of medication errors. The World Health Organization (WHO) created the Patient Safety Curriculum Guide that stressed the importance of incorporating patient safety education in the curriculum of nursing students (Asensi-Vicent et al., 2018). Educating NGRNs to apply pharmacology concepts to patient care is an integral part of nursing curriculum and as this project will demonstrate, a missing component in some ADN programs, which could be a contributing factor to increased medication errors.

The Agency for Healthcare Research and Quality ([AHRQ], 2019) estimated medication error rates as high as 8% to 25% during the actual administration process and estimated error rates for intravenous medication administration is double, 48% to 53%. The National Coordinating Council for Medication Error Reporting and Prevention (2009) defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of healthcare professionals, patients, or consumers" (para

1). The goal of this project was to demonstrate the benefits a formal pharmacology course would play in decreasing medication errors and increasing the NGRNs knowledge of pharmacology content. Key components of pharmacology knowledge include; drug actions, uses, interactions, contraindications, dosages, appropriate evaluation after administration, and the rights of medication administration. The rights of medication administration include; right patient, right drug, right time, right route, right evaluation, right dose, and right documentation (Rubaiy et al., 2021). It is this author's opinion that proper education in the form of a formal pharmacology course can increase their knowledge and skill in administering medications thereby decreasing errors.

It is pertinent to note the original problem statement developed sought to identify the correlation between actual medication errors committed by NGRNs and the relationship to how pharmacology content was delivered during the respective nursing program. Obtaining data from acute care facilities related to medication administration errors (MAEs) was not easily obtainable. Acute care facilities are not amenable to providing such data. As a result, the problem statement was changed to focus on the student and the knowledge comparison of those students receiving a formal pharmacology course as part of the curriculum and those who do not receive such education.

Problem Question

Will the ADN students who have had a formal pharmacology course score higher on a pharmacology knowledge pretest and posttest than their colleagues who have not had a formal pharmacology course in the nursing program? This DNP project will provide a quality initiative comparing two associate degree nursing (ADN) programs and how they differ in providing pharmacology content. One study mentioned several NGRNs voiced their opinion that better

curriculum might have improved their pharmacology knowledge (Trieber & Jones, 2018). Medication errors are a problem to both the patient and the NGRN. In one study, a newly licensed nurse who committed a medication error expressed fear and panic for the patient's safety; but the NGRN expressed gratefulness the patient was safe (Trieber & Jones, 2018). This study also mentioned several NGRNs who voiced their opinion noting better curriculum might have improved their pharmacology knowledge (Trieber & Jones, 2018). The economic impact to the facility and the NGRN could be overwhelming and costly. The cost for the facility is monetary while the cost for the NGRN could be emotional, psychological, and career ending. It is this author's opinion, NGRNs fall under the vulnerable population category. Since the COVID pandemic, nursing programs are experiencing difficulties in securing clinical sites for students, resulting in decreased and limited acute care experiences with administering medications. Casey et al., (2021), noted many nursing programs are not able to provide adequate content with real time clinical experiences related to administration of medications therefore, contributing to errors among NGRNs. Nursing schools vary in the delivery of pharmacology content. The current curriculum for many associate degree programs is to incorporate pharmacology content within the curriculum. Trieber & Jones (2018) reinforced the importance of instructing nursing students to practice safe medication administration, but acknowledge the lack of adequacy and consistency among nursing program curriculums.

Purpose

This author is employed and resides in the state of Georgia therefore, the Georgia Board of Nursing will be utilized as a point of reference related to curriculum content for ADN programs. This author teaches at a major university that offers both ADN and Bachelor of Science Nursing (BSN) tracks for the nursing program. The ADN program does not offer a formal pharmacology

course as part of the nursing curriculum while the BSN track does require a formal course be completed prior to graduation. The students of the ADN program not requiring a formal pharmacology course are lacking content that is not mandated placing them at a disadvantage upon graduating to and advancing to a NGRN. Chapter 410-8, of the Rules and Regulations of the State of Georgia found on the Georgia Board of Nursing website discusses the specifics for curriculum however, does not offer any specific stipulations for a formal pharmacology course as a requirement (Georgia Board of Nursing, 2017). This author will highlight several of the rules as they pertain to curriculum related to pharmacology content. Rule 410-8-04(1) noted the nursing program must be consistent with the mission, purpose, and outcome of the parent institution (Georgia Board of Nursing, 2017). Rule 410.-8-.4(6) explains, nursing programs have to provide practice based learning activities while section (7) notes the curriculum should include current issues involving nursing, health, and society (Georgia Board of Nursing, 2017). Rules 8 and 9 focus on teaching and learning activities which should facilitate the students' transition into the professional practice of nursing by using activities that foster reflection, critical thinking, clinical-reasoning, and decision making (Georgia Board of Nursing, 2017).

Of the twelve rules compiled by the Georgia Board of Nursing (2017), none discussed the specifics related to a formal pharmacology course. The rules do not mandate the content to be provided by the institutions and rather leave autonomy to the instructors and programs (Rule 410-8.04; 1-13). The vagueness of the curriculum mandated by the Georgia Board of Nursing adds to the relevance of this DNP project and the importance of a formal pharmacology course for all ADN students. It is this author's goal to emphasize, once the graduate students have successfully completed the NCLEX exam and is deemed a registered nurse (RN), they are held to the same practice standards as all RNs despite the nursing degree they obtained.

Literature Searches

This project reviewed literature accessible through the Georgia State University (GSU) library. The following databases utilized to obtain the literature included: Cumulative Index of Nursing and Allied Health (CINAHL), PubMed, and Agency for Healthcare Research and Quality (AHRQ), Health and Human Services, various college university websites in Georgia, Institute for Safe Medication Practices (ISMP), the American Association of Colleges of Nursing (AACN), Georgia Board of Nursing, and National Coordinating Council for Medication Error Reporting Prevention. Key words for the search included; medication errors, new graduate registered nurses, Swiss cheese model, medication errors committed by new graduate nurses and near miss medication errors, pharmacology, Benner's novice to expert theory, associate degree nursing program (ADN) curriculums, student nurses and medication errors, and pharmacology courses. The search formula created and utilized include ("Medication error* [tiab] OR "students" [tiab] OR "Students, nursing" [MESH] OR Education, Nursing, Associate" [MESH] OR "Associate Nursing Education [tiab] AND (Pharmacology [tiab] OR "Pharmacology" [MESH])). (Appendix A)

Search Results

The search resulted in more than 100 articles found. The literature review yielded 23 articles used for this paper. Several articles were eliminated due to non-specific content related to the problem statement. The website search of colleges in Georgia found, out of 25 colleges with ADN programs in Georgia, only 15 colleges provided online information regarding their program curriculum and outline. To keep a similar sample size to ADN nursing programs, 15 colleges in Georgia with BSN programs identified were used for reviewing nursing program curriculum outlines. The college search concluded; 60% of the ADN programs offered a formal

pharmacology course. In comparison, 100% of the BSN colleges provided a formal pharmacology course. From the search, this author identified there were two colleges who offered both ADN and BSN nursing tracks, however only the BSN track offered a pharmacology course as part of the curriculum and the ADN programs did not offer a formal pharmacology course to students. While the population for this DNP project has changed from the previous literature search, the information related to BSN curriculum is pertinent because ADN new graduates are held to the same practice standards as BSN new graduates upon obtaining their RN status (Benner, 2001). This author's passion for this DNP project arises from the above noted differences between the ADN and BSN program curriculums at my university of employment as well as the inconsistency of pharmacology content that is taught among ADN programs. Teaching in an ADN program, this author recognizes these students need a formal program consisting of pharmacology content. While the original DNP project was devised to compare ADN to BSN NGRNs, this focus changed to include only ADN students as comparisons for pharmacology content. It is this author's opinion to provide the brief background of BSN curriculum as it pertains to pharmacology content because all nurses who have successfully passed the NCLEX are held to the same standards of care despite the type of nursing program one might have graduated from. (Appendix B)

Literature Review

The literature reviewed for this DNP project focused on medication errors among student nurses and NGRNs and the correlation of a formal pharmacology course within the curriculum. The majority of articles reviewed noted a lack of or inadequate knowledge of medications and pharmacology content as major contributors to errors particularly in the new graduate population

(Rubaiy, 2021; MacDowell et al., 2021; Bennett et al., 2017; Yang et al., 2021; Simonsen et al., 2014; DiSimone et al., 2018; Trieber & Jones, 2018; Khan & Hood, 2018).

Pharmacology Content in Nursing Programs Varies

The first study reviewed by Khan and Hood (2018) emphasized how pharmacology education for nursing students varies among programs and curriculums contributing to the various types of errors. These authors also acknowledged medication administration is complex with many outside factors contributing to the errors (Khan & Hood, 2018). Outside factors include illegible or incorrect transcription of the order, pharmacy errors related to dosages, incorrect dosage calculations and non-adherence to the 5 rights of medication administration. The 5 rights of medication administration include, right patient, right drug, right route, right time, and right reason. Incorrect dosage calculations, non-adherence to the 5 rights of medication administration, and non-adherence to patient identifiers are direct results of nursing omissions that could lead to medication administration errors (MAEs). When outside causes were analyzed, the underlying theme was lack of education of how the medication works on the body and the fundamental foundation of pharmacology (Lim & Honey, 2017). Despite the type of error discussed, inadequate education related to the foundations of pharmacology appeared to be a contributing factor. This lack of pharmacology knowledge by the NGRN while administering medications to patients could ultimately cause harm if an error occurred. It is this author's opinion, all nursing programs should have a formal pharmacology course to decrease the risk of MAEs and harm to patients.

Breach in the “Rights of Medication Administration” Can Lead to Errors

The second study discussed the correlation between medication errors that lead to adverse drug effects and medication errors (MacDowell et al., 2021). This article emphasized a breach of

the 5 rights of medication administration as contributing factors to these errors, which appears to be a common theme among the literature (MacDowell et al., 2021). Conclusion from the first two articles revealed the inadequate knowledge of NGRNs coupled with little to no clinical experience were major contributors to the increased number of medication errors. Schools of nursing are having more difficulty obtaining clinical sites for students to complete hands on skills to include, medication administration. This author has observed the difficulty students have with assimilating didactic knowledge to clinical practice in the educational realm further emphasizing the need for this project and increased rigor for current pharmacology curriculum.

Relationship between Pharmacology Education and Errors

Trieber and Jones (2018) was the third article reviewed discussing education and medication errors among BSN students. The survey polled BSN nurses to assess the adequacy of pharmacology education and the relationship to medication errors. The deficits in pharmacology knowledge can contribute to human error and carelessness in dosage calculation as well as failure to evaluate the risks of the patient's condition leading to improper evaluation (Trieber & Jones, 2018). This article pertained specifically to BSN students because medication errors can occur to any nurse despite their training. However, the ADN student graduate remains at a further disadvantage due to lack of educational preparation. Trieber and Jones (2018) noted 55% of NGRNs admitted to committing a MAE during the first year of nursing practice emphasizing the need for adequate pharmacology education during the nursing programs. The review of BSN nursing programs highlighted 100% of these programs offer and require their graduates to complete a formal pharmacology course as part of the curriculum. In contrast, only 60% of the ADN programs offer a formal pharmacology course to the graduates leaving them at a disadvantage. (Appendix B)

Medication Errors

The following four articles (DiSimone et al., 2018; Harkanen et al., 2018; Simonsen et al., 2014; Wondemienh et al., 2020) all discussed the threat to patients' wellbeing related to medication errors. Harkanen et al. (2018) noted there are particular tasks associated with medication administration such as preparing the medication, calculating the dosage, educating the client, and self-awareness by the nurse of his/her knowledge of pharmacology and medication. Lack of adequate knowledge of the medications and the administration process ranked high on the list of concerns by the focus group in this study (Harkanen et al., 2018).

Medication Errors in the ED

The article written by DiSimone et al. (2018) reported "medication error rates are at an increase in the emergency department (ED) from 4% to 14%" (p. 26). DiSimone et al., (2018) article noted incorrect dosage calculation led to medication errors further increasing the rate of errors being committed by NGRNs. Ninety five percent of interviewees felt specific training would help decrease errors in medication administration (DiSimone et al., 2018). The category of behaviors on the survey looked at handwashing, obtaining correct vital signs, and double checking for high alert medications as a need for further education as it relates to medication errors (DiSimone et al., 2018).

Knowledge of New Graduate Nurses Compared to Experienced Nurses

The literature reviewed from Simonsen et al. (2014) identified the differences in medication knowledge and increased medication errors among newly graduated nurses and experienced nurses. The study revealed, most experienced nurses developed increased medication knowledge

during the first-year post graduation allowing the experienced nurse to have greater knowledge of pharmacology concepts compared to NGRNs (Simonsen et al., 2014).

Unsafe Practices

A subsequent article by Wondmieneh et al. (2020) focused on unsafe medication practices and the role nurses played in the errors. Through a survey questionnaire, 203 nurses answered questions related to medication errors and the factors leading to the error (Wondmieneh et al., 2020). Lack of adequate training scored as high as 95% by the nurses' surveyed (Wondmieneh et al., 2020). Wondmieneh et al., (2020) further explained, "Factors such as the lack of adequate training (95%), unavailability of guidelines for medication administration (95%), inadequate work experience (95%), interruptions during medication administration (95%), and night duty shift (95%) were significant predictors of MAEs" (p 1).

Inadequate Knowledge

A number of articles addressed the NGRNs' perception of medication errors and knowledge of pharmacology concepts related to estimated risks for errors (Preston et al., 2019; Caboral-Stevens et al., 2020; Schroers et al., 2020). The underlying theme within these articles suggested inadequate pharmacology knowledge and education led to increased incidences in medication errors especially among NGRNs (Preston et al., 2019). The above named articles provided the evidence-based practice guidelines to support this project's hypothesis which advocates for a formal pharmacology course being a required addition to nursing curriculums. The study written by Preston et al., (2019) recognized nursing as a complex discipline where change is needed in regards to the curriculum to better equip the NGRNs with the pharmacology knowledge required to avoid committing medication errors.

Self-perception of Errors

In reviewing the two articles by Schroers et al. (2020) and Caboral-Stevens et al. (2020), the authors studied the self-perception of both nursing students and nurses as to the causes of medication errors. Both groups identified inadequate or lack of medication knowledge as a main reason for errors and risk of errors. Many factors contributed to medication errors that can be improved upon by the NGRN to decrease the number of errors. Factors to be improved included; miscalculations by the NGRN of medication dosages, lack of knowledge related to the actions of the medications, extreme fatigue or tiredness on the part of the NGRN, inadequate or little work experience, and hospital negligence in providing proper protocols related to medication administration (Caboral-Stevens et al., 2020). These potential risks resonate with the proposed DNP project and the need for formal pharmacology education within nursing curriculums to mitigate and decrease medication errors, potentially saving lives. The article written by Schroers et al. (2020), validated the findings in Caboral-Stevens et al. (2020) article by noting the number one reason for medication errors was lack of knowledge. Other factors included fatigue, distractions during medication administration preparation and complacency by the nurse with routine skills (Caboral-Stevens et al., 2020).

Limited Clinical Time and Safety

An article written by Murray et al. (2019b) discussed the correlation between the limited exposure time the NGRNs had in the clinical sites and the inability to practice clinical safety by only practicing in a skills laboratory and not the acute care setting. Murray et al. (2019a) further emphasized the need for educators and nurse managers to recognize this gap in knowledge and implement the needed changes to decrease medication errors and provide safer patient care. As an educator, this author recognized the gap while implementing strategies to increase

pharmacology knowledge among the students in the ADN program by developing pharmacology content with increased rigor as the students progressed through the nursing program.

Simulation and Pharmacology Content

Several articles discussed the education practices of teaching pharmacology content (Gill et al. 2019; Harris et al. 2014; Lee & Quinn, 2019). Intriguingly, the article by Gill et al. (2019) emphasized from the research, simulation improved knowledge of pharmacology content and the skills needed for successful medication administration. Harris et al. (2014) further described students preferred simulation above lecture, problem-based learning, and the flipped classroom. Similarly, Harris et al. (2014) added simulation improved accuracy of medication calculation and administration for nursing students. The use of simulation allowed the students to emerge in patient scenarios to practice skills, specifically medication administration, in a safe, non-threatening environment. Simulation improved student performances in medication administration and the application of didactic content with this skill (Harris et al., 2014).

Quality and Safety Evaluation

Lee and Quinn (2019) incorporated the importance of the Quality and Safety Evaluation (QSEN) tools to evaluate students' knowledge, skills, and attitudes of medication administration. Incorporating simulation, didactic pharmacology content, technology aids, and additional online learning modules to include medication administration into the curriculum improved the students' confidence and knowledge. The QSEN tool of evaluation is widely used by many nursing programs.

National Database

As provided by this literature review, the incidence of medication errors was of concern for educators, managers, experienced nurses, and NGRNs. Several of the articles noted the decrease in reporting of these errors and the need for further education related to pharmacology concepts and content prior to graduation for many students. Africa and Shinnors (2019) proposed the creation of a national database to report and track medication errors with transparency. As it stands, errors were occurring but little effort to reeducate the nursing population as a whole in regards to the specifics of the error were evident in practice. NGRNs can learn from near misses of errors and the actual errors if the database were created and accessible.

Collaboration

Much literature existed related to medication errors among NGRNs. This next article emphasized the need for collaboration between nursing faculty and college administration to create organizational change (Schriner et al., 2010). This particular article written in 2010, coupled with the continued lack of collaboration, continues to be a concern in modern nursing education. The nursing educator shortage that existed over 20 years ago remains of concern in the current state of nursing education. Post COVID pandemic created a greater need for collaboration to assist the NGRNs in competencies during their nursing program. This article used Lewin's Change Theory as a foundational framework to institute change in curriculum (Schriner et al., 2010). While this article was not necessarily research focused, it provided a method to institute change within a liberal arts, ADN program, much as this DNP project is proposing. For this reason, the above noted article was included in the literature review.

Needed Skills

Nursing students complete a rigorous program which incorporates all aspects of patient care and safety during the nursing program. A gap existed and continue to exist between nursing education and the acquisition of clinical skills and knowledge for safe medication administration (Bennett et al., 2017). A quantitative descriptive design study was performed by Bennett et al. (2017), and indicated NGRNs felt real-life and clinical skills were not sufficient to prepare them for the reality and pressure of nursing. The participants included nurses who had worked 3 months or less after graduation. While nursing school is stressful for the students, this author, witnesses as an instructor, these students are not prepared for the reality that awaits upon graduating and becoming NGRNs.

Implications for Practice

The disparities in nursing program curriculums could be a cause for increased error among NGRNs during the medication administration process. A study by Bennet et al. (2017) explored these disparities in knowledge by explaining the gap between nursing education and clinical skills with the results of the study revealing nursing school is considered a controlled environment because the instructors are watching and verifying the procedures and tasks the students perform, including medication administration. The clinical rotations were assigned to the students with little input from the students themselves, students cared for only two patients at the most, clinical days are shorter than work days, and the students had the added confidence because instructors were at their side during the medication administration process. Once these nurses became NGRNs, they found themselves in a different reality, which led to anxiety, poor time management skills, and increased stress leading to possible errors (Bennet et al., 2017). NGRNs, while in nursing school, had limited exposure to the actual process of medication

administration which left them at a disadvantage of pharmacology knowledge and the nursing process as it relates to medication administration (Bennet et al., 2017). A formal pharmacology course in the ADN programs could improve their medication knowledge, and provide improved confidence, leading to safer care provided and decreased medication administration errors.

Conceptual Frameworks

Conceptual frameworks are broadly defined as a tool for integrating and interpreting information in a systematic organized manner, which provide a greater focus of the concept and a rationale for its use (Moran et al., 2020). Conceptual frameworks are used to guide quality improvement projects such as this DNP project. These conceptual and theoretical frameworks guide the doctorate student to identify and use the relationships between the various variables (Moran et al., 2020). This project used Patricia Benner's Novice to Expert Theory as well as James Reason's Swiss cheese model as the guiding theory and framework for completion.

Benner's Novice to Expert Theory

Patricia Benner developed the Novice to Expert theory in 1984 to demonstrate stages the new nurse progresses through upon graduation (Benner, 2001). Per Benner's stages, NGRNs enter the workforce as advanced beginners suggesting the student nurse is a novice in the field (Murray et al., 2019a). Murray et al. (2019a) explained, NGRNs at this stage can demonstrate basic skills as a result of the exposure they received in nursing school. Furthermore, Murray et al. (2019b), suggested NGRNs have difficulty assimilating textbook knowledge, to include pharmacology content, to the clinical setting while performing medication administration. For this reason, education is of utmost importance to foster success in the NGRNs. Nursing schools assist the advanced beginner with the varied aspects of patient care while educating NGRNs how to follow

guidelines and rules for procedures and patient care. When faced with an abnormal or emergency situation, the NGRNs often waste time attempting to remember the guidelines and procedure rules, and frequently miss the patient's deterioration or changing condition prior to an emergency situation occurring (Murray et al., 2019b). If the NGRN was not familiar with a medication's action, use, and expected outcomes untoward events may have occurred to the patient due to the limited exposure and insufficient pharmacology education these nurses obtained. With education and understanding of pharmacology and medication, the new nurse will be more equipped to care for the patient.

Benner's novice to expert theory was developed after revising a previous framework created by Dreyfus and Dreyfus in 1980 (Landers et al., 2020). The Dreyfus model was created after an intense study of chess players and airline pilots to understand how these individuals developed skills (Landers et al., 2020). Landers (2020) noted, "the Dreyfus model posits that in the development of acquisition of a skill, a person passes through five stages of proficiency: novice, advanced beginner, competent, proficient, and expert" (p. 161). Chess players and airline pilots require great concentration and skill to be high performers making this an explanation for Benner's use of this model as a framework to explore and expand the novice to expert theory. Benner expanded on this previous framework applying it to the nursing profession and elaborating on the concepts of clinical judgement as it pertains to nursing interventions and the nurse-patient relationship (Landers et al., 2020). As part of Benner's framework, 31 competencies and 7 domains of practice were developed (Landers et al. 2020). Benner explained in her updated theory how a hybrid exists between didactic instruction and clinical experience, and the use of situation-based approaches assist the NGRN to bridge the knowledge to practice (Landers et al., 2020). It is this author's observation and teaching experience that identifies the

gap between didactic pharmacology knowledge and the actual application of the concepts to the clinical arena, supporting the importance of Benner's competencies and domains as a framework for this project. The 7 domains of nursing practice include; "the helping role, the teaching-coaching function, the diagnostic and patient-monitoring function, effective management of rapidly changing situations, administering and monitoring therapeutic interventions and regimens, monitoring and ensuring the quality of health care practices, organizational and work-role competencies" (Benner 2001, p. 46). There were several of the 7 domains that are most relevant to this DNP project as it pertains to pharmacology knowledge and medication administration to avoid errors. Without proper education a NGRN may not be equipped to properly monitor or evaluate the patient after medication administration therefore, not meeting the diagnostic and patient monitoring function of one of Benner's domains. A patient's condition can change at any moment requiring the effective management by the NGRN to these rapidly changing situations. As noted previously, NGRNs often spend undue time on following guidelines and often miss patient cues of deterioration (Murray et al., 2019a). The decline in patient condition could possibly require the use of medication. During an especially stressful situation, which could ensue after improper medication administration, the NGRNs need to quickly understand how to appropriately respond (Benner, 2001).

Students alternate between the stages of novice, advanced beginner, and competent during their undergraduate program (Benner, 2001). The level of competency is fluid and therefore changes according to the time, previous content learned, and subject matter the NGRN has previously experienced. This transition can be applied to the experienced nurse when he or she is moved to a different specialty area. An example might be the competent nurse in a labor and delivery unit who transitioned to the emergency department as a novice or advanced beginner

nurse in the area of emergency nursing. Nursing school is considered a controlled environment, where these NGRNs are now being placed in vulnerable circumstances in the acute care setting requiring increased support due to the lack of experience and insufficient knowledge while administering often lifesaving medications (Murray et al., 2019b). Benner's stages of advancement assist the NGRN to advance in these vulnerable environments. Benner's theory plays a significant role in this DNP project as it explains the NGRNs' level of educational experience upon graduation. These advanced beginner NGRNs have difficulty with medication administration due to lack of knowledge of medications as stated above, however equipping them with the knowledge and skills they need to be successful is key.

Reason's Swiss Cheese Model

James Reason studied human error in the early 1970's and focused on industrial injuries and how to prevent these injuries (Seshia et al., 2018). Since that time, Reason's Swiss Cheese Model theory evolved to encompass healthcare accidents and injuries that Reason noted were much more complex than industrial accidents as healthcare accidents involve patients (Seshia et al., 2018). James Reason's Swiss cheese model explains and demonstrates the complex process associated with medication errors and it is not simply one factor that causes the error (MacDowell et al., 2021). This author will discuss Reason's Swiss Cheese Model since it is often used to identify errors in healthcare and is relevant to medication errors due to a breach in the complex process of medication administration (MacDowell et al., 2021). Reason's Swiss cheese model proposes the mental picture of Swiss cheese slices stacked next to or on top of each other further explaining medication errors are a complex failure of more than one system or one or more causes (Perneger, 2005). Reason describes the cheese slices as successive layers of defenses, barriers, and safeguards throughout the healthcare system (Seshia et al., 2018). The

medication administration process has safety nets in place to prevent medication errors with weaknesses represented by the holes in the Swiss cheese (Weigmann et al., 2022). Using the Swiss cheese model to look at these systems, the holes in the layers of cheese are representative of failures or breaches in the safety barriers within the healthcare system (Weigmann et al., 2022). For example, in this author's argument, a safety barrier would be the NGRN's appropriate knowledge of the medication's intended action, side effects, and appropriate evaluation of the patient after medication administration. Other safety barriers include proper use of medication administration pumps, the performance of double checks with two RNs for high alert medications, the NGRN's ability to correctly identify the patient, and the completion of the 5 rights of medication administration (Weigmann et al., 2022). Should the NGRN fail to follow the proper procedures of safe medication administration or not have the knowledge of the medications administered, the patient's condition could be compromised causing harm to the patient. Weigmann et al. (2022) notes, if the holes of the Swiss cheese slices align, the error could reach the patient potentially leading to harm or death. A study conducted by Schroers et al., (2020) concluded, the perceived factors leading to medication errors by practicing nurses was knowledge-based and lack of knowledge about medication, personal factors to include fatigue and complacency, and contextual factors such as increased workloads and interruptions during the administration process. The above named factors represented by each layer of cheese, added lack of knowledge of how the medications work, complacency from the nurse, increased workloads, and multiple interruptions during administration being represented by the aligning holes. The harm has now reached the patient as demonstrated in Reason's Swiss cheese model (See Figure 2). Reason's theory stresses the holes in the cheese represent failure or safety barriers that exist within a system, as in instance of safe medication practices, or absence of

safety barriers within the process (Weigmann et al., 2022). Weigmann et al. (2022) pointed out that not all holes that align in a particular system lead to harm for the patient but the chances are increased. The other factors related to the incident play a large role as well. An example of this in relation to medication administration would be failure to perform the two patient identifiers while only verifying the patient's name and omitting the birthdate. This oversight is represented by a hole in the cheese but does not always lead to an accident or error (Weigmann et al., 2022). A third aspect to consider in Reason's theory is the holes in the cheese are dynamic and resilient. Hollnagel et al. (2006) defined a resilient system as "one that is capable of adapting and adjusting to changes or disturbances in the system in order to keep functioning safely" (np). Weigmann et al. (2022) further explained there are two types of failures, active and latent. The active failures being representative of holes occurring while treating patients, performing surgery or dispensing medications. In contrast, the latent failures occur at the organizational or supervisory level not being visible or causing harm to the patient (Weigmann et al., 2022). An important fact to consider with MAEs or patient safety errors, there could be both active and latent errors occurring as in the incidence of medication errors. Furthermore, it is important to recognize as Weigmann et al., (2022) noted, there could be a multitude of failures within each level that interact causing an adverse event leading to patient harm. Seshia et al. (2018) explained, "Multipronged system-based approaches are needed to enhance patient safety across the continuum of care, and the integrated model provides an evidence-informed framework to evaluate strategies that may result in improvement" (p. 194).

Figure 2

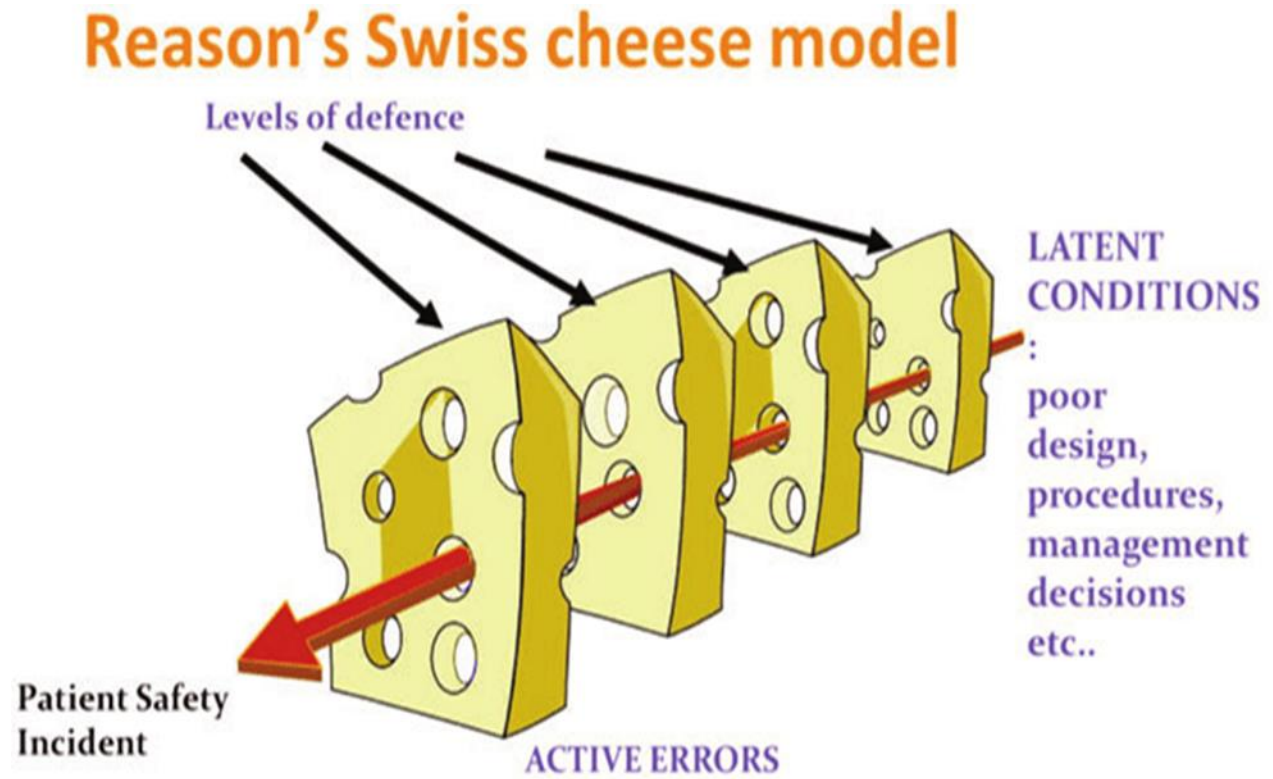


Figure 2 is a visualization of Reason's Swiss Cheese Model depicting how if the holes of the cheese line up the error passes through the various layers of defense, reaching the patient, causing potential harm.

Project Design

Methodology

The methodology used to complete a DNP project connects how the project was developed and implemented to the overall purpose of the project (Moran et al., 2020). The methodology section of the DNP project discusses in further detail the project's; design, participants, setting, tools, intervention(s) used, ethical considerations, data collection and analysis, and results (Moran et al., 2020).

The purpose of this DNP project was to evaluate the knowledge gap or potential knowledge gap between ADN students who had completed a dedicated, formal pharmacology course and those ADN students who had not been offered the same opportunity. Murray et al., (2019b) emphasized the need for educators and nurse managers to recognize this gap in knowledge and implement the needed changes to decrease medication errors and provide safer patient care. This DNP statistically analyzed the data obtained from the pre and post tests administered to the two groups of student participants, those who completed a formal pharmacology course and those who received the content intermittently throughout the two-year nursing curriculum.

The Statistical Package for the Social Sciences (SPSS) was used for data analysis. Data analysis was completed with the assistance of Dr. Halley Riley, Data Analysis Specialist, Georgia State University. No outside funding was obtained. The costs incurred were related to travel to Dalton State College in Dalton, Georgia on two separate occasions. The cost for snacks, pizza, and drinks for the participants for both colleges was solely incurred by this author.

Design

A pre and posttest was used to identify the knowledge gap related to pharmacology between the ADN students attending two Georgia colleges (Appendix A). The twenty-five question pre and posttest included four high-risk medication classifications and dosage calculation problems. The results of this project will assist to identify curriculum practices for pharmacology content and its delivery. The comparison was made between two Georgia ADN programs; one program offered a formal 2-credit hour pharmacology course Dalton State College (DSC) while the other college threaded the content throughout the two-year curriculum Georgia State University Perimeter College (GSUPC).

Participants

Participants were recruited in August 2023 after Georgia State University (GSU) Institutional Review Board (IRB) approval was received in July 2023. Dalton State College did not require IRB approval. A goal of 80 participants was desired during the planning phase of this project. Ideally, the project would consist of 40 participants from each college. Considering this was a voluntary commitment to participate, the goal was not achieved. The available size of the two cohorts played a role in the lower number of participants at each college. Thirty students were enrolled in the DSC pharmacology course with twenty-two students participating in the pretest session. The cohort number for GSUPC was 36 resulting in twenty-three student participants volunteering and completing the pretest. A convenience sampling of volunteer students was used to select participants.

Inclusion and Exclusion Criteria

Inclusion criteria for participants to be a part of this study were: 1) be a current associate degree nursing student in one of the two chosen University Systems of Georgia (USG) schools, and 2) have completed the required formal pharmacology course NUR 1112, if the student was attending DSC. The pharmacology requirement would not be applicable to the GSUPC students. The participants were 18 years or older. There was no exclusion criteria related to gender, race, ethnicity, age or religion.

Setting

Georgia State University Perimeter College (GSUPC)

Georgia State University Perimeter College is one of five Perimeter campuses which merged with the larger college, Georgia State University in 2016. This merger allowed the college to broaden degrees ranging from associate degree to doctoral studies in various disciplines. Georgia State University Perimeter College enrolls over 5,000 students from 100 different countries, located in Clarkston, Georgia. This campus is noted for its ethnic diversity seen in the student population. The Clarkston campus nursing department is part of the larger school of nursing, Byrdine F. Lewis College of Nursing and Health Professions, located at GSU in downtown Atlanta, Georgia. The GSUPC campus was established in 1964 and is ranked among the top twenty, two-year colleges in the nation, known for its high passing scores on the NCLEX, with 100% pass rate in May 2023 (Georgia Board of Nursing, 2023). The nursing department at GSUPC admits 80 students to the program twice a year in January and August. The age range for students enrolled is GSUPC is 18 to 60 years old, with a mean age of individuals enrolled in the nursing program being 30 years old. Both male and female genders are represented within the nursing program, with female students' admission consistently higher than their male

counterpart. Georgia State University Perimeter College has consistently maintained accreditation by the American Association of Colleges of Nursing (AACN). Georgia State University Perimeter College does not offer student housing however does offer student participation in various clubs and organizations. The nursing department offers participation in national organizations such as; Student Nurses Association (SNA) with a local chapter of the Student Nurses Association Perimeter College (SNAPC), Men in Nursing, and Student Christian Fellowship. Georgia State University Perimeter College was chosen for this DNP project because the ADN students are not offered a formal pharmacology course as part of curriculum completion.

Dalton State College

The subsequent college site utilized for this DNP project was DSC located in Dalton, Georgia. Dalton State College is a public college founded in 1963, part of University System of Georgia (USG). Students attending DSC are from 26 states in the United States (US) and 35 nations. The college campus is located 30 miles south of the Georgia – Tennessee border in north Georgia, and 80 miles north of the city of Atlanta. This college does provide on campus residences as well as a variety of clubs and organizations. Total enrollment for DSC in 2022 – 2023 academic year was 4,535 students (DSC, 2022). The nursing department offers an ADN track, Licensed Practical Nursing (LPN) to Registered Nurse (RN) track, paramedic to RN track and online RN to BSN track. The college and nursing program has maintained accreditation from the Southern Association of Colleges and Schools Commission on Colleges (SASCOC). The mean age of nursing students at DSC is 18 to 24 years old with less than 1,000 students over the age of 25 years currently enrolled in the college. The NCLEX pass rate for DSC in 2022 was

90% (DSC, 2023). Dalton State College was chosen for this DNP project because a formal pharmacology course is required prior to graduation from the ADN program.

College Comparison

Both GSUPC and DSC provide the same types of programs within their respective schools of nursing. Admission to both nursing programs require the students to complete the Test of Essential Academic Skills (TEAS) provided by ATI prior to acceptance into the respective nursing programs. Assessment Technology Institute's practice and proctored examinations are utilized by both DSC and GSUPC to assess the students' readiness and probability of passing (POP) the NCLEX. The course curriculum appears to align for both colleges requiring similar basic prerequisite courses.

Tools

Permission was obtained and granted from Assessment Technologies Institute (ATI) to use questions from the private reserve, faculty test bank. ATI is a nationally recognized company used by many colleges for the standardized examinations offering assessment and review tools to assist students (ATI, 2023). Students who utilize the ATI exams have higher probability of success with NCLEX on the first attempt (ATI, 2023). Topics available within the ATI pharmacology exams include; dosage calculation and safe medication administration, active stack pharmacology flash cards, and pharmacology made easy (ATI, 2023). The variety of tools available, coupled with the standardization and probability of passing NCLEX score provided by ATI, deemed this a valid tool for use with this DNP project. Over 100 questions were reviewed within each of the following high-risk classifications; beta blockers, insulin/antidiabetic medications, epinephrine, and anticoagulants. Twenty questions were identified from the above noted categories and reviewed with the DNP team for use to create a Qualtrics examination for

the participants to complete. Qualtrics is a Customer Experience Management (CXM) software platform focusing on collecting and organizing data (GSU, 2023a). Qualtrics allows the author to develop questions in a survey format using open-ended, fill-in-the-blank, and multiple choice question types. The use of the Qualtrics platform allowed this student Principal Investigator (PI) to add flexibility in the types of questions and number used. A 5-point Likert scale question (Do you feel adequately prepared to administer medications upon successful completion of NCLEX?) was used with open-ended questions to obtain demographic information such as; participants' name, gender, highest level of education, and first language spoken, from the participants. Multiple choice questions were utilized for the content questions, and fill-in-the-blank questions for the completion of the dosage calculation questions. Qualtrics software was obtained from the GSU Instructional Technology website free of charge for students and faculty. The 25-question Qualtrics examination was reviewed and approved by the DNP faculty serving on this student PI's project DNP team prior to use.

Intervention

The initial session was conducted at GSUPC on August 29, 2023. Twenty-three ADN student participants reviewed and signed the informed consent to participate (See Appendix A for informed consent). The 25-question pretest was administered via Qualtrics in the GSUPC Clarkston campus computer lab. Each participant completed demographic information and the twenty-five question Qualtrics exam. Light snacks and pizza were provided as incentive for participation.

A participation flyer and short video describing the project and requesting participation from DSC students was developed and used to recruit student participants at DSC. Dr. Kim Horne assisted with posting the information and video on DSC student resource page. This method of

recruitment was utilized due to the proximity and distance of the student PI from the data collection site (116 miles one way). The use of this media proved beneficial as 22 student participants agreed to complete the pretest. Written informed consent was obtained from 22 DSC ADN participants on September 5, 2023. Twenty-two student participants successfully completed the 25-question Qualtrics examination. Pizza, light snacks, and drinks were provided as an incentive for participation.

A forty-five minute educational session was conducted at GSUPC on October 24, 2023 covering the following medication classifications; anticoagulants, epinephrine, beta blockers, insulin, and antidiabetic medications with dosage calculation practice. The actions, interactions, contraindications, side effects, and nursing interventions for administration were discussed using interactive activities and flipped classroom pedagogy. A flipped classroom pedagogy transforms traditional learning into more interactive activities, such as the use of games, puzzles, case studies, and collaborative learning to foster the application of the concepts to patient care (Sajjad & Cowani, 2021). Gamification incorporates games and technology into didactic learning, while invoking motivation to learn through friendly competition (Zugai et al., 2022). Gamification was utilized during both the GSUPC and DSC sessions. The students were grouped into 3-4 teams and participated in a Jeopardy like game presenting the content of the above named classifications. Georgia State University Perimeter College in person education session was completed on October 23, 2023 and the DSC session was completed on November 7, 2023. Upon completion of the learning sessions participants completed the 25 question posttest. Each student participant was awarded a certificate of completion for participating in this DNP project (Appendix B).

Ethical Considerations

The IRB approval for this project completion was obtained from GSU in July 2023.

Permission to conduct, complete the project, and support of this DNP project was obtained from GSUPC, Contessar Maddox, MSN, RN, Director of Nursing, prior to initiation of the project. Dalton State College did not require IRB approval. Dr. Sylvia Driver, DNP, Nursing Department Chair and Professor of Nursing RN BSN Program and Dr. Kim Horne, DNP, RN, Assistant Professor of Nursing, assisted with securing a computer lab on DSC campus and posting the recruitment flyer and video on the DSC learning platform. Dr. Driver provided written consent for student participation in July 2023 after GSU IRB approval was obtained.

Informed consent was obtained from participants at both colleges by the student PI. Written consents were transported by the student PI in a locked backpack to the PI's office further secured in a locked file cabinet in a locked office. The project does not involve adolescents or participants' health records nor any vulnerable population group. No further ethical considerations have been identified.

Data Collection and Analysis

Pretest data was obtained from Qualtrics data, analysis, and reports. Individual college participant results were exported to the SPSS data analysis tool. Data cleaning and descriptive statistical measures were completed using SPSS (Version 29), for the two participant groups obtaining a mean average score and standard deviation for each group. Dr. Riley, GSU Data Analyst Specialist, assisted with finalization of data collected. Analysis and evaluation of the DNP project identifies what worked well during the project implementation and what improvements might need to occur for future projects (Moran et al., 2020). A paired t-test was used to analyze the data collected related to the specific questions. Wadwa and Marappa-

Ganeshran (2023) noted, a t-test provides a rational quantifying how significant or non-significant the difference is between the “means” of a small sample group. A paired t-test was chosen for this DNP project because the two-sample t-test allows the researcher to test the values of a particular statistic between two groups. As noted by Wadwa & Marrappa-Ganeshran (2023) “the paired t-test is used in scenarios where measurements from the two groups have a link to one another” (p. 2).

Results

Demographic Content Analyzed Pre Test

Results are provided comparing DSC and GSUPC participants from the completed pre-test examination. There were twenty-three participants from GSUPC and twenty-two participants from DSC, totaling 45 participants who completed the one-time demographic survey. The demographic data was analyzed and reported for both colleges. Fifteen percent of the participants reported previously obtaining an associate degree in a different discipline, 13.3% completed some college schooling, 2.2% obtained the General Educational Development (GED) test, and 48.9% completed high school obtaining a diploma with no further education before entering the nursing program. The participants consisted of 86.71% female gender and 13.3% reported being male gender. Eighty-eight percent reported English as a first language, 6.7% reported Spanish, and 2.2% reported Bulgarian and Korean as a first language. A five-point Likert scale was used to obtain the participants’ level of confidence with the type of educational preparation received in regards to pharmacology and feeling prepared for medication administration. Fifty-one percent felt they were prepared, 8.9% felt very prepared, 6.7% felt unprepared, 4.4% felt the education they received insufficiently prepared them, and 2.8% reported a neutral response. Data was collected and categorized between the four available answer choices for each question. The data

obtained related to the students' individual confidence of feeling prepared was noted by this student PI to be more confident than expected in relation to the number of MAEs committed by NGRNs. A future study might investigate the relationship between students' confidence level with medication administration and actual observation of proper procedures during this process.

Data Analysis Posttest

It is important to note for the posttest results there was no demographic information collected as the same student population for the pretest completed the posttest. No new participants were recruited. There was a difference between the sample size of the pre and posttests at both colleges. The pretest for DSC consisted of 22 participants with 21 completing the DSC posttest. One student was unaccounted for and did not provide a reason for not participating in the posttest. The number of student participants from GSUPC decreased from 23 participants completing the pretest to only 20 participants completing the posttest with one student leaving early due to being notified of a death in the family at the start of the day. Two students were unaccounted for. The total, final number of participants from both colleges was 41 (N=41).

The results obtained from comparing the pretest and the posttest between the two colleges' revealed GSUPC student participants scored higher on both the pre and posttests as compared to DSC. Georgia State University Perimeter College student participants obtained a mean pretest score of 16.34 (SD=2.25) correct answers out of 25 questions, which corresponds to a score of 65.4% correct. In comparison, DSC student participants obtained a mean pretest score of 9.29 (SD=3.13) correct answers out of 25 questions, or 37% correct. For the combined sample, the mean pre-test score was 12.66 (SD=4.45), or 51% correct.

Upon completion of the educational intervention, test scores increased significantly for both colleges. For GSUPC participants, the mean test score increased to 18.4 (SD=1.98) or 74%

correct, ($p < 0.001$). For DSC participants, the mean test score increased to 13.7 (SD= 4.12), or 55% correct ($p < 0.001$). The mean posttest score for the combined sample was 16.02 (SD=6.01) or 64.08% correct. After the intervention, the mean full sample test score increased by 3.37 points (14%). This was a statistically significant increase ($p < 0.001$). See table 1 for analyzed scores.

Table 1

Results of paired t-tests:

Item	Pre-test		Post-test		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
GSUPC	16.34	2.25	18.4	1.98	<0.001
DSC	9.29	3.13	13.7	4.12	<0.001
Full Sample	12.66	4.5	16.02	3.98	<0.001

Table 1 shows the paired sample statistics for both student participant populations for both the pre and posttest scores with standard deviation.

Using independent sample t-tests, this author compared test scores across the two groups. The college that dispersed the pharmacology content throughout the program had a mean pre-test score significantly higher than the college who had a formal pharmacology course with a mean pre-test score ($p < 0.001$). Similarly, the college without a formal course mean posttest score was significantly higher than the other college's mean pre-test score ($p < 0.001$). However, after the intervention, the student participants who have complete a formal pharmacology course had a mean score that increased by 4.47 points, while the other college scores improved by a mean of 2.20 points (Table 2). The student participants that completed a formal course improved significantly more upon the completion of both the formal course and the teaching intervention ($p = 0.027$). This author's opinion is that the higher, more significant increase in scores for the

college who has a formal course is due to the dedicated pharmacology course this participant population received.

Table 2

Item	Score Differences				<i>p</i>
	GSUPC		DSC		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Score Difference	2.29	2.52	4.48	3.68	0.027

Table 2 shows the improved scores with a mean differences of the two participant populations.

Limitations

Several limitations were identified while completing and compiling the data obtained from this project. A larger sample size of participants might reveal a greater variation in actual exam scores. A second identified limitation was the short time period for completion of the study, limiting the participant population. As mentioned in previous sections, the total enrollment in the cohort used from each college was low therefore limiting participation. Considering the time period for project completion was fall 2023 (September 2023 to November 2023) there was minimal participation. When results were analyzed the advanced knowledge the cohort had previously gained because they were in their senior cohort could contribute to the higher pre and post test scores than the students who completed the formal pharmacology course were in their first semester. The senior student participants were better versed on medications and medication administration as well as the effects the medications have on the various body systems because they are in their senior semester of nursing school. This student participant population had gained disease process knowledge and were engaged in the practice of medication administration during their clinical rotations. In contrast, the first year student participants had not been afforded

the opportunity to gain sufficient knowledge related to the disease processes and how medications may affect these illnesses.

Biases

One might consider the fact, author is part of the faculty at the college where the student participants upon pharmacology content throughout the curriculum and is the instructor that teaches the pharmacology content as a bias.

Implications to Educational Practices

The literature reviewed discussed the rise in medication errors from NGRNs and the attributing factors are lack of education and knowledge of the medications being administered (Trieber & Jones, 2018). The results of this project were not the expected outcomes upon completion however, the data collected is relevant and useful for future endeavors to the educational setting. Follow up conversations were had with the senior student participants who voiced their appreciation and approval of having the pharmacology content dispersed within the program. Several of the students voiced their concerns with having to complete a formal pharmacology course within the first semester of nursing school and not having foundational nursing knowledge to apply the pharmacological concepts to the patients' conditions. This author intends to increase the rigor of the content currently being taught in relation to pharmacology content and strive to foster greater understanding of high risk medications to the student nursing population. Trieber & Jones (2018) noted 55% of NGRNs admitted to making at least one medication error and some admitted to more. In the same study, Trieber & Jones (2018) noted, 24% of NGRNs admitted to committing a MAE but did not report the error. This data is alarming to faculty, patients, and consumers and can negatively impact the healthcare setting, therefore, more rigorous education on pharmacological concepts is needed.

Conclusion

This project proved to be very informative with the data compiled and statistics analyzed. The data suggests the hypothesis that the students who received training by a formal pharmacology course would score higher on pre and posttest examination resulted in a nulled hypothesis. In actuality, the student participants who obtained the pharmacology content throughout their nursing program scored higher on both the pre and posttests. This hypothesis was nulled however, after considerable data analysis, the student participants who completed the formal pharmacology course did reveal a more significant score in the posttest than the comparable student participant group that received the content throughout the nursing program. This student PI was somewhat disappointed with the data obtained but can utilize the received data to provide increased rigor to the current teaching pedagogy of pharmacology for ADN students.

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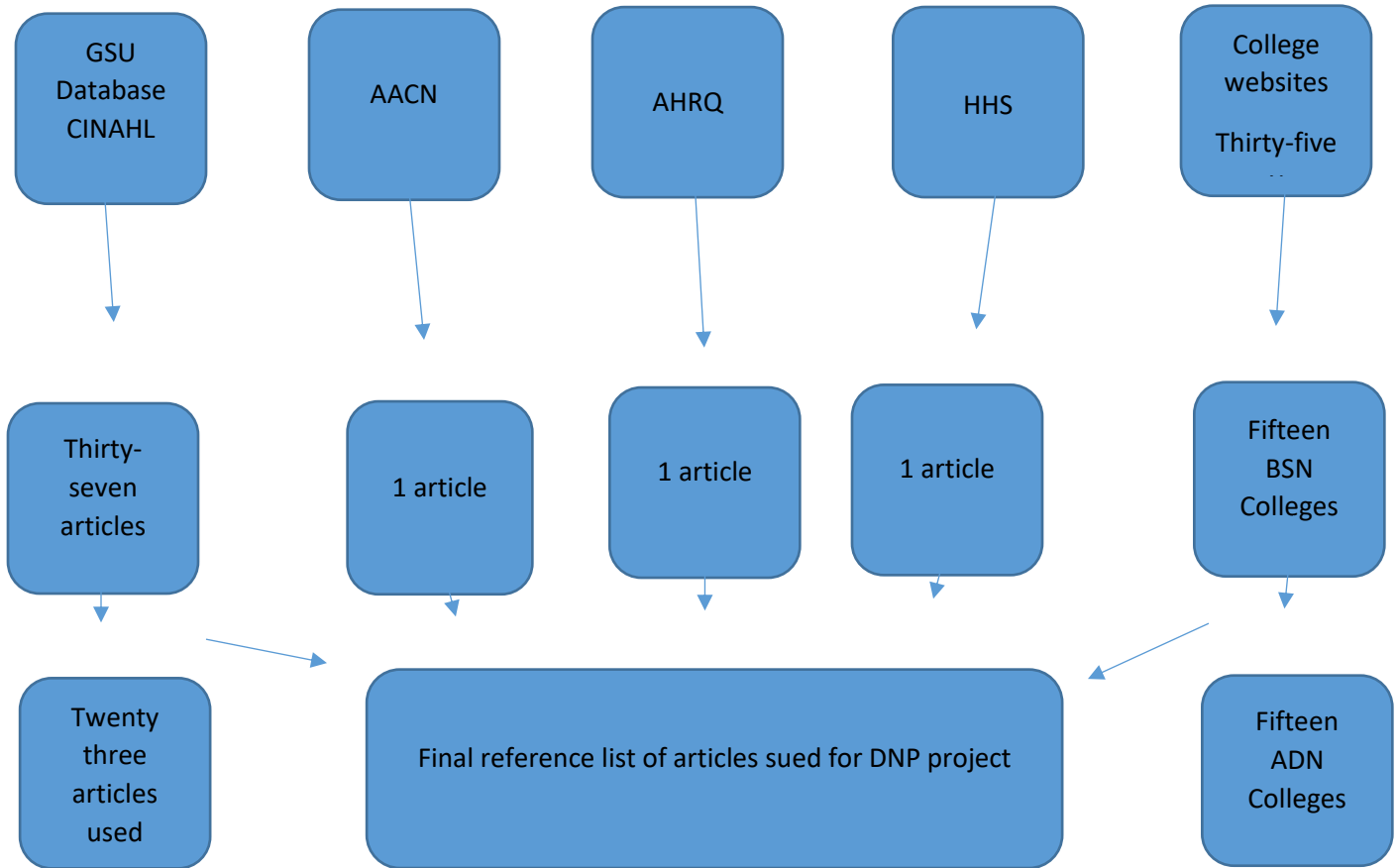
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Figures

Figure 1



Article Search Results

Figure 2*ADN programs in Georgia*

College	Program	Formal Pharmacology Course as part of Curriculum
Abraham Baldwin Agricultural College	Associate Degree Nursing	Yes
Albany Technical College	Associate Degree Nursing	Yes
Athens Technical College	Associate Degree Nursing	No
Atlanta Technical College	Associate Degree Nursing	Yes
Augusta Technical College	Associate Degree Nursing	No
Chattahoochee Technical College	Associate Degree Nursing	Yes
College of Coastal Georgia	Associate Degree Nursing	No
Dalton State College	Associate Degree Nursing	Yes
Georgia Highlands College	Associate Degree Nursing	No
Gordon State College	Associate Degree Nursing	Yes
Gwinnett Technical College	Associate Degree Nursing	Yes
Perimeter College at GSU	Associate Degree Nursing	No
South Georgia Technical College	Associate Degree Nursing	Yes
West Georgia Technical College	Associate Degree Nursing	No
North Georgia Technical College	Associate Degree Nursing	Yes

Figure 2 represents a website search of 15 ADN programs in Georgia, which offer a formal pharmacology course as part of their nursing program curriculum and those that do not. The number 15 (n=15) was chosen for both ADN and BSN programs because the other colleges did not have adequate information on the website related to the program curriculum whether a formal pharmacology was offered or not.

Figure 3*BSN Programs in Georgia*

College	Program	Formal Pharmacology Course as part of Curriculum
Emory University	Bachelor Degree Nursing	Yes
Georgia State University	Bachelor Degree Nursing	Yes
Mercer University	Bachelor Degree Nursing	Yes
Augusta University	Bachelor Degree Nursing	Yes
University of West Georgia	Bachelor Degree Nursing	Yes
Columbus State University	Bachelor Degree Nursing	Yes
Kennesaw State University	Bachelor Degree Nursing	Yes
Georgia Southern University	Bachelor Degree Nursing	Yes
University North Georgia	Bachelor Degree Nursing	Yes
Chamberlain University	Bachelor Degree Nursing	Yes
Georgia College & State	Bachelor Degree Nursing	Yes
Valdosta State University	Bachelor Degree Nursing	Yes
Gordon State College	Bachelor Degree Nursing	Yes
Brenau University	Bachelor Degree Nursing	Yes
Capella	Bachelor Degree Nursing	Yes

Figure 3 represents a website search of 15 BSN programs in Georgia, which offer a formal pharmacology course as part of their nursing program curriculum.

Appendices

Appendix A

Georgia State University Informed Consent

Title: A Quality Improvement Initiative to Bridge the Gap of Pharmacology Knowledge among Associate Degree Nursing Students

Principal Investigator: Dr. Lisa Cranwell-Bruce

Co-Investigator: Dr. Chandler Padgett

Student Principal Investigator: Maria LePage

Introduction and Key Information

You are being asked to take part in a research study. You will decide if you would like to take part in this project. This is completely a volunteer opportunity.

The purpose of this project is to determine if a formal pharmacology course in associate degree nursing (ADN) programs can increase the new graduate registered nurses' (NGRN) knowledge of pharmacology in an effort to decrease medication errors.

Your role in the project will last approximately one to three months consisting of the completion of a 25-question pharmacology pretest and posttest. The content of the pretest will include; basic pharmacology knowledge on medications, administration, correct dosage calculation and the nursing process as it relates to administration. The Qualtrics survey will consist of basic demographic information and the 25-question pretest and posttest. In the first session, you will also complete a brief questionnaire about your demographic information. Your name and initials will be collected.

You will not have any more risks than you would have in a typical day.

We hope to gain valuable knowledge that supports the hypotheses of a formal pharmacology course for all ADN nursing students and the benefits once becoming a new graduate registered nurse. You may opt out of participating not signing this consent form.

Purpose

The purpose of this study is to determine if a formal pharmacology course in ADN programs can assist the new graduate registered nurses (NGRN) knowledge of pharmacology to help decrease medication errors. You are invited to participate in this study because you are an ADN student who has completed education on pharmacology content. There will be fifty participants from each college invited to participate in this study.

Procedures

If you decide to take part of this study, you are being asked to complete a 25-question pharmacology knowledge pretest using Qualtrics, attend two, one ½-hour sessions completing the pre and posttest and listening to a 45-minute session on pharmacology information.

As a participant in this project, you might:

- Interact with the student project investigator
- Interact with other consented participants in the project
- Be asked to attend the 2 sessions on your own time
- You may remove yourself from the project at any time without penalty to grade or injury

Future Research

By consenting to participate in this study, you understand the information gathered may be used for future studies without additional consent needed. We will remove any identifying personal information.

Risks

There is no risk for you to participate that what you would have in a normal day of life. We do not expect injury from participating in this project. If you are harmed, contact the project team as soon as possible. Georgia State University and the project team have not set aside funds to pay for any injury.

Benefits

We hope to gain information about ADN students' pharmacology knowledge and the benefits of a dedicated, formal pharmacology course within the nursing program and the positive role this knowledge has for the NGRN in the workforce. Once graduated and successfully completing the National Council Licensure Exam (NCLEX), all registered nurses (RNs) are held to the same expectations and standard of nursing practice in the acute care arena. Your participation and the results of the study will benefit the future of nursing curriculum and be shared with you.

Alternatives

The only alternative to participating in this study is to refuse participation.

Voluntary Participation and Withdrawal

You do not have to participate in this project. If you decide to participate in this project and change your mind, you can drop out at any time. Participation in this project will not affect grades or how you are treated in the workplace. If you do not take or if you leave this project early, you will not lose any benefits that you are otherwise entitled to.

Confidentiality

We will keep your records private to the extent required by law. The following people and groups will have access to the information you provide:

- Maria LePage, MSN, BSN, RN, CEN, Dr. Modupeola Adebayo, Dr. Chandler Padgett
- Georgia State University Institutional Review Board (IRB)
- Office for Human Research Protection (OHRP)
- Georgia State University DNP course faculty

We will use your initials, rather than your name on project records. We will store the information you provide in a locked file cabinet, in Maria LePage’s locked office. The data will be stored on a password protected computer. When we present or publish the results of this project, we will not use information that may identify you. Names or identifying information will not be used in presentations or publications.

Contact Information

You can contact Maria LePage at 404-432-7890 and mlepage@student.gsu.edu.

- If you have questions about the project or your part in it
- If you have questions, concerns, or complaints about the project

The IRB at Georgia State University reviews all research that involves human participants. You can contact the IRB if you would like to speak to someone who is not involved directly with the project. You can contact the IRB for questions, concerns, problems, information, input, or questions about your rights as a project participant. Contact the IRB at 404-413-3500 or irb@gsu.edu

Consent

We will give you a copy of this information Consent Form to keep.

If you are willing to be in this DNP project, please sign below.

Printed Name of Participant

Signature of Participant Date

Principal Investigator or Researcher Obtaining Consent Date

Appendix B

Pretest Pharmacology

1. A nurse is preparing to administer medication to a client who has gout. The nurse discovers that an error was made during the previous shift and the client received atenolol instead of allopurinol. Which of the following actions should the nurse take first?
 - a. Obtain the client's blood pressure and heart rate
 - b. Contact the client's provider to inform them of the error
 - c. Complete an incident report
 - d. Obtain the client's pulse oximetry and respiratory rate

Answer: A

2. A nurse is administering cefotetan via intermittent IV infusion to a client who suddenly develops dyspnea and widespread hives. Which of the following actions should the nurse take first?
 - a. Administer epinephrine 0.5mL via IV bolus
 - b. Discontinue the medication IV infusion
 - c. Elevate the client's legs above the level of the heart
 - d. Collect a blood specimen for ABGs

Answer: B

3. A nurse is preparing to administer 0.9% sodium chloride 1L IV over 8 hours to a client. The drop factor of the normal IV tubing is 15gtts/mL. The nurse should set the manual IV infusion to deliver how many gtts/min? (Round the answer to the nearest whole number. Use a leading zero if it applies. Do not use a trailing zero).

Answer: 31gtts/min

4. The nurse is assessing a client after administering a dose of cefazolin IV. The nurse noted the client to exhibit anxiety, hypotension, and dyspnea. Which of the following medications should the nurse administer first?
 - a. Diphenhydramine IM
 - b. Albuterol nebulizer
 - c. Solu Medrol IV
 - d. Epinephrine IM

Answer: D

5. A nurse is preparing to administer heparin subcutaneously to a client. Which of the following actions should the nurse plan to take?

- a. Administer the medication outside the 5cm radius of the umbilicus
- b. Aspirate for blood return before injecting
- c. Rub vigorously after the injection to promote absorption
- d. Place a pressure dressing on the injection site to prevent bleeding

Answer: A

6. A nurse is preparing to administer 0.9% sodium chloride (NaCl) 1,500mL to infuse over 8 hours to a postoperative client. The nurse should set the IV pump to deliver how many mL/hr. (Round to the nearest whole number. Use a leading zero if it applies. Do not use a trailing zero).

Answer: 188mL/hr

7. The nurse is providing discharge instructions to a client who is to self-administer insulin at home. Which of the following client statements should indicate to the nurse that the teaching is effective?
 - a. "I should avoid getting rid of the air bubble in the syringe:
 - b. "I should inject the insulin into my thigh for fastest absorption".
 - c. "I need to shake the insulin before using it to make sure it is well mixed".
 - d. "I should store my unopened bottle of insulin in the refrigerator".

Answer: D

8. A nurse is reviewing the laboratory results for a client who is receiving heparin via continuous IV infusion for deep vein thrombosis. The nurse should discontinue the medication infusion for which of the following client findings?
 - a. Potassium 5.0mEq/L
 - b. aPTT 2 times the control
 - c. Hemoglobin 15g/dL
 - d. Platelets 96,000/mm³

Answer: D

9. A nurse is planning care for a client who has hypertension and is to start taking metoprolol. Which of the following instructions should the nurse include in the plan of care?
 - a. Weigh the client slowly
 - b. Obtain apical pulse prior to administering
 - c. Administer the medication 30 minutes prior to breakfast
 - d. Monitor the client for jaundice

Answer: B

10. A nurse is caring for a client who is recovering from deep-vein thrombosis and is to start taking warfarin. For which of the following findings should the nurse monitor as an adverse effect of warfarin?
- Hypertension
 - Low INR
 - Constipation
 - Bleeding gums

Answer: D

11. A nurse is completing an incident report for a medication error. Which of the following information should the nurse include in the report?
- This could have been avoided if I had double-checked the medication administration record with the client's identification band.
 - It was easy to get confused because another client is receiving a similar sounding medication.
 - Administered propranolol 80mg PO at 1800 to the client who did not have a prescription for the medication.
 - While I rarely make medication errors the client was given 80mg of propranolol by mistake at 1800.

Answer: C

12. A nurse is teaching a client about warfarin. The client asks if they can take aspirin while taking the warfarin. Which of the following responses should the nurse make?
- "It is safe to take an enteric-coated aspirin".
 - "Aspirin will increase the risk of bleeding".
 - "Acetaminophen may be substituted for aspirin".
 - "The INR lab work must be monitored more frequently is aspirin is taken".

Answer: B

13. A nurse is caring for a client who has diabetes mellitus and is taking glyburide. The client reports feeling confused and anxious. Which of the following actions should the nurse take first?
- Perform a capillary blood glucose test
 - Provide the client with a protein rich snack
 - Give the client 120mL of orange juice
 - Schedule an early meal tray

Answer: A

14. A nurse is reviewing the medical record for a client who has hypertension. The nurse should identify which of the following findings as a contraindication for receiving propranolol?
- Cholelithiasis
 - Asthma
 - Angina pectoris
 - Tachycardia

Answer: B

15. A nurse is preparing to administer heparin 5,000 units subcutaneously. Available is heparin injection 10,000 units/mL. How mL should the nurse administer per dose? (Round the answer to the nearest tenth. Use a leading zero if it applies. Do not use a trailing zero).

Answer: 0.5mL

16. A nurse is preparing to administer 15 units of regular insulin along with 20 units of NPH insulin. Which of the following actions should the nurse plan to take?
- Shake the NPH insulin vial vigorously to mix the insulin
 - Use a new needle to draw up the insulin from the second vial
 - Inject 20 units of air into the NPH insulin fist
 - Draw the longer acting insulin into the syringe first

Answer: C

17. A nurse is providing discharge instructions to a client who has a new prescription for warfarin. Which of the following client statements should the nurse identify as an indication that the client understands the teaching?
- “I should report a change in the color of my stools”.
 - “I can take acetaminophen to treat a headache”.
 - “I will take a calcium supplement while taking this medication”.
 - “I will return in a month to have blood tested”.

Answer: A

18. When caring for a child, a nurse plans to use non-pharmacological interventions to enhance the effectiveness of pain medication. Which of the following strategies incorporates visualization techniques to help decrease the child's discomfort?
- Coloring with crayons in a coloring book
 - Deep breathing and “going limp as a rag doll”.

- c. Blowing bubbles with liquid soap to “blow the hurt away”.
- d. Taking a warm bath and playing with a bath toy

Answer: C

19. A nurse is preparing to administer insulin to a client via a pen device. Which of the following actions should the nurse take?

- a. Shake the insulin pen device prior to injecting the medication
- b. Withdraw the insulin from the pen device into an insulin syringe
- c. Hold the pen device in place for 3 seconds after injecting the insulin
- d. Hold the insulin pen device perpendicular to the client’s skin to inject the medication

Answer: D

20. A nurse is providing teaching to a client who has a new diagnosis of type 1 diabetes mellitus and will be discharged with insulin. The nurse should instruct the client to monitor for which of the following findings as a manifestations of hypoglycemia?

- a. Irritability
- b. Increased urination
- c. Vomiting
- d. Facial flushing

Answer: A

21. A nurse is providing teaching about disease management for a client who has a new diagnosis of type 1 diabetes mellitus. Which of the following activities is the nurse’s priority?

- a. Instruct the client about the importance of regular medical appointments
- b. Ensure the client understands medication regimen
- c. Explain proper foot care techniques to the client
- d. Encourage the client to participate in daily exercise

Answer: B

22. A nurse is caring for a client who has a pulmonary embolism. The client is receiving heparin via continuous IV infusion at 1200units/hr and warfarin 5mg PO daily. The morning laboratory values for the client are aPTT 98 seconds and INR 1.8. Which of the following actions should the nurse take?

- a. Prepare to administer vitamin K
- b. Prepare to administer alteplase
- c. Withhold the heparin infusion
- d. Withhold the next dose of warfarin

Answer: C

23. A nurse is assessing a client who is taking propranolol. Which of the following findings should indicate to the nurse that this client is experiencing an adverse reaction to propranolol?
- a. Weight loss
 - b. Wheezing
 - c. Blood pressure 146/92mmHg
 - d. Heart rate 110 beats/minute

Answer: B

24. A nurse is assessing a client after administering epinephrine. Which of the following findings should the nurse identify as an adverse effect of this medication?
- a. Hypotension
 - b. Report of tinnitus
 - c. Ecchymosis at injection site
 - d. Report of chest pain

Answer: D

25. A nurse is providing discharge teaching for a client who had a new prescription for warfarin. Which of the following instructions should the nurse include in the teaching?
- a. Mild nosebleeds are common during initial treatment
 - b. Use an electric razor while on this medication
 - c. If a dose of the medication is missed, double the dose at the next scheduled time
 - d. Increase fiber intake to reduce the adverse effect of constipation

Answer: B

Appendix C

Posttest Pharmacology

1. A nurse is preparing to administer medication to a client who has gout. The nurse discovers that an error was made during the previous shift and the client received atenolol instead of allopurinol. Which of the following actions should the nurse take first?
 - a. Obtain the client's blood pressure and heart rate
 - b. Contact the client's provider to inform them of the error
 - c. Complete an incident report
 - d. Obtain the client's pulse oximetry and respiratory rate

Answer: A

2. A nurse is administering cefotetan via intermittent IV infusion to a client who suddenly develops dyspnea and widespread hives. Which of the following actions should the nurse take first?
 - a. Administer epinephrine 0.5mL via IV bolus
 - b. Discontinue the medication IV infusion
 - c. Elevate the client's legs above the level of the heart
 - d. Collect a blood specimen for ABGs

Answer: B

3. A nurse is preparing to administer 0.9% sodium chloride 1L IV over 8 hours to a client. The drop factor of the normal IV tubing is 15gtts/mL. The nurse should set the manual IV infusion to deliver how many gtts/min? (Round the answer to the nearest whole number. Use a leading zero if it applies. Do not use a trailing zero).

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 - a. Diphenhydramine IM
 - b. Albuterol nebulizer
 - c. Solu Medrol IV
 - d. Epinephrine IM

Answer: D

5. A nurse is preparing to administer heparin subcutaneously to a client. Which of the following actions should the nurse plan to take?

- a. Administer the medication outside the 5cm radius of the umbilicus
- b. Aspirate for blood return before injecting
- c. Rub vigorously after the injection to promote absorption
- d. Place a pressure dressing on the injection site to prevent bleeding

Answer: A

6. A nurse is preparing to administer 0.9% sodium chloride (NaCl) 1,500mL to infuse over 8 hours to a postoperative client. The nurse should set the IV pump to deliver how many mL/hr. (Round to the nearest whole number. Use a leading zero if it applies. Do not use a trailing zero).

Answer: 188mL/hr

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 - c. "I need to shake the insulin before using it to make sure it is well mixed".
 - d. "I should store my unopened bottle of insulin in the refrigerator".

Answer: D

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 - a. Potassium 5.0mEq/L
 - b. aPTT 2 times the control
 - c. Hemoglobin 15g/dL
 - d. Platelets 96,000/mm³

Answer: D

9. A nurse is planning care for a client who has hypertension and is to start taking metoprolol. Which of the following instructions should the nurse include in the plan of care?
 - a. Weigh the client slowly
 - b. Obtain apical pulse prior to administering
 - c. Administer the medication 30 minutes prior to breakfast
 - d. Monitor the client for jaundice

Answer: B

10. A nurse is caring for a client who is recovering from deep-vein thrombosis and is to start taking warfarin. For which of the following findings should the nurse monitor as an adverse effect of warfarin?
- Hypertension
 - Low INR
 - Constipation
 - Bleeding gums

Answer: D

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Answer: B

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- Perform a capillary blood glucose test
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 - Give the client 120mL of orange juice
 - Schedule an early meal tray

Answer: A

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Answer: C

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- d. Hold the insulin pen device perpendicular to the client’s skin to inject the medication

Answer: D

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- b. Increased urination
- c. Vomiting
- d. Facial flushing

Answer: A

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- c. Withhold the heparin infusion

d. Withhold the next dose of warfarin

Answer: C

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- c. Ecchymosis at injection site
- d. Report of chest pain

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24. A nurse is providing discharge teaching for a client who had a new prescription for warfarin. Which of the following instructions should the nurse include in the teaching?

- a. Mild nosebleeds are common during initial treatment
- b. Use an electric razor while on this medication
- c. If a dose of the medication is missed, double the dose at the next scheduled time
- d. Increase fiber intake to reduce the adverse effect of constipation

Answer: B

*** If is important to note, the pre and posttest contained the same questions and content ***

Appendix D



Appendix C is the participation certificate provided to student participants upon completion of DNP project.

Appendix E**IRB Approval Letter**

INSTITUTIONAL REVIEW BOARD

Mail: P.O. Box 3999 In Person: 3rd Floor
Atlanta, Georgia 30302-3999 58 Edgewood
Phone: 404/413-3500 FWA: 00000129

June 30, 2023

Principal Investigator: Lisa Cranwell

Key Personnel: Cranwell, Lisa; LePage, Maria A; Padgett, Chandler

Study Department: B.F. Lewis School of Nursing

Study Title: A Needs Assessment Initiative to Bridge the Gap of Pharmacology Knowledge among Associate Degree Nursing Students

Submission Type: Exempt Protocol Category 2

IRB Number: H23594

Reference Number: 374873

Determination Date: 06/28/2023

Status Check Due By: 06/27/2026

The above-referenced study has been determined by the Institutional Review Board (IRB) to be exempt from federal regulations as defined in 45 CFR 46 and has evaluated for the following:

1. Determination that it falls within one or more of the eight exempt categories allowed by the institution; and
2. Determination that the research meets the organization's ethical standards

If there is a change to your study, you should notify the IRB through an Amendment Application before the change is implemented. The IRB will determine whether your research continues to qualify for exemption or if a new submission of an expedited or full board application is required.

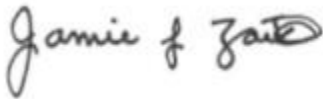
A Status Check must be submitted three years from the determination date indicated above. When the study is complete, a Study Closure Form must be submitted to the IRB.

This determination applies only to research activities engaged in by the personnel listed on this document.

It is the Principal Investigator's responsibility to ensure that the IRB's requirements as detailed in the Institutional Review Board Policies and Procedures For Faculty, Staff, and Student Researchers (available at gsu.edu/irb) are observed, and to ensure that relevant laws and regulations of any jurisdiction where the research takes place are observed in its conduct.

Any unanticipated problems resulting from this study must be reported immediately to the University Institutional Review Board. For more information, please visit our website at www.gsu.edu/irb.

Sincerely,

A handwritten signature in cursive script that reads "Jamie f Zaik". The signature is written in black ink and is positioned below the word "Sincerely,".

Jamie Zaikov, IRB Member

APPENDIX F**ACADEMIC HONESTY STATEMENT**

Author Note:

Pursuant to the academic honesty standards of the University, it is important to note that some of the information pertaining to my DNP project, and some of the same references, and verbiage have been used in other classes to build on my DNP project, the interventions, and methods of implementation of the interventions. Additionally, some of the research related to my DNP project has been used as background information for other papers or projects conducted throughout the study and then added to throughout the curriculum. In all circumstances, the information has been built upon to gain depth and knowledge related to the area of pharmacology knowledge and medication administration errors among associate degree nursing students and other information used for the project, and this assignment has not been submitted in full for any other assignment within the School of Nursing or the University.

Maria LePage