

CLICKER EFFECTIVENESS ON NURSING STUDENTS' LEVEL OF KNOWLEDGE
AS EVIDENCED BY EXAM PERFORMANCE

by

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ABSTRACT

A lack of research exists regarding clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. Further research was needed to explore this topic. The null hypothesis of this study was that clickers will not have any effect ($p < .05$) on nursing students' level of knowledge as evidenced by exam performance. The alternative hypothesis was that clickers will have an effect on nursing students' level of knowledge as evidenced by exam performance. A pretest and posttest design with a comparison group was used to determine a valid association between the independent variable of clickers and the dependent variable of nursing students' level of knowledge as evidenced by exam performance. Descriptive statistics, including the mean and standard deviation, were calculated for the test scores received. The numerical variables were compared by independent samples t tests. Statistical analyses revealed that the control group showed greater improvement in scores post-intervention than did the experimental group. Clickers were not effective on nursing students' level of knowledge as evidenced by exam performance.

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CHAPTER 1

INTRODUCTION

Student response systems are a fairly new pedagogical feedback tool that encourages active learning for students and allows the educator to evaluate effective instruction and identify potential misunderstandings within the classroom (Kaleta & Joosten, 2007; Revell & McCurry, 2010; Zurnehly & Leadingham, 2008). Common synonyms for student response systems include “classroom communication system,” “audience response system,” “voting machine,” and, colloquially, “clickers” (Beatty & Gerace, 2009). The word “clickers” is the terminology used for this dissertation to describe the student response system used in this study. Clickers consist of a wireless response system that allow faculty to actively engage students (Kaleta & Joosten). For instance, the educator can display questions at pedagogically strategic moments within the classroom and students answer the displayed question anonymously with their individual clicker device (Kaleta & Joosten).

Despite the accolades regarding clickers and the potential pedagogical possibilities within the classroom with their use, limited research exists in nursing education to support clicker effectiveness on nursing students’ level of knowledge as evidenced by exam performance. Following an analysis of 26 research studies in mathematics, chemistry, and humanity courses, Roschelle, Penuel, and Abrahamson (2004) reported that clickers are beneficial to the classroom. Specifically they reported greater student engagement, increased student understanding of complex subject matter, increased student interest and enjoyment, heightened discussion and

interactivity, increased student awareness of individual levels of comprehension, and increased teacher insight into student difficulties with the use of clickers (Roschelle et al., 2004).

In a separate analysis that involved 24 research studies in mathematics and physical and life sciences, Fies and Marshall (2006) found that clickers are also beneficial to the classroom. Specifically, the authors discovered that clickers promote student learning with greater cognitive gains over traditional environments (Fies & Marshall). However, based on the literature review, there is a need for comparison research of clickers to determine effectiveness in which the only difference is the use or lack of use of clickers (Fies & Marshall). This comparison research of clickers should involve the use of questions to promote student learning (Fies & Marshall).

Based on the aforementioned multidisciplinary findings, it is imperative to expand current clicker research for higher education and nursing education to determine true effectiveness of clickers on student knowledge levels. Comparative research of clickers should involve a pretest and posttest design with a comparison group. Other methodologies which strengthen results include a time series or a crossover design. Clicker research studies currently available in nursing education include a majority of posttest-only designs. As nursing education strives to transform nursing student knowledge levels with the implementation of clicker technology, evidence of clicker effectiveness is vital for a classroom based upon current nursing educational research findings.

Purpose of the Study

The purpose of this study was to determine clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. A lack of research exists regarding clicker effectiveness on nursing students' level of knowledge.

Hypothesis

The null hypothesis of this study was that clickers will not have any effect ($p < .05$) on nursing students' level of knowledge as evidenced by exam performance. A null hypothesis rather than a research question was used in order to establish a valid relationship between the variables (Polit & Beck, 2008). The independent variable of this study was clickers, and the dependent variable of this study was nursing students' level of knowledge as evidenced by exam performance.

Description of Clickers

For the past 40 years, clicker technology has been used to improve the classroom experience for both the student and educator (Beatty, 2004; Deal, 2007). The earliest clickers in higher education were expensive and difficult to use, which severely hampered their potential implementation within the classroom (Deal; Duncan, 2005). However, advances to clicker hardware and technology have created a surge in the use of clickers within numerous disciplines over the past decade (Beatty; Caldwell, 2007; Deal; Duncan; Zhu, 2007). Clicker technology is considered any system that is used to engage students within the classroom by means of gathering question responses (Caldwell; Deal). A clicker either consists of an infrared or a radio frequency signal that is connected to a central computer in the classroom (Beatty; Caldwell; Deal). The use of radio frequency signal clickers is becoming increasingly popular over the infrared signal clickers due to their ability to send stronger signals within large lecture classrooms (Caldwell). Also, the use of web-based clicker technology has recently evolved, which allows students to respond via their laptops, PDAs, or Smartphone devices (Schaffhauser, 2010). To use clickers, students simply select an answer on the keypad located on their

individual clicker to submit a response to the question posed by the educator and this answer choice selection allows the answer to be tabulated and stored in the central computer (Beatty; Caldwell; Deal). Once the anonymous answers from the entire class are tabulated, a histogram is displayed on the projection screen for the entire class to visualize the distribution of class answers (Beatty; Caldwell; Deal). This answer display allows for a level of metacognition, thinking about thinking, within the classroom that would otherwise not be possible (Deal; National Research Council, 2000). Without revealing the answer to a question, the educator directs the class into discussion regarding the rationale behind each answer choice (Beatty; Caldwell; Deal). If necessary, the educator may initiate a brief lecture based upon a “need” determined by the answers revealed (Beatty).

Various commercial clicker technology systems are available for use within a classroom (Caldwell, 2007). However, regardless of the clicker vendor whom the educator chooses, use of the clicker technology only requires an “intermediate” level of computer knowledge (Brewer, 2004; Caldwell; Parsons, 2005). Questions used by the educator with clickers can be formatted into PowerPoint slides with grading instruments also available for the educator to specify which answer choice will be the correct one (Caldwell). Also, most clicker technologies allow educators to export and track student responses into course management systems like Blackboard and WebCT (Caldwell; Deal, 2007). Therefore, the educator is then able to monitor a student’s learning progress over an entire semester and perhaps intervene if necessary (Deal).

Instructionally, clickers coincide with the components of a successful educational environment such as Gagnes’ *Essentials of Learning for Instruction* (Moredich & Moore, 2007). With the use of clickers in an instructional environment, students actually become active participants in their learning as they receive immediate feedback regarding their content

knowledge (Moredich & Moore; Zurmehly & Leadingham, 2008). For example, within large classrooms lecture is the primary teaching strategy used, yet lecture is often seen as impersonal and intimidating to the student (DeBourgh, 2007). As an alternative to lecture, clickers within a classroom offer an instructional environment for nursing students that is positive and engaging (DeBourgh; Moredich & Moore). Also, clicker implementation encourages active learning with increased individual achievement due to the clarification of answers and the feedback provided (DeBourgh; Moredich & Moore). For example, clickers can increase student participation in class, even within large classrooms, with the combination of application and analysis style multiple-choice questions (DeBourgh). Answering application and analysis style multiple-choice questions, in an organized question-cycle, anonymously with clickers allows the student to become quickly engaged in learning within a nonthreatening instructional environment that lacks any peer pressure (Moredich & Moore; Zurmehly & Leadingham). An organized question cycle consists of providing students with a question, allowing time for peer discussion, collecting answers, displaying the answer histogram, and lastly promoting class-wide discussion based on the answer results (Beatty, 2004). The organized question-cycle associated with clickers is considered an effective method to offer immediate feedback to students and to also prepare nursing students to think critically and strategically within clinical environments (Beatty; DeBourgh; Moredich & Moore; Zurmehly & Leadingham).

To make future decisions within clinical environments students need to understand their knowledge base and build upon this knowledge base in order to improve it (DeBourgh, 2007). Consistent with Kolodner's case-based reasoning, an "expectation failure" requires students to focus on the future and use "adaptation" to make the connection between what students know and what students do not know to ensure a deep understanding of the content (National Research

Council, 2000). Kolodner's case-based reasoning also requires students to know why they failed in order to understand what to do or not do in the future when they encounter similar problems (National Research Council). To increase this foundational knowledge base for students, it is necessary for the nurse educator to provide formative feedback and opportunities for student revision that focuses on understanding of the content (DeBourgh). The use of clickers allows students to visualize their thinking as they promote "critical thinking, evaluation, and argumentation in the class" (National Research Council). These activities are all essential components of an effective and interactive instructional classroom which provides formative feedback and student revisions. Clicker technology has been cited as one of the most promising technological transformations within the classroom as the classroom will become more knowledge and learner-centered due to clicker implementation (National Research Council).

Conceptual Framework

An educational theory, Gagne's *Essentials of Learning for Instruction*, provided the theoretical perspective for this pretest and posttest design with a comparison group study regarding clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. *Essentials of Learning for Instruction* is an information processing theory and the events of instruction depicted within the theory provided the instructional design framework for this study.

Learning is a process that involves the interaction of the individual with the external environment; yet how this learning process occurs is not completely understood (Gagne & Driscoll, 1988). A lack of understanding of learning is due to the complexity and intricacies involved with learning as knowledge of true learning can only be indicated by research findings

(Gagne & Driscoll). However, as knowledge of true learning is suggested by research findings then learning knowledge can be labeled as learning principles (Gagne & Driscoll). Thus, these learning principles suggest that a model of learning constructs into a learning theory, a learning theory for which educators can base their instructional design (Gagne & Driscoll). Therefore, educators must have knowledge of learning theories and the process of learning in order to plan and deliver instruction within their classrooms (Gagne & Driscoll).

As previously stated, learning occurs due to the interaction of the individual with their external environment (Gagne & Driscoll, 1988). An educator can observe this learning within the external environment, such as the classroom, because of a change in the learner's performance (Gagne & Driscoll). This change in the learner's performance with clickers would involve more questions answered correctly. For example, within the nursing classroom that incorporates clickers, the nurse educator could ask the nursing students to answer a question using their individual clickers. Then, a histogram appears based upon the answers selected by nursing students and classroom discussion emerges. The question is then repeated by the nurse educator as nursing students attempt to identify again, using their individual clicker, which answer choice is correct. After the nursing students see the repeated answer choice results via the histogram they immediately receive feedback from the nurse educator regarding the correct answer choice. This reinforcement can internally motivate nursing students regarding their learning process as the communication barrier between the nurse educator and nursing student is decreased. Also, the nurse educator is able to observe a behavioral change such as increased participation and engagement in nursing students due to clicker technology and the learning that has taken place. Thus, this process of "learning occurs as a result of the interaction of an individual and the

environment” and is evident due to the change in the learners’ performance and behavior within the external environment (Gagne & Driscoll, p. 21).

Within the *Essentials of Learning for Instruction*, Gagne takes a closer look at the learning processes that transpire in the act of knowledge development (Gagne & Driscoll, 1988). The processes in an act of knowledge development involve the following per the *Essentials of Learning for Instruction* by Gagne: sensory registry, short-term memory, coding, long-term memory, retrieval, and the response organization of performance, feedback, and reinforcement (Gagne & Driscoll). As the educational theory of Gagne’s *Essentials of Learning for Instruction* guides this research study, each act of knowledge development with clicker questions were briefly described. For example, the information within each clicker question produced short-term memory development for the learner based upon the first answer selection; however, post-question discussion regarding the various clicker answer choices allowed for retrieval of this short-term knowledge. Upon a second attempt to the identical question, short-term knowledge was retrieved and encoded into long-term memory as the learner’s correct question answer and increased questions answered correctly could signify that learning had taken place. Lastly, the learners with clickers within this study received further feedback, also called informational feedback, from the educator regarding why the answer choice was correct, which reinforced the learning (Gagne & Driscoll). Gagne and Driscoll emphasized that expectancy is interlaced with learning and reemphasized by reinforcement as, “the learning loop is closed by reinforcement” (p. 38). However, even though the aforementioned process of learning is not directly observational, the process of learning can be influenced by the external environment and what external events the educator brings to the learning environment to motivate and grasp student attention (Gagne & Driscoll). For instance, an educator may implement clickers within the

classroom, as illustrated above, and the implementation of an external event such as clickers could potentially influence the process of learning. Also, the use of clickers within the classroom may motivate students and gain their attention during class as a means to promote the process of learning. Thus, the process of learning may vary in time from seconds to much longer; however, the internal processes of learning can also be influenced by external events (Gagne & Driscoll, 1988). Gagne and Driscoll stated that “external events, when they are planned for the purpose of supporting learning, are called by the general name of instruction” (pp. 38-39). Therefore, the educator is in charge of planning instruction with the notion to include the aforementioned processes of learning (Gagne & Driscoll).

As previously mentioned, Gagne and Driscoll (1988) suggested that external stimulation must support the internal stimulation learning process. In order to make learning more effective Gagne and Driscoll offered nine instructional events that can be employed by the educator as a means to plan effective instruction. The figure below shows Gagne’s Nine Events of Instruction on the left and the internal process of learning associated with the instruction on the right:

Nine Events of Instruction	Internal Process of Learning
1. Gaining attention	Stimuli activates receptors (reception)
2. Informing learners of the objectives	Creates level of expectation for learning (expectancy)
3. Stimulating recall of prior learning	Retrieval and activation of short-term memory (retrieval)
4. Presenting the content	Selective perception of the content (selective perception)
5. Providing “learning guidance”	Semantic encoding for storage long-term memory (semantic encoding to long-term memory)
6. Eliciting performance	Responds to questions to enhance encoding and verification (responding)
7. Providing feedback	Reinforcement and assessment of correct performance (reinforcement)
8. Assessing performance	Retrieval and reinforcement of content as final evaluation (retrieval and reinforcement)
9. Enhancing retention and transfer	Retrieval and generalization of learned content to a new situation (retrieval and generalization)

Figure 1. Gagne’s Nine Events of Instruction and the internal process of learning.

The first event of instruction, gaining attention, has the purpose of capturing the attention of the student (Gagne & Driscoll, 1988). This gaining of attention may involve an auditory or visual stimulus such as playing music or flashing bright lights. It could even include a joke or a thought-provoking question to grab students’ attention. The second event of instruction is informing the student of the objectives (Gagne & Driscoll). Acknowledgement of class objectives allows for students to understand what they will receive out of class. This acknowledgement of objectives also motivates students and may prove to be an incentive toward

their learning. The third event of instruction is stimulating recall of prior learning (Gagne & Driscoll). New learning must be associated with prior knowledge in order to promote the learning process. One way an educator can stimulate recall of prior learning is through questions. Questions can bring forth prior experiences, assumptions, and understanding of previous content to allow for new information to emerge.

The fourth event of instruction is presenting the stimulus (Gagne & Driscoll, 1988). At this point in the instruction the new content is presented to the student. This presentation may vary from verbal, demonstration, or both. However, regardless of the form of presentation, the content must be presented in an organized fashion with the use of multi-media. The fifth event of instruction is providing learning guidance (Gagne & Driscoll). Within this event of instruction, the educator offers examples to increase student learning. These examples may include mnemonics, case studies, or a verbal cue for learning guidance. The sixth event of instruction is eliciting performance (Gagne & Driscoll). At this point the student is required to retrieve their knowledge and prove to themselves and others that learning has indeed taken place. This elicitation of performance may include answering questions as a means for the student to confirm their correct answer and content understanding.

The seventh event of instruction is providing feedback (Gagne & Driscoll, 1988). At this point in the instruction the educator is providing specific and immediate information to the student based upon their previous performance. Additional answers and directions necessary at this time of instruction could also be called formative feedback. The eighth event of instruction is assessing performance (Gagne & Driscoll). To assess performance the educator may wish to provide a post-test to the class. The post-test offers both the educator and student the opportunity to determine whether or not the student has mastery of the content without any penalties on their

course grade. The ninth event of instruction is enhancing retention and transfer (Gagne & Driscoll). The educator at this point may require an exam that has questions to determine the student's knowledge of prerequisites while ensuring the student has long-term memory of the content. This transfer of knowledge requires the student to address and apply previously learned content to new questions as a means to enhance retention of knowledge.

In order to expand future bodies of knowledge, clicker research should contain and support previous theoretical frameworks and contribute to the development of a larger research base (Brady, Taylor, &, Hamilton, 1989; Dillon, 1984; Gall, 1984; Lemke, 1990; Redfield & Rousseau, 1981; Roschelle et al., 2004; Samson, Strykowski, Weinstein, & Wallbery, 1987). Thus, the investigator incorporated the theory *Essentials of Learning for Instruction* by Gagne as the theoretical framework for this pretest and posttest design with a comparison group study. All aspects of this theory provided the investigator with the essential tools necessary to conduct an educational study that involves the use of clickers within the classroom.

Definition of Terms

Active learning strategies: Active learning strategies refer to anything that involves students engaging in activities and thinking about these activities. These strategies require the student to think and formulate knowledge at a higher level. This formulation of knowledge at a higher level enables the student to construct futuristic knowledge. To think at a higher level, the educator must provide active learning strategies that include tasks such as analysis, synthesis, and evaluation. The use of problem-based learning, which involves multiple-choice questions, is one strategy to promote active learning. Technology can also be used with active learning

strategies, such as problem-based learning, to increase student motivation and engagement in the classroom.

Infrared clicker technology: Infrared clicker technology works by the same technology as a television remote as it requires a direct sight view between the clicker and the receiver. Better suited for small classrooms, however, the infrared clicker technology is more affordable and less expensive than radio frequency clicker technology.

Pedagogical practices: The development of classroom experiences, such as active learning activities, to provide opportunities for students to engage in complex, real-life challenges.

Pedagogy: The art or science of teaching.

Question cycle: Question cycles are used for question-driven instruction with clickers. The question cycle consists of displaying a question for the class, collecting individual answers, posing the identical question again and allowing for question discussion in small groups, displaying the final question histogram with further classroom discussion, and question closure.

Question-driven instruction: Question-driven instruction consists of the use of a question cycle to improve students' problem-solving abilities, cognitive skills, and analysis regarding a subject matter.

Question sets: Question sets consist of a set of related questions used together to pinpoint specific instructional classroom objectives. Question sets may consist of a particular pattern such as easy-hard-hard or rapid-fire in which the difficulty of question sets may differ to build student confidence and understanding of a concept.

Radio frequency clicker technology: Radio frequency clicker technology works by radio frequency as the radio frequency receiver can accommodate hundreds of radio frequency clicker

responses per one receiver. This clicker technology is better suited for large classrooms as a direct sight view is not necessary due to the radio frequency. The radio frequency clicker technology is more expensive than the infrared clicker technology and is commonly used in large classrooms.

Student response systems/clicker technology/clickers: Student response systems/clicker technology/clickers is the terminology used for a wireless response system that allows educators to pose questions that students can respond back to by using a clicker. The educator who uses clickers within the classroom will need a receiver and appropriate software from the clicker vendor in order for the clickers to work properly within the classroom. A clicker is a hand-held device used by individual students to answer questions posed. This answer response is sent by either an infrared or radio frequency signal from the individual student clicker to the receiver. The educator's computer software will collect the answers from the attached receiver and display the clicker answer responses, if the educator so desires, in the form of a histogram for the entire class to view.

Assumptions of the Study

For the purpose of this study the following assumptions were made:

1. The participants within this study were an accurate representation of the undergraduate nursing population at the university study site.
2. The participants' responses on both the pretest and posttest exams were representative of their knowledge.

Limitations of the Study

For the purposes of this study the following limitations were made:

1. The participants consisted of only one nursing class within one university setting in one geographical area.
2. The total population of the study was relatively small and homogenous.
3. The population was a convenience sample.
4. The population was not given an incentive to participate and adhere to the study.

Significance of the Study

This research study is one of the first to determine clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. Specifically, this research was one of the first to include a pretest and posttest design instead of a posttest-only design in nursing education. The use of a pretest and posttest design is essential to decipher change within groups versus a posttest-only design, which is not appropriate for the determination of change (Polit & Beck, 2008). The results of this study will contribute to the growing body of knowledge regarding clickers and their effectiveness on nursing students' level of knowledge.

Chapter Summary

In summary, this chapter addressed a statement of purpose, identified the null hypothesis, proposed Gagne's *Essentials of Learning for Instruction* as the conceptual framework, outlined definitions chosen by the investigator as significant for the research, provided investigator assumptions, presented limitations of the study, and included discussion of the significance of the research study.

CHAPTER 2

REVIEW OF THE LITERATURE

The chapter presents a review of the literature pertinent to the study. Primary concepts of this review include clickers in higher education and clickers in nursing education. Further, the review of the literature will be targeted to constructs appropriate to the use of clickers within the university setting.

Clickers in Higher Education

As a means to offer a pedagogical approach other than traditional lecture, educators have looked to a better understanding of clickers and their implementation within the classroom (Caldwell, 2007; Graham, Tripp, Seawright, & Joeckel, 2007). Clickers have been present in higher education since the 1960s; however, it is only within the last decade that adoption and use of clickers have dramatically increased (Caldwell; Dangel & Wang, 2008; Graham et al., 2007). Clickers are used to promote active learning within the classroom as they positively influence student motivation (Caldwell; Corcos & Monty, 2008; Graham et al.; Martyn, 2007; Simpson & Oliver, 2007; Walton, Homan, & Naimi, 2008). For clickers to be used effectively, a knowledge and belief in active learning is necessary (Caldwell; Simpson & Oliver). Active learning refers to techniques that students must actively process and cognitively apply knowledge rather than passively acquiring it, which is what normally takes place within traditional lecture classrooms (Caldwell; Nelson & Hauck, 2008). These active learning techniques frequently involve higher-order thinking such as analysis, synthesis, and evaluation strategies (Nelson & Hauck).

Knowledge of active learning with the use of clickers requires faculty development to ensure that an understanding of technology application is achieved (Caldwell; Simpson & Oliver). An essential knowledge of supporting educational concepts is also necessary (Caldwell; Simpson & Oliver).

Based upon former studies of clickers, results have reported either improved student performance or no significant improvement within classrooms that integrate clickers (Caldwell, 2007; Corcos & Monty, 2008; Dangel & Wang, 2008; Graham et al., 2007; Hicks, 2009; Martyn, 2007). Some feel that clickers are more effective, with improved student performance, within smaller classes rather than within larger classes as current research suggest that students learn better in small classes (Simpson & Oliver, 2007; Walton et al., 2008). However, regardless of student performance, multiple indirect measures of student learning have indicated that students do like clickers and students would recommend the future use of clickers in the classroom (Caldwell; Dangel & Wang; Draper & Brown, 2004; Graham et al.; Hicks; Kaleta & Joosten, 2007; Keller et al., 2007; Martyn; Simpson & Oliver; Walton et al.).

Reluctant Learners and Clickers

Aware of previous research studies, which indicate that students do like and would recommend clickers, Graham et al. (2007) sought to discover the impact of clickers on reluctant learners within the classroom. This area had not been previously addressed in higher education research. Their quantitative survey study involved 688 student participants within undergraduate courses in chemistry, biology, physics, psychology, education, statistics, and marriage family and human development. Within this study, surveys of learners who perceived themselves as reluctant participants reported clickers as helpful (Graham et al., 2007). When the reluctant

learners were asked what they liked best about clickers, the learners mentioned student participation and self-assessment ($n = 443$), which coincides with other research findings (Graham et al.; Hicks, 2009) and with Gagne's Essentials of Learning for Instruction (1988) as essential events of instruction. There was a desire by reluctant participants to know their classmates' opinions ($n = 322$) and build a mutual awareness within the classroom, as reluctant learners are often unwilling to offer their own opinions in class (Graham et al.). Thus, clickers help create an atmosphere of true engagement and mutual awareness for every student involved, even those students who perceive themselves as reluctant learners (Draper & Brown, 2004; Fies & Marshall, 2006; Hicks, 2009; Simpson & Oliver, 2007).

Formative Assessment and Pedagogical Uses of Clickers

The most successful use of clickers has been documented as formative assessment in research findings (Cain, Black, & Rohr, 2009; Caldwell, 2007; MacArthur & Jones, 2008). These findings are consistent with the educational theories of constructivism as the connection of clickers to formative assessment does create a large research base for higher education (Brady, Taylor, & Hamilton, 1989; Dillon, 1984; Gall, 1984; Lemke, 1990; MacArthur & Jones; Redfield & Rousseau, 1981; Samson et al., 1987). With clicker applications, questions posed to students provide formative feedback to the educator (Cain et al., 2009; MacArthur & Jones). This formative feedback allows the educator to assess for content comprehension and correct understanding as outlined in Gagne's Essentials of Learning for Instruction (1988). Due to the anonymity of answers, students tend to view clickers positively when clickers are used in a formative assessment manner rather than a testing manner (Caldwell; Graham et al., 2007; MacArthur & Jones; Medina, Medina, Wanzer, Wilson, Nelson, & Britton, 2008; Nelson &

Hauck, 2008; Simpson & Oliver, 2007). MacArthur and Jones (2008) encourage educators to use clickers for formative assessment rather than for summative assessment as pedagogical practices that involve formative feedback offer the greatest benefit for educators and students alike (Cain et al.; Caldwell; Draper & Brown, 2004; Medina et al.).

Pedagogical uses of clickers, such as formative assessment, are important for every educator in higher education to comprehend prior to the implementation of clickers within the classroom (Draper & Brown, 2004; Fies & Marshall, 2006). Pedagogically, clickers create a community of mutual awareness as each student is aware of how the class is answering questions and where each student fits into the learning community (Cain et al., 2009; Corcos & Monty, 2008; Draper & Brown; Hicks, 2009). The conclusion by the authors, in terms of pedagogical uses of clickers, is that education must ensure pedagogy first and then technology implementation second (Corcos & Monty; Draper & Brown; Fies & Marshall). It has been suggested that when pedagogy is emphasized first that educators will see the benefits of technology implementation within the classroom (Corcos & Monty; Draper & Brown; Fies & Marshall).

Technological Proficiency and Clicker Implementation

Technological proficiency of the educator is necessary prior to the implementation of any new form of technology within the classroom (Draper & Brown, 2004; Graham et al., 2007). For the educator who is relatively inexperienced with the use of clickers and perhaps technologically insufficient, Dangel and Wang (2008) offer pedagogical principles for those who wish to use clickers for the first time. These tips include to keep questions short and straightforward, to have

no more than five answer choices, to allow time for discussion, to provide students with clear instructions, and to rehearse your presentation (Dangel & Wang, 2008).

Keller et al. (2007) found, in their quantitative study ($n = 3,697$), that a strong correlation exists between the educator's technological proficiency with clickers and the students' perception of usefulness of clicker technology ($r = 0.52$). A degree of technical confidence and expertise is needed to develop clicker questions and operate the clicker technology system (Simpson & Oliver, 2007). During clicker question development, Wit (2003) offers that educators new to the implementation of clickers include an "I don't know" option within each clicker question rather than force students to commit to an answer. Lastly, novice educators should seek assistance and practice with clicker technology prior to the implementation of clickers within the classroom (Keller et al., 2007).

Kaleta and Joosten (2007) conducted a large scale ($n = 2,684$ students, $n = 27$ faculty), quantitative study on the implementation and perception of clicker technology within the classroom. The student survey was internet-based with a 5-point Likert-type scale (*strongly disagree, disagree, neutral, agree, strongly agree*) and consisted of 61-items regarding their perception and satisfaction with the use of clickers (Kaleta & Joosten). Faculty completed a separate 68-item internet-based survey with a 5-point Likert-type scale (*strongly disagree, disagree, neutral, agree, strongly agree*) regarding their experience and perception of clickers (Kaleta & Joosten). The findings revealed that overall both faculty and students enjoyed using clickers, and both groups perceived clickers as having a positive impact on teaching and learning within the classroom (Kaleta & Joosten). This finding coincides with other research as both faculty and students do perceive the benefits of clickers within the classroom far outweigh any

disadvantages involved with the technological proficiency required with clicker technology implementation (Caldwell, 2007; Draper & Brown, 2004; Hicks, 2009; Kaleta & Joosten).

Not only do both faculty and students enjoy the use of clickers but both groups strongly agreed that clickers increase student engagement, assessment of knowledge, learning of content, and overall performance in class (Kaleta & Joosten, 2007). These findings correlate with Gagne's *Essentials of Learning for Instruction* (1988), which emphasizes that educators should offer instructional events that gain attention, elicit performance, and provide feedback and enhancement of content retention. These findings also coincide with other research which reiterates that clickers do create an interactive class as the anonymity that clickers provide allows students to take part in class without any risk of embarrassment (Caldwell, 2007; Corcos & Monty, 2008; Draper & Brown, 2004; Hicks, 2009; Nelson & Hauck, 2008). Overall, faculty agreed within the Kaleta and Joosten (2007) study that clickers afforded them the opportunity to implement new pedagogical practices once the technological proficiency associated with clicker technology was mastered. Lastly, a quantitative statistical analysis of student grades was also collected within 11 parallel clicker and non-clicker courses. *T* tests of the course grades indicated a statistical significance ($p < 0.05$) between clicker and non-clicker courses (Kaleta & Joosten). This finding is consistent with the previously mentioned survey data regarding the positive impact of clickers within the classroom.

With regard to the implementation of clicker technology, Twetten, Smith, Julius, and Murphy-Boyer (2007) offer that standardization on a single clicker system will enhance the pedagogical use and the implementation of clickers. This standardization will also create a reduction in technical assistance and student costs (Twetten et al.). The presence of multiple clicker technologies on a campus setting creates problems for various stakeholders (Twetten et

al.). Therefore, standardization is necessary with the implementation of clickers, as well as, a small deployment of the chosen clicker system initially (Hicks, 2009; Judson & Sawada, 2002; Twetten et al.). Thus, for clicker implementation to be successful, educators and students must perceive clickers as beneficial to the learning process with one clicker system standardization (Twetten et al.).

Active Learning and Clickers

To promote active learning within the classroom, the use of clickers is highly recommended and encouraged (Caldwell, 2007; Corcos & Monty, 2008; Graham et al., 2007; Hicks, 2009; Martyn, 2007; Medina et al., 2008). Active learning is widely acclaimed as an effective learning strategy within higher education (Corcos & Monty; Graham et al.; Hicks; Martyn; Nelson & Hauck, 2008). The use of active learning engages students by requiring individual students to discuss, problem-solve, analyze, synthesize, and evaluate classroom material (Mareno, Bremner, & Emerson, 2010). Chickering and Gamson (1991) have been avid proponents of active learning and list it as one of the seven principles of good practice in higher education. In addition, Bonwell and Eison (1991) ascertain that active learning produces long-term retention of course material and is more effective than traditional lecture within the classroom.

As a means to investigate active learning and clickers, Martyn (2007) designed a quantitative pretest-posttest study to compare the learning outcomes of two introductory computer classes that used the active learning with clickers ($n = 45$) versus two introductory computer classes that used the active learning strategy of class discussion without clickers ($n = 47$). The means, calculated using analysis of variance (ANOVA), indicated a lack of statistical

significant difference in the pretest scores ($p < 0.203$) or the posttest scores ($p < 0.428$) between the two groups (Martyn, 2007). Due to the lack of statistical difference between the groups, the author does call for more comparison research, as this study was the first time the researcher used clickers within the classroom (Martyn). However, even though there was a lack of statistical difference in the study, the students perceived clickers as a valuable tool, and due to this finding the use of clickers is recommended by Martyn. This finding also correlates with a research study from Miller, Ashar, and Getz (2003) where they implemented clickers within a continuing medical education course to assess effectiveness.

Miller et al. (2003) designed a quantitative posttest study to assess the efficiency of clickers as an active learning tool for health care providers. A comparison of knowledge scores was used between one class that used clickers ($n = 164$) versus one class that did not use clickers ($n = 119$). The means, calculated using analysis of variance (ANOVA), indicated a lack of statistical significant difference in the posttest scores ($p = .129$) between the two groups when adjusted for differences in gender and specialty (Miller et al., 2003). However, the knowledge scores were based on only seven questions and this limited amount of questions may prove to be a poor indicator of knowledge retention and application. Survey findings from the study indicated that clicker participants viewed the quality of the class and their level of attention higher ($p < .05$) than the participants who attended the class without clickers (Miller et al., 2003). Thus, similar to the findings of Martyn (2007), participants viewed the use of clickers within a classroom as favorable and helpful to their learning process (Miller et al.).

Even though students perceive clickers as a valuable tool, for active learning to be effective more than just “clicking” is necessary (Dangel & Wang, 2008; Simpson & Oliver, 2007). For students to actively learn with clickers, students must be able to discuss, reflect,

relate, and apply their learning (Dangel & Wang), as the events of instruction should include feedback, assessment of performance, and generalization to a new situation per Gagne's *Essentials of Learning for Instruction* (1988). It is not sufficient for students to just "click" to engage in active learning, educators must also ask deeply challenging questions that require the application and analysis of content (Caldwell, 2007; Corcos & Monty, 2008; Dangel & Wang; Keller et al., 2007). Keller et al. reported, in a quantitative survey study, that within 69 multidisciplinary courses across a single university setting, factual recall-type questions were used only second to conceptual-type questions with clickers. Also, students found the conceptual-type questions more useful ($3.92 + 0.02$, on a scale of 1-5, negative to positive) to their learning than the factual recall-type ($3.51 + 0.02$) questions (Keller et al.). Thus, for clickers to improve learning there must be an elaboration on knowledge, application, and the evaluation of essential concepts, which conceptual questions with clickers can offer, for students to acquire the essential core knowledge they need (Corcos & Monty; Dangel & Wang).

Impact of Clickers on Course Grades

To assess the impact of clickers on course grades, Kaleta and Joosten (2007) conducted a quantitative statistical analysis of student grades from courses without clickers during fall 2004 to the same courses taught by the same instructor during fall 2005 with implementation of clickers. Approximately 11 courses met the criteria of being taught both consecutive fall semesters by the same instructor (Kaleta & Joosten). The *t*-test results collected from the 11 parallel courses were statistically significant ($p < 0.05$) regarding clicker use on student performance in class and this finding coincided with additional survey data within the study regarding the positive impact of clickers within the classroom (Kaleta & Joosten). The student

grade finding coincides with statistically significant ($p < 0.004$) research by Hicks (2009) in which students with clickers scored higher than students in the same course without clickers.

Clickers in Science Courses

Clickers have been extremely popular within the science courses of higher education (Beatty & Gerace, 2009). However, questions of clicker technology pedagogical implementation and effectiveness deserve further investigation as little research has been done to answer these questions in higher education science courses (Beatty & Gerace). Beatty and Gerace (2009) acknowledged three separate ways to implement clicker pedagogies in science courses and they include peer instruction, question-driven instruction, and coordinated question sets (Beatty & Gerace).

Clicker Pedagogies in Higher Education Science Courses

The first pedagogical offering involves peer instruction, in which the class is asked to discuss a question first among their peers and then answer the question individually (Beatty & Gerace, 2009). The second pedagogical offering of question-driven instruction and the question cycle, as acknowledged by other authors, is considered the primary mechanism by which question-driven instruction operates (Beatty & Gerace; Smith & Rosenkoetter, 2009). Because students must reason their answers prior to their answer choice commitment, research offers that questions stimulate cognition (Beatty & Gerace; DeBourgh, 2007), as the use of questions increases the likelihood of knowledge retention per Gagne's *Essentials of Learning for Instruction* (1988). Due to the use of high-level questions with clickers, students become active participants through discussion within the question cycle for various answer choices (Beatty &

Gerace; DeBourgh; Moredich & Moore, 2007; Smith & Rosenkoetter; Zurnehly & Leadingham, 2008). Lastly, the third pedagogical offering of coordinated question sets contain patterns such as easy-hard-hard and rapid-fire to expose students to high-level questions to ensure essential concepts are understood by students within a variety of contexts (Beatty & Gerace). Of the three clicker pedagogies mentioned, only question-driven instruction has been research-based on a pedagogical perspective (Beatty & Gerace).

Research Findings of Clickers in Higher Education Science Courses

As pedagogical implementation of clickers in science courses is important, so is the effectiveness of clicker implementation within the classroom. Crossgrove and Curran (2008) conducted a quantitative study that involved student survey and test scores with clicker implementation in non-biology major ($n = 425$) and biology major ($n = 96$) courses in comparison to non-biology major ($n = 463$) and biology major ($n = 87$) courses without clicker implementation. Student test scores were compared using t tests between the non-biology and biology major courses, both with and without clickers. Analysis of variance (ANOVA) was used to analyze all test questions from both majors. T tests of the non-biology majors pointed to no significant difference between the two sections ($p < 0.740$). In addition, t tests of the biology majors also indicated no statistical significance between the two sections ($p < 0.333$). When all test questions were analyzed by ANOVA, results suggested a statistical significance between the answers to clicker-based questions versus nonclicker-based questions ($p < 0.007$). The student survey was administered at the end of a semester and the means and chi square analysis of student responses to the survey questions were configured for both the non-biology major and biology major level courses (Crossgrove & Curran, 2008). Results of the survey reported that

both groups favored clickers; however, the non-biology majors (average Likert score of 3.8) had a more positive opinion than the biology major (average Likert score of 3.6) students (Crossgrove & Curran).

This finding is consistent with Holmes, Blalock, Parker, and Haywood (2006) who collected quantitative survey findings regarding student perceptions of clicker implementation within a school of dentistry. Holmes et al. found that students ($n = 62$) had an overall favorable perception of clickers and students especially liked the ability to participate anonymously within the classroom with clicker implementation. Findings of Cain, Black, and Rohr (2009) also reiterate the findings of Crossgrove and Curran (2008) and Holmes et al. (2006) in relation to student perceptions of clickers within the classroom. Cain et al. implemented clickers in a physiological chemistry/molecular biology course within a college of pharmacy as a means to improve student attention during class. Quantitative research of the study included student survey results and course grade comparisons. Student survey results found that students ($n = 111$) viewed clickers as a beneficial instructional technology and therefore recommended the use of clickers in future course lectures (Cain et al.). The only negative finding within the student survey results dealt with the cost of the clicker device and this negative finding agrees with the findings of other research studies (Cain et al.; Draper & Brown, 2004; Graham et al., 2007; Kaleta & Joosten, 2007; MacArthur & Jones, 2008). Course grade comparisons involved mean final grades of the physiological chemistry/molecular biology students over the last 3 years with only the last year involving clicker implementation. Analysis of variance (ANOVA) results ($p < 0.001$) suggested a statistical significance in the mean final grades of the course. The mean course grade in the 2008 course, which included clickers, was significantly higher from the 2007 ($p < 0.05$) and from the 2006 ($p < 0.001$) courses (Cain et al.).

As previously stated, Crossgrove and Curran (2008) collected quantitative data and compared overall student exam performance within non-biology majors and biology major level courses with and without clickers. *T*-test results reported no significant difference between the two sections of non-biology majors ($p < 0.740$) and biology majors ($p < 0.333$) courses, with and without clickers, in relation to exam scores (Crossgrove & Curran, 2008). Also as previously stated, Cain et al. (2009) analyzed course grades over the past 3 years of a physiological chemistry/molecular biology course and did find the highest mean final grade within the course that used clickers versus the course that did not use clickers. The results of a one-way ANOVA ($p < 0.001$) reported this significant difference in mean final grades over the last 3 years of a physiological chemistry/molecular biology course as students grades were positively affected due to the implementation of clickers (Cain et al., 2009). To assess longer term effects of clickers in science courses, Crossgrove and Curran (2008) compared the retention of course information associated with clickers 4 months after the course ended. Retention of course information associated with clickers was higher within the nonmajors' course and not within the major level biology course, although very few students of the non-biology majors ($n = 14$) and biology majors ($n = 15$) participated in the post-posttest.

Like Crossgrove and Curran (2008); Schackow, Chavez, Loya, and Friedman (2004) also found the highest retention of information within courses that encompassed clickers versus traditional lecture in medical education as a student's ability to generalize and retain information is due to their opportunity within class to respond and retrieve essential content per the events of instruction in Gagne's *Essentials of Learning for Instruction* (1988). In the Schackow et al. (2004) quantitative study, which included *t* tests, post-lecture quiz scores of medical residents ($n = 23$) in a classroom with clickers ($p < 0.05$) were statistically significant over medical residents

(n = 22) in a classroom with traditional lecture ($p < 0.12$) format as the pedagogical offering (Schackow et al., 2004). Thus, implementation of clickers provides an innovative pedagogical format to science courses as most science courses currently taught remain strongly didactic in nature (Cain et al., 2009). Also, the implementation of clickers within a science classroom helps create an atmosphere of active student participation, which leads to improved retention of vital course content (Schackow et al., 2004).

Clickers in Non-Science Courses

Although Judson and Sawada (2002) report that clickers have been predominately implemented in higher education science courses solely, clickers have also been adopted within non-science courses of higher education. Currently, a few areas of clicker adoption within non-science courses of higher education include management, library, psychology, and business.

Clickers in Management Courses

To illustrate clicker use within a non-science course, Nelson and Hauck (2008) implemented clickers within an introductory management information systems course. This course was composed of a large student population, of which the majority of the students were non-management information system majors (Nelson & Hauck, 2008). Quantitative research was implemented, which included actual student performance and surveys administered to three different introductory management information system classes 2 weeks prior to the end of the semester (Nelson & Hauck). Survey items were measured on a 5-point Likert-type scale from *strongly disagree* (1) to *strongly agree* (5). The three classes were composed of a high-end usage class (section A) that used approximately 270 clicker questions during the semester (n = 175), a

low usage class (section B) that used approximately 50 clicker questions during the semester ($n = 65$), and a control group (section C) that did not use clickers ($n = 63$) during the semester (Nelson & Hauck).

Results from the Nelson and Hauck (2008) study survey indicated that section A students liked clickers more than students in section B. Also, with greater clicker use, students perceived an overall improvement of their individual class performance due to the learning which emerged. This finding is also mirrored in other education studies in relation to clickers (Hicks, 2009; Nelson & Hauck, 2008). Even though actual student grades did not improve largely with greater use of clickers, a correlation between student attendance and student grades did improve in sections A (average course grade 82% with attendance correlation of 0.18) and B (average course grade 78% with attendance correlation of 0.14) over section C (average course grade 79% with attendance correlation of 0.12) per statistically significant ($p < 0.01$) t tests (Nelson & Hauck). The authors concluded that with greater clicker use students did perceive an improvement in self-assessment, increased self-participation during class, and the ability to compare individual performance against that of the entire class (Nelson & Hauck). These findings also coincide with the findings of other higher education research in relation to positive students' perceptions of clicker use (Caldwell, 2007; Draper & Brown, 2004; Hicks; Kaleta & Joosten, 2007; Nelson & Hauck).

Clickers in Library Courses

Corcos and Monty (2008) coincided with Nelson and Hauck's (2008) attempt to try clickers outside of science courses and implemented clickers in a library research skills presentation. Within the authors' quantitative survey study, students either attended a library

skills presentation ($n = 127$) with clickers or ($n = 127$) without clickers (Corcos & Monty, 2008). Afterwards, students answered a survey questionnaire regarding the library content presented (Corcos & Monty). Approximately 254 students participated in the study with an equal proportion of female to male students within each group (Corcos & Monty). Only two of the survey questions varied the non-clicker group from the clicker group and were found statistically significant (Corcos & Monty). The group exposed to clickers did find the library session more enjoyable ($p < 0.05$) and better organized ($p < 0.01$) over the non-clicker group (Corcos & Monty). These findings offer that clickers do enable good pedagogy, an idea originally presented and supported by Draper and Brown (2004) and others (Caldwell, 2007; Hicks, 2009).

Clickers in Psychology Courses

Further use of clickers outside of a science course also encompasses Stowell and Nelson's (2007) quantitative study to determine whether or not the use of clickers within an undergraduate introductory psychology class setting would create higher learning, increased student participation, and positive academic emotion. To assess emotion, students completed an Academic Emotions Questionnaire (AEQ), which is a tool used to measure emotion in academic settings (Stowell & Nelson, 2007). The Academic Emotions Questionnaire (AEQ) was completed by students prior to the introductory psychology course, during the course, and after the course was completed (Stowell & Nelson). Students were also assigned to one of four groups for 2 weeks (Stowell & Nelson). The groups consisted of standard lecture ($n = 34$), hand-raising ($n = 35$), response cards ($n = 36$), and clickers ($n = 35$) (Stowell & Nelson).

Student participation and correct responses to questions asked in class were coded by two raters and their results were found in high agreement with an intraclass correlation coefficient

agreement of 0.98 (Stowell & Nelson, 2007). The findings of student participation were significant ($p < 0.001$) using analysis of variance (ANOVA) and indicated that class participation was found highest in the clicker group ($M = 100\%$), followed by the response cards ($M = 97\%$), and hand-raising ($M = 76\%$) (Stowell & Nelson). A statistical difference did not exist ($p > 0.18$) between the groups in relation to post-lecture quiz scores; therefore, none of the groups proved higher learning over any of the other groups (Stowell & Nelson). The authors believe these results are either due to a difficult post-lecture quiz or students not motivated to do well on a quiz that did not affect their course grade (Stowell & Nelson). Lastly, the mean emotion ratings indicated statistical significance ($p < 0.05$) per ANOVA only between the standard lecture and hand-raising groups as academic emotion was found lowest overall in the standard lecture group (Stowell & Nelson). Further research is needed, per the authors, regarding the effect of emotional changes within a classroom setting and their greater impact over time (Stowell & Nelson).

Findings suggest that the use of clickers can increase class participation over other pedagogical methods such as hand-raising and standard lecture (Stowell & Nelson, 2007). These findings reiterate other research, which offers that clickers do create increased class participation (Caldwell, 2007; Corcos & Monty, 2008; Draper & Brown, 2004; Hicks, 2009; Kaleta & Joosten, 2007; Nelson & Hauck, 2008). This increased class participation is due to the anonymity associated with clickers, which allows students to partake in class without any risk of embarrassment (Caldwell; Corcos & Monty; Draper & Brown; Hicks; Kaleta & Joosten; Nelson & Hauck). Perhaps this increase in class participation creates an avenue for interaction with students who have tendencies toward introversion (Graham et al., 2007; Stowell & Nelson). The authors suggest the use of clickers within the classroom, if financially feasible for the university, to increase class participation and student enjoyment (Stowell & Nelson). Response cards and

hand-raising are more financially manageable yet both are susceptible to classroom conformity that may convey to the educator that students understand content, when in fact they do not (Stowell & Nelson).

Clickers in Business Courses

Lastly, use of clickers outside of a science course also involved a quantitative study using survey methodology by Walton, Homan, and Naimi (2008) in which they examined how clickers affect students' perceptions toward learning. Clickers were essentially used within an undergraduate business course for pretests and posttests and also for non-graded discussions (Walton et al., 2008). A survey containing 48 questions on a 5-point Likert-type scale (1= *strongly agree* to 5= *strongly disagree*) was administered to students (n = 572) and the means statistically analyzed by analysis of variance (ANOVA) (Walton et al.). The results of the survey indicated that students perceive clickers as a positive impact on their learning, correlating with other research studies (Hicks, 2009; Walton et al.). Due to clickers, students prepared more for class instruction and attended class regularly (Walton et al.). Also, students felt that clickers were an effective part of class time and appreciated how their clicker answers were kept anonymous (Walton et al.). Findings from Walton et al. (2008) coincide with others who have suggested that students not only like clickers but clickers also increase students' classroom participation due to the anonymity and feedback received with implementation of clickers (Corcos & Monty, 2008; Draper & Brown, 2004; Hicks; Kaleta & Joosten, 2007; Nelson & Hauck, 2008).

Clickers in Large Lecture Courses

The use of clickers has become especially popular among educators of large lecture classes (Caldwell, 2007; MacGeorge et al., 2008). The large lecture classes into which clickers have been incorporated include the disciplines of nursing, communication, engineering, computer science, mathematics, chemistry, philosophy, biology, physics, premedical, medical, veterinary, dental, business, economics, and psychology (Caldwell).

Clickers in Large Lecture Courses and Student Perceptions

Due to the limitations of clicker research in large lecture classes, MacGeorge et al. (2008) conducted a multidimensional evaluation of clicker technology within a large lecture university classroom over an entire semester with the use of a newly-developed measure, the *Audience Response Technology Questionnaire* (ART-Q). Undergraduate students' ($n = 854$) perceptions of clicker technology were measured at three different times within the semester using the *Audience Response Technology Questionnaire* (ART-Q), a measure developed by the authors (MacGeorge et al., 2008). The first survey was available in the 7th week of the semester, the second survey in the 12th week of the semester, and the third survey in the 16th week of the semester. Each survey was different and contained multiple items for each of the 15 dimensions of the *Audience Response Technology Questionnaire* (ART-Q). Item reliability for the 15 dimensions within all three surveys was good to excellent (Cronbach's alpha = 0.70) during all three surveys (MacGeorge et al.). Findings from the study indicated that clickers are easy to use and their benefits remained consistent over the entire semester as clickers increased student performance within the classroom (MacGeorge et al.). Pedagogically, clickers create a "sense of community" within the classroom and it is within this community that students acknowledge their individual

performance and where their individual performance measures into the entire classroom community (Cain et al., 2009; Caldwell, 2007; Corcos & Monty, 2008; Draper & Brown, 2004; Hicks, 2009; MacGeorge et al.), which correlates with the instructional event of assessment of performance within Gagne's *Essentials of Learning for Instruction* (1988).

Dating back to earlier work regarding students' perceptions of clickers, Barnett (2006) qualitatively explored undergraduate students' ($n = 560$) perceptions of clickers via an online survey. Overall, student perceptions of clickers were positive with the suggestion to include clickers in more courses (Barnett, 2006). Study results pointed to reasons why students liked clickers and they included feedback, class discussion, and peer instruction, as these findings coincide with other research studies (Barnett; Caldwell, 2007; MacGeorge et al., 2008). Peer instruction is a pedagogical offering often used within science courses (Beatty & Gerace, 2009). Within peer instruction, if a large number of students answer a question incorrectly then the class is asked to discuss the question among their peers and answer the question again (Beatty & Gerace). Barnett (2006) and others indicated that students perceive the metacognitive benefits, such as peer instruction, as the most beneficial aspect of clickers within courses (Caldwell). Negative perceptions of clickers were also linked to the additional cost students endured with clicker implementation, which reiterates with other study findings (Barnett; Cain et al., 2009; Draper & Brown, 2004; Graham et al., 2007; Kaleta & Joosten, 2007; MacArthur & Jones, 2008).

Patry (2009) also performed a survey, a quantitative study with three open-ended questions, on undergraduate students ($n = 516$) to explore students' perceptions of clickers within a large classroom. The survey contained six quantitative questions regarding clickers and each item was highly inter-related for bivariate correlations among items, Cronbach's alpha, and

split-half reliability analysis (Patry, 2009). Unlike the findings in the Barnett (2006) study, Patry did not find clear data that suggested that students liked clickers. Instead, an overarching theme from the open-ended responses was that students did perceive clickers as a helpful tool to assist them with learning course content (Patry). However, negative themes were also identified regarding clicker implementation with the most prominent being increased costs students incurred with clickers, a finding suggested by others (Barnett, 2006; Cain et al., 2009; Draper & Brown, 2004; Graham et al., 2007; Kaleta & Joosten, 2007; MacArthur & Jones, 2008; Patry).

Clickers in Large Lecture Courses versus the Absence of Clickers in Large Lecture Courses

Rather than perceive the impact of clickers within the large lecture class, Lowry, Romano, and Guthrie (2006) performed quasi-experimental non-equivalent group research to compare a large class with clickers ($n = 178$) to a large class that did not implement clickers ($n = 168$). However, both the control and experimental groups did use active learning techniques with the only difference between groups being the implementation of clickers, as the experimental group answered questions anonymously via clickers and the control group answered questions by raising their hands (Lowry et al., 2006). Approximately 346 undergraduate students participated in the research and the results suggested that students within the experimental group exhibited higher levels of interactivity than students within the control group, based on the means for the F -statistics and p -values reported (Lowry et al., 2006). Within large classes, clickers typically produce either a benign or positive effect on student test performance, yet, a more active and positive atmosphere with the implementation of clickers is frequently reported (Caldwell, 2007; Lowry et al.). Students in large classes have typically been unwilling or hesitant to speak up in class due to fear of disapproval or embarrassment, and the implementation of clickers has been

found to make students more responsive and willing to elicit discussion in large classes (Caldwell).

Barriers of Clickers in Higher Education

Barriers of clicker implementation have been acknowledged in higher education literature. The most prominent barrier of clicker implementation is the additional cost students acquire in order to purchase clickers, which is approximately \$35 per device (Barnett, 2006; Cain et al., 2009; Draper & Brown, 2004; Graham et al., 2007; Kaleta & Joosten, 2007; MacArthur & Jones, 2008; Patry, 2009). Other prominent barriers cited with clicker implementation in higher education include registration of individual clickers, technical difficulties with clicker implementation, clicker use limitations, additional class preparation required of educators with clicker implementation, and clicker standardization (Barnett; Cain et al.; Draper & Brown; Graham et al.; Kaleta & Joosten; MacArthur & Jones; Medina et al., 2008; Patry). Within higher educational settings, a standardization decision is necessary with the implementation of clickers as well as a small deployment of clicker technology, initially (Hicks, 2009; Judson & Sawada, 2002; Twetten et al., 2007). However, campus-wide clicker implementation is rapidly taking effect (Hicks; Judson & Sawada; Twetten et al.).

Clickers in Nursing Education

The use of clickers in other disciplines is far from untried, as clickers have been incorporated into disciplines such as communication, engineering, computer science, mathematics, chemistry, philosophy, biology, physics, premedical, medical, veterinary, dental, business, economics, and psychology education (Caldwell, 2007). However, the use of clickers

in nursing education is a fairly new pedagogical tool (Zurmehly & Leadingham, 2008). Only within the last decade has nursing education considered the use of clickers as an effective way to engage nursing students within the classroom (Zurmehly & Leadingham).

Clickers in Nursing Education and Instructional Design

With the use of clickers in the classroom, elements of instructional design are essential for nursing education to initiate clicker implementation to engage nursing students and ensure their learning (DeBourgh, 2007; Jensen, Meyer, & Sternberger, 2009). One such element of design is Chickering and Gamson's seven principles for good practice in undergraduate education (DeBourgh; Jones, Henderson, & Sealover, 2009; Skiba, 2006). The use of clickers coincides with Chickering and Gamson's seven principles for good practice in undergraduate education. The seven principles include to (1) encourage contact between students and faculty, (2) develop reciprocity and cooperation among students, (3) encourage active learning, (4) give prompt feedback, (5) emphasize time on task, (6) communicate high expectations, and (7) respect diverse talents and ways of learning (DeBourgh; Jones et al.; Skiba).

According to Skiba (2006), there are a number of best instructional design practices which the nurse educator can initiate with implementation of clickers. These instructional design practices can coincide with Chickering and Gamson's best practices and may include encourages active learning, increases student-faculty contact, heightens cooperation among students, and provides prompt feedback (Skiba, 2006). In addition, DeBourgh (2007) offers that strategic placement and timing of clicker questions may keep the nurse educator on task with major emphasis placed on the pertinent content the nurse educator desires for their nursing students to understand. Also, diverse learning styles of nursing students is encouraged with clicker

implementation with appropriate instructional design, as clicker technology does offer options such as text and multimedia (DeBourgh, 2007). Another element of instructional design that implementation of clickers may support is Gagne's components of a successful instructional environment (Moredich & Moore, 2007). The components of a successful instructional environment by Gagne (1975) include the following: present a stimulus, direct attention, provide a model for terminal performance, furnish external prompts, guide the direction of thinking, induce transfer of knowledge, assess learning attainment, and provide feedback (Moredich & Moore). Moredich and Moore offer that when clickers are used correctly with appropriate instructional design, such as Gagne's components of a successful instructional environment, the learning styles of adult learners are supported.

As a means to use clickers effectively with appropriate instructional design, various nursing authors offer methods for instruction with clickers (DeBourgh, 2007; Jensen et al., 2009; Jones et al., 2009; McRae & Elgie-Watson, 2010; Moredich & Moore, 2007; Skiba, 2007, 2006; Smith & Rosenkoetter, 2009; Zurmehly & Leadingham; 2008). Such methods for instruction with clickers should begin with application and analysis-type questions in every class as a way to revisit important points from previous assignments and assigned readings (DeBourgh; Jensen et al.). In terms of question presentation, McRae and Elgie-Watson (2010) suggest that clicker questions must be concise and organized onto one PowerPoint slide so that each question can be viewed by nursing students from all areas of a classroom. In addition, if case studies with large amounts of material are used with clickers then the case study must be provided to the nursing students in a written format separately (McRae & Elgie-Watson). This organization is necessary because nursing students will find it difficult to view the case study on one PowerPoint slide and the clicker question on the other (McRae & Elgie-Watson). Also, specific metacognitive goals

are imperative for clicker question design (Smith & Rosenkoetter). As a way to extend classroom knowledge to outside the classroom, a question cycle should be used by nurse educators with regard to clicker questions and instructional design (Smith & Rosenkoetter). A question cycle requires the nurse educator to display a question and then allow small, multiple groups of nursing students to discuss the potential answer for the displayed question (Smith & Rosenkoetter).

After the question is individually answered and displayed via clicker technology, class-wide discussion can emerge (McRae & Elgie-Watson, 2010; Smith & Rosenkoetter, 2009). A question cycle allows for a question-driven instructional environment with feedback mechanisms involved (Smith & Rosenkoetter). These application and analysis-type questions within a question cycle will stimulate thinking as nursing students must reason their answers prior to their answer choice commitment (DeBourgh, 2007; Jensen et al., 2009). Nursing students then become active participants of their own learning due to the use of appropriate instructional design involving application and analysis-type questions with clickers (DeBourgh; Jensen et al.; Moredich & Moore, 2007; Smith & Rosenkoetter; Zurmehly & Leadingham, 2008). The use of clickers with application and analysis-type questions placed throughout a concept lesson can promote an interactive classroom, even within large nursing classrooms (DeBourgh; Jensen et al.).

Further suggestions from nursing authors regarding instructional design with clickers includes that clickers should be used as a formative evaluation tool (DeBourgh, 2007; Jones et al., 2009; McRae & Elgie-Watson, 2010; Porter & Tousman, 2010; Zurmehly & Leadingham, 2008). When clickers are used as a formative evaluation tool, the nurse educator is able to assess how nursing students understand content within the classroom (DeBourgh; Jones et al.; McRae & Elgie-Watson; Porter & Tousman; Zurmehly & Leadingham). The inclusion of a formative

evaluation tool provides the nurse educator with adequate time within the semester to make adjustments as necessary (DeBourgh; Zurmehly & Leadingham). No longer should nurse educators wait until the end of the semester, in the form of summative evaluation, to determine whether or not effective learning has occurred for nursing students (Zurmehly & Leadingham). Lastly, it is encouraged for nursing students and faculty to evaluate clicker use within the classroom with the prediction that greater use of clickers with appropriate instructional design enhances student learning (Jones et al.; Moredich & Moore, 2007).

Clickers in Nursing Education and Evidence-based Findings

As suggestions for instructional design with clickers are important so are evidence-based findings of clickers in nursing education. One such evidence-based finding is the quantitative study by Berry (2009), as the author sought to determine whether clickers enhanced nursing student learning within a pediatric nursing course. The sample involved 126 undergraduate nursing students in two different pediatric nursing courses with an experimental group ($n = 65$) and a control group ($n = 61$) (Berry, 2009). The two groups used within the study were similar in size, however, factors such as student composition and grade point average were not taken into consideration as a means to equally match the two groups (Berry). Besides the variation of clicker use between the groups, nothing else within the classroom itself differed such as content or instructor. The two-tailed t tests indicated that clickers were effective for exam two ($p < 0.000$) and the overall course grade ($p < 0.000$) of the experimental group (Berry). Based upon these findings, Berry (2009) suggested that the introduction of clickers within the classroom heightened nursing student understanding of the topics taught. The classroom with clicker implementation proved to be an environment in which nursing students were more engaged in

discussion versus the traditional classroom with lecture (Berry). Lastly, end semester student surveys were also positive surrounding the use of clickers with only the cost of clickers deemed as a negative aspect (Berry). Recommendations from the end semester student surveys were to use clickers within multiple nursing courses in order for nursing students to benefit from the cost incurred with clicker implementation (Berry).

Similar to Berry (2009), Filer (2010) also sought to determine whether or not clickers improved student knowledge levels. A quantitative study was done and all nursing students ($n = 174$) within the study served as both a control and experimental group, based upon their course section enrollment, which led to a total of four groups to compare (Filer, 2010). The *t*-tests results of the study pointed to no significant improvement in test scores ($p < .05$) based upon the use of clickers versus non-clickers (Filer). However, the nursing student test scores were based on only five multiple-choice questions, and a limited amount of questions is perhaps a poor indicator of definite knowledge development. Lastly, survey results of the study from both the clicker and control groups were compared by chi-square analysis (Filer). The survey results suggested that nursing students within the clicker groups felt more motivation to answer questions ($\text{Chi} = 19.8, df = 2, p = 0.00$); were more comfortable within the classroom ($\text{Chi} = 25, df = 2, p = 0.00$); and participated more ($\text{Chi} = 24.5, df = 2, p = 0.00$) than nursing students within the control groups (Filer). In particular, nursing students reported increased discussion of individual answers with fellow classmates and the technological ease of use with clickers as reasons to implement clickers within future nursing education classes (Filer). The implications for nursing education from the author include how the use of clickers enhances the ability of the nurse educator to assess current knowledge-levels in students and perhaps make instructional changes if necessary in a timely manner rather than at the end of the semester (Filer).

Like Berry (2009) and Filer (2010), Patterson, Kilpatrick, and Woebkenberg (2010) also investigated the impact of clickers on nursing student learning outcomes as reflected by test scores. A quantitative study was implemented by the authors and it involved a quasi-experimental design with a two-group comparison (Patterson et al.). Approximately 70 nursing students participated in the study with students divided into class sections comprised of an experimental group ($n = 38$) and a control group ($n = 32$) (Patterson et al.). Class content was identical for both groups with the only difference being that the control group answered questions with a “hand raise” response and the experimental group answered questions with clickers (Patterson et al.). Analysis of the t tests reported no significant difference in test scores ($p < .05$) between the experimental and control group based upon the use of clickers versus non-clickers (Patterson et al.). An additional qualitative component of the study was optional for the nursing students within the experimental group, as these nursing students were asked questions regarding their experience with clickers (Patterson et al.). Approximately three themes emerged from the qualitative data collected: being able to respond anonymously, validating an answer while providing immediate feedback, and interactive and engaging environments (Patterson et al.). The authors suggest that although test scores did not vary between the groups in this study, perhaps due to the limited intervention time associated with clicker implementation, the use of clickers did allow increased engagement and interaction within the nursing classroom (Patterson et al.).

Findings from nursing survey studies have also proved beneficial in regard to the effects of clickers within the nursing classroom. Porter and Tousman (2010) sought to determine the effect of clicker use with question-driven instruction in the classroom on the nursing students' ($n = 23$) perceived learning experiences within a medical-surgical course. A Hinde and Hunt (2010)

11-item Likert-type scale survey instrument was used for this study due to the statistical significance ($p < .05$) of the survey when tested at the 0.5 level (Porter & Tousman, 2010). Final data analysis of the survey was done with the use of SPSS version 15.0.1 software (Porter & Tousman). Mean scores for all items on the survey results ranged between 4.30 and 4.61, indicating *agree*, per the 5-point scale (Porter & Tousman). Lastly, two qualitative comments were also collected within the survey and the three themes that emerged from the narrative data included the following: better understanding of material via post-question discussion, enhanced NCLEX-RN preparation, and increased interactivity in class (Porter & Tousman). Based upon these findings, student experiences with the use of clickers with question-driven instruction was positive and favorable with recommendations from the authors for further use in nursing education (Porter & Tousman).

In an additional nursing survey study, which involved the use of an online survey methodology, a convenience sample of undergraduate nursing students ($n = 65$) were surveyed within an advanced nursing therapeutics course regarding their satisfaction of clickers within the classroom (DeBourgh, 2007). Survey results suggested that nursing students were highly satisfied with clicker technology in the classroom and 75.8% ($n = 47$) recommended clicker use for future classrooms (DeBourgh). Other positive results from the survey found that nursing students were active in their learning, clicker answers were anonymous, and class discussion resulted because of the introduction of clicker technology (DeBourgh). This finding correlates with Mareno et al. (2010), who cited that clickers create a learning environment in which two-way communication between the educator and the student takes place. Negative results from the survey were in relation to additional cost as nursing students were concerned about cost versus use of clicker technology (DeBourgh). Therefore, an important consideration posed by the author

is to standardize clicker technology across the educational institution in order to prevent unnecessary costs and potential complaints from students (DeBourgh). Other authors have also pointed to the cost of clickers as a negative aspect for nursing students and perhaps an overall negative aspect of clicker implementation (Berry, 2009; Moredich & Moore, 2007; Roberson, 2009). The author concludes that clickers will enhance metacognition for nursing students while students did report within the survey a high level of satisfaction with clicker use (DeBourgh). However, there are challenges for nurse educators who plan to initiate the use of clickers within their classroom (DeBourgh). These challenges include acquired knowledge of the technology, increased class participation time, and the development of further application and analysis type questions for in-class use only (DeBourgh). The use of application and analysis-type questions within the classroom creates an environment of metacognition based upon appropriate instructional design (DeBourgh). Also, application and analysis-type questions create new thought processes that will enhance futuristic clinical reasoning for undergraduate nursing students (DeBourgh).

In order to improve futuristic clinical reasoning, nurse educators must improve nursing student learning outcomes. Stein, Challman, and Brueckner (2006) wanted to determine whether or not the use of clickers within a pretest review will improve nursing students' learning outcomes. Therefore, Stein et al. performed pretest reviews with clickers as a way to enhance student learning within an undergraduate anatomy and physiology course. This quantitative study involved 283 freshman nursing students with a control group ($n = 155$) and an experimental group ($n = 128$). The experimental group was exposed to an examination pretest review that included clickers, while the control group received an examination pretest review minus the involvement of clickers (Stein et al.). No other factors beside the involvement of clickers differed

between the groups in terms of the examination pretest reviews (Stein et al.). As scores of the class averages on examinations were compared, approximately 76 students from the experimental group also responded to a 5-point Likert-type student satisfaction survey scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) regarding clicker pretest reviews (Stein et al.). The survey results suggested that nursing students found the clickers more beneficial than traditional lecture-style test review (Stein et al.). Nursing students also pointed to the discussion of wrong answer choices as beneficial to their individual learning (Stein et al.), as the reinforcement and assessment of answers assists students with learning new information per Gagne's *Essentials of Learning for Instruction* (1988). The class averages on examinations, however, were not affected by the pretest review with clickers (Stein et al.). Only specific test questions appeared to be positively influenced by the pretest review with clicker implementation (Stein et al.). The authors believe that clicker pretest review questions do help familiarize nursing students with the format and structure of the class examinations while also allowing nursing students to narrow their problem content for the test (Stein et al.). Clickers also allow for an immediate assessment on the part of the nursing student and the nurse educator regarding the student's knowledge of the material in the form of formative assessment. This formative assessment of correct performance may allow for a deeper interaction of the nursing student with their nurse educator as further discussion emerges to clarify any problem content areas per Gagne's (1988) instructional event of providing feedback to the student.

As a means to point to further evidence-based findings regarding clickers in nursing education, Revell and McCurry (2010) evaluated and compared the effectiveness of clicker technology and nursing student learning within large and small nursing classrooms. The large classroom incorporated was a junior level medical-surgical course (n = 116) and the small

classroom was a nursing research course ($n = 33$). Researchers incorporated clicker multiple-choice questions, NCLEX-RN alternative format questions, and reading questions in PowerPoint style presentations within each class (Revell & McCurry, 2010). This study involved a mixed-method approach that contained both a quantitative survey using a 6-point Likert-type scale (1 = *strongly disagree*, 6 = *strongly agree*) and qualitative open-ended questions (Revell & McCurry). Results from the study suggested that clicker technology furthers class participation and student engagement, reinforces required concepts and enhances learning, and integrates testing for student comprehension (Revell & McCurry). Nursing students within both the large and small classrooms equally found clickers effective for their individual learning (Revell & McCurry). These results indicate that clicker technology can be equally effective in small classes as well as large classes (Revell & McCurry). The study did not investigate the effect of clicker technology on examination grades, although nursing students within the study identified this as a future potential use of the technology (Revell & McCurry). Revell and McCurry recommend future nursing education research studies to incorporate the use of clicker technology on course grades and NCLEX results, as such research studies currently do not exist.

Lastly, qualitative findings have also pointed to positive results with clickers (Moredich & Moore, 2007; Zurnehly & Leadingham, 2008). Zurnehly and Leadingham indicated that nursing students ($n = 93$) within a medical-surgical course reacted positively to clickers with the emergence of such themes as increased class participation, increased learning and understanding, and enhanced student-faculty contact within their research, which correlates with Gagne's (1988) instructional events of eliciting performance and providing feedback. Also within the study findings, nursing students voiced that any missed questions in class led to moments in which the instructor clarified the misunderstood material versus using it as an opportunity for ridicule

based upon appropriate instructional design measures (Zurmehly & Leadingham). Negative aspects of clickers for the nurse educator dealt with the preparation time associated with clicker technology, as the preparation time involved with clickers proved to be extensive because of application and analysis-type question development and technology orientation (Zurmehly & Leadingham). For nursing students, the negative aspect of clickers was related solely to their individual cost (Moredich & Moore).

Clickers in Nursing Education and Classroom Engagement

As a means to further the interaction between nursing student and nurse educator, Smith and Rosenkoetter (2009) sought to evaluate the outcomes and benefits of clicker implementation. Within this quantitative survey study, the authors investigated whether or not the integration of clickers within an undergraduate ethics course might motivate and engage nursing students (Smith & Rosenkoetter, 2009). After completing an ethics course, nursing students ($n = 60$) completed a two-portion survey questionnaire regarding their experience with clickers within the classroom (Smith & Rosenkoetter). The first portion of the survey included individual characteristics and the second portion contained a 4-point Likert-type scale (*strongly disagree* to *strongly agree*) regarding perceptions of clickers (Smith & Rosenkoetter). Validity and reliability of the survey was not yet established within this pilot study. The results of the study indicated that the majority of the nursing students within the class supported the use of clickers and also encouraged their use within other courses. If clickers are used for quizzes then nursing students strongly encouraged a hard copy of their test to be submitted in addition to their original clicker answers (Smith & Rosenkoetter). The problems associated with clickers resulted in difficulty registering clickers, dead batteries, unregistered responses, and a failure for nursing students to

bring their clickers to class (Smith & Rosenkoetter). Authors did note that cheating with clickers is difficult to assess; therefore, they recommend that quizzes via clickers be used as a small portion of each nursing student's overall grade (Smith & Rosenkoetter). Due to the potential of cheating among nursing students with clickers, the authors also suggest that future research regarding clickers should incorporate this ethical aspect.

Clickers in Nursing Education and Cheating

A quantitative study by Roberson (2009) encompasses recent research in regard to high levels of cheating within schools of nursing. As a way to deter any academic integrity violation, the use of technology can be implemented by nursing faculty to help reduce cheating while also promoting effective learning. Within this research study, a clicker system was implemented as a means to produce a testing environment that would deter any potential cheating (Roberson, 2009). Two large nursing courses were used to implement this study with an experiment group ($n = 111$) and a control group ($n = 110$), respectively. The control group was used to compare test scores from the experimental group minus the use of clickers. The experimental group was administered a test through the clicker system. At the end of the semester, the experimental group completed an anonymous survey, using a 5-point Likert-type scale (1 = *completely disagree* to 5 = *completely agree*) and open response, regarding their perception and ease of clicker use, cost and reliability of the clicker system, and ability to cheat during a test with clickers. Results of the survey suggested that nursing students liked the clickers for testing and quizzes; however, cheating was witnessed within the classroom by other nursing students (Roberson). Examples of cheating included incidences in which nursing students exchanged clickers or changed their individual answers from outside the classroom (Roberson). Academic

integrity changes were made within future classrooms, based upon these survey findings, as a means to deter any future cheating violations (Roberson). These changes included turning in clickers after each test and the development of multiple versions of every test. After these academic integrity changes were made, additional nursing students surveyed verbalized that it was not easy to cheat on a test with clickers (Roberson). Based upon these findings, the author acknowledges that testing with clickers can reduce instances of academic integrity violations, such as cheating.

Clickers in Graduate Nursing Education

As cheating is a factor for nurse educators to consider within the classroom, so is the attainment of essential core concepts by nursing students. The ability for nurse educators to receive immediate feedback within a traditional classroom is extremely difficult, yet necessary, to determine nursing student knowledge acquirement (Grimes, Rogers, Volker, & Ramberg, 2010). Therefore, clickers were implemented within an accelerated graduate nursing program to provide nursing students with application practice and to give nurse educators' immediate feedback regarding nursing students' knowledge of core material, also known as formative feedback (Grimes et al.). A total of 48 nursing students served as participants within the quantitative survey study. In the comparison of final examination scores, an experimental ($n = 49$) and control group ($n = 39$) was used to compare the t tests, processed by SPSS software. Based upon the study results ($p < 0.001$), clickers were found to be an effective learning tool, as the experimental group surpassed the control group on classroom tests (Grimes et al.). Also, faculty acknowledged clickers as a valuable active learning tool as little effort was necessary for implementation of the new technology within the classroom (Grimes et al.).

Barriers of Clickers in Nursing Education

Barriers of clicker implementation also exist in nursing education. The additional nursing student cost of clicker implementation is a negative aspect and perhaps an overall barrier of clicker implementation within nursing education (Berry, 2009; DeBourgh, 2007; Filer, 2010; McRae & Elgie-Watson, 2010; Moredich & Moore, 2007; Roberson, 2009; Zurmehly & Leadingham, 2008). In order to reduce this barrier, recommendations from nursing education literature encourage clicker implementation within multiple nursing courses in order for nursing students to benefit from the individual cost incurred (Berry; Jones et al., 2009). Other barriers of clicker implementation in nursing education for nursing students include difficulty registering clickers, dead batteries, unregistered responses, and a failure to bring the clickers to class (Patterson et al., 2010; Smith & Rosenkoetter, 2009). Barriers of clicker implementation in nursing education for nurse educators include additional classroom preparation time associated with clickers because of application and analysis-type question development and technology orientation (McRae & Elgie-Watson; Patterson et al.; Zurmehly & Leadingham). Also, a potential for student cheating on tests via clickers is a barrier for nurse educators (Jones et al.; Roberson; Smith & Rosenkoetter). As cheating with clickers is difficult to assess, tests via clickers should be an overall minimal portion of each nursing student's grade (Smith & Rosenkoetter).

Chapter Summary

In summary, this chapter contained the review of the literature pertinent to this research study. The primary concepts of this review included (a) clickers in higher education and clickers in nursing education. The secondary concepts of this review included (b) reluctant learners and

clickers, formative assessment and pedagogical uses of clickers, technological proficiency and clicker implementation, active learning and clickers, impact of clickers on course grades, clickers in science courses, clickers in non-science courses, clickers in large lecture courses, clickers in nursing education and instructional design, clickers in nursing education and evidence-based findings, clickers in nursing education and classroom engagement, clickers in nursing education and cheating, and clickers in graduate nursing education. The tertiary concepts of this review included (c) clicker pedagogies in higher education science courses, survey findings of clickers in higher education science courses, exam findings of clickers in higher education science courses, clickers in library courses, clickers in psychology courses, clickers in business courses, clickers in large lecture courses and student perceptions, and clickers in large lecture courses versus the absence of clickers in large lecture courses.

CHAPTER 3

RESEARCH METHODOLOGY OF THE STUDY

The purpose of this study was to investigate clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. This chapter describes the research process used by the investigator to determine whether a difference exists between nursing students' level of knowledge with the use of clickers and without the use of clickers. This research could potentially establish a correlation between student level of knowledge prior to clicker use and after the use of clickers within a learning environment. One group of nursing students received learning activities in class with the inclusion of clicker technology. The other group of nursing students received learning activities in class minus the use of clicker technology. This chapter includes the research design, setting, population and sample, sampling procedures, sample size, recruitment, data collection, data analysis, and chapter summary.

Research Design

This study employed a pretest and posttest design with a comparison group. This methodology was used to test the effect of clicker technology on nursing students' level of knowledge as evidenced by exam performance.

Setting

The research was conducted at one southeastern university in the United States. Currently, this university setting contains approximately 940 faculty and staff members and

11,500 undergraduate and graduate degree students. Approximately 9,230 of the total 11,500 student population includes undergraduates and of this undergraduate population, 40% of enrollment consists of men and 60% consists of women. This university is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools and has been named by The Princeton Review as one of the Best Southeastern Colleges and one of America's Best Value Colleges. At the time of this study more than 100 programs are offered at this university through three colleges and one school. The School of Nursing at this institution offers both a baccalaureate and master's degree in nursing. The Bachelor of Science in Nursing program has full approval by the Board of Nursing of the state in which it resides and both the Bachelor of Science in Nursing and the Master of Science in Nursing programs are accredited by the Commission on Collegiate Nursing Education (CCNE).

There are approximately 811 undergraduate nursing majors within this university setting and 339 undergraduate students are currently registered for nursing courses. Based upon the last fiscal year report of this undergraduate nursing program, 99% of BSN graduates passed NCLEX-RN on their first attempt and 100% of BSN graduates passed NCLEX-RN one year post-graduation. The last fiscal year report also showed that 90% of BSN graduates agreed that caring, holism, critical thinking, and professional commitment characterized the learning environment at this School of Nursing. Additional strengths of the undergraduate nursing program include the caring curriculum with the inclusion of Caring Groups for the undergraduate students. Also, full-time and part-time nursing program options are available at various campus locations.

For this study, the investigator worked with the course coordinator of a senior nursing course, titled Adult Health, within this university setting to implement the research process of

determining clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. This study was conducted by the investigator and the course coordinator, who was the faculty member primarily responsible for the Adult Health course, which occurs in the third semester of a four-semester nursing program. The course coordinator of the Adult Health course was responsible for the implementation and evaluation of students within the course while also working closely with clinical instructors assigned to the course. The investigator's roles within the Adult Health course were to serve as a clinical instructor and provide clinical instruction to nursing students within local healthcare environments. Qualifications of the investigator to implement a research study on clickers in nursing education included a Master's of Science in Nursing degree with a nursing education focus and approximately two years of classroom clicker experience.

Population and Sample

The population for this study was 60 traditional, full-time, undergraduate nursing students who were pursuing a baccalaureate degree in nursing and were enrolled in the senior level Adult Health nursing course. Thus, a convenience sample was used for this research study. A convenience sample is appropriate for a homogeneous population and is often used during preliminary research studies when a large amount of data regarding the research topic currently does not exist (Polit & Beck, 2008). The total population of the convenience sample consisted of nursing students from only one Adult Health nursing course. Each nursing student within this course had an opportunity to participate in the research study. The majority of the potential participants were 20-to-30 years old, female, and Caucasian. All potential participants currently reside in the southeastern portion of the United States and speak the English language. More

generally, this potential population was essentially homogeneous in nature due to their similarities in degree major, full-time nursing program status, age, sex, race, and geographical residence at the time of this study based upon School of Nursing demographic data at the research institution.

Sampling Procedures

For this pretest and posttest with a comparison group research method, a convenience sample of nursing students was employed. The experimental and control groups consisted of senior nursing students in the Bachelor of Science in Nursing program. The use of a control group was included to strengthen the internal validity of the research (Polit & Beck, 2008). The potential population of nursing students, at the time of this study, was enrolled in an Adult Health nursing course in the fall semester of 2010. Within the Adult Health nursing course, students who agreed and students who did not agree to participate in the research study were randomly assigned to one of two treatment groups, with one group functioning as the experimental group and the other as the control group.

All students within the Adult Health nursing course were listed alphabetically via the class role and, based upon this alphabetical list, the course coordinator assigned each student a number, beginning with the number one. Students with odd numbers were placed within the experimental group and students with even numbers were placed within the control group. Thus, student one was assigned to the experimental group and student two was assigned to the control group, and so forth, as a means to prevent any systematic bias in the assignment of potential participants (Creswell, 2009). The course coordinator maintained a master list of the class role

with name identification and number assignment of each student within a locked file cabinet in the School of Nursing. This list will be kept for a period of three years and then destroyed.

After the assignment of numbers, anonymity of pretest-posttest scores was guaranteed as number assignments were aligned with pretest-posttest scores and no other identifying information was used. A letter designation was associated with each assigned student number to identify the difference between the pretest, posttest one, and posttest two. For example, nursing student one's test scores were identified as 1A, 1B, and 1C for clarity. The course coordinator used the master list of the class role with name identification and number assignment of each student to ensure each test score for the pretest, posttest one, and posttest two was accurately recorded. Table 1 provides an example of the experimental group number assignment test score system used in the study.

Table 1

Example of Experimental Group Number Assignment Test Score System

Student number	Pretest	Posttest one	Posttest two
Student 1	1A	1B	1C
Student 3	3A	3B	3C
Student 5	5A	5B	5C

Table 2 provides an example of the control group number assignment test score system used in the study.

Table 2

Example of Control Group Number Assignment Test Score System

Student number	Pretest	Posttest one	Posttest two
Student 2	2A	2B	2C
Student 4	4A	4B	4C
Student 6	6A	6B	6C

Therefore, once a participating student was assigned a number, the identification of his or her name was removed from the alphabetical lists so the investigator could not identify any of the participants individually or which group to which they were assigned.

Approval for this study was obtained from both the university research-site's Institutional Review Board (IRB) and The University of Alabama's Institutional Review Board (IRB) to conduct this study (Polit & Beck, 2008). Permission was also obtained from the Dean of the School of Nursing at the institution where this study took place.

Sample Size

To reduce the risk of Type II errors in research, power analysis was used in advance of the research to determine how large a sample was needed for the research study (Polit & Beck, 2008). In new areas of research, the effect sizes are normally small versus medium versus large and if no previous research currently exists the researcher may estimate the expected effect size as either of those previously mentioned (Cohen, 1988; Polit & Beck). The standard value of effect size for two-group *t*-test means was estimated at ".20 for small effects, .50 for medium effects, and .80 for large effects" (Polit & Beck, p. 604).

As a means to estimate the expected effect for this research study, due to a lack of prior research beforehand as aforementioned, an estimated effect size of .80 was used for this research study. Therefore, an approximate sample size necessary to achieve a selected power of .80 and

an estimated effect size of .80 is 50 students total with 25 students required for each group (Polit & Beck, 2008). This estimated sample size was necessary for *t* tests of two means with a significance criterion that equals .05 (Polit & Beck). An accurate significance criterion level is important because the level of significance selection helps control the risk of Type I errors in research and decreases the possibility of falsely rejecting a true null hypothesis (Polit & Beck). Also, a level of significance at .05 is the minimum level acceptable in research as stricter levels are necessary for research that involves potential health considerations to the study participants (Polit & Beck).

In review, to calculate a sample size for this research study, a power analysis was completed. The following steps were used to project the sample size of 50 subjects.

1. Significance level = .05.
2. Effect size = .80 for large effect size.
3. Desired power level = conventional power level of .80 was used.
4. Given $\alpha = .05$ and effect size = .80, the sample size was 25 for each group with a total sample size of 50 (Cohen, 1988).

Recruitment

Discussion of the research and the benefits of participating in the study were explained to each potential research participant by the investigator as a means to gain cooperation for this research study (see Appendix A). The nursing student recruitment involved the investigator describing the research study to the potential participants within the Adult Health course in the middle of the semester. One week prior to when the research study began, informed consents of participants were collected by the course coordinator (see Appendix B).

Data Collection

A pretest and posttest design with a comparison group was used to determine an association between the independent and dependent variable. One pretest and two posttests (see Appendices C and D) were used in this study. The pretest-posttests used for data collection did not have any affect towards nursing students' individual course grades. Also, the pretest-posttests were identical and consisted of 50 multiple-choice questions that pertained to the concept of elimination. The multiple-choice questions were based on the Adult Health course objectives for the concept of elimination.

Classroom Pedagogy

Pedagogies for the concept of elimination were identical for both the experimental and control groups (see Appendix E). The course coordinator taught the experimental group and the investigator taught the control group. The following teaching plan was used by both the course coordinator and the investigator for the concept of elimination.

1. Day One

- a. Elimination pretest (50 items)
- b. Break
- c. Assessment of renal/urinary system decision-making challenge
- d. Assessment of renal/urinary system case study
- e. Assessment of renal/urinary system multiple choice questions
- f. Break
- g. Care of patients with urinary problems decision-making challenge
- h. Care of patients with urinary problems case study

- i. Care of patients with urinary problems multiple choice questions
- 2. Day Two
 - a. Care of patients with renal disorders decision-making challenges
 - b. Care of patients with renal disorders case study
 - c. Care of patients with renal disorders multiple choice questions
 - d. Break
 - e. Care of patients with acute renal failure and chronic kidney disease decision-making challenges
 - f. Care of patients with acute renal failure and chronic kidney disease case study
 - g. Care of patients with acute renal failure and chronic kidney disease multiple choice questions
- 3. Day Three
 - a. Care of male patients decision-making challenges
 - b. Care of male patients case study
 - c. Care of male patients multiple choice questions
 - d. Break
 - e. Elimination posttest (50 items)

Specifically, day one contained the elimination pretest and learning strategies about renal assessment and urinary problem criteria (see Appendixes F, G, H, I, J, and K). The learning activities on day two contained renal disorders and renal failures (see Appendixes L, M, N, O, P, and Q). Lastly, day three contained the male urinary disorder learning activities and the elimination posttest that followed (see Appendixes R, S, and T).

Clickers were used individually by nursing students only in the experimental group classroom on a daily basis to answer the multiple-choice questions provided in class. Clickers were not used to answer multiple-choice questions on the pretest-posttests, as those questions were answered individually by study participants only. Within the control group classroom, nursing students answered the identical multiple-choice questions provided in class by simply raising their hands. Different multiple-choice questions were used on the pretest-posttests than the multiple-choice questions provided in class (see Appendixes D, H, K, N, and T). The aforementioned decision-making challenges and case studies were answered as an entire group within both the experimental and control groups without the use of clickers. Identical 50-item pretests-posttests were given to both the experimental and control groups prior to classroom instruction and afterwards. As stated previously, the pretest-posttests were identical tests and consisted of 50 multiple-choice questions that pertained to the concept of elimination. The multiple-choice questions on the pretest-posttests were answered by study participants only.

Essentials of Learning for Instruction, a theoretical framework by Gagne (1988), provided the conceptual and theoretical basis for the research study, as the events of instruction for both the experimental and control groups contained the components of a successful instructional environment. For the experimental group, the course coordinator presented a stimulus, directed attention, furnished an external prompt that involved clickers, guided the direction of learning, induced transfer of knowledge, assessed learning attainment, and provided feedback. For the control group, the investigator provided all of the aforementioned events of instruction minus the external prompt of clickers.

Test Item Analysis

The 50-item pretest-posttests provided data regarding students' current knowledge level of renal alterations and conditions. The pretest-posttests also provided a stimulus and directed students' attention per Gagne's (1988) instructional events. A Course Den computer testing program was used to determine reliability of the test items on the pretest-posttests based on the internal consistency of the test and the point biserial index (PBI) of previously used test items (see Appendix U). The best measure of internal consistency within a test is directly influenced by the point biserial index (PBI), which represents the discrimination ability of test items (Haladyna, 1997; McDonald, 2002). Only previously used test items of former nursing classes were used for the pretest-posttests with point biserial indexes (PBI) above 0.20, as this parameter defines a highly discriminating test item on an exam (Haladyna). These highly discriminating and previously used test items consisted of only application and analysis style multiple-choice questions.

In addition to reliability, validity of the test items was also necessary (McDonald, 2002). A well-constructed test should include vital portions of the class such as the course objectives for the concept tested (McDonald). As a means to ensure construct validity of the test, the investigator asked an expert to judge the relationship between the test items and the concept objectives to verify that the test items did measure the learning outcomes of the concept of elimination (AERA et al., 1999). To do so, the investigator asked a member of the dissertation committee, a doctorally prepared nurse educator with over 40 years of experience in item writing and test analysis, to review the concept of elimination objectives and the test items to verify construct validity. A test also requires face validity so that students feel the test coincided with required course content (Popham, 1999). The pretest-posttests did cover the concept of

elimination, as tests that are related to course content have face validity and course content related tests have been found to motivate students to try harder in class (Lyman, 1988).

Educational Intervention

The items on the pretest-posttests included concepts and subconcepts on renal alterations and conditions. A main concept of elimination existed with subconcepts such as urinary tract infections, glomerulonephritis, renal failure, renal transplantation, and urolithiasis. After the pretest, a three-week unit on the concept of elimination was provided to nursing students in the experimental group with the incorporation of clickers and to nursing students in the control group without the incorporation of clickers. During this time, both the course coordinator and the investigator guided the direction of student learning with assessment and feedback opportunities per Gagne's (1988) nine events of instruction within each group minus the external prompt of clickers within the control group.

Gagne's nine events of instruction. The nine events of instruction depicted within the educational theory (Gagne, 1988), provided the theoretical framework and guided the study. For example, attention was gained in each classroom as the course coordinator and investigator performed a "check-in" with their experimental or control group to assess if nursing students were able to access their elimination concept material within the course management system. The "check-in" process also involved discussion of how the clinical experience was progressing for the nursing students within their individual healthcare environments. Second, the unit objectives and outlines of each class were presented to the nursing students so students knew what to expect within their classroom experience. Thirdly, multiple-choice questions were

presented in class and the necessary information to answer the multiple-choice questions required retrieval of short-term memory information from the nursing students.

Fourth, based upon the multiple-choice question answers, the course coordinator and investigator informally redirected the nursing students regarding essential elimination concept material necessary to answer the multiple-choice question. This redirection may have required the nursing students to review either their textbook or content notes for essential information. Fifth, before answering the same multiple-choice question again, discussion regarding the multiple-choice question was encouraged between small groups of nursing students in the form of a “think-pair-share” activity. Sixth, each nursing student responded individually as they answered the displayed multiple-choice question for the second time. This second attempt at the same question required short-term knowledge retrieval and encoded the knowledge into the student’s long-term memory (Gagne & Driscoll, 1988). Also, the increased performance of the nursing student on the second attempt to the same multiple-choice question signified that learning took place as a result of the interaction between the student and their classroom environment (Gagne & Driscoll, 1988).

Seventh, the course coordinator and investigator reinforced, based upon the multiple-choice question results, why the correct answer choice was correct to the experimental and control group. Eighth, performance was later assessed via the posttests as the course coordinator and investigator wanted to determine whether or not students developed mastery of the content. Ninth, the elimination exam within the Adult Health class had new multiple-choice questions that required all of the nursing students to acquire long-term memory of the content. The elimination exam also required the nursing students to transfer their knowledge to new questions, which also further determined mastery of the content.

Pretest-posttests. Following the educational intervention of the concept of elimination, with or without clickers, a posttest identical to the pretest was administered immediately following the conclusion of the concept of elimination at week three, and the second posttest was given three months later. An instrumentation threat did not exist within this research study, as the same identical test was used for both the pretest-posttests (Polit & Beck, 2008). The purpose of the posttests was to determine whether a difference existed in nursing students' knowledge level of renal alterations and conditions between the groups.

As a means to obtain potentially different estimates of nursing students' level of knowledge, data from two posttests was collected. One posttest was administered at three weeks, which was immediately following the conclusion of the concept of elimination on day three of class (see Appendix E). The second posttest was administered at three months. A correlation of clicker technology and posttest scores can depend on how much time elapses between the two posttests, since each identical posttest did measure the same thing (Polit & Beck, 2008). Previous research has shown the shorter the time gap, the higher the correlation and the longer the time gap, the lower the correlation (Polit & Beck).

The pretest-posttests and educational intervention regarding the concept of elimination with clickers was administered to the experimental group by the course coordinator to remove any biases regarding the use of clicker technology. The pretest-posttests and education intervention regarding the concept of elimination without clickers was administered to the control group by the investigator. As previously stated, lesson plans for the concept of elimination were identical for both the experimental and control groups with the only exception being the inclusion of clickers for the experimental group (see Appendix E). The qualifications of the course coordinator who conducted the unit on elimination with the use of clickers in the

experimental group included a Master's of Science in Nursing with a focus in nursing education, two years experience with clicker technology within the classroom setting, certification in critical-care nursing, and over 10 years of bedside critical-care experience within a teaching hospital setting. The course coordinator has routinely taught within the Adult Health course for the last three years.

Interrater Reliability

Interrater reliability considerations, due to the use of two nurse educators, resulted in the need to address the consistency of the implementation of the concept of elimination (Polit & Beck, 2008). To ensure interrater reliability it became essential that the investigator and the course coordinator were consistent (Polit & Beck). Similarities in training and education can enhance interrater reliability (Polit & Beck). As a means to prove more consistency than inconsistency, the investigator and the course coordinator attended the same School of Nursing for both their undergraduate and graduate years and received identical nursing degrees. Also, both individuals currently hold national certifications in critical care nursing as they also worked within the same teaching hospital setting for a period of over five years. Lastly, the investigator and the course coordinator also "team-taught" the Adult Health course content together for a period of over three years. During this time period, the investigator and the course coordinator worked closely together as each individual was very much aware of the other's teaching methods. The individual teaching methods of the investigator and the course coordinator became very similar and consistent over time, due to their education, training, and lived experiences.

Instructional Setting

The instructional setting of the experimental and control group consisted of a large lecture classroom with multiple rectangular tables and individual chairs available for the students. Within this setting, each nursing student in the experimental group had a clicker, provided by the school of nursing. The course coordinator passed out and collected the clickers before and after each class session within the experimental group. During class time for both the experimental and control groups, identical multiple-choice questions were provided which consisted of the organizing concepts and subconcepts of the renal alterations and conditions unit. Application and analysis level multiple-choice questions were given to the students in class to enhance their test-taking skills but also to allow for further discussion and feedback regarding the content (Caputi & Engelmann, 2005). Within the experimental group, nursing students answered the multiple-choice questions provided in class with their individual clickers. Within the control group, nursing students answered the multiple-choice questions by raising their hands. The development and use of effective questions are crucial to the successful implementation of clickers within the classroom, as multiple-choice questions help determine the depth of conceptual learning (Deal, 2007; Duncan, 2005; Caputi & Engelmann).

The use of clickers was consistent with knowledge-centered frameworks described in *How People Learn* and involved the use of multiple-choice questions written at the application and analysis level (National Research Council, 2000). As the multiple-choice questions encompassed content from the renal alterations and conditions unit, the questions also allowed students to understand the relevant knowledge they must acquire (National Research Council). Multiple-choice questions are designed to promote complex understanding of content, an essential criteria of knowledge-centered environments (National Research Council). By exposing

nursing students to the major features of the renal unit with multiple-choice questions either with or without clickers, students were able to visualize, understand, verbalize, and monitor their progress in class.

Within the three weeks of the elimination content, nursing students within the experimental group met for class four hours each week and each student was exposed to clickers for approximately one hour of class time. Essentially, this time allocated for clickers was based upon literature that suggests that it takes students anywhere between one to four minutes per question for productive discussion (Duncan, 2005; Ribbens, 2007). Therefore, based upon this recommendation, students were exposed to approximately four to six multiple-choice questions for 15 minutes per hour during the four-hour class time, as indicated by previous clicker findings (Duncan; Ribbens). The other three hours of class time consisted of learning strategies such as decision-making challenges and case studies. Also, within the three weeks of elimination content, nursing students within the control group met for a four-hour class time each week and were not exposed to clickers. Instead, control group students were exposed to the identical multiple-choice questions and learning strategies such as decision-making challenges and case studies.

Data Analysis

A pretest and posttest design with a comparison group was used to test the effect of clicker technology on nursing student knowledge level as evidenced by exam performance. Pretest and posttest scores for each group were compared, and then the scores for the groups were compared. The null hypothesis of this study was that clickers will not have any effect ($p < .05$) on nursing students' level of knowledge as evidenced by exam performance. The alternative

hypothesis of this study was clickers will have an effect on nursing students' level of knowledge as evidenced by exam performance. Descriptive statistics, including the means and standard deviations, were calculated for the test scores received. Additionally, *t* tests were employed as final data analysis was conducted with the SPSS statistical program to evaluate and compare both the experimental and control groups. All *t* tests were two-tailed with a $p < 0.05$ considered statistically significant. Data collected helped determine the effectiveness of clickers on nursing students' level of knowledge.

Chapter Summary

In summary, this chapter discussed the research design, setting, population and sample, sampling procedure, sample size, recruitment, data collection, and data analysis. This study compared two groups of nursing students taking the same class with one experimental group exposed to clickers and the other control group not exposed to clickers. A pretest and posttest design with a comparison group research model framework was used.

CHAPTER 4

RESEARCH RESULTS

The purpose of this study was to examine clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. In this chapter a description of the sample is provided, including the number of participants per test for the experimental and control groups. The results of the statistical analysis used to test the null hypothesis of the study are presented. The chapter closes with a brief summary.

Description of the Sample

Approximately 49 of a potential of 60 full-time, undergraduate nursing students enrolled in the Adult Health nursing course served as participants and completed the pretest. Of the original 49 students, 41 completed the posttest immediately following the renal alterations and conditions unit, and 14 of the aforementioned students completed the posttest at three months. Random assignment to either the experimental group or the control group was done to eliminate any possibility of biases. The two groups were similar in size; however, factors such as age and grade point average were not taken into consideration as a means to equally match the two groups. Table 3 provides the total number of participants per test per group by gender.

Table 3

Number of Participants per Test per Group by Gender

Group	Female	Male	Total
Control			
Pretest	23	1	24
Posttest 1	20	0	20
Posttest 2	8	0	8
Experimental			
Pretest	22	3	25
Posttest 1	18	3	21
Posttest 2	5	1	6

Clickers and Nursing Students' Level of Knowledge

The experimental and control groups of students were given a pretest to examine nursing students' current knowledge level of renal alterations and conditions. Independent samples *t* test was conducted to determine whether there were pre-intervention differences between the groups in terms of their level of knowledge. The null hypothesis of this study stated that clickers will not have any effect ($p < .05$) on nursing students' level of knowledge as evidenced by exam performance. The alternative hypothesis stated that clickers will have an effect on nursing students' level of knowledge as evidenced by exam performance. To test for differences in knowledge between the experimental group and control group, independent samples *t* tests were conducted to compare pretest scores, posttest one scores, and pretest-posttest one difference scores.

All tests were conducted with $\alpha = .05$. Group differences at posttest two were not analyzed due to the extremely low number of participants who completed this test. Levene's test for homogeneity of variance was not significant, indicating that this assumption was not violated. Results indicated that the experimental group ($M = 40.96$, $SD = 7.75$) had higher pre-intervention

scores than did the control group ($M = 36.58$, $SD = 5.36$), $t(47) = -2.29$, $p > .03$. The results are indicated below in Table 4.

Table 4

Independent Samples T-Test Results for Pre-Intervention Scores as a Function of Intervention

Group	N	M	SD	t	p
Control	24	36.58	5.36	-2.29	.08*
Experimental	25	40.96	7.75		

* $p < .05$

After the pretest, a three week unit on the concept of elimination was provided. Specifically, day one contained the elimination pretest and learning strategies about renal assessment and urinary problem criteria (see Appendixes F, G, H, I, J, and K). The learning activities on day two contained renal disorders and renal failures (see Appendixes L, M, N, O, P, and Q). Lastly, day three contained the male urinary disorder learning activities and the elimination posttest, which followed (see Appendixes R, S, and T).

Immediately following the three week unit on the concept of elimination, a posttest, identical to the pretest, was administered to both the experimental and the control groups of students. Independent samples t test was conducted to determine whether there were post-intervention differences between the groups in terms of their level of knowledge. Levene's test for homogeneity of variance was not significant, indicating that this assumption was not violated. Results indicated that the control group ($M = 59.50$, $SD = 10.17$) had higher post-intervention scores than did the experimental group ($M = 51.33$, $SD = 9.19$), $t(39) = 2.71$, $p < .01$. The results are indicated below in Table 5.

Table 5

Independent Samples T-Test Results for Post-Intervention Scores as a Function of Intervention

Group	N	M	SD	t	p
Control	20	59.50	10.17	2.71	.01*
Experimental	21	51.33	9.19		

* $p < .05$

Independent samples t test was not conducted to determine whether there were differences between the groups in terms of their level of knowledge at posttest two due to the extremely low sample size at this time period.

Further analysis was conducted to test the null hypothesis. Difference scores were created by subtracting the pretest scores from the posttest one scores. Independent samples t test was conducted to determine whether the intervention had an impact on nursing students' gains in knowledge, that is, whether nursing students' knowledge scores improved more in the experimental group than in the control group. Levene's test for homogeneity of variance was not significant, indicating that this assumption was not violated. Results indicated that there were significant differences in nursing students' knowledge difference scores across the different levels of intervention, $t_D(39) = 3.86, p < .001$. The control group showed greater improvement in scores post-intervention ($M_D = 21.90, SD_D = 11.76$) than did the experimental group ($M_D = 10.19, SD_D = 7.24$). The results are indicated below in Table 6.

Table 6

Pre-Intervention, Post-Intervention, and Pre-Post Difference Scores as a Function of Intervention

Group	Pre M(SD)	Post M (SD)	M_D (SD_D)	t_D	p
Control	36.58 (5.36)	59.50 (10.07)	21.90 (11.76)	3.86	< .001*
Experimental	40.96 (7.75)	51.53 (9.19)	10.19 (7.24)		

* $p < .05$

Therefore, the null hypothesis of this study, clickers will not have any effect ($p < .05$) on nursing students' level of knowledge as evidenced by exam performance, was rejected at the .05 level of significance. The alternative hypothesis, clickers will have an effect on nursing students' level of knowledge as evidenced by exam performance, was accepted.

Chapter Summary

Data were collected and analyzed for the purpose of investigating clicker effectiveness on nursing students' level of knowledge. There were pre-intervention, post-intervention, and pre-post intervention differences across the groups. In particular, the control group showed greater improvement in scores post-intervention ($M_D = 21.90$, $SD_D = 11.76$) than did the experimental group ($M_D = 10.19$, $SD_D = 7.24$). Group differences at posttest two were not reported due to the extremely low sample size at that time period. The null hypothesis was rejected.

CHAPTER 5

DISCUSSION OF RESEARCH RESULTS

The purpose of this study was to determine clicker effectiveness on nursing students' level of knowledge as evidenced by exam performance. A pretest and posttest research design with a comparison group was used to test the effect of clicker technology on nursing students' level of knowledge. Descriptive statistics were utilized in the data analysis to test the hypothesis. Major findings, limitations, discussion of the findings, implications for nursing education, conclusions, and recommendations for research are presented.

Major Findings

Post-intervention scores improved within both the experimental group and the control group. Research findings failed to support the null hypothesis that clickers will not have any effect on nursing students' level of knowledge as evidenced by exam performance. Instead, the results showed an association between clickers and nursing students' level of knowledge. In particular, students not exposed to clickers within the control group outperformed students exposed to clickers within the experimental group on the posttest, as the *t*-tests results of the posttest were statistically significant ($p < 0.05$).

The results from this study are inconsistent with former results reported in the literature. Martyn (2007) found a lack of statistical difference in pretest versus posttest scores between one group who used clickers and one group who did not use clickers in introductory computer classes. Like Martyn (2007), results from Crossgrove and Curran (2008) also reported a lack of

difference in test scores with and without clickers between two sections of non-biology and biology major courses.

In undergraduate nursing education, Berry (2009) found that clickers increase nursing students' knowledge of content as nursing students who used clickers had significantly higher exam scores within a pediatric course. However, Filer (2010) revealed results within a medical-surgical course which indicated no significant improvement in test scores based upon the use of clickers versus non-clickers. Similar to Filer (2010), Patterson et al. (2010) also suggested that clickers made no impact on nursing students' level of knowledge as findings reported no significant difference in test scores between the experimental and control groups based upon the use of clickers versus non-clickers. Lastly, within graduate nursing education, Grimes et al. (2010) indicated that clickers were an effective learning tool as examination scores of the experimental group exposed to clickers surpassed the control group not exposed to clickers.

Limitations

Generalizations of the results of this study are limited by several factors. First, the participants consisted of only one nursing class within one university setting. The addition of another nursing class, either within the research site or within another university setting, may have produced different results as nursing student populations vary between individual classes. Second, the total population of the study was relatively small. Most nursing studies include populations that are relatively small due to practical constraints such as time, resources, and subject availability (Polit & Beck, 2008). However, small sample sizes may collect data that do not support the hypothesis, even when the hypothesis is correct (Polit & Beck). A large sample size is preferable to a small sample size (Polit & Beck). Third, the population was a convenience

sample. Because the population was a convenience sample perhaps the participants were atypical of other nursing students within the same geographical area or nationally.

Fourth, the sample was geographically limited and may not represent the overall population of an Adult Health course within other university settings. This research was conducted at only one southeastern university in the United States. Fifth, the research setting was conducted at the same university where the investigator was currently employed. This convenient location for the investigator may have produced results that emphasized the investigator's familiarity of the renal alterations and conditions unit and teaching ability versus clicker effectiveness on nursing student performance in class. The renal alterations and conditions unit was taught solely by the investigator at the research site for the last four years prior to the research study. Sixth, the sample was voluntary and may not accurately represent the population desired. The population who chose to participate may have been nursing students already familiar with clickers and their use within a classroom setting. Also, those who participated may have been a majority of nursing students within the investigator's clinical groups and not an equal representation of the entire class. Lastly, those who participated may have been nursing students who are predominately "overachievers" within their cohort versus an equal representation of the entire population in the Adult Health class.

Seventh, the sample size was less than the number of subjects necessary to maintain the desired power level as predetermined by the analysis of power. The analysis of power projected a necessary sample size of 50 subjects for the research study and this subject size was never achieved during the study. Eighth, the last analysis data was ignored due to the low number of participants. Posttest two was based on only 14 nursing students, an insufficient analysis of power to accurately determine clicker effectiveness. The low number of participants could have

been due to nursing students not motivated to take a posttest that did not affect their individual course grade.

Discussion of the Findings

Generalizations of the findings of this study are necessary for understanding of the results. First, two nurse educators separately led the experimental and the control groups. Also, identical pedagogies were used by the investigator and course coordinator within this research study as teaching plans were identical for both the experimental and control groups. Further, interrater reliability considerations were addressed as both the investigator and course coordinator have similar education, training, and lived experiences. However, the investigator and course coordinator are separate individuals, each with their own unique abilities to lead a classroom and reinforce student learning, thus producing varying results. Perhaps the use of one nurse educator would have eliminated any possible presentation differences, which could have produced different findings.

Second, a lack of “buy-in” was present because this study was the investigator’s doctoral dissertation and not the course coordinator’s study. Therefore, the investigator was internally motivated to lead the control group in this study and this motivation may have heightened the posttest results of the control group, thus overshadowing the results of the experimental group. Third, a Hawthorne effect on the dependent variable may have resulted from everyone’s awareness that they were participants within the study. Perhaps the very nature of being in the study affected everyone’s behavior and obscured clicker effectiveness as well as differences between the groups. This behavioral change may have been present in not only the nursing students but also the investigator and course coordinator as well.

Fourthly, the low number of participants could have been the result of nursing students not motivated to do well on a pretest-posttests that did not affect their individual course grade. Perhaps if more nursing students were motivated academically to participate in the research study the findings would have produced results that were significant for clicker effectiveness on nursing student knowledge levels. Lastly, another aspect of nursing education is clinical experiences, where knowledge is applied and new knowledge gained. Nurse educators try to ensure that nursing students receive clinical experiences related to class content, but these experiences vary for each student depending upon opportunities available at clinical sites. Also during a clinical day, nurse educators usually have a “post conference” to share learning experiences, answer questions, and provide feedback to nursing students. Perhaps nursing students within the control group had more “renal experiences” or received additional information during this “post conference” time which may have affected their knowledge levels.

Implications for Nursing Education

The findings from this study contribute to nursing education’s limited body of knowledge regarding clicker effectiveness on nursing student knowledge levels. Essentially, lower posttest scores of nursing students exposed to clickers were revealed as nursing students not exposed to clickers achieved higher posttest scores. This study is one of the first reports of clicker implementation within nursing education to have a negative effect on student exam scores. Previous studies regarding clicker effectiveness in nursing education either suggests positive posttest scores or no significant difference in posttest scores post-clicker implementation.

Gagne’s (1988) *Essentials of Learning for Instruction* provided the theoretical framework for this quasi-experimental study regarding clicker effectiveness on nursing students’ level of

knowledge as evidenced by exam performance. This framework was implemented as each clicker question allowed for short-term memory development with the potential for long-term memory development based upon a second attempt to answer the identical question. An organized question cycle was also used within the study which consisted of providing the question, allowing time for peer-discussion, answer collection, histogram display of answers, and class-wide discussion. The visual display of answers via the histogram was only present within the experimental classroom as clicker technology allowed students to visualize their thinking with the histogram, which provided further critical thinking and evaluation within the classroom. Informational feedback was encouraged within both classrooms by the course coordinator and the investigator as the nursing students needed to know why the correct answer choice was indeed correct. This type of reinforcement strengthens the knowledge development of the student per Gagne as the “learning loop is closed by reinforcement” (Gagne & Driscoll, 1988, p. 38). Gagne’s *Essentials of Learning for Instruction* was useful in providing a framework for this study and was supported by an increase in posttest scores within both the experimental and control group.

In particular, the results from this study seem to indicate that the control group started out lower on their pretest than the experimental group. This deficiency gave the control group more room for improvement over the experimental group on their posttest one scores. Because the control group had lower scores on the pretest, students within the control group may have studied the material more to improve their scores over the experimental group. The improvement in posttest scores of the control group could also be due to slightly varying motivational environments between the experimental and control groups. Within the *Essentials of Learning for Instruction*, Gagne emphasizes how educators can motivate and grasp student attention thus

the process of learning can be influenced by motivation within the external environment (Gagne & Driscoll, 1988). Thus, extrinsic motivation does provide students with the desire to learn more within the classroom setting (Cannon & Boswell, 2012). Current literature on motivation in nursing education simply provides nurse educators with strategies to increase motivation with students (Cannon & Boswell). However, a closer investigation at what motivates nursing students and how nurse educators influence the motivation of their students seems two areas of further nursing research with the incorporation of clickers in nursing education.

The variation of improvement in posttest scores could also be due to varying interactions of nursing students with their external environment. Within this study, the use of clickers within the experimental classroom revealed a histogram based upon the answers selected by the nursing students. However, a potential for limited reinforcement by the course coordinator based upon the histogram results may have produced different nursing student outcomes. The importance of what Gagne calls “informational feedback,” in which the educator explains why the answer choice is correct to reinforce learning, should be emphasized with the use of clickers in nursing education.

Gagne and Driscoll(1988) also emphasize that answer expectancy is interlaced with learning and reemphasized by reinforcement as “the learning loop is closed by reinforcement” (p. 38). This reinforcement of the correct answer for a question and the encouragement of class-wide discussion with educator feedback within a classroom typically results in increased student learning (Bruff, 2009). The process of learning can be influenced by the external environment and what the educator brings to the learning environment to grasp student attention per Gagne. However, the use of technology is not sufficient enough by itself to ensure that “informational feedback” is being emphasized within the classroom; it is up to the educator to create the

interaction that produces cognitive development in students. Lastly, how clicker implementation is encouraged by the nurse educator may also be a significant variable in the impact of clickers on nursing students' learning. Personal "buy-in" of the educator creates an environment of technological acceptance within the classroom. However, without technological acceptance of the educator the opposite may also be created, an environment in which technology dissonance is allowed and encouraged. Technologies are a supplement to the educator and not a replacement as technologies offer visual, auditory and tactile components that encourage learning. There are a vast amount of technologies currently available within higher education; however, evaluation of the technologies is a critical component regarding their use.

Additional research is needed to provide adequate understanding of the effectiveness of clickers within the nursing education classroom. Currently, there is a dearth of nursing research literature that addresses clicker effectiveness and learner gains in both undergraduate and graduate nursing education. Lastly, the findings should be disseminated to schools of nursing as further adoption of clicker technology within nursing education is being considered.

Conclusions

Based on analysis of the data and limitations noted, the following preliminary conclusions are offered.

1. Gagne's (1988) *Essentials of Learning for Instruction* was useful in providing a framework for this study, as evidenced by an increase in posttest scores within both the experimental and control group.

2. Significant differences were noted in nursing students' knowledge difference scores across the different levels of intervention. Nursing students' knowledge scores improved more in the control group than in the experimental group.

3. Clickers were not effective on nursing students' level of knowledge as evidenced by exam performance.

Recommendations

Based on the findings and discussion from the study, recommendations for further research are presented.

1. Future studies should not be limited to one geographical area. Replication of this study in other university settings is essential to determine true clicker effectiveness on nursing students' level of knowledge.

2. A follow-up study should try to accrue a more diverse population since this current study had research participants that consisted of only one class within one university setting.

3. An incentive for potential participants should be considered in further research to achieve a larger sample size and an appropriate estimated power of analysis.

4. Replication of this study should involve solely one nurse educator who will conduct both the experimental group with clickers and the control group without clickers to eliminate any possible differences in presentation of content. Replication of the study over at least a two semester time period could also involve switching the experimental group nurse educator to the control group and the control group educator to the experimental group.

5. The educational theory, Gagne's (1988) *Essentials of Learning for Instruction*, should be used as a conceptual framework in the duplication of this clicker research as Gagne's events of instruction provided positive results for both the experimental and control groups.

6. Further research regarding the motivation of students within the classroom and clicker implementation should be investigated. The findings from this study are unclear as to whether the student or the use of clicker technology motivates involvement within the classroom.

7. Future studies can also include how nurse educators influence student motivation within the classroom with the implementation of clicker technology. The findings from this study are also unclear as to whether nurse educators can influence student motivation with clickers in the classroom.

8. Lastly, a follow-up study should try to determine whether or not technological acceptance of the nurse educator alters clicker effectiveness on nursing student performance in class.

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APPENDIX A
RECRUITMENT SCRIPT

Recruitment Script

Hello, my name is Susan Welch and I am a graduate student at the University of Alabama under the direction of Professor Dr. Vivian Wright. I am also an assistant professor in the School of Nursing at the University of West Georgia. To complete my doctoral studies at the University of Alabama, I am conducting a research study to find out if clickers cause an increase in student knowledge levels. Clickers have been used for the last 40 years in numerous college classrooms, however, schools of nursing lack enough information to find out if clickers bring about an increase in student knowledge.

I am recruiting individuals to understand more about clickers. You have been asked to be in this study because you are a nursing student in a class that uses clickers. Participation in this study is voluntary. If you agree to participate in the study you will be asked to complete a 50-item multiple-choice test in the Adult Health class before you go over any renal content. After the first test, you will attend your Adult Health class about renal content and participate in a class either with or without a clicker to use based on student assignment by your course coordinator. After all of your Adult Health classes about renal content, you will be asked to complete a second 50-item multiple-choice test immediately and then a third test in 3 months. The 3 multiple-choice tests you take will be the same and will not count toward any of your Adult Health course grade. Each test should take approximately 50 minutes or less, 150 minutes for all three tests. Class time will be provided to complete each tests. This study will not cost you anything to participate and you will not be compensated for being in this study. Although you will not benefit personally from being in the study, this study will help nurse educators use more effective teaching strategies within the classroom.

Lastly, your participation in this research study is voluntary. If you have any questions concerning this research study, please contact me at (770) 354-9154 or my dissertation chair, Dr. Vivian Wright, at (205) 348-1401. Thank you.

APPENDIX B
INFORMED CONSENT FOR A NON-MEDICAL STUDY

Informed Consent for a Non-Medical Study

Study title: “Clicker Effectiveness on Nursing Student Level of Knowledge as Evidenced by Exam Performance”

Investigator’s Name: Susan Welch, graduate student

Institution: University of Alabama

You are being asked to be in a research study. This study is called “Clicker Effectiveness on Nursing Student Level of Knowledge as Evidenced by Exam Performance”. This study is being done by Susan Welch. She is a graduate student in the College of Education at the University of Alabama.

What is this study about? What is the investigator trying to learn?

This study is being done to find out if clickers cause an increase in student knowledge levels. For the last 40 years clickers have been used in numerous college classrooms, however, schools of nursing lack enough information to find out if clickers bring about an increase in student knowledge. Clickers are a handheld device in which a student will simply select an answer on the keypad located on their individual, handheld clicker to answer a question given by their nursing instructor during class. The student’s answer choice with the clicker will allow the student’s answer to be counted and stored in the nursing instructor’s computer. To understand more about what clickers can do, you will be asked to complete a 50-item multiple-choice test in the Adult Health class before you go over any renal content. After the first test, you will attend your Adult Health class about renal content and participate in a class either with or without a clicker to use based on student assignment by your course coordinator. After all of your Adult Health classes about renal, you will be asked to complete a second 50-item multiple-choice test immediately and then a third test in 3 months. The 3 multiple-choice tests you take will be the same and will not count toward any of your Adult Health course grade. With this study, the investigator is trying to learn if clickers used in class increases students’ knowledge levels.

Why is this study important or useful?

This knowledge is important because it will help nurse educators know if clickers should be used within the nursing classroom with nursing students. The results of this study will help nurse educators understand better ways to help nursing students learn nursing content.

Why have I been asked to be in this study?

You have been asked to be in this study because you are a nursing student in a class that uses clickers. Participation in this study is voluntary.

How many people will be in the study?

About 60 other people will be in the study.

What will I be asked to do in this study?

If you agree to be in this study, you will be asked to do these things:

- Take a test before any Adult Health renal content in class
- Attend Adult Health classes about renal content either with or without clicker use based on student assignment by your course coordinator
- Take a test after Adult Health renal content is complete
- Take a test in 3 months about the Adult Health renal content

How much time will I spend being in this study?

Each test should take approximately about 50 minutes or less, 150 minutes for all three. Class time will be provided to complete the tests.

Will being in this study cost me anything?

This study will not cost you anything to participate.

Will I be compensated for being in this study?

You will not be compensated for being in this study.

What are the risks (dangers or harms) to me if I am in this study?

There is no risk foreseen to you in this study.

What are the benefits (good things) that may happen if I am in this study?

There are no direct benefits to you. Although, you will not benefit personally from being in the study, you may feel good about knowing that you have helped nursing education find out if clickers increase student knowledge.

What are the benefits to science or society?

This study will help nurse educators be more helpful to students.

How will my privacy be protected?

After the assignment of numbers to each student, privacy of test scores will be guaranteed as student numbers will be placed with test scores and no other identifying information will be used.

How will my confidentiality be protected?

The course coordinator will maintain a master list of the Adult Health class role with name identification and number assignment of each student within a locked file cabinet in her office in the School of Nursing for a period of three years. After the period of three years, the research data will be destroyed by the course coordinator. As all study data will be kept confidential, this information may be used in nursing publications or presentations.

What are the alternatives to being in this study?

The alternative to being in this study is not to participate. Participation in this study is completely voluntary.

What are my rights as a participant in this study?

Taking part in this study is voluntary. It is your free choice. You can refuse to be in it at all. If you start the study, you can stop at any time. There will be no effect on your Adult Health course grade if you stop participating in the study. There will be also no effect on your relations with the University of Alabama if you do not participate in this study.

The University of Alabama Institutional Review Board (“the IRB”) is the committee that protects the rights of people in research studies. The IRB may review study records from time to time to be sure that people in research studies are being treated fairly and that the study is being carried out as planned.

Who do I call if I have questions or problems?

If you have questions about the research study, please ask them. If you have questions, concerns, or complaints about the study later on, please call the investigator Susan Welch at 770-354-9154. If you have questions about your rights as a person in a research study, call Ms. Tanta Myles, the Research Compliance Officer of the University, at 205-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at <http://osp.ua.edu/site/PRCOWelcome.html>. After you participate, you are encouraged to complete the survey for research as a participant that is online, or you may ask Mrs. Welch for a copy of it. You may also email us at pariticipantoutreach@bama.ua.edu.

I have read this consent form. I have had a chance to ask questions.

Signature of Research Participant

Date

Signature of Investigator

Date

NOTE TO READER: This study would qualify for expedited review. The reading level (Flesch-Kincaid grade level) of the form is 9.0.

APPENDIX C
PRETEST-POSTTESTS WITH QUESTION TITLES:
INSTRUCTOR COPY OF TEST

Pretest-Posttests with Question Titles
Instructor Copy of Test

1. Acute glomerulonephritis AP, I

A client is diagnosed with acute glomerulonephritis. Which question by the nurse regarding risk factors is appropriate with this finding?

1. "Do you have any recent history of burning on urination?"
2. "Have you had any type of infection within the last 2 weeks?"
3. "Did you notice an inability to get to the toilet to urinate?"
4. "Has anyone in your family had any chronic kidney problem?"

2. Acute pyelonephritis AP, A

Which finding should a nurse recognize as an indication of worsening lower urinary tract infection?

1. Cloudy urine
2. Hematuria
3. Urethral Discharge
4. Fever and chills

3. Creatinine clearance C, A

Which laboratory test is most accurate in assessing renal function?

1. 24 hour creatinine clearance
2. Urine specific gravity level
3. Serum creatinine level
4. Blood urea nitrogen level

4. Diminished renal reserve AP, I

A client with acute renal failure asks a nurse how prevent further damage to the kidneys. What is an appropriate response by the nurse?

1. "The diuretics you take every day will help by initiating urine production."
2. "Unfortunately, further irreversible kidney damage is inevitable with time."
3. "Check with your health care provider before taking new medications."
4. "You will need to follow a high-protein and low-fat diet on a daily basis."

5. Erythropoietin further teaching E, A

A client with chronic renal failure is prescribed erythropoietin (Epogen) injections triweekly. Which statement by the client indicates a need for further teaching about the effects of erythropoietin (Epogen)?

1. "Iron is necessary for erythropoietin to work well, therefore, I may need to take iron supplements"
 2. "Erythropoietin is given to alleviate my symptoms of malaise and decreased activity tolerance"
 3. "Erythropoietin will help prevent infections and bleeding when it begins to have an effect in several weeks"
 4. "I will experience flu-like symptoms during the initiation of Erythropoietin, which will subside with repeated doses"
6. Hyperkalemia AP, I
A client with acute renal failure develops hyperkalemia. Which drug should the nurse administer FIRST?
1. Kayexalate
 2. Sodium bicarbonate
 3. Calcium gluconate
 4. Insulin
7. Normal peritoneal dialysis AP, I
A client undergoes peritoneal dialysis and a nurse notes the color of the effluent appears light yellow. What should the nurse do NEXT?
1. Follow the prescribed time for infusion of dialysate
 2. Rotate the catheter to facilitate inflow and outflow
 3. Teach the client about home care of the access site
 4. Irrigate the peritoneal catheter prior to the infusion
8. Overflow incontinence I, AP
A client is admitted to the hospital with dehydration and electrolyte imbalance. The client is confused and has a history of overflow incontinence. Which action should the nurse initiate for the client's incontinence?
1. Insert an indwelling Foley catheter
 2. Restrict fluids after the evening meal
 3. Assist the client to the bathroom as needed
 4. Drink 8 ounces of fluid every two hours
9. Amphotericin B complication I, AP
A client diagnosed with chronic renal failure (CRF) has renal osteodystrophy. The nurse should anticipate the administration of which medication to prevent uremic bone loss?
1. Milk of Magnesia (Magnesium hydroxide)

2. Zyloprim (Allopurino)
3. Erythropoietin Alpha (Epogen)
4. Amphojel (aluminum hydroxide)

10. Post renal failure AP, AN

Which client is at risk for developing post renal failure?

1. Recovering from glomerulonephritis
2. Congestive heart failure
3. Takes NSAIDS for arthritis pain
4. Diagnosed with renal calculi

11. Prostate cancer manifestations AP, A

Which finding should alert the nurse to the possibility of prostate cancer?

1. Dribbling after urination
2. Urinary frequency
3. Bladder distention
4. Painless hematuria

12. Prostate cancer metastasis-AP, A

A client with prostate cancer reports pain in the lower back and both hips. A nurse should recognize that these findings may indicate what process?

1. Rheumatoid arthritis
2. Urinary retention
3. Bone metastasis
4. Muscle atrophy

13. Renal calculi priority A, AN

A client diagnosed with renal calculi is admitted to the medical unit. Which action should the nurse FIRST?

1. Increase oral fluid intake
2. Obtain vital signs
3. Assess the level of pain
4. Monitor urinary output

14. Urinary stone diet AP, E

Which statement by a client with calcium oxalate kidney stones indicates understanding of dietary modifications?

1. "Limit animal protein, sodium, and calcium"

2. "Avoid spinach, black tea, and rhubarb."
3. "Limit wine, meat, and shellfish products"

15. UTI and chronic pyelonephritis A, AP

Which finding in a client with recurrent urinary tract infections should cause a nurse to suspect the onset of pyelonephritis?

1. Urgency
2. Flank pain
3. Hematuria
4. Dysuria

16. Kidney transplant rejection A/E, AP

Which manifestation in a post kidney transplantation client during the postoperative period, should a nurse associate with the development of transplant rejection?

1. Bacteriuria
2. Dysuria
3. Pyuria
4. Oliguria

17. Pyelonephritis priority AP, I

A client is admitted to the medical floor with a diagnosis of acute pyelonephritis. Which intervention should the nurse implement FIRST?

1. Obtain a urine specimen for culture and sensitivity
2. Initiate an intravenous access with a 20-gauge catheter
3. Increase fluid intake to two-three liters a day
4. Administer the IV antibiotic within 2 hours of admission

18. AV fistula C, A

Which assessment finding should a nurse recognize as indicating a client's arteriovenous fistula is patent?

1. Equivalent blood pressure measurements in each arm
2. Presence of a thrill, no bruit at arteriovenous fistula site
3. Presence of a thrill and bruit arteriovenous fistula site
4. Strong pulsation present at site of the anastomosis

19. Flomax side effects AP, I

Which intervention should a nurse implement for a client with benign prostatic hypertrophy (BPH) treated with tamsulosin (Flomax)?

1. Check the client's blood pressure

2. Plan a scheduled voiding pattern
3. Determine if the client has nocturia
4. Send an urinalysis to the laboratory

20. BPH teaching AP, I

A client with benign prostatic hyperplasia (BPH) asks the nurse how the enlarged prostate causes difficulty with urination. What is an appropriate response by the nurse?

1. “Pressure by the prostate on the kidneys decreases the formation of urine”
2. “Nerves to the bladder are destroyed which decreases the urge to urinate.”
3. “The urethra becomes compressed and urine outflow becomes blocked.”
4. “Acids secreted by the prostate weaken the bladder wall, causing urine dribbling.”

21. Chronic renal failure complications AP, AS

Which assessment finding in a client with chronic renal failure should a nurse recognize as requiring emergency treatment?

1. Distant heart sound
2. Absent graft “thrill”
3. Nausea and vomiting
4. Bilateral base crackles

22. Chronic renal failure laboratory values AP, AN

Which laboratory finding should a nurse anticipate in a client with chronic renal failure?

1. Hypokalemia and metabolic acidosis
2. Hypophosphatemia and hypocalcemia
3. Hyperphosphatemia and hypocalcemia
4. Hyperkalemia and metabolic alkalosis

23. Antihypertensive prior to dialysis AP, I

A client with chronic renal failure due to hypertension is scheduled for hemodialysis. What intervention by the nurse is appropriate in relation to the administration of enalapril (Vasotec) prior to dialysis?

1. After dialysis
2. During dialysis
3. Before dialysis
4. Next day

24. Disequilibrium syndrome findings C, A

Which findings should a nurse attribute to disequilibrium syndrome in a client diagnosed with chronic renal failure and on hemodialysis therapy?

1. Nausea, vomiting, and seizures
2. Hypertension, tachycardia, and fever
3. Hypotension, bradycardia, and tachypnea
4. Hypothermia, restlessness, and weakness

25. Peritoneal dialysis complications AP, I

Which nursing intervention is necessary to prevent peritonitis associated with peritoneal dialysis?

1. Maintain strict aseptic technique
2. Add heparin to dialysate solution
3. Keep outflow bag lower than abdomen
4. Change the catheter site dressing daily

26. TURP priority AP, I

Which nursing intervention would minimize potential bleeding after a transurethral resection of the prostate (TURP)?

1. Bed rest until bleeding diminishes
2. Patency of the catheter drainage system
3. Traction on the indwelling catheter
4. Continuous irrigation of the bladder

27. Urge incontinence teaching AP, I

Which nursing intervention demonstrates proper care of a client with urge incontinence?

1. Apply incontinence garments
2. Schedule urinary habit training
3. Teach self-catherization
4. Provide a bedside commode

28. Urinary tract infection causes AP, A

Which statement by a client would alert the nurse to the risk of a lower urinary tract infection?

1. “Wipe from front to back after voiding”
2. “Go 8 hours without emptying bladder”
3. “Drink a lot of water during the day”
4. “Take a tub bath every other week”

29. Urinary tract infection progression AP, AS

Which clinical manifestation in a client with a urinary tract infection alerts the nurse to the possibility of acute pyelonephritis?

1. Fever and chills
2. Hypertension
3. Dysuria
4. Hematuria

30. Lasix effectiveness AN, E

A client diagnosed with benign prostatic hypertrophy (BPH) and congestive heart failure (CHF) is receiving furosemide (Lasix) daily. Which information provided by the unlicensed assistive personnel (UAP) best indicates to the nurse that the medication is effective?

1. Records the intake as 350 mL and the output as 450 mL
2. States that the client ambulated to bathroom without dyspnea
3. Reports client lost 1 pound of weight from the day before
4. A moderate amount of urine was emptied from bedside commode

31. ACE inhibitor C, A

A client with stress incontinence and diabetes is diagnosed with hypertension and started on an angiotensin converting enzyme inhibitor (ACEI). What side effect of this treatment therapy should the nurse monitor for in the client?

1. Hyponatremia
2. Hypokalemia
3. Hyperkalemia
4. Hypernatremia

32. Amphojel scientific rationale AP, I

Which statement best describes the scientific rationale for the administration of aluminum hydroxide (Amphojel) to a client in chronic renal failure (CRF)?

1. Neutralizes gastric acid production in the stomach
2. Binds to phosphorus to help decrease hyperphosphatemia
3. Decreases the calcium level in the body after administration
4. Reduces constipation by promoting peristalsis

33. Intermittent self-catherization AP, P

What client with detrusor hyperreflexia (reflex incontinence) should the nurse plan for an alternative to the use of intermittent self-catherization?

1. Paraplegia
2. Elderly
3. Blind
4. Dementia

34. Fibrin clot in PD catheter AP, I

A client undergoing peritoneal dialysis experiences decreased dialysate outflow.

What is an appropriate action by the nurse?

1. Raise and lower the drainage bag
2. Disconnect and flush the tubing
3. Verify tube placement by x-ray
4. Milk the peritoneal dialysis catheter

35. Hyperkalemia drug AP, I

A client with acute renal failure develops hyperkalemia. Which drug should the nurse administer FIRST?

1. Kayexalate
2. Sodium bicarbonate
3. Calcium gluconate
4. Insulin

36. Renal calculus AP, I

A client with no known metabolic defects has passes a renal calculus and expresses concern about a strategy should the nurse teach this client?

1. “Restrict dairy products and other sources of calcium.”
2. “Start taking antibiotics at the first sign of a stone.”
3. “Avoid aspirin and aspirin-containing products.”
4. “Drink at least 3 to 4 liters of fluid each day.”

37. TURP emergency AP, A

Which assessment finding in a client 48 hours post transurethral resection (TURP) requires immediate action?

1. Red bloody urine in foley bag
2. Pain related to bladder spasms
3. BP 110/80, HR 100, RR 22, Temp 99.6F
4. Urine output more than intake

38. Cystitis with Pyridium AP, I

A client with severe bacterial cystitis is prescribed to take cefadroxil (Duricef) and phenazopyridine (Pyridium). What should the nurse teach this client regarding the medication regimen?

1. “Discoloration of your urine is normal.”
2. “Stop these drugs if you think you are pregnant.”
3. “Do not take these drugs with food or milk.”
4. “Drink a liter of cranberry juice each day.”

39. Stress incontinence diet therapy AP, E

Which statement made by a client with stress incontinence indicates further teaching is necessary regarding dietary therapy?

1. "Avoid drinking alcoholic beverages."
2. "Quit drinking coffee in the morning."
3. "Limit my total intake of daily fluids."
4. "Reduce intake of caffeinated beverages."

40. Post-peritoneal dialysis finding AP, E

Which finding should a nurse recognize as normal in a post-peritoneal dialysis client?

1. Increased magnesium
2. Increased sodium
3. Increased potassium
4. Increased glucose

41. Post-hemodialysis finding AP, E

Which finding in a client with chronic renal failure should a nurse recognize as demonstrating effective hemodialysis treatment?

1. Decreased calcium
2. Increased sodium
3. Increased potassium
4. Decreased phosphorus

42. Proscar intervention AP, I

Which intervention is appropriate by the nurse for a client diagnosed with mild benign prostatic hypertrophy (BPH) who is prescribed finasteride (Proscar)?

1. Tell the client to drink at least 8-10 glasses of water a day
2. Schedule an appointment with health care provider in 1-week
3. Have the laboratory draw a prostate-specific antigen level
4. Give the client a urinal to measure his daily output on urine

43. Kidney biopsy AN, I

A client reports an increase in pain after a closed percutaneous kidney biopsy. Which action should the nurse perform immediately?

1. Assess pulse rate and blood pressure
2. Check the Foley catheter for kinks
3. Administer prescribed opioid analgesic
4. Reposition the client on the operative side

44. Hyperkalemia priority AN, I

A client with acute renal failure has a serum potassium of 6.8mEq/L. What is the priority intervention by the nurse?

1. Recheck serum potassium level
2. Place client on a cardiac monitor
3. Administer 500cc normal saline bolus
4. Restrict dietary intake of potassium

45. Question order/Lasix with low BP A, AP

An elderly client with a history of hypertension is admitted to a medical unit from a nursing home because of confusion, elevated temperature, decreased urine output, and hypotension. Current vital signs: T 130.7F, RR 14 breaths per minute, HR 130 beats per minute, and BP 75/40 mmHg. Which order should the nurse question?

1. Venti mask with 70% oxygen
2. Initiating Heparin Protocol
3. Begin NS a 150 ml/hr
4. Lasix 60 mg IV push now

46. Allopurinol K, I

Which drug should the nurse be prepared to administer to the client diagnosed with renal calculi from hyperuricemia?

1. Chlorothiazide (Diuril)
2. Captopril (Capoten)
3. Phenazopyridine (Pyridium)
4. Allopurinol (Zyloprim)

47. Elevated BUN K, AS

A client has an elevated blood urea nitrogen (BUN) level and an increased ration of blood urea nitrogen to creatinine. What is the nurse's BEST response of these laboratory results?

1. "Kidney may be hypoperfused."
2. "Client may be over hydrated."
3. "Kidney may be damaged."
4. "Client may be hypertensive."

48. Kidney stones from hyperoxaluria C, E

What statement made by a client who has kidney stones secondary of hyperoxaluria indicates correct understanding of the role of dietary modification?

1. "Limit intake of wine, meat, and shellfish in diet."
2. "Remove all dairy products and vitamin D from meals."
3. "Avoid dark green leafy vegetables, chocolate, and nuts."
4. "Quit dietary modifications because stones are not caused by diet."

49. Renal calculus recurrence AP, I

A client with no known metabolic defects has passes a renal calculus and expresses concern about a strategy should the nurse teach this client?

1. "Restrict dairy products and other sources of calcium."
2. "Start taking antibiotics at the first sign of a stone."
3. "Avoid aspirin and aspirin-containing products."
4. "Drink at least 3 to 4 liters of fluid each day."

50. Pre-renal failure AP, AN

A client is diagnosed with prerenal failure due to hypovolemia. What action should the nurse perform FIRST?

1. Hydrate with IV fluids
2. Prepare client for hemodialysis
3. Identify the underlying cause
4. Provide high carbohydrate diet

APPENDIX D

PRETEST-POSTTESTS WITHOUT QUESTION TITLES:
STUDENT COPY OF TEST

Pretest-Posttests without Question Titles
Student Copy of Test

1.
A client is diagnosed with acute glomerulonephritis. Which question by the nurse regarding risk factors is appropriate with this finding?

1. "Do you have any recent history of burning on urination?"
2. "Have you had any type of infection within the last 2 weeks?"
3. "Did you notice an inability to get to the toilet to urinate?"
4. "Has anyone in your family had any chronic kidney problem?"

2.
Which finding should a nurse recognize as an indication of worsening lower urinary tract infection?

1. Cloudy urine
2. Hematuria
3. Urethral Discharge
4. Fever and chills

3.
Which laboratory test is most accurate in assessing renal function?

1. 24 hour creatinine clearance
2. Urine specific gravity level
3. Serum creatinine level
4. Blood urea nitrogen level

4.
A client with acute renal failure asks a nurse how prevent further damage to the kidneys. What is an appropriate response by the nurse?

1. "The diuretics you take every day will help by initiating urine production."
2. "Unfortunately, further irreversible kidney damage is inevitable with time."
3. "Check with your health care provider before taking new medications."
4. "You will need to follow a high-protein and low-fat diet on a daily basis."

5.
A client with chronic renal failure is prescribed erythropoietin (Epogen) injections triweekly. Which statement by the client indicates a need for further teaching about the effects of erythropoietin (Epogen)?

1. "Iron is necessary for erythropoietin to work well, therefore, I may need to take iron supplements"

2. "Erythropoietin is given to alleviate my symptoms of malaise and decreased activity tolerance"
 3. "Erythropoietin will help prevent infections and bleeding when it begins to have an effect in several weeks"
 4. "I will experience flu-like symptoms during the initiation of Erythropoietin, which will subside with repeated doses"
- 6.
- A client with acute renal failure develops hyperkalemia. Which drug should the nurse administer FIRST?
1. Kayexalate
 2. Sodium bicarbonate
 3. Calcium gluconate
 4. Insulin
- 7.
- A client undergoes peritoneal dialysis and a nurse notes the color of the effluent appears light yellow. What should the nurse do NEXT?
1. Follow the prescribed time for infusion of dialysate
 2. Rotate the catheter to facilitate inflow and outflow
 3. Teach the client about home care of the access site
 4. Irrigate the peritoneal catheter prior to the infusion
- 8.
- A client is admitted to the hospital with dehydration and electrolyte imbalance. The client is confused and has a history of overflow incontinence. Which action should the nurse initiate for the client's incontinence?
1. Insert an indwelling Foley catheter
 2. Restrict fluids after the evening meal
 3. Assist the client to the bathroom as needed
 4. Drink 8 ounces of fluid every two hours
- 9.
- A client diagnosed with chronic renal failure (CRF) has renal osteodystrophy. The nurse should anticipate the administration of which medication to prevent uremic bone loss?
1. Milk of Magnesia (Magnesium hydroxide)
 2. Zyloprim (Allopurino)
 3. Erythropoietin Alpha (Epogen)
 4. Amphojel (aluminum hydroxide)

10.

Which client is at risk for developing post renal failure?

1. Recovering from glomerulonephritis
2. Congestive heart failure
3. Takes NSAIDS for arthritis pain
4. Diagnosed with renal calculi

11.

Which finding should alert the nurse to the possibility of prostate cancer?

1. Dribbling after urination
2. Urinary frequency
3. Bladder distention
4. Painless hematuria

12.

A client with prostate cancer reports pain in the lower back and both hips. A nurse should recognize that these findings may indicate what process?

1. Rheumatoid arthritis
2. Urinary retention
3. Bone metastasis
4. Muscle atrophy

13.

A client diagnosed with renal calculi is admitted to the medical unit. Which action should the nurse FIRST?

1. Increase oral fluid intake
2. Obtain vital signs
3. Assess the level of pain
4. Monitor urinary output

14.

Which statement by a client with calcium oxalate kidney stones indicates understanding of dietary modifications?

1. “Limit animal protein, sodium, and calcium”
2. “Avoid spinach, black tea, and rhubarb.”
3. “Limit wine, meat, and shellfish products”

15.

Which finding in a client with recurrent urinary tract infections should cause a nurse to suspect the onset of pyelonephritis?

1. Urgency
2. Flank pain
3. Hematuria
4. Dysuria

16.

Which manifestation in a post kidney transplantation client during the postoperative period, should a nurse associate with the development of transplant rejection?

1. Bacteriuria
2. Dysuria
3. Pyuria
4. Oliguria

17.

A client is admitted to the medical floor with a diagnosis of acute pyelonephritis. Which intervention should the nurse implement FIRST?

1. Obtain a urine specimen for culture and sensitivity
2. Initiate an intravenous access with a 20-gauge catheter
3. Increase fluid intake to two-three liters a day
4. Administer the IV antibiotic within 2 hours of admission

18.

Which assessment finding should a nurse recognize as indicating a client's arteriovenous fistula is patent?

1. Equivalent blood pressure measurements in each arm
2. Presence of a thrill, no bruit at arteriovenous fistula site
3. Presence of a thrill and bruit arteriovenous fistula site
4. Strong pulsation present at site of the anastomosis

19.

Which intervention should a nurse implement for a client with benign prostatic hypertrophy (BPH) treated with tamsulosin (Flomax)?

1. Check the client's blood pressure
2. Plan a scheduled voiding pattern
3. Determine if the client has nocturia
4. Send an urinalysis to the laboratory

20.

A client with benign prostatic hyperplasia (BPH) asks the nurse how the enlarged prostate causes difficulty with urination. What is an appropriate response by the nurse?

1. “Pressure by the prostate on the kidneys decreases the formation of urine”
2. “Nerves to the bladder are destroyed which decreases the urge to urinate.”
3. “The urethra becomes compressed and urine outflow becomes blocked.”
4. “Acids secreted by the prostate weaken the bladder wall, causing urine dribbling.”

21.

Which assessment finding in a client with chronic renal failure should a nurse recognize as requiring emergency treatment?

1. Distant heart sound
2. Absent graft “thrill”
3. Nausea and vomiting
4. Bilateral base crackles

22.

Which laboratory finding should a nurse anticipate in a client with chronic renal failure?

1. Hypokalemia and metabolic acidosis
2. Hypophosphatemia and hypocalcemia
3. Hyperphosphatemia and hypocalcemia
4. Hyperkalemia and metabolic alkalosis

23.

A client with chronic renal failure due to hypertension is scheduled for hemodialysis. What intervention by the nurse is appropriate in relation to the administration of enalapril (Vasotec) prior to dialysis?

1. After dialysis
2. During dialysis
3. Before dialysis
4. Next day

24.

Which findings should a nurse attribute to disequilibrium syndrome in a client diagnosed with chronic renal failure and on hemodialysis therapy?

1. Nausea, vomiting, and seizures
2. Hypertension, tachycardia, and fever
3. Hypotension, bradycardia, and tachypnea
4. Hypothermia, restlessness, and weakness

25.

Which nursing intervention is necessary to prevent peritonitis associated with peritoneal dialysis?

1. Maintain strict aseptic technique
2. Add heparin to dialysate solution
3. Keep outflow bag lower than abdomen
4. Change the catheter site dressing daily

26.

Which nursing intervention would minimize potential bleeding after a transurethral resection of the prostate (TURP)?

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2. Increased sodium
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A client reports an increase in pain after a closed percutaneous kidney biopsy. Which action should the nurse perform immediately?

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2. Check the Foley catheter for kinks
3. Administer prescribed opioid analgesic
4. Reposition the client on the operative side

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A client with acute renal failure has a serum potassium of 6.8mEq/L. What is the priority intervention by the nurse?

1. Recheck serum potassium level
2. Place client on a cardiac monitor
3. Administer 500cc normal saline bolus
4. Restrict dietary intake of potassium

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An elderly client with a history of hypertension is admitted to a medical unit from a nursing home because of confusion, elevated temperature, decreased urine output, and hypotension. Current vital signs: T 130.7F, RR 14 breaths per minute, HR 130 beats per minute, and BP 75/40 mmHg. Which order should the nurse question?

1. Venti mask with 70% oxygen
2. Initiating Heparin Protocol
3. Begin NS a 150 ml/hr
4. Lasix 60 mg IV push now

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Which drug should the nurse be prepared to administer to the client diagnosed with renal calculi from hyperuricemia?

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A client has an elevated blood urea nitrogen (BUN) level and an increased ration of blood urea nitrogen to creatinine. What is the nurse's BEST response of these laboratory results?

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What statement made by a client who has kidney stones secondary of hyperoxaluria indicates correct understanding of the role of dietary modification?

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2. "Remove all dairy products and vitamin D from meals."
3. "Avoid dark green leafy vegetables, chocolate, and nuts."
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3. "Avoid aspirin and aspirin-containing products."

4. "Drink at least 3 to 4 liters of fluid each day."
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- A client is diagnosed with prerenal failure due to hypovolemia. What action should the nurse perform FIRST?
1. Hydrate with IV fluids
 2. Prepare client for hemodialysis
 3. Identify the underlying cause
 4. Provide high carbohydrate diet

APPENDIX E
ELIMINATION CONTENT TEACHING PLAN FOR
EXPERIMENTAL AND CONTROL GROUPS

Elimination Content Teaching Plan for Experimental and Control Groups

Day 1:

Elimination pretest (50 items)

Break

1. Assessment of renal/urinary system decision-making challenge
2. Assessment of renal/urinary system case study
3. Assessment of renal/urinary system multiple choice questions

Break

1. Care of patients with urinary problems decision-making challenge
2. Care of patients with urinary problems case study
3. Care of patients with urinary problems multiple choice questions

Day 2:

1. Care of patients with renal disorders decision-making challenges
2. Care of patients with renal disorders case study
3. Care of patients with renal disorders multiple choice questions

Break

1. Care of patients with acute renal failure and chronic kidney disease decision-making challenges
2. Care of patients with acute renal failure and chronic kidney disease case study
3. Care of patients with acute renal failure and chronic kidney disease multiple choice questions

Day 3:

1. Care of male patients decision-making challenges
2. Care of male patients case study
3. Care of male patients multiple choice questions

Break

Elimination posttest (50 items)

APPENDIX F
ASSESSMENT OF THE RENAL/URINARY SYSTEM
DECISION-MAKING CHALLENGE

Assessment of the Renal/Urinary System Decision-Making Challenge

The patient is a 24-year-old man who arrives with a report of a headache for the past 4 days and nausea and vomiting for the past 3 days. He has never had any serious illness or surgery. He mentions that he has not voided for over 12 hours despite taking in about a liter of fluid over the past 6 hours.

1. What personal or demographic data should you obtain?
2. How would you proceed in gathering physical assessment data?
3. What laboratory or diagnostic testing do you anticipate?

The 24-year-old patient has these vital signs and laboratory data: T = 98.4° F; P = 80; R = 16; BP = 138/90; oxygen saturation = 98%; serum sodium = 140, potassium = 4.5, chloride = 101, BUN = 21 mg/dL, creatinine = 8 mg/dL. Urinalysis: 2+ protein, 2+ blood, 1-2 WBCs.

Although he is not taking any prescription drugs, he does take vitamin C regularly and recently increased his dose to 5000 mg daily for 5 days when he had symptoms of a cold about a week before his current symptoms began. He reports that he just finished his undergraduate education and has returned to parent's house while he looks for employment. He does not believe he has ever had exposure to any environmental hazards.

1. Do any of these data support the possibility of dehydration contributing to acute renal dysfunction?
2. What do the alterations in BUN and creatinine indicate?
3. What independent and collaborative interventions can you anticipate in the care of this patient at this time?

A 78-year-old man with hypertension reports worsening symptoms of frequent urination, nocturia, straining to urinate, and a weak stream.

1. What questions can you ask to distinguish between obstructive symptoms associated with benign prostatic hyperplasia (BPH) and irritative symptoms that may indicate an infection?
2. What additional diagnostic testing can you anticipate at this time?

3. What nursing diagnosis do you consider?

4. What educational and psychosocial concerns can you anticipate for this patient?

APPENDIX G

ASSESSMENT OF THE RENAL/URINARY SYSTEM CASE STUDY

Assessment of the Renal/Urinary System Case Study

Case Study: A 74-year-old man comes to the clinic for changes in urinary patterns. He reports, “I am pretty healthy for my age. I do have some of the typical problems that all old folks have, but nothing serious.”

1. What types of questions would the nurse ask using Gordon’s functional assessment?
2. Identify changes related to aging and appropriate nursing interventions for older adults with regard to the renal system.
3. The patient is scheduled to have a series of urologic studies for diagnostic purposes. The physician orders the following: urinalysis, urine for culture and sensitivity, BUN, serum creatinine, and 24-hour urine for creatinine clearance. The tests will be conducted on an outpatient basis. Describe what the nurse should do to instruct the patient in the collection of these laboratory specimens.
 - Voided urine
 - Clean-catch specimen for culture and sensitivity
 - 24-hour urine collection for creatinine clearance
 - BUN and serum creatinine
4. Which specimens should be collected first?
5. The patient returns the collection container with a 24-hour urine specimen to the physician’s office. As he gives it to the nurse, he comments, “I had a hard time remembering to save it all. Actually, I think I missed some when I forgot and used a bathroom at the shopping mall yesterday.” What should the nurse do?
6. Further tests are ordered for the patient, including a renal ultrasound and IV pyelography (IVP). These are scheduled at an outpatient radiology clinic. Design a teaching-learning plan for the patient to prepare him for these studies.
 - For the ultrasound
 - For the IVP
7. Following the ultrasound and IVP, what assessments should be made for the patient?

APPENDIX H

ASSESSMENT OF RENAL AND URINARY SYSTEM MULTIPLE CHOICE QUESTIONS

Assessment of Renal and Urinary System Multiple Choice Questions

Assessment of the Renal/Urinary System

Susan Welch, RN, MSN, CCRN

Assessment of the Renal/Urinary System

Which patient is more likely to experience renal compromise (decreased urine production)?

- A. A patient with a blood pressure of 92/46 mm Hg for 12 hours
- B. A patient with a white blood cell count of 12,000/mm³
- C. A patient with a 5-year history of diabetes mellitus
- D. A patient with a history of a myocardial infarction

Assessment of the Renal/Urinary System

A patient with renal failure is complaining of dyspnea. The patient's pulse oximeter reading is 96% on room air. However, the patient is visibly distressed with a respiratory rate of 32 breaths/min. A priority intervention would be:

- A. Elevate the head of the bed to 90 degrees.
- B. Notify the respiratory therapist.
- C. Administer a respiratory nebulizing treatment.
- D. Administer oxygen by nasal cannula.

Assessment of the Renal/Urinary System

A patient with a history of renal disease is admitted with acute shoulder pain. Which order should the nurse question?

- A. Pan cultures for a temperature $>38.5^{\circ}\text{C}$
- B. Metoprolol 50 mg by mouth twice daily
- C. Ibuprofen 600 mg by mouth every 8 hours as needed for pain
- D. Digoxin 0.125 mg daily

Assessment of the Renal/Urinary System

A priority assessment of a patient who has had kidney biopsy includes:

- A. Assess for compliance with strict bed rest.
- B. Assess for signs of hypovolemia.
- C. Monitor for hematuria.
- D. Assess for pain.

Assessment of the Renal/Urinary System

Confirmed by palpation and x-ray study, the client's right kidney is lower than the left kidney. Which is the nurse's interpretation of this finding?

- A. The client has a problem involving the right kidney.
- B. The client has a problem involving the left kidney.
- C. The client has both kidneys in the normal position.
- D. The client is at increased risk for kidney impairment.

Assessment of the Renal/Urinary System

With a renal threshold for glucose of 220 mg/dL, what is the expected response when a client has a blood glucose level of 400 mg/dL?

- A. 400 mg/dL of excreted glucose in the urine
- B. 220 mg/dL of excreted glucose in the urine
- C. 180 mg/dL of glucose is excreted in the urine
- D. No excreted glucose in the urine

Assessment of the Renal/Urinary System

Which of the following conditions is associated with over secretion of renin?

- A. Alzheimer's disease
- B. Hypertension
- C. Diabetes mellitus
- D. Diabetes insipidus

Assessment of the Renal/Urinary System

The client is taking a medication for an endocrine problem that inhibits aldosterone secretion and release. For which complications of this therapy should the nurse be alert?

- A. Dehydration, hypokalemia
- B. Dehydration, hyperkalemia
- C. Overhydration, hyponatremia
- D. Overhydration, hypernatremia

Assessment of the Renal/Urinary System

Which is the result of stimulation of erythropoietin production in the kidney tissue?

- A. Increased blood flow to the kidney
- B. Inhibition of vitamin D and loss of bone density
- C. Increased bone marrow production of red blood cells
- D. Inhibition of the active transport of sodium, leading to hyponatremia

Assessment of the Renal/Urinary System

Which change in renal or urinary functioning as a result of the normal aging process increases the older adult client's risk for infection?

- A. Decreased glomerular filtration
- B. Decreased filtrate reabsorption
- C. Weakened sphincter muscles
- D. Urinary retention

Assessment of the Renal/Urinary System

The client reports the regular use of all the following medications. Which one alerts the nurse to the possibility of renal impairment when used consistently?

- A. Antacids
- B. Penicillin
- C. Antihistamine nasal sprays
- D. Nonsteroidal anti-inflammatory drugs (NSAIDs)

Assessment of the Renal/Urinary System

The client has an elevated blood urea nitrogen (BUN) level and an increased ratio of blood urea nitrogen to creatinine. Which is the nurse's interpretation of these laboratory results?

- A. The client probably has a urinary tract infection.
- B. The client may be over hydrated.
- C. The kidney may be hypoperfused.
- D. The kidney may be damaged.

Assessment of the Renal/Urinary System

The client scheduled for intravenous urography informs the nurse of the following allergies. Which one should the nurse report to the physician immediately?

- A. Seafood
- B. Penicillin
- C. Bee stings
- D. Red food dye

Assessment of the Renal/Urinary System

The client scheduled to have intravenous urography is a diabetic and taking the antidiabetic agent metformin. What should the nurse tell this client?

- A.“Call your diabetes doctor and tell him or her that you are having an intravenous urogram performed using dye.”
- B.“Do not take your metformin the morning of the test because you are not going to be eating anything and could become hypoglycemic.”
- C.“You must start on an antibiotic before this test because your risk of infection is greater as a result of your diabetes.”
- D.“You must take your metformin immediately before the test is performed because the IV fluid and the dye contain a significant amount of sugar.”

Assessment of the Renal/Urinary System

The client is going home after urography. Which instruction or precaution should the nurse teach this client?

- A.“Avoid direct contact with the urine for 24 hours until the radioisotope clears.”
- B.“You are likely to experience some dribbling of urine for several weeks after this procedure.”
- C.“Be sure to drink at least 3 L of fluids today to help eliminate the dye faster.”
- D.“Your skin may become slightly yellow-tinged from the dye used in this procedure.”

Assessment of the Renal/Urinary System

Two hours after a closed percutaneous kidney biopsy, the client reports a dramatic increase in pain. Which is the nurse's best first action?

- A. Repositioning the client on the operative side
- B. Administering prescribed opioid analgesic
- C. Assessing pulse rate and blood pressure
- D. Checking the Foley catheter for kinks

Assessment of the Renal/Urinary System

To obtain a sterile urine specimen from a client with a Foley catheter, the nurse begins by applying a clamp to the drainage tubing distal to the injection port. What should the nurse do next?

- A. Clamp another section of the tube to create a fixed sample section for retrieval.
- B. Insert a 5-mL syringe into the injection port and aspirate the quantity of urine required.
- C. Clean the injection port cap of the catheter drainage tubing with povidone-iodine solution.
- D. Request assistance from the health care provider.

APPENDIX I

CARE OF PATIENTS WITH URINARY PROBLEMS DECISION-MAKING CHALLENGE

Care of Patients with Urinary Problems Decision-making Challenge

The patient is a 24-year-old woman with a history of type 1 diabetes mellitus for the past 10 years. She is two days postpartum after an emergency C-section. She was 34 weeks pregnant and had difficulties throughout her pregnancy with hypertension. During the delivery, a Foley catheter was inserted to help manage fluid balance. Her Foley catheter was removed last night, and she reported burning during her first void about 4 hours after the Foley was removed. Today with her second void, she continues to describe pain on urination; her urine is pink-tinged, cloudy, and straw-colored. Her current vital signs are: T, 97.8° F; P, 88; R, 12; and BP, 142/88. Morning laboratory test results included a CBC with normal values, including a white blood cell count of 9600. Her basic metabolic panel was normal with a BUN of 13 mg/dL and a creatinine of 1.0 mg/dL.

1. What risk factors are present in this patient related to a urinary tract infection?
2. What other assessment data should you obtain and why?
3. What interventions will you teach her for comfort and treatment of this infection?
4. She asks if this means her kidneys will be harmed; she knows as a diabetic she is already at increased risk for nephropathy. As you respond, what level of language will you use?

The patient is a 72-year-old woman who reports new-onset incontinence. She reports three or four episodes of voiding a large amount of urine involuntarily when outside her home. She sensed a full bladder but was unable to find a bathroom quickly. She states, "When I have to go, I really have to go right then." She does not use a diuretic and has no history of diabetes. She says she tries to drink very little, especially when she is "out and about" so that she will remain dry. Her only health problem is osteoporosis; she takes vitamin D and calcium supplements. She states that both of her sisters have the same urinary problem.

1. What other questions should you ask?
2. What type or types of incontinence is she most likely to have from the information she has provided thus far?
3. Is this problem likely to be genetic? Why or why not?
4. Which nursing diagnoses would be priority for this patient?

Your older patient is diagnosed with mixed stress and urge incontinence. Her environment has no barriers to toileting. Her diet history has little impact on the incontinence, with only infrequent use of caffeine—about twice monthly at a social event. She has been prescribed topical estrogen and bladder training including pelvic muscle exercises. In addition, she is instructed to regularly void to avoid a full bladder.

1. What should you teach her about the effects and side effects of her newly prescribed drug?
2. What approaches are useful to teach her pelvic floor muscle exercises?
3. How can you help evaluate her response to exercise and the prescribed drug to improve continence?

APPENDIX J

CASE STUDY OF THE PATIENT WITH URINARY PROBLEMS

Case Study of the Patient with Urinary Problems

The patient is a 45-year-old female who has had several full-term pregnancies. She is active and generally healthy, saying, “I take good care of myself.” She comes to the clinic for advice about “losing a little urine when I laugh.” She reports voiding between 6 and 10 times a day depending on fluid intake. She denies dysuria, back pain, hematuria, fever, or vaginal discharge.

1. What should be included in the assessment of a patient with incontinence?
2. What are the most common types of urinary incontinence? Which type is the patient most likely to have?
3. Identify at least three nursing diagnoses specific to the patient who also has a diagnosis of urinary incontinence.
4. Why is this patient a good candidate for Kegel exercises? What information should the nurse give about performing the exercises?
5. What topics would the nurse include in the teaching plan for this patient?

APPENDIX K

CARE OF PATIENTS WITH URINARY PROBLEMS MULTIPLE CHOICE QUESTIONS

Care of Patients with Urinary Problems Multiple Choice Questions

Susan Welch, RN, MSN, CCRN

CARE OF PATIENTS WITH URINARY PROBLEMS

Care of Patients with Urinary Problems

Which client is at greatest risk for development of a bacterial cystitis?

- A. Older female client not taking estrogen replacement
- B. Older male client with mild congestive heart failure
- C. Middle-aged female client who has never been pregnant
- D. Middle-aged male client who is taking cyclophosphamide for cancer therapy

Care of Patients with Urinary Problems

The nurse is assessing the laboratory findings of a client with a urinary tract infection.

Which finding requires immediate intervention?

- A. Left shift in the white blood cell (WBC) differential
- B. Serum white blood cell count of 8000/mm³
- C. Presence of red blood cells in the urine
- D. Presence of white blood cells in the urine

Care of Patients with Urinary Problems

Which client statement indicates understanding regarding antibiotic therapy for recurrent urinary tract infections?

- A. “If my urine becomes lighter and clear, I can stop taking my medicine.”
- B. “Even if I feel completely well, I should take the medication until it is gone.”
- C. “When my urine no longer burns, I will no longer need to take the antibiotics.”
- D. “If my temperature goes above 100° F (37.8° C), I should take twice as much medicine.”

Care of Patients with Urinary Problems

The postmenopausal female client has had two episodes of bacterial urethritis in the last 6 months. She asks her nurse why this is happening to her now. Which is the nurse's best response?

- A. "Your immune system becomes less effective as you age."
- B. "Low estrogen levels can make the tissue more susceptible to infection."
- C. "You should be more careful with your personal hygiene in this area."
- D. "It is likely that your sexual partner is traumatizing this area."

Care of Patients with Urinary Problems

The hospitalized client with a urethral retention catheter has cystitis. Which is the priority nursing diagnosis for this client?

- A. Risk for Infection
- B. Disturbed Body Image
- C. Risk for Impaired Skin Integrity
- D. Risk for Urge Urinary Incontinence

Care of Patients with Urinary Problems

The client with severe bacterial cystitis is prescribed to take cefadroxil (Duricef) and phenazopyridine (Pyridium). What will the nurse teach this client regarding the drug regimen?

- A. “Do not take these drugs with food or milk.”
- B. “Stop these drugs if you think you are pregnant.”
- C. “Do not be alarmed by the discoloration of your urine.”
- D. “Drink a liter of cranberry juice every day.”

Care of Patients with Urinary Problems

Which statement made by the client with stress incontinence indicates a need for clarification of nutrition therapy?

- A. “I will limit my total intake of fluids.”
- B. “I will avoid drinking alcoholic beverages.”
- C. “I will avoid drinking coffee and other caffeinated beverages.”
- D. “I will try to reduce my total body weight by at least 10%.”

Care of Patients with Urinary Problems

- Which client will not be able to adhere to bladder training for incontinence?
- A. An older man who is confused
 - B. An older woman with diabetes
 - C. A middle-aged man with early-stage renal failure
 - D. A middle-aged woman with early menopause

Care of Patients with Urinary Problems

- Which client is not a candidate for intermittent self catheterization training?
- A. Older female client
 - B. Middle-aged female client who is blind
 - C. Older male client with dementia
 - D. Middle-aged client who has paraplegia

Care of Patients with Urinary Problems

Which intervention is most likely to be effective in stimulating the initiation of voiding for the client with overflow incontinence?

- A. Stroking the medial aspect of the thigh
- B. Using intermittent catheterization
- C. Providing digital anal stimulation
- D. Using the Valsalva maneuver

Care of Patients with Urinary Problems

The caretaker of a confused client with functional incontinence asks about having an in-dwelling catheter placed. Which is the nurse's best response?

- A. "You must be very aggravated about this situation. I will call the physician with this request."
- B. "I will teach you how to insert the catheter, which should be used just at night."
- C. "We can teach you how to perform intermittent catheterization to drain the bladder."
- D. "Pads can be worn to prevent smells and leaks. Social services can help you obtain these supplies at a reasonable cost."

Care of Patients with Urinary Problems

Which client is at highest risk for developing a renal calculus?

- A. An older man with diabetes mellitus
- B. A young woman who is 6 months pregnant
- C. A middle-aged woman with mild congestive heart failure
- D. A young man who had a renal calculus 1 year ago

Care of Patients with Urinary Problems

Which prevention strategy will the nurse teach the client with a risk for renal calculi?

- A. “Drink at least 3 to 4 L of fluid every day.”
- B. “Avoid dairy products and other sources of calcium.”
- C. “Avoid aspirin and aspirin-containing products.”
- D. “Start taking antibiotics at the first sign of a stone.”

Care of Patients with Urinary Problems

Which statement made by the client who has kidney stones from secondary hyperoxaluria indicates correct understanding of the role of dietary therapy for this condition?

- A. "No modifications are needed because this type of stone is not caused by diet."
- B. "I will avoid dark green leafy vegetables, chocolate, and nuts."
- C. "I will avoid all dairy products and vitamin D."
- D. "I will avoid wine, meat, and shellfish."

Care of Patients with Urinary Problems

The client with a renal calculus has just returned from an extracorporeal shock wave lithotripsy procedure and the nurse finds an ecchymotic area on the client's right lower back. Which is the nurse's priority intervention?

- A. Notifying the physician
- B. Applying ice to the site
- C. Placing the client in the prone position
- D. Documenting the observation as the only action

Care of Patients with Urinary Problems

Which drug will the nurse administer to the client diagnosed with renal calculi from hyperuricemia?

- A. Allopurinol (Zyloprim)
- B. Captopril (Capoten)
- C. Chlorothiazide (Diuril)
- D. Phenazopyridine (Pyridium)

Care of Patients with Urinary Problems

Which personal factor places the client at risk for bladder cancer?

- A. Has worked in a lumber yard for 10 years
- B. A 50 pack-year cigarette smoking history
- C. Numerous episodes of bacterial cystitis
- D. History of gonorrhea

Care of Patients with Urinary Problems

Which is an initial priority intervention for the client with stress incontinence?

- A. Beginning medication teaching
- B. Having the client sign an informed consent form for surgery
- C. Assisting the client in finding a supplier of absorbent pads and undergarments
- D. Instructing the client to maintain a diary that records times of urine leakage, activities, and diet

Care of Patients with Urinary Problems

A client presents with senile dementia, Alzheimer's type (SDAT) and incontinence. Which therapy will best help this client?

- A. Bladder training
- B. Habit training
- C. Exercise therapy
- D. Electrical stimulation

Care of Patients with Urinary Problems

The client is being admitted with a suspected diagnosis of bladder cancer. Which question will assist in determining risk factors?

- A. “Do you smoke cigarettes?”
- B. “Do you use alcohol?”
- C. “Do you use recreational drugs?”
- D. “Do you take any prescription drugs?”

Care of Patients with Urinary Problems

The client is a young woman who is being treated with amoxicillin (Amoxil) for a urinary tract infection. Which is the highest priority instruction for the nurse to give the client?

- A. “Use a second form of birth control while on the drug.”
- B. “You will experience increased menstrual bleeding while on this drug.”
- C. “You may experience an irregular heartbeat while on the drug.”
- D. “Watch for blood in your urine while taking this drug.”

Care of Patients with Urinary Problems

Which is an appropriate dietary choice for the client with uric acid renal calculi?

- A. Chicken salad sandwich, potato chips
- B. Chef salad, low sodium crackers
- C. Mixed green salad, melba toast
- D. Baked fish, steamed vegetables

Care of Patients with Urinary Problems

Which type of incontinence is most common after a difficult vaginal delivery?

- A. Stress incontinence
- B. Urge incontinence
- C. Reflex incontinence
- D. Overflow incontinence

Care of Patients with Urinary Problems

Which is priority discharge teaching for a client who has undergone the removal of a renal calculus?

- A. “Do not expect to see any blood in your urine.”
- B. “Expect to experience pain in the bladder area.”
- C. “Look for bruising and report it.”
- D. “Drink at least 3 L of fluid daily and monitor urine pH.”

Care of Patients with Urinary Problems

The client is beginning to undergo urinary habit training. Which is an effective instruction to give this client’s caregiver?

- A. “Keep a continence record for at least 3 days.”
- B. “Do not resort to running water in an attempt to prompt client.”
- C. “Establish a toileting interval of not less than 4 hours.”
- D. “Avoid leaving the client on the toilet for more than 15 minutes.”

Care of Patients with Urinary Problems

The client is beginning to undergo urinary bladder training. Which is an effective instruction to give this client?

- A. "Use the toilet at the first urge, rather than at specific intervals."
- B. "Try to consciously hold your urine until the scheduled toileting time."
- C. "Initially try to use the toilet at least every half-hour for 24 hours."
- D. "The toileting interval can be increased once you have been continent"

APPENDIX L

CARE OF PATIENTS WITH RENAL DISORDERS DECISION-MAKING CHALLENGES

Care of Patients with Renal Disorders Decision-Making Challenges

The patient is a 31-year-old woman at 24 weeks' gestation with her first pregnancy. She reports new flank and suprapubic pain and dysuria. She states that urgency, nocturia, and frequency are unchanged "but I go a lot since I became pregnant." She says that she has had cystitis a few times in the past but none since she married 1 year ago and that she has had kidney stones twice in the past 7 years. She says, "I usually work the register at the grocery store in the evenings but I had to call in sick yesterday because I was so tired and nauseated." Her vital signs are T, 102° F; P, 114; R, 22; and BP, 130/90. Her urine is cloudy, amber, and foul smelling, positive for both leukocyte esterase and nitrate, with white blood cells and gram-negative bacteria.

1. What additional assessment data should you obtain?
2. Which manifestations are specific to cystitis, which are specific to pyelonephritis, and which are common to both?
3. What risk factors for pyelonephritis are present for this patient?

The patient is diagnosed with acute pyelonephritis. Because she is pregnant, she is considered a "complicated" presentation of pyelonephritis. A urine culture is obtained along with a Gram stain that shows gram-positive cocci. She is started on ampicillin sulbactam (Unasyn). The perineal examination indicates that her urethral meatus is located abnormally close to her vagina. She will undergo cystography after she recovers from her delivery of her child in 6 to 12 months from now. Further testing is deferred because of her pregnancy. Her serum creatinine is normal at 1.0, which indicates adequate renal function, further indicating that additional diagnostic testing can be deferred.

1. Explain whether this patient's acute pyelonephritis is an ascending or a descending infection.
2. How do the findings of the physical examination relate as a cause of her acute pyelonephritis?
3. In addition to adherence to any chronic antiseptic or antibiotic therapy, what could you suggest as measures for this patient to reduce her risk for future episodes of pyelonephritis and cystitis?

APPENDIX M
CARE OF PATIENTS WITH RENAL DISORDERS CASE STUDY

Care of Patients with Renal Disorders Case Study

A 30-year-old white male patient comes to the clinic reporting dull, aching abdominal and flank pain. He reports nocturia and a family history of autosomal dominant PKD. He reports no known personal health problems, although he was instructed to monitor his blood pressure at home and he admits to “not doing so well with that.” Today his blood pressure is 130/90 mm Hg; pulse is 72 and regular; respirations 12/min, and temperature is 98.8° F.

1. What additional information should the nurse elicit during the interview?
2. What are the key features of PKD?
3. Describe the causes of pain for patients with PKD.
4. What are typical findings of a urinalysis in a patient with PKD?
5. What are the causes of hypertension and renal ischemia in a patient with PKD?
6. What is the risk involved with other organs and tissues in the progression of PKD?
7. Patients with PKD often have other tissue involvement. List several of the complications that can be present.
8. List reasons that patients diagnosed with PKD may need a nursing diagnosis of Impaired Coping.
9. Identify priority nursing care needs for the patient with PKD.
10. What would the nurse include in the teaching plan for this patient?

APPENDIX N

CARE OF PATIENTS WITH RENAL DISORDERS MULTIPLE CHOICE QUESTIONS

Care of patients with renal disorders multiple choice questions

CARE OF PATIENTS WITH RENAL DISORDERS

Susan Welch, RN, MSN, CCRN

Care of Patients with Renal Disorders

Which clinical manifestation in a client with a urinary tract infection alerts the nurse to the possibility of acute pyelonephritis?

- A. Burning on urination
- B. Cloudy, dark urine
- C. Fever and chills
- D. Hematuria

Care of Patients with Renal Disorders

The middle-aged client with diabetes mellitus is being treated for the third episode of acute pyelonephritis in the past year and asks what can be done to help prevent these infections. Which is the nurse's best response?

- A. "Test your urine daily for the presence of ketone bodies and proteins."
- B. "Use tampons rather than sanitary napkins during your menstrual period."
- C. "Drink more water and try to empty your bladder at least every 2 to 3 hours while you are awake and increase your water intake."
- D. "Inject your insulin in larger doses or more frequently to keep your blood sugar lower so the microorganisms have fewer nutrients for growth."

Care of Patients with Renal Disorders

In assessing the client recently diagnosed with acute glomerular nephritis, the nurse asks which question to determine potential contributing factors?

- A. "Are you sexually active?"
- B. "Do you have pain or burning on urination?"
- C. "Has anyone in your family had chronic kidney problems?"
- D. "Have you had any type of infection within the last 2 weeks?"

Care of Patients with Renal Disorders

The nurse completes which assessment in the client with acute glomerulonephritis and periorbital edema?

- A. Auscultating breath sounds
- B. Checking blood glucose levels
- C. Measuring deep tendon reflexes
- D. Testing urine for the presence of protein

Care of Patients with Renal Disorders

The client with glomerular nephritis has a glomerular filtration rate (GFR) of 40 mL/min, as measured by a 24-hour creatinine clearance. Which is the nurse's interpretation of this finding?

- A. Excessive glomerular filtration rate, client at risk for dehydration
- B. Excessive glomerular filtration rate, client at risk for fluid overload
- C. Reduced glomerular filtration rate, client at risk for dehydration
- D. Reduced glomerular filtration rate, client at risk for fluid overload

Care of Patients with Renal Disorders

The nurse correlates the decreased glomerular filtration rate in the client with acute glomerulonephritis to which pathophysiologic process?

- A. Decreased renal-induced constriction of the renal arteries
- B. Necrosis of 70% or more of the nephrons secondary to increased kidney interstitial hydrostatic pressure
- C. Scar tissue formation throughout the proximal convoluted tubule secondary to toxin-induced collagen synthesis
- D. Thickened capillary membranes secondary to immune complex deposition and cellular proliferation

Care of Patients with Renal Disorders

Which dietary modification will the nurse teach to the client with nephrotic syndrome and a normal glomerular filtration rate?

- A. Decreased intake of protein
- B. Increased intake of protein
- C. Decreased intake of carbohydrates
- D. Increased intake of carbohydrates

Care of Patients with Renal Disorders

- In assessing the client 6 hours after a radical nephrectomy for renal cell carcinoma, the nurse notes that the client's blood pressure has decreased from 134/90 to 100/56 mm Hg and the urine output is 20 mL for this past hour. Which is the nurse's best action?
- A. Positioning the client so that the remaining kidney is not dependent
 - B. Measuring the specific gravity of the urine
 - C. Documenting the findings as the only action
 - D. Notifying the health care provider

Care of Patients with Renal Disorders

- The nurse incorporates which information in the discharge teaching for the client who has undergone a nephrectomy?
- A. "Limit your intake of fluid to no more than 2000 mL/day."
 - B. "Test your urine daily for ketone bodies and blood."
 - C. "You should avoid contact sports."
 - D. "Avoid all alcoholic beverages."

Care of Patients with Renal Disorders

In reviewing laboratory results with a client with diabetes mellitus, the nurse stresses which value as most indicative of tight glycemic control?

- A. Hb_{A1c} level below 8%
- B. Fasting blood glucose of 85 mg/dL
- C. Random serum glucose of 120 mg/dL
- D. Absence of glucose in the urine

Care of Patients with Renal Disorders

Which statement by the client being treated for a urinary tract infection (UTI) indicates that teaching was effective?

- A. “I need to take all the antibiotics, even when symptoms go away.”
- B. “My urine will be cloudier because of the antibiotics.”
- C. “I only have to take the antibiotics until I no longer have a temperature.”
- D. “I should limit my fluid intake while taking these antibiotics.”

Care of Patients with Renal Disorders

A client presents to the emergency department with severe dehydration, and is ordered to receive 3 L of fluid over 6 hours. At what rate will the nurse set the intravenous pump? _____

APPENDIX O

CARE OF PATIENTS WITH ACUTE RENAL FAILURE AND CHRONIC KIDNEY DISEASE DECISION-MAKING CHALLENGES

Care of Patients with Acute Renal Failure and Chronic Kidney Disease Decision-Making Challenges

The patient is a 64-year-old man. He visits the primary care provider because of mild lower abdominal pain, decreased urine output, and increased shortness of breath. He is 5 feet, 8 inches tall and weighs 246 pounds. The only drugs he takes include a daily multivitamin, a beta blocker, and occasionally acetaminophen for headache. His past medical history includes kidney stones 1 year ago and mild hypertension over the past 5 years. Physical assessment reveals bilateral crackles in the lung bases. Vital signs are T, 98.8° F; P, 96/min, R, 28/min, and BP, 148/92.

1. For which type(s) of acute renal failure is he at risk? Why?
2. Do any of his usual drugs increase his risk for ARF? Which one(s) and why?
3. Is there any specific assessment data you could obtain without a prescription to evaluate his risk for acute renal failure? If so, which ones and why?

The physician prescribes these interventions:

IV placement with a 20-gauge cannula, NS at 20 mL/hr
Accurate intake and output
Ibuprofen 600 mg orally
Furosemide 40 mg IV

4. In what order (and why) should you perform these interventions?

The patient is a 27-year-old woman who was diagnosed with type 1 diabetes at the age of 6 years and hypertension at age 21 years. She describes an increase in urine output with clear, dilute-appearing urine. Her skin is pale and dry. She reports palpitations and dizziness when getting out of bed or suddenly rising from her chair. She tells you that she has gained 5 pounds over the past 2 weeks and that when she sits all day, her ankles look swollen. The drugs she takes include NPH and Regular insulin every morning and evening, hydrochlorothiazide 20 mg once a day, and birth control pills. Vital signs are T, 98.8° F; P, 94/min and irregular; R, 26/min; BP, 136/92.

1. What other assessment data should you obtain? What physical manifestations might you find when assessing this patient?
2. What risk factors for the development of CKD are noted in her past medical history? What is the rationale for these risk factors?
3. Why does the patient have an increased urine output at this time?
4. What is the priority nursing diagnosis or collaborative problem for the patient at this time? Provide a rationale for your choice.

A year later, your patient with CKD has been diagnosed with ESKD. Her nephrologist has prescribed HD three times a week for 4 to 5 hours, as well as fluid and diet teaching. She has a temporary HD dialysis catheter in place, and the surgeon created an AV fistula 2 weeks ago. The patient tells you that she is concerned about missing so much work and losing her job.

1. What teaching should you provide regarding the diet and fluid needs of this patient?
2. What should you teach the patient regarding care of her temporary and permanent HD sites?
3. What changes, if any, will need to be made in her therapy for diabetes and hypertension?
4. What complications should you monitor for during and immediately after dialysis?

The patient is a 58-year-old woman with ESKD from long-standing and uncontrolled hypertension and diabetes. She is scheduled to receive a kidney from her 42-year-old daughter. The daughter, who left home at age 17 when the mother married a man who was abusive toward the daughter, has not been in touch with her mother for more than 25 years. The patient's husband tracked the daughter down because none of this couple's three children have the mother's blood type.

When you meet with the daughter, she is quiet and responds abruptly to direct questions. In response to the question "why are you donating your kidney to your mother?" she responds, "Because my step-father is giving me \$50,000 for doing this." She then admits that she is scared because she is newly married and would like to have a child as soon as possible.

1. Is her concern about a future pregnancy valid? (Consult Chapter 68 and a maternity nursing book).
2. Are there any other questions you should ask her about her decision to donate her kidney?
3. What should you do with the information about the \$50,000?

APPENDIX P

CARE OF PATIENTS WITH ACUTE RENAL FAILURE AND CHRONIC KIDNEY DISEASE CASE STUDY

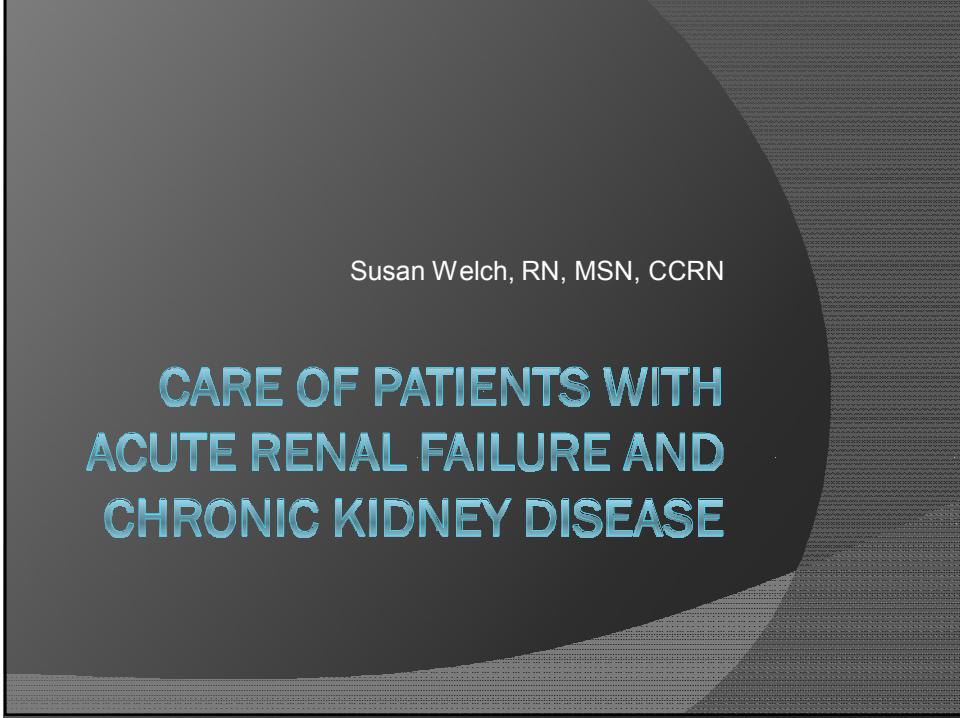
Care of Patients with Acute Renal Failure and Chronic Kidney Disease Case Study

A 36-year-old woman is married and has two adopted children. She is diagnosed with polycystic kidney disease (PKD), and she will soon have to go on dialysis or consent to a renal transplant.

1. What additional data should the nurse collect to help the patient make the best decision for herself?
2. How would the nurse briefly describe the process of dialysis to the patient? Include information about the following questions:
 - a. In peritoneal dialysis, what is the membrane through which the process occurs?
 - b. Identify the types of peritoneal dialysis.
 - c. What is used to prevent fibrin clot formation in peritoneal dialysis?
 - d. How is peritonitis identified and diagnosed in the patient receiving dialysis?
 - e. List three advantages of using peritoneal dialysis instead of hemodialysis.
3. Identify the source of possible problems with the flow of dialysate in patients with peritoneal dialysis.
4. What are the protein needs of the patient receiving peritoneal dialysis?
5. Due to the long distance the patient lives from the medical center, she elects to begin CAPD. What would be included in a plan of hospital care for the patient for this procedure?
6. What could the nurse explain and demonstrate about the steps of caring for the dialysis catheter?
7. The patient has been performing PD at home. She calls the nurse to report about outflow from the first peritoneal dialysis. What does the nurse tell the patient about the appearance of the outflow?

APPENDIX Q

CARE OF PATIENTS WITH ACUTE RENAL FAILURE AND CHRONIC KIDNEY DISEASE QUESTIONS



Susan Welch, RN, MSN, CCRN

CARE OF PATIENTS WITH ACUTE RENAL FAILURE AND CHRONIC KIDNEY DISEASE

Acute Renal Failure and Chronic Kidney Disease

Which of the following clients is most at risk for developing postrenal renal failure?

- A. Client diagnosed with renal calculi
- B. Client with congestive heart failure
- C. Client taking nonsteroidal anti-inflammatory drugs (NSAIDs) for arthritis pain
- D. Client recovering from glomerulonephritis

Acute Renal Failure and Chronic Kidney Disease

A client is admitted to the hospital with a serum creatinine level of 2 mg/dL. When taking the client's history, which question will the nurse ask first?

- A. "Do you take any nonprescription medications?"
- B. "Does anyone in your family have kidney disease?"
- C. "Do you have yearly blood work done?"
- D. "Is your diet low in protein?"

Acute Renal Failure and Chronic Kidney Disease

A client with a decreased glomerular filtration rate asks how to prevent further damage to the kidneys. Which is the nurse's best response?

- A. "The diuretics you are taking will prevent further damage."
- B. "Kidney damage is inevitable as you age."
- C. "Avoid taking nonsteroidal anti-inflammatory drugs."
- D. "You will need to follow a high-protein diet."

Acute Renal Failure and Chronic Kidney Disease

A client who has chronic kidney disease is being discharged from the hospital after being treated for a hip fracture. Which information is most important for the nurse to provide the client prior to discharge?

- A. "Increase your intake of foods with protein."
- B. "Monitor your daily intake and output."
- C. "Maintain bedrest until the fracture is healed."
- D. "Take your aluminum hydroxide (Nephrox) with meals."

Acute Renal Failure and Chronic Kidney Disease

Which intervention is most important for the nurse to implement in a client after renal transplant surgery?

- A. Flushing peritoneal dialysis catheter once per shift
- B. Monitoring magnesium levels daily
- C. Placing the client on contact isolation
- D. Removing indwelling (Foley) catheter as soon as possible

Acute Renal Failure and Chronic Kidney Disease

During a hot summer day, an older adult client tells the nurse that he “is not voiding that much.” On taking his vital signs, the nurse notes a heart rate of 100 beats/min and a blood pressure of 90/60 mm Hg. Which action will the nurse take first?

- A. Have the client drink fluid.
- B. Insert an intravenous catheter.
- C. Place the client on intake and output measurement.
- D. Place a Foley catheter to monitor urine output.

Acute Renal Failure and Chronic Kidney Disease

To detect a common untoward effect of furosemide (Lasix), the nurse obtains which assessment?

- A. Breath sounds
- B. Heart sounds
- C. Intake and output
- D. Nutritional patterns

Acute Renal Failure and Chronic Kidney Disease

A client with acute renal failure and on dialysis asks how much fluid will be permitted each day. Which is the nurse's best response?

- A. "This is based on the amount of damage to your kidneys."
- B. "You will be permitted to drink an amount equal to the urine you excrete, plus 700 mL."
- C. "It is based on your body weight."
- D. "You will be permitted to drink approximately 2 L of fluid each day."

Acute Renal Failure and Chronic Kidney Disease

Which statement by client who has undergone renal transplantation indicates a need for more teaching?

- A. "I will need to continue to take insulin for my diabetes."
- B. "I will have to take my cyclosporine for the rest of my life."
- C. "I will take the antibiotics three times daily until the medication is finished."
- D. "My new kidney is working fine. I do not need to take medications any longer."

Acute Renal Failure and Chronic Kidney Disease

The client has been missing some scheduled hemodialysis sessions. Which intervention is most important for the nurse to implement?

- A. Discussing with the client his acceptance of the disease
- B. Discussing with the client the option of peritoneal dialysis
- C. Rescheduling the sessions to another day
- D. Stressing to the client the importance of going to these sessions

Acute Renal Failure and Chronic Kidney Disease

A client with chronic hypertension is seen in the clinic. Which assessment indicates that the client's hypertension is not under control?

- A. Heart rate of 55 beats/min
- B. Elevated serum creatinine level
- C. Blood glucose level of 128 mg/dL
- D. Irregular heart sounds

Acute Renal Failure and Chronic Kidney Disease

To determine the effectiveness of fluid restriction on a client in renal failure, the nurse will assess for which finding?

- A. Absence of lung crackles
- B. Decreased serum creatinine level
- C. Decreased serum potassium level
- D. Increased muscle strength

Acute Renal Failure and Chronic Kidney Disease

The client with chronic kidney disease is prescribed drugs to be given at 9 AM, digoxin (Lanoxin) and epoetin alfa (Epogen). He is complaining of nausea and vomiting. Which action will the nurse take first?

- A. Administers both medications
- B. Checks the hemoglobin and hematocrit levels
- C. Holds the dose of digoxin
- D. Notifies the health care provider

Acute Renal Failure and Chronic Kidney Disease

Which is the nurse's highest priority for meeting the needs of a client who presents with a 3-day history of vomiting and diarrhea, blood pressure of 85/60 mm Hg, and heart rate of 105 beats/min?

- A. Finding the source of infection
- B. Preventing nutritional deficit
- C. Replacement of fluid loss
- D. Relief of nausea

Acute Renal Failure and Chronic Kidney Disease

Which response by the client indicates an understanding of measures to facilitate the flow of peritoneal dialysate fluid?

- A. "I will take my stool softeners every day."
- B. "I will keep the drainage bag at the level of my abdomen."
- C. "Flushing the catheter with each exchange is needed."
- D. "Warmed dialysate infusion increases the speed of flow."

Acute Renal Failure and Chronic Kidney Disease

When providing care for a client receiving peritoneal dialysis, the nurse notices that the effluent is cloudy. Which intervention is the most important for the nurse to carry out?

- A. Irrigating the peritoneal catheter
- B. Sending a specimen of the effluent for culture and sensitivity
- C. Documenting the finding
- D. Changing the dialysate solution and catheter tubing

Acute Renal Failure and Chronic Kidney Disease

During hemodialysis, a client with chronic kidney disease develops headache, nausea, vomiting, and restlessness. After notifying the physician, which action by the nurse is most appropriate?

- A. Administering an intravenous bolus of dextrose solution
- B. Discontinuing the hemodialysis immediately
- C. Ordering a blood urea nitrogen level STAT
- D. Preparing to administer an anticonvulsant

Acute Renal Failure and Chronic Kidney Disease

A client's temperature after dialysis is 99° F (37.2° C) and was normal predialysis. Which is the nurse's best action?

- A. Continuing to monitor the temperature
- B. Encouraging the client to drink at least 1 L of fluid
- C. Obtaining a white blood cell count
- D. Preparing to culture the fistula site

Acute Renal Failure and Chronic Kidney Disease

The RN has assigned a client with a newly placed arteriovenous (AV) fistula in his right arm to an LPN. Which information about the care of this client is most important for the RN to provide to the LPN?

- A. "Avoid movement of the right extremity."
- B. "Place gentle pressure over the fistula site after blood draws."
- C. "Start any IV lines below the site of the fistula."
- D. "Take blood pressure in the left arm"

Acute Renal Failure and Chronic Kidney Disease

Which condition warrants the nurse administering protamine sulfate to a client receiving hemodialysis?

- A. Absent bruit and thrill over vascular access site
- B. Decreased activated partial thromboplastin time
- C. Excessive bleeding from the vascular access site
- D. Thrombosis of the AV fistula

Acute Renal Failure and Chronic Kidney Disease

Which clinical finding indicates to the nurse that a client's renal failure is getting worse?

- A. Hemoglobin level of 30%
- B. Nausea and vomiting
- C. Paresthesias of the lower extremities
- D. Soft, less audible heart sounds

Acute Renal Failure and Chronic Kidney Disease

Selection of which food indicates to the nurse that the client understands teaching about a low-sodium and low-potassium diet?

- A. Bananas
- B. Ham
- C. Herbs
- D. Salt substitutes

Acute Renal Failure and Chronic Kidney Disease

A client who is admitted to the hospital with a history of kidney disease begins to have difficulty breathing. The vital signs are as follows: blood pressure of 100/80 mm Hg, heart rate of 40 beats/min. His heart sounds are difficult to hear. Which intervention will the nurse anticipate will be done first?

- A. Administration of digoxin (Lanoxin)
- B. Draining pericardial fluid with a needle
- C. Hemodialysis
- D. Placement of a pacemaker

Acute Renal Failure and Chronic Kidney Disease

A client hospitalized for worsening renal failure suddenly becomes restless and agitated. The assessment reveals tachycardia and crackles bilaterally at the bases of the lungs. Which is the nurse's first intervention?

- A. Beginning ultrafiltration
- B. Administering an antianxiety agent
- C. Placing the client on mechanical ventilation
- D. Placing client in a high Fowler's position

Acute Renal Failure and Chronic Kidney Disease

A nurse observes tall, peaked T waves on the electrocardiogram (ECG) of a client with end-stage kidney disease (ESKD). Which is the nurse's best action?

- A. Checking the serum potassium level
- B. Nothing. This is a normal finding for individuals with ESRD.
- C. Preparing to give sodium bicarbonate to correct the acidosis
- D. Repeating the ECG

Acute Renal Failure and Chronic Kidney Disease

Which assessment parameter will the nurse monitor in a client with chronic kidney disease to determine fluid and sodium retention status?

- A. Capillary refill
- B. Intake and output
- C. Muscle strength
- D. Weight and blood pressure

Acute Renal Failure and Chronic Kidney Disease

The nurse is caring for a client who is receiving peritoneal dialysis (PD). Which nursing intervention has the greatest priority when performing a dialysis exchange?

- A. Adding potassium and antibiotic to the dialysate bags
- B. Positioning the client on his side
- C. Using sterile technique when hooking up dialysate bags
- D. Warming the dialysate fluid in a microwave oven

Acute Renal Failure and Chronic Kidney Disease

The occurrence of which condition warrants the nurse immediately discontinuing a peritoneal dialysis exchange?

- A. Brown color effluent
- B. Outflow less than inflow
- C. Pain during dialysate inflow
- D. Poor dialysate flow

Acute Renal Failure and Chronic Kidney Disease

A client who is 12 hours post-kidney transplantation puts out 2000 mL of urine in 1 hour. Which assessment will the nurse carry out first?

- A. Skin turgor
- B. Blood pressure
- C. Serum BUN level
- D. Weight of the client

Acute Renal Failure and Chronic Kidney Disease

A client who underwent kidney transplantation 7 days ago has developed oliguria, an elevated temperature, lethargy, and elevations in the serum creatinine, BUN, and potassium levels. Which initial intervention will the nurse anticipate for this client?

- A. Hemodialysis
- B. Increase in the doses of immunosuppressive drugs
- C. Immediate removal of the transplanted kidney
- D. Peritoneal dialysis

APPENDIX R

CARE OF MALE PATIENTS WITH REPRODUCTIVE PROBLEMS DECISION-MAKING CHALLENGES

Care of Male Patients with Reproductive Problems Decision-making Challenges

A 61-year-old widower has just been diagnosed with prostate cancer after having a biopsy. He is very upset about the diagnosis, stating that he was planning to get remarried in 6 months. He is very concerned that his fiancée may change her mind about the wedding if she finds out about his cancer. She is 37 years old and has no children from her previous marriage. They have discussed having a baby, and now he does not know if that can still be possible. The urologist has encouraged him to decide on a treatment and begin it soon. The patient is thinking about waiting until after the wedding to deal with his diagnosis but asks you what you think he should do.

1. How should you respond to this patient at this time?
2. What legal/ethical principles are involved in this case?
3. What factors does he need to consider when making his decision?
4. What treatment options does this patient have given his age and the urologist's suggestion?

APPENDIX S

CASE STUDY OF THE MALE PATIENT WITH URINARY RETENTION SECONDARY TO PROSTATE ENLARGEMENT

Case Study of the Male Patient with Urinary Retention Secondary to Prostate Enlargement

A 73-year-old man comes to the ambulatory urgent care center reporting burning on urination, urgency, dribbling of urine, and a feeling of bladder fullness. He states that he has noticed a gradual change in his urinary pattern over the past few months but attributes it to “old age.” He adds that he would not have come in at all except that he noticed some burning when he urinated today. He also says his back has been hurting, but he attributes that to yard work and gardening.

1. When interviewing this patient, what questions should the nurse ask?
2. What are the symptoms of LUTS?
3. What symptoms differentiate an obstructive problem from a non-obstructive problem?
4. What nursing diagnoses would be appropriate for this patient?
5. What laboratory tests and/or procedures can be expected for this patient?
6. The patient is diagnosed with BPH. State four effects of BPH on urinary elimination.

APPENDIX T
CARE OF MALE PATIENTS MULTIPLE CHOICE QUESTIONS

Care of Male Patients with Reproductive Problems

Susan Welch, RN, MSN, CCRN

The nurse is assisting a client with limited mobility into position for examination of his prostate gland. How will the nurse best assist the client?

- A. Assisting the client to bend over the examination table
- B. Holding the client up as he bends over the bedside table
- C. Helping the client lie down in a side-lying fetal position
- D. Assisting the client to lie in a prone position

Which statement indicates that the client understands the most appropriate time of day to take an alpha blocker drug for treatment of benign prostatic hypertrophy (BPH)?

- A. "I should take my medication at bedtime."
- B. "I should take my medication as soon as I get up."
- C. "I should take my medication with each meal."
- D. "I should take my medication on an empty stomach."

The nurse is assessing a client who has undergone a transurethral resection of the prostate (TURP). Which assessment finding requires immediate action by the nurse?

- A. Client passes small blood clots after catheter removal.
- B. Client experiences urinary frequency after catheter removal.
- C. Client experiences bleeding during the 24 hours after surgery.
- D. Client has the urge to void continuously while catheter is inserted.

Which is an accurate interpretation of a prostate-specific antigen (PSA) level of 2.0 ng/mL?

- A. The finding is within normal limits. There is no indication of prostate cancer.
- B. The finding is in normal range. Schedule the client for a digital rectal examination.
- C. The finding is considered elevated. The client is at risk for prostate cancer.
- D. The finding is considered elevated. The physician recommends watchful waiting.

The client scheduled for a prostatectomy asks whether he will have to have a urinary catheter in place after surgery. Which is the nurse's best response?

- A. "Possibly. It depends on where the surgeon makes the incision."
- B. "Yes, you will need the catheter at least for a day."
- C. "Yes, you will need the catheter until the sutures are removed."
- D. "No, the surgery will fix the problem. You will be able to urinate freely again."

The client is scheduled for a prostatectomy for BPH. On the morning of surgery, the laboratory report on the client's urine indicates the presence of red blood cells, white blood cells, and bacteria. Which is the nurse's highest priority action?

- A. Documenting the report as the only action
- B. Removing the Foley catheter
- C. Straining the client's urine
- D. Notifying the physician

A client having continuous bladder irrigation at a rate of 1000 mL/hr has a urinary output of 200 mL/hr. Which will the nurse do first?

- A. Notify the physician.
- B. Stop the irrigation flow.
- C. Document the finding as the only action.
- D. Irrigate the catheter with a large-piston syringe.

Which client statement indicates a need for clarification about interventions post-transurethral prostatectomy?

- A. "I will practice stopping the urine stream to strengthen my sphincter control."
- B. "I will limit my fluid intake to less than 2 L every day to prevent incontinence."
- C. "I will avoid vigorous activity for the first 3 weeks after the surgery."
- D. "I will avoid caffeinated beverages and spicy foods."

The client with prostate cancer complains of pain in his lower back and legs. Which problem does the nurse suspect?

- A. Arthritis
- B. Urinary retention
- C. Metastasis to the bone
- D. Muscle atrophy from inactivity

A client diagnosed with stage 0 prostate cancer is concerned that surgery has not been planned. Which is the nurse's best response?

- A. "The disease is slow-growing. The risks of surgery at your age are not justified by the outcome."
- B. "Your disease is so advanced that surgery at this point would not increase your chances of cure."
- C. "Your disease is in a very early stage and slow-growing. Your doctor will monitor you."
- D. "This stage indicates that you do not really have cancer, so surgery is not necessary."

The client with BPH asks why his enlarged prostate is causing difficulty with urination. Which is the nurse's most accurate response?

- A. "The enlarged prostate gland compresses the urethra, blocking the flow of urine."
- B. "The enlarged prostate gland presses on the kidneys, decreasing the formation of urine."
- C. "The enlarged prostate gland secretes acids that weaken the bladder wall, causing urine dribbling."
- D. "The enlarged prostate gland destroys nerves to the bladder, decreasing your awareness of the need to urinate."

The client has decided to treat his enlarged prostate with saw palmetto. Which is the nurse's best response?

- A. "You'll need to get permission from your physician to make that decision."
- B. "Saw palmetto is a well-respected alternative therapy for BPH."
- C. "Have you discussed this decision with your family?"
- D. "What has your physician told you about this choice of therapy?"

The nurse is caring for a young adult who is married and has been diagnosed with testicular cancer. To which community resource will the nurse refer him?

- A. American Cancer Society
- B. Red Cross
- C. Sperm bank
- D. Public Health Department

The older client with BPH and hypertension is being treated with doxazosin (Cardura) while staying in the hospital. Which should the nurse monitor for following the first dose?

- A. Increased heart rate and shortness of breath
- B. Orthostatic hypotension and syncope
- C. Prolonged erection and loss of appetite
- D. Drowsiness and temporary memory loss

APPENDIX U

CONCEPT OF ELIMINATION PRETEST-POSTTESTS QUESTION STATISTICS

Question title	Whole group	Upper 25%	Lower 25%	Discrimination	Mean	Standard Deviation
1. Acute glomerulonephritis AP, I	97.56	100%	90.91%	0.48	97.56%	15.62%
2. Acute pyelonephritis AP, A	65.85	81.82%	63.64%	0.24	65.85%	48.01%
3. Creatinine clearance C, A	70.73	72.73%	63.64%	0.29	70.73%	46.06%
4. Diminished renal reserve/ARF education AP, I	75.61	100.00%	54.55%	0.23	75.61%	43.48%
5. Erythropoietin further teaching E, A	95.12	90.91%	90.91%	0.24	95.12%	21.81%
6. Hyperkalemia AP, I	82.93	90.91%	72.73%	0.40	82.93%	38.09%
7. Normal peritoneal dialysis AP, I	87.80	100.00%	81.82%	0.40	87.80%	33.13%
8. Overflow incontinence I, AP	60.98	81.82%	27.27%	0.46	60.98%	49.39%
9. Amphotericin complication I, AP	43.90	72.73%	36.36%	0.35	43.90%	50.24%
10. Post renal failure AP, AN	90.24	90.91%	81.82%	0.43	90.24%	30.04%
11. Prostate cancer manifestations AP, A	85.37	100.00%	63.64%	0.35	85.37%	35.78%
12. Prostate cancer metastasis AP, A	60.98	72.73%	27.27%	0.36	60.98%	49.39%
13. Renal calculi priority A, AN	95.12	100.00%	81.82%	0.66	95.12%	21.81%
14. Urinary stone diet AP, E	75.61	100.00%	63.64%	0.39	75.61%	43.48%
15. UTI & Chronic pyelonephritis A, AP	97.56	100.00%	90.91%	0.44	97.56%	15.62%
16. Kidney transplant rejection A/E, AP	92.68	100.00%	81.82%	0.30	92.68%	26.37%
17. Pyelonephritis priority AP, I	97.56	100.00%	90.91%	0.48	97.56%	15.62%
18. AV fistula C, A	90.24	100.00%	72.73%	0.33	90.24%	30.04%
19. Flomax side effects AP, I	78.05	90.91%	45.45%	0.52	78.05%	41.91%
20. BPH teaching AP, I	97.56	100.00%	90.91%	0.39	97.56%	15.62%

21. Chronic renal failure complications AP, AS	58.54	72.73%	45.45%	0.23	58.54%	49.88%
22. Chronic renal failure laboratory values AP, AN	80.49	100.00%	72.73%	0.43	80.49%	40.12%
23. Antihypertensive prior to dialysis AP, I	82.93	100.00%	63.64%	0.27	82.93%	38.09%
24. Disequilibrium syndrome findings C, A	53.66	63.64%	27.27%	0.30	53.66%	50.49%
25. Peritoneal dialysis complications AP, I	78.05	90.91%	45.45%	0.50	78.05%	41.91%
26. TURP priority AP, I	31.71	45.45%	18.18%	0.24	31.71%	47.11%
27. Urge incontinence teaching AP, I	68.29	72.73%	45.45%	0.32	68.29%	47.11%
28. Urinary tract infection causes AP, A	90.24	100.00%	81.82%	0.25	90.24%	30.04%
29. Urinary tract infection progression AP, AS	85.37	100.00%	72.73	0.23	85.37%	35.78%
30. Lasix effectiveness AN, E	37.78	58.33%	25.00%	0.33	37.78%	Not provided
31. ACE inhibitor C, A	33.33	50.00%	8.33%	0.42	33.33%	Not provided
32. Amphojel scientific rational AP, I	93.33	100.00%	75.00%	0.25	93.33%	Not provided
33. Intermittent self-catherization AP, P	75.56	91.67%	66.67%	0.25	75.56%	Not provided
34. Fibrin clot in PD catheter AP, I	86.67	91.67%	66.67%	0.25	86.67%	Not provided
35. Hyperkalemia drug AP, I	53.33	91.67%	25.00%	0.25	66.67%	Not provided
36. Renal calculus AP, I	85.11	100.00%	75.00%	0.25	85.11%	Not provided
37. TURP emergency AP, A	87.23	100.00%	66.67%	0.33	87.23%	Not provided
38. Cystitis with pyridium AP, I	93.62	100.00%	75.00%	0.25	93.62%	Not provided
39. Stress incontinence diet therapy AP, E	87.23	100.00%	75.00%	0.25	87.23%	Not provided

40. Post-peritoneal dialysis finding AP, E	80.00	100.00%	50.00%	0.50	80.00%	Not provided
41. Post-hemodialysis finding AP, E	82.22	91.67%	58.33%	0.33	82.22%	Not provided
42. Proscar intervention AP, I	51.11	50.00%	25.00%	0.25	51.11%	Not provided
43. Kidney biopsy AN, I	43.48	66.67%	16.67%	0.50	43.48%	Not provided
44. Hyperkalemia priority AN, I	89.13	100.00%	75.00%	0.25	89.13%	Not provided
45. Question order/Lasix with low BP; A, AP	56.52	58.33%	33.33%	0.25	56.52%	Not provided
46. Allopurinol K, I	51.85	71.43%	28.57%	0.20	51.85%	50.92%
47. Elevated BUN K, AS	22.22	28.57%	0.00%	0.34	22.22%	42.37%
48. Kidney stones from hyperoxaluria C, E	66.67	100.00%	42.86%	0.39	66.67%	48.04%
49. Renal calculus recurrence AP, I	74.07	71.43%	28.57%	0.33	74.07%	44.66%
50. Pre-renal failure AP, AN	58.42	60.22%	29.02%	0.30	58.62%	Not provided