HIGH-FIDELITY SIMULATION: A NEW METHOD FOR IMPROVING MEDICATION ADMINISTRATION SKILLS OF UNDERGRADUATE NURSING STUDENTS IN JORDAN

By

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HIGH-FIDELITY SIMULATION: A NEW METHOD FOR IMPROVING MEDICATION ADMINISTRATION SKILLS OF UNDERGRADUATE NURSING STUDENTS IN JORDAN

Abstract

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Although administering medicines is one of the core nursing actions, errors surrounding this task are prevalent amongst nurses and nursing students. Continued dependence on traditional teaching methods and greater demand and competition for clinical placements are some barriers to expanding medication administration practices for nursing students. High Fidelity Simulation (HFS) is one promising approach; however, there is a dearth of literature examining whether medication-related skills gained from simulation translate into actual clinical settings. A theory-guided, randomized, two-group, observer-blind, repeated measures (one pretest measurement and two posttest measurements) experimental design was utilized to investigate and compare the effectiveness of HFS and traditional lecture to decrease nursing student medication administration errors in an actual medical-surgical setting in Jordan. A convenience sample of 89 second-year BSN students who had no previous experience with medication administration and simulation was recruited. Nursing students were randomly assigned to either HFS group (n = 45), who attended a 1.5-hour HFS scenarios on medication administration, or traditional lecture group (n = 44) who received a 1.5-hour PowerPoint presentation on the same topic. Five blind raters— who demonstrated high inter- and intra-rater reliability—scored students medication
administration practices during the third week (Time 1: pretest), sixth week (Time 2: posttest one), and eleventh week (Time 3: posttest two) of Adult Health Nursing II Clinical rotation using a vailed and reliable tool called the Medication Administration Safety Assessment Tool (MASAT). A two (lecture vs. HFS) by three (Time 1 vs. Time 2 vs. Time 3) mixed ANOVA was used to examine within group changes, between group difference, and the interaction between time and group. The results revealed that the means medication error score on the MASAT for the two treatment groups significantly decreases over time. However, the HFS group had a larger decrease in the mean medication error score on the MASAT at Time 2 (posttest one) and Time 3 (posttest two) compared to the lecture group. Thus, HFS is superior and significantly improves students’ medication administration skills. This study can contribute to a needed paradigm shift in Jordan’s nursing education, moving to more advanced educational methods.
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CHAPTER ONE

INTRODUCTION

Statement of the Problem

Around the world and across all levels of development, the problem of medication errors (MEs) continues to adversely affect patient safety, and may result in serious injury or death (WHO, 2009). Administering medicines has been shown to be a most intricate and seemingly risky endeavor that nursing students are expected to put into action many times each day. Although administering medicines is considered one core nursing action (Armitage & Knapman, 2003), errors surrounding this task are prevalent amongst nurses (Aboshaiqah, 2014; Al-Shara, 2011; Barker, Flynn, Pepper, Bates, & Mikeal, 2002; Brady, Malone, & Fleming, 2009; Fahimi, Ariapanah, Faizi, Shafaghi, Namdar, & Ardakani, 2008; Kim & Bates, 2013; Mrayyan, 2012; Mrayyan, Shishani, & Al-Faouri, 2007; Vazin & Delfani, 2012) and nursing students (Baghcheghi & Koohestani, 2008; Cooper, 2014; Ebrahimi Rigi Tanha, Baghaei, & Feizi, 2012; Harding & Petrick, 2008; Koohestani & Baghcheghi, 2008; Koohestani, Baghcheghi, & Khosravi, 2008; Wolf, Hicks, & Serembus, 2006). There are many factors leading to nursing students MEs, including the violation of the rights of medication administration: the right patient, the right medication, the correct route of administration, the right dose, the right time and the right documentation (Cooper, 2014; Harding & Petrick, 2008; Valdez, de Guzman, & Escolar-Chua, 2013; Wolf et al., 2006). This violation appeared to be influenced by the challenges facing faculty to provide nursing students with sufficient experience that ensure gaining the necessary knowledge and skills to handle and give medicine in a safe and authentic approach (Cooper, 2014; Harding & Petrick, 2008; Valdez et al., 2013; Wolf et al., 2006). Overreliance on traditional teaching methods that don't reflect the dynamic complexity of administering medicine
are some barriers to expanding medication administration practices for undergraduate nursing students (Baghcheghi & Koohestani, 2008; Cooper, 2014; Ebrahimi Rigi Tanha, et al., 2012; Harding & Petrick, 2008; Vaismoradi, Jordan, Turunen, & Bondas, 2014; Wolf et al., 2006). This has created a growing concern among nursing educators that new BSN graduates are not sufficiently skilled in many of the psychomotor skills required to provide safe nursing care (Gerrish, 2000; Nursing Executive Center, 2008; Salyers, 2007), especially those related to medication administration (Nursing Executive Center, 2008). Students lacking sufficient hands-on training and experience may result in an increased risk of making deleterious errors. Such concerns are alarming and should mobilize researchers and educators to devise teaching strategies that ensure sufficient teaching input on medication administration (Baghcheghi & Koohestani, 2008; Harding & Petrick, 2008; Vaismoradi et al., 2014; Wolf et al. 2006).

Medication errors (MEs). MEs are significant, costly, and still affect patient safety during hospitalization. The United States-based Institute of Medicine (US-IOM) report on MEs revealed that one ME occurs per hospitalized patient per day, resulting in over 7,000 deaths per year, and adding an estimated $3.5 billion to the already high cost of health care in the U.S. (IOM, 2006; WHO, 2012). Research from other countries, including a systematic review regarding MEs in Middle Eastern countries (Alsulami, Conroy, & Choonara, 2013), also reports alarming statistics on MEs. In a study of Jordanian nurses’ perception on MEs, Al-Shara (2011) reported that Jordanian nurses’ perspectives on rates of MEs is estimated at 48%. Mrayyan and colleagues (2007) indicated in their descriptive study that the estimated, average recalled number of MEs reported per nurse—recruited from several Jordanian hospitals—was 2.2 over the entire span of their careers, which averaged about 3.5 years (Mrayyan et al., 2007).

The process in which MEs can occur involves five major stages: Prescription,
transcription, preparation, dispensation, and administration (Kohn, Corrigan, & Donaldson, 2000). At each stage, there is the potential for errors to be made; however, the majority of errors occur during medication administration stage, largely the duty of nurses (Al-Shara, 2011; Fahimi et al., 2008; Fahimi, Sistanizad, Abrishami, & Baniasadi, 2010; Hemingway, White, Turner, Dewhirst, & Smith, 2012; IOM, 2006; Kiekkas, Karga, Lemonidou, Aretha, & Karanikolas, 2011; Mansouri et al. 2013; NPSA, 2009; Tzeng, Yin, & Schneider, 2013; Vazin & Delfani, 2012). Medication administration errors commonly happen due to violation practices against the rights of medication administration (Cooper, 2014; Harding & Petrick, 2008; Kim & Bates, 2013; Stetina et al., 2005; Vaknin et al., 2003; Wolf et al., 2006). Several researchers indicated that lack of competence in the rights of medication administration among nursing students appeared to be influenced by the challenges facing nursing educators to provide them with sufficient knowledge and practicum experiences that ensure handling medicines in a prudent, safe manner as possible (Cooper, 2014; Harding & Petrick, 2008; Wolf et al., 2006). Without direct intervention by educators, MEs may become an even greater problem that may become more and more difficult to rollback. Therefore, educators and practitioners must address the risk of MEs, as they continue to threaten the lives and well-being of patients around the world.

The World Health Organization (WHO) report on patient safety (2012) aimed at improving the safety of medication usage by reducing MEs among nurses. In 2009, the WHO highlights the problem of MEs as one of the top research priorities and calls for innovative teaching strategies to improve the competency of nurses’ medication administration. Alsulami et al. (2013) indicated in their recent systematic review regarding MEs in Middle Eastern countries that a lack of quality research related to interventions contributes to the continued problem of MEs in these countries. They also raised an urgent call to introduce new educational strategies like simulation,
to improve nurses' competency regarding drug administration in these countries (Alsulami et al., 2013).

**Simulation.** Lopreiato et al. (2016) defined simulations as “a technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions” (p. 33). Several types of simulations have been used in nursing education and related health professions, such as anatomical models, static mannequins, task trainers, role playing, standardized patients, virtual reality (e.g., Second Life™), and low- to high-fidelity simulation (Nehring & Lashley, 2009). Fidelity refers “to the degree that the object mimics reality” (Nehring & Lashley, 2009, p. 536). Low-fidelity simulator (LFS) represents a selected part of the human body with no physiological signs or parameters, such as breath and heart sounds, voice, or any interactive features (Nehring & Lashley, 2009). High-fidelity simulator (HFS) utilizes a digitalized high-tech real life looking mannequin that can be programmed to cope with real-life physical patient states and to be able to realistically respond to expected relevant participant interactions (Nehring & Lashley, 2009). Nurses have utilized low-fidelity static mannequins for years to gain knowledge and to teach basic nursing skills. The addition of medium- and high-fidelity human simulators in undergraduate nursing education programs appeared in the late 1990s and accelerated in the mid-2000s (Nehring, 2010). This acceleration appears when nursing instructors grew aware that simulations afforded students a great chance to put into practice skills learned in the classroom, expand critical thinking, gain needed practice, and make necessary decisions about interventions in a non-threatening setting.

**Simulation and transfer of medication learning and skills.** Variables central to clinical practice such as fewer clinical opportunities for nursing students to practice nursing skills has
often limited students' exposure to clinical experience (Akhu-Zaheya, Gharibeh, & Alostaz, 2013; Aqel & Ahmad, 2014; Tawalbeh & Tubaishat, 2014; Wilford & Doyle, 2006; Wolf et al., 2006; Wolf et al., 2009). Further, O'Brien (2014) revealed that clinical opportunities for students to practice medication administration are not readily available in actual healthcare environments, due to concerns with patients’ safety (p. 2). Wolf et al. (2006) review of 1,135 medical records demonstrated that one of the primary leading cause of student MEs resulted from lack of clinical experience.

A nationwide survey of 400 U.S. nursing school directors and over 3,500 nurse executives executed in 2008 by the U.S. Nursing Executive Center covered 36 skills that recent nursing graduates are assumed to possess and which are deemed vital for competent nursing practice. The study demonstrated that a huge gap exists between skills learned in academia and those put into practice in real-life settings. The investigators emphasized the need for improved preparation of students in all 36 skill levels and recognized administering medications skills as one of the top ten areas where improvement is needed (Nursing Executive Center, 2008). Because of the concern about entry-level nurses’ insufficient medication administration skills, nurse educators must utilize novel approaches in teaching future nurses safe medication administration to make the transition to clinical practice as simple as possible.

Transferring of learning (cognitive, psychomotor, and affective) gained in nursing school to a real-life clinical practice is the fundamental goal of any nursing education to provide competent, safe nursing care (Lauder, Reynolds, & Angus, 1999, as cited in Ross, 2011; Perkins & Salomon, 1992). Lauder et al. (1999) indicates that “transfer and transferability imply that knowledge, metacognitive strategies and psychomotor skills which have been gained in one context can be applied in another contexts” (p. 480). In this investigation, transfer reflects
nursing students’ ability to apply medication administration skills gained from simulation to real-life patient care setting. The way through which nursing students are exposed to the practice or the environment in which teaching and learning processes takes place (e.g., quality and reality of simulation setting) can influence effective transfer (Lauder et al., 1999). Unlike traditional learning such as lecturing and application on static manikin, it is anticipated that through using HFS, educators can create a robust method to simulate actual performance in clinical setting. Using HFS as an innovative teaching approach affords several advantages to students trying to gain key knowledge and psychomotor skills with ongoing faculty oversight and feedback (Jeffries, 2005). When using simulation, care of patients occur in a healthcare environment that is safe and authentic; students can commit mistakes and then get constructive feedback that will greatly help to develop their abilities and learning while not putting a patient’s life in danger (O’Brien, 2014).

Recent studies indicates that there is a clear void in the literature examining the successful transfer of skills from a simulation-based learning setting to real-world settings (Harris, Pittiglio, Newton, & Moore, 2014; Sears, Goldsworthy, & Goodman, 2010). Hayden and colleagues found in the NCSBN National Simulation Study that the skills gained from simulation translated into actual clinical settings when traditional clinical hours replaced up to 50% simulation (Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries, 2014). However, there are, to my knowledge, only three studies (Campbell, 2013; Ross, 2015; Sears et al., 2010) discussed the impact of simulation based nursing education on directly observed nursing students’ MEs in a real clinical setting. The literature shows mixed results and concludes that more research should be conducted to investigate whether the medication-related competencies gained from simulation translated into actual patient care settings (Campbell, 2013; Ross, 2015; Sears et al.,
This current study examined whether the use of HFS can improve student nurses’ competence in the rights of medication administration by reducing MEs in an actual patient care setting. This study is also the first study undertaken in a Middle Eastern country that address the use of HFS as an innovative teaching method in undergraduate nursing courses to decrease MEs. The finding helps to fill that gap in the education of nurses in an effort to significantly reduce MEs in the long run.

Nurse education in Jordan. Jordan, a small country in the Middle East region, has 15 governmental and private universities offering a variety of undergraduate and graduate nursing degrees (Akhu-zaheya et al., 2013; Jordanian Nursing Council [JNC], 2011). Levels of nursing education range from an associate degree (2-years of education after high school) to a bachelor degree (4-years of education after high school) to a masters level (2 years of study post baccalaureate) to a doctoral degree (4 years of study post masters). In Jordan, the BSN degree is considered the ‘entry-level’ for nursing.

Baccalaureate nursing education began in Jordan in 1972 (Sultan 1998). The programs are four years in duration and require a total of 132-134 credit hours (Akhu-zaheya et al., 2013; Tawalbeh & Tubaishat, 2014), with 60% in clinical practicum. The undergraduate nursing programs in Jordan follow the American model, particularly with regard to the textbooks used in education and the English language used in instruction (Akhu-zaheya et al., 2013; Tawalbeh & Tubaishat, 2014; Zahran, 2011). Furthermore, the undergraduate nursing programs in Jordan are accredited both nationally and internationally and are compatible with the global standards of the “International Council of Nurses” (ICN) and the “American Nurses Association” (ANA) (Akhu-zaheya et al., 2013, p. e337).

Traditionally, Jordanian nursing students receive explicit academic instructions in the
classroom setting and acquire a wide variety of nursing skills in a clinical setting during their clinical practicum. Due to the large number of undergraduate nursing programs and the competition over clinical settings, nursing education faces several challenges including: (a) greater demand for clinical placements that leads to fewer opportunities for nursing students to obtain chances to take part in actual patient care (Akhu-zaheya et al., 2013; Aqel & Ahmad, 2014; JNC-publications, 2011; Tawalbeh & Tubaishat, 2014); and (b) overcrowding of teaching hospitals with medical and nursing students from many different academic institutions, and this can seriously hinder the overall clinical education (Akhu-zaheya et al., 2013; JNC, 2011; Tawalbeh & Tubaishat, 2014). These challenges can pose a threat to the development of medication administration competencies among Jordanian BSN students. Particularly, the literature indicates to a connection between students’ inexperience and their ability to competently carry out vital tasks, like the administration of medicine (Wolf et al., 2006). Thus, transforming nursing education to enhance patient safety mandates the advent of standardized approaches and advanced technologies to reproduce the day-to-day situations found in actual health-care settings (JNC - publications, 2011).

The World Health Organization in the Middle East recommended in 2013 that nursing educators change their curriculum to bridge the practice–education gap, absorb the complexity of health care delivery, improve nursing students' clinical skills, and foster patient safety. The Jordanian Higher Education Accreditation Commission and the JNC encouraged nursing schools to integrate new instructional approaches, particularly simulated learning, in their nursing education (Akhu-zaheya et al., 2013; JNC-publications, 2008, 2011). However, employing simulation in nursing schools in Jordan is relatively new (Akhu-zaheya et al., 2013; Tawalbeh & Tubaishat, 2014).
Many researchers pointed out that to develop safe nursing medication administration practices, nursing faculty should incorporate experiential learning strategies like HFS into the teaching of medication administration to reflect the dynamic complexity of this task (Baghccheghi & Koohestani, 2008; Bourbonnais & Caswell, 2014; Harding & Petrick, 2008; Mrayyan, 2012; Mrayyan & Al-Atiyyat, 2011; Mrayyan et al., 2007; Vaismoradi et al., 2014; Wolf et al. 2006). It is anticipated that the integrated HFS as an adjunct teaching strategy can provide students with a rich learning environment that is not readily available to them currently in clinical settings for learning safe medication administration.

**Statement of the Purpose**

The overall purpose of this dissertation research was to investigate and compare the effectiveness of two educational methods (HFS and traditional lecture) to decrease medication administration errors in an actual medical/surgical patient care setting, in a convenience sample of 89 Jordanian second-year BSN students.

**Study Variables**

The design of this study involved two independent variables and one dependent variable. The first independent variable of teaching method was operationalized at two levels: HFS and traditional teaching method (lecture on medication administration). The second independent variable was time, which was repeated across all study participants. In this case, the variable of time was considered a repeated factor with three levels because all participants were exposed to its three measurements; all participants were tested on the outcome variable three times. Participants were assessed once before the intervention, and twice afterward. The continuous dependent variable was the mean ME score on an instrument called the “Medication Administration Safety Assessment Tool” (MASAT). The MASAT is an eight-item checklist with
dichotomous responses measuring student competency in practicing the six rights of medication administration, including giving the right drug and dose of the drug to the right patient, in addition to using the correct route of administration, and at the correct time using the correct documentation (Goodstone & Goodstone, 2013).

Research Questions

The research questions that guided this investigation were:

Q1: Are there significant within-group changes in the mean score of ME on the MASAT across three measurement occasions (T1: pretest, T2: posttest one, T3: posttest two)?

Q2: Is there a significant between-group difference (lecture group vs. HFS group) in the mean score of ME on the MASAT among second year nursing students in Jordan?

Q3: Is there a significant interaction between time (three measurement occasions) and group (Lecture vs. HFS) on mean values of MASAT?

Specific Aims

1. Describe the key demographics and baseline characteristics of the sample.

2. Examine within-group changes in the mean score of ME on the MASAT across three measurement occasions (T1: pretest, T2: posttest one, T3: posttest two).

3. Examine between-group differences (lecture group vs. HFS group) in the mean score of ME on the MASAT at three discrete measurement occasions.

4. Examine the interaction between time (three measurement occasions) and group (Traditional lecture, HFS) by mean values of ME on the MASAT.

Definition of Terms

Actual patient care setting: Actual patient care setting is an actual clinical setting where students apply theoretical and simulation-based learning content to real hands-on patient care
settings (to actual patients in a real-life clinical setting). In this investigation, students administered medicines to real medical/surgical patients under direct supervision of raters.

**Debriefing:** “An activity that follows a simulation experience and led by a facilitator. To encourage participants’ reflective thinking and provide feedback about their performance while various aspects of the completed simulation are discussed” (Lopreiato et al., 2016, p. 8).

**Fidelity:** “The degree to which the simulation replicates the real event and/or workplace; this includes physical, psychological, and environmental elements” (Lopreiato et al., 2016, p. 11). Simulation fidelity has been defined by Lopreiato et al. (2016) as “the level of realism associated with a particular simulation activity” (p. 34). Simulation can be classified according to their fidelity into low-, intermediate-, and high-fidelity simulation (Nehring & Lashley, 2009).

**High-Fidelity Simulation (HFS):** “In healthcare simulation, high-fidelity refers to simulation experiences that are extremely realistic and provide a high level of interactivity and realism for the learner” (INACSL, 2013, as cited in Lopreiato et al., 2016, p. 14). For this study, a high fidelity simulator produced by METI® (version 6) was the robotic mannequin in the simulation scenarios. Not only does this manikin resemble a human, but it has human actions (e.g., Heart, lung, and bowel sounds; the chest rises and falls with respiration; palpable pulse; and simulator voice) and accurate physiological responses (e.g., Vital Signs and Electrocardiogram change appropriately in response to IV medications given) to provide students with real situations for practice.

**Low-Fidelity Simulation (LFS):** “Not needing to be controlled or programmed
examples include case studies, role playing, or task trainers used to support students or professionals in learning a clinical situation or practice” (Adapted from NLN-SIRC, 2013, as cited in Lopreiato et al., 2016, p. 20).

**Knowledge deficit:** One scenario had a student who gave a patient an anti-diabetic medicine properly and who followed all of the medication-administering protocols correctly but just didn’t comprehend that the medication in fact should not have been given to the patient before the blood glucose level was received back from laboratory. Another Scenario had students not comprehending the pain scale as it related to the medication scale (Cooper, 2014).

**Performance deficit:** Performance deficit is the expectation that even though nursing students may have had the skills and learning needed to administer medicines safely but fails to carry out duties successfully (Wolf et al., 2006, p. 48).

**Medication Administration:** This investigation measures nursing students’ competencies in practicing the six rights of medication administration on the MASAT. The six rights of medication administration is a complex skill that requires many steps to ensure accuracy and prevent errors, which can be accomplished by giving the right drug and dose of the drug to the right patient, in addition to using the correct route of administration, and at the correct time using the proper documentation (Goodstone & Goodstone, 2013; Lisby, Nielsen, & Mainz, 2005).

**Medication administration protocols:** Specified measures performed by medical-delivery entities and their staffers to facilitate the operation of medication administration process and thus deliver a mandated quality of care (Manias & Street, 2000). Any protocol Includes guidelines regarding adherence to the rights of medication administration and basic infection and
safety regulations (Kim & Bates, 2013). This investigation aimed to measure second year BSN students’ competencies in practicing the MASAT medication administration skills. However, the raters instructed students to not violate any step related to adherence to basic infection regulation (e.g., hand washing) but this was not accounted in the student evaluation.

**Medication Error (ME):** A ME has been defined as a deviation in course from what a clinician actually ordered; or in other words is a dose given at odds from which was requested on a patient’s medical record (Barker et al. 2002, p. 1897; Mayo & Duncan 2004, p. 209). In this investigation, a ME is the mean score of medication administration errors among nursing students in treating medical/surgical patient as measured using the MASAT (Goodstone & Goodstone, 2013). Scores on the MASAT was used as a proxy for “potential to commit a ME”.

In this dissertation research, the operational definition of potential medication error was a ME that could result in any possible harm to the patient in the observing RN’s judgment.

**Routes of medication administration:** Medication is administered through different routes. The routes that were studied in this investigation are: oral (by mouth), intravenous (IV), intramuscular (IM), and subcutaneous (sub-Q).

**Scenario:** “In healthcare simulation, a description of a simulation that includes the goals, objectives, debriefing points, narrative description of the clinical simulation, staff requirements, simulation room set up, simulators, props, simulator operation, and instructions for SPS” (Alinier, 2011, as cited in Lopreiato et al., 2016, p. 30). In this investigation, two high fidelity medical/surgical simulation scenarios were used to guide and facilitate the medication administration simulation experience for both instructors and learners to achieve learning outcomes.

**Simulation:** “A technique that creates a situation or environment to allow persons to
experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions” (Lopreiato et al., 2016, p. 33).

**Simulated-Based Learning Experience:** “An array of structured activities that represent actual or potential situations in education and practice. These activities allow participants to develop or enhance their knowledge, skills, and attitudes, or to analyze and respond to realistic situations in a simulated environment” (Pilcher, Goodall, Jensen, Huwe, Jewell, Reynolds, and Karlson, 2012, as cited in Lopreiato et al., 2016, p. 32).

**Traditional Lecture:** It’s a one and a half hours lecture on medication administration. As usual, nursing students enrolled in NUR228 (Adult health nursing II clinical course) receive lecture on medication administration in the first week of class and start going to the clinical site at the beginning of the second week until the 15th Week. The study shifted the lecture that students supposed to take during the first week to the fourth and fifth weeks for traditional lecture group and replace it with HFS intervention for HFS group. The contents of the educational lecture was drawn from fundamentals and medical surgical nursing textbooks [(Brunner and Suddarth's textbook of medical-surgical nursing 13th edition) & (Kozier & Erb's fundamentals of nursing 9th edition)]. The content included: a PowerPoint presentation about medication administration (definitions; components of a drug order; types of medication orders; six rights of medication administration including dosage calculations; routes of administration; getting off the tablet medication; drawing up medication from a vial and an ampule; IM and SC injection sites; IM and SC injection volumes; angles of insertion; type of syringes & needles; infusion pumps; step by step administration of oral, IV, SC, and IM medications).

**Types of error:** “The manifestation of an action that characterizes or represents the overall description of a medication error” (Wolf et al., 2006, p. 45). In this investigation, the
MASAT reflects six ME types including: wrong patient, wrong medication, wrong dose, wrong route, wrong time, and wrong documentation (Goodstone & Goodstone, 2013).

**Wrong patient:** Students make mistakes in identifying the correct patient the medication has been ordered for before they administer it. Failure to correctly identify patients resulted from student’s violation to the following measures: not asking patient to state name and date of birth (DOB), not checking name and DOB against MAR, and not checking patient’s ID band for name and DOB (Goodstone & Goodstone, 2013).

**Wrong drug:** Included in this category are: (a) the giving of medicines that had not even been ordered for a certain patient; (b) same medication given in the wrong form, such as giving plain aspirin instead of coated aspirin; (c) not checking for drug allergy; (d) giving an expired medicine; and (e) giving the ordered drug without sufficient assessment or contacting physician or supervisor for questionable issues such as increase/decrease in heart rate, blood pressure, respiratory rate, blood glucose level, PT, PTT, etc. (Wolf et al., 2006).

**Wrong dose:** Any dose (tablets, intravenous, intramuscular, and subcutaneous) that contained the wrong strength (concentration), quantity, dilution, form, or number (Wolf et al., 2006, p. 1899).

**Wrong route:** Medicines being given to their patients via a route other than was requested or ordered. Included in this category are doses given at a wrong needle angle and in a wrong site (e.g., lateralis site vs. dorsogluteal site vs. deltoid muscle) (Wolf et al., 2006, p. 1899).

**Wrong time:** Included in this category are: (a) giving of a dose over one hour prior to or after the requested administration time (Wolf et al., 2006, p. 1899); and (b) giving medicine without checking when the last dose was given.

**Wrong documentation:** A student don’t document a medication the time that s/he give
the medication. Student must complete all of the documentation that is required on the
medication administration record.

**Significance of the Study**

**Significance to nursing education.** The use of HFS in nursing education in the Middle
East and Jordan is relatively new. This study can contribute to a needed paradigm shift regarding
the use of advanced educational methods in Jordan’s undergraduate nursing programs. The
study’s findings can help to garner the attention of Jordanian faculty members to consider
innovative and efficient methods for educating nursing students on medication administration.
Furthermore, it can enhance the use of new teaching methods to ensure competent future nurses
in light of both the escalating number of nursing students and the training deficiencies that still
hinder the chances for nursing students to gain meaningful experience in real-life settings.

**Significance to nursing practice.** Medication administration errors is a significant
problem in health care settings (WHO, 2009). Nursing education aims to matriculate competent
and skilled graduate nurses who provide safe, competent, and quality patient care. One factor
that can lead to MEs is the training deficiencies or lack of experience at the baccalaureate
nursing degree level (Harding & Petrick, 2008; Wolf et al., 2009; Wolf et al., 2006). The study’s
findings can help in adopting advanced educational methods to improve the education of health-care
workers by permitting students and clinicians to be educated in a setting where errors are
permitted but will not cause harm to real patients. This study aimed at the application of HFS and
traditional learning to undergraduate nursing students to determine the effect on MEs, fulfilling
one of the goals that have long been advocated by the WHO-EMRO and JNC.

**Significance to nursing research.** Even though simulation is ubiquitous in nursing
education, there remains limited empirical data examining whether the medication-related skills
gained from simulation translated into actual patient care settings. Likewise, contemporary academic nursing literature includes a great evidence-based protocols for administering medicine; but there is a paucity of recent work examining effective teaching tools and methods for this vital psychomotor skill.

**Significance to nursing leadership.** This investigation can provide valuable data for the WHO-EMRO, JNC, Jordanian Higher Education Accreditation Commission, who often call for the integration of new educational approaches, particularly simulated learning, in education. The greater realization regulators get out of HFS and its effects on BSN education, the better they can develop effective undergraduate education courses, methods, and requirements in an effort to reduce the MEs made by nurses around the world.

**Summary**

The occurrence of errors in administering medicines has been on the increase amongst nurses and nursing students (Aboshaiqah, 2014; Al-Shara, 2011; Baghcheghi & Koohestani, 2008; Brady et al., 2009; Cooper, 2014; Ebrahimi Rigi Tanha, et al., 2012; Fahimi et al., 2008; Kim & Bates, 2013; Mrayyan, 2012; Mrayyan et al., 2007; Vazin & Delfani, 2012) and thus can cause patients dire unexpected outcomes like having to be hospitalized and can even result in their deaths (WHO, 2009). Recently, the gap between what students learned in nursing classes and actual work settings has, alas, even seemed to be growing (Hughes, Smith, Sheffield, & Wier, 2013; Nursing Executive Center, 2008). The theory-practice gap creates a huge problem for educational institutions in making sure that their graduate are actually ready to provide the best healthcare possible for an ever more at-risk population (Nursing Executive Center, 2008). This gap can be aggravated by reliance on traditional teaching methods and fewer clinical opportunities for nursing students to practice nursing skills (Aqel & Ahmad, 2014; Tubaishat &
Therefore, nurse educators must address this limited experience and develop or adapt other methods for teaching safe medication administration to help in bridging the gap; thus preventing MEs and improve the delivery of prudent and safe care. This study explored the effectiveness of two instructional method, HFS and traditional teaching method (lecture), in Jordanian undergraduate nursing education to determine the effect on MEs in actual medical/surgical patient care settings.
CHAPTER TWO

REVIEW OF LITERATURE

The review of literature for this current work was conducted for the purpose of (a) providing an overview of the Kolb’s experiential learning theory that serve as a guide for this inquiry; (b) reviewing of the previous relevant literature related to types of MEs, prevalence of MEs, factors contributing to MEs, barriers to the reporting of MEs, and interventional studies designed to reduce MEs amongst nurses and nursing students in Middle Eastern countries; (c) summarizing the current studies concerning medication administration errors in the U.S. hospitals, among practicing nurses, and nursing students; (d) reviewing research studies on the use of simulation to improve medication related knowledge, skills, and errors among nurses and nursing students; and (e) identifying gaps in the existing literature.

Theoretical Framework

The theory that guided this investigation is Kolb’s (1984) experiential learning theory. Simulation, particularly HFS-based learning, is a form of experiential learning, where the learner can gain knowledge and skills through reflection and manipulation of the simulation environment (Jeffries, 2005). Kolb’s (1984) learning model in Figure 1 has four cyclical stages. The cycle starts with concrete experience, where the learner actively encounter a new experience (e.g., HFS lab experience). The conscious reflection back on that experience represents the second stage of Kolb’s theory (reflective observation). Reflection enables learners to understand their action and identify what areas need improvement and suggest appropriate interventions to what they have just experience. Learner's reflection followed by abstract conceptualization. Abstract conceptualization is where the learner think deeply. In this stage, the learner gives rise to a new idea or modifies an existing abstract concept, and then generalizes actions to other
previously experienced. Lastly, in the active experimentation phase, learner try to apply what s/he has gained from the previous experience and reflection in the world around him/her (Kolb, 1984).

This dissertation study included students who took part in two simulation scenarios. In both scenarios, students administered medication to a high-fidelity mannequin, which reflects the concrete experience in Kolb’s theory Kolb’s theory. After completion of the simulation experience, students then took part in a debriefing session. This debriefing is the self-reflection part of Kolb's theory in which students reflect on their simulated medication administration experience, discuss and focus on points that raised during the medication administration process gained via the simulation experience, and receive faculty and peer feedback on their medication administration performance. The third stage, in which the learners modify an existing concept, enabled the student to identify what aspects of their medication administration needed improvement, and to generate appropriate interventions. Finally, in the active experimentation phase, students were able to incorporate their learned actions gained from the previous experience and reflection in order to ascertain how efficient they are in actual medical/surgical settings, completing Kolb's theory cycle (Kolb, 1984).
Medication Errors in Middle Eastern Countries

Medication errors (MEs) are a significant worldwide issue that can cause serious injury and even death (Alsulami et al., 2013; WHO, 2009). Many studies have addressed the problem of MEs in Western countries, however, little is known about MEs in the Middle Eastern region (Alsulami et al., 2013). One recent systematic review (Alsulami et al., 2013) summarized research conducted in Middle Eastern countries concerning MEs. This section expands on Alsulami’s et al. (2013) systematic review to identify and review relevant studies done on MEs in every country in the Middle East for the purpose of identifying common types of MEs, prevalence of MEs, factors contributing to MEs, barriers to the reporting of MEs, and interventional studies designed to reduce MEs.

Middle East. There are sixteen countries in the Middle East region (see Appendix M), with an approximate population of 400 million people (World Bank, 2015). Although the Middle
Eastern country’s healthcare systems have evolved in recent years, they still lag behind when compared to the standard of healthcare systems operating in Western countries. WHO statistics in 2013 revealed that the average life expectancy at birth in the Eastern Mediterranean region is 68 years, versus 77 years in Americas (North America and South America) and 76 years in Europe (WHO, 2013). The average density of the health workforce in Eastern Mediterranean region stood at 12.7 physicians and 18 nurses per 10,000 population, far less than that of Americas (21.5 physicians and 72 nurses per 10,000 population) and Europe (32.1 physicians and 80.2 nurses per 10,000 population) (Statista, 2013; WHO, 2015).

Jordan has one of the most advanced health care systems in the Middle East region (WHO, 2006). The WHO statistics (2013) revealed that the average life expectancy at birth in Jordan was 74 years, the total expenditure on health services accounted for about 7.2% of gross domestic product, and the health expenditure per capita was $336. The average density of healthcare provider in Jordan stood at 25.6 physicians and 40.5 nurses per 10,000 population, similar to a certain extent to that of Americas, and far less than that of Europe (Statista, 2013; WHO, 2015).

**Search strategy.** An extensive literature review pertaining to MEs in Middle Eastern countries was performed in December 2016. The search strategy included all MEs that occurred at any phase of the medication management cycle from prescribing of a drug to transcribing, dispensing, administration, and lastly, documentation. The investigator limited search strategy to peer-reviewed research articles in English. The search strategy did not include any restriction to a population of interest, type of study, and type of MEs. Databases including CINAHL, PubMed, Cochrane, MEDLINEplus, Web of Science (ISI), Google, and Google Scholar, were utilized for this search. References within eligible articles were manually searched for the purpose of
identifying additional articles of relevance. The time span was between September 2000 and September 2015.

Multiple keywords were used to search the above databases: drug error(s), drug mistake(s), medication error(s), medication mistake(s), prescribing error(s), prescribing mistake(s), administration error(s), administration mistake(s), transcribing error(s), transcribing mistake(s), dispensing error(s), dispensing mistake(s), documentation error(s), nurse(s), nursing student(s), pharmacist(s), physician(s), wrong medication(s), incorrect medication(s), wrong drug(s), incorrect drug(s), wrong patient(s), incorrect patient(s), wrong dose(s), incorrect dose(s), wrong route(s) of administration, incorrect route(s) of administration, and wrong documentation(s). The keywords were combined using “OR” then combined using “AND” with the keyword “Middle East” and with the name of every country in the Middle East (Alsulami et al., 2013, p. 996).

The total search of literature from the seven databases yielded 520 published articles. After reviewing for relevance and appropriateness to the topic, papers that did not discuss MEs explicitly in the Middle East were excluded. A total of 42 articles were identified as eligible for inclusion in this review, based on contributions to the existing body of knowledge in terms of the methodological approaches, the target populations, the type and the frequency of the MEs, reporting of MEs, and the interventions utilized to decrease MEs among Middle East countries. The majority of the studies were concerning MEs among nurses, with only five Iranian studies concerning nursing students’ MEs. The full texts the five articles were in Persian (Farsi) but the abstract were in English. The investigator decided to include the five studies in this review relying on the information stated in the abstracts and on the information reported in the systematic review regarding MEs in Middle Eastern countries performed by Alsulami et al.
(2013) and a literature review on the incidence and types of MEs in Iranian healthcare settings performed by Mansouri, Ahmadvand, Hadjibabaie, Kargar, Javadi, and Gholami (2013). Consequently, 42 studies were included in the final review.

The relevant studies for every country in the Middle East were classified according to: (a) type of MEs occurring at any phase in the medication management cycle including prescribing, transcribing, dispensing, administration, and documentation errors; (b) factors contributing to MEs; (c) barriers to the reporting of MEs; and (d) intervention studies on MEs. Medication administration errors were also summarized within the context of nurses’ MEs and nursing students’ MEs (see Appendix N for the origin and classification of included studies).

**Prescribing errors.** Most studies identified in this review defined prescription error as any error committed during the prescribing phase. These include (a) selection of wrong medication; (b) incorrect dose, including dosage form and strength; (c) wrong frequency; (d) wrong route of administration; and (e) lack of instruction for use of a medication (Al-Dhawailie, 2011; Al Khaja, Al Ansari, Damanhori, & Sequeira, 2007; Al Khaja, Al-Ansari, & Sequeira, 2005; Lustig, 2000; as cited in Alsulami et al., 2013, p. 998). Ten studies addressed the problem of prescribing errors in Middle Eastern countries. These studies will be summarized within the context of: (a) origin of study; (b) type of study; (c) population of interest; (d) sample; (e) setting; and (f) type and frequency of error.

In Saudi Arabia, Neyaz, Khoja, Quresh, Magzoub, Haycox, and Walley (2011) reviewed 600 prescriptions written by 87 physicians working in private and public primary health care settings. They found that 63 physicians out of 87 physicians wrote low-quality prescriptions. Khoja, Neyaz, Quresh, Mogzoub, Haycox, and Walley (2011) found 990 in 5,299 prescriptions—written by primary care physicians—had some sort of prescribing error. One
prospective study undertaken in a teaching hospital in Saudi Arabia revealed a prescribing error rate of 7.1% (113 prescribing errors among 1,580 medication orders) (Al-Dhawailie, 2011). Prescribing the wrong strength followed by prescribing the wrong frequency were the most frequent prescribing errors detected (Al-Dhawailie, 2011). Another prospective study conducted in a general hospital found 3,963 prescribing errors among 2,627 medical records (Dibbi, Al-Abrashy, Hussain, Fatani, & Karima, 2006). The wrong strength in 914 medical records (35%) followed by the wrong route in 807 medical records (35%) and wrong dosage in 788 medical records (30%) were the most common prescribing errors (Dibbi et al. 2006).

In Bahrain, Al Khaja et al. (2005) conducted a prospective study on prescribing errors. Results revealed a prescribing error rate of 7.7%, with 5,959 prescribing errors among 77,511 prescriptions ordered in primary care setting. Omission error in dosage strength, form, and frequency were the most common types of prescribing errors reported. Al Khaja et al. (2007) reviewed 2,282 infant prescriptions ordered in primary care setting in Bahrain. They found a medication related prescribing error rate of 90.5%, with omission (54.1%), wrong frequency (20.8%) and wrong strength (17.7%) being the most common types of errors. Another nationwide retrospective study conducted by Al Khaja, Sequeira, and Damanhori (2012) for the purpose of detecting prescribing errors pertaining to cardiovascular and anti-diabetic medication. They evaluated 2,773 prescriptions issued by 194 primary care physicians for a prescription audit. Results concluded a high prevalence of medication prescribing errors; around 25% of prescriptions (n=690) had errors with the majority of errors occurring in prescribing B-blockers and loop diuretics (8%).

In Oman, Al Shahaibi, Al Said, Chitme, and Kini (2012) collected and reviewed 900 handwritten outpatient prescriptions issued from different hospitals. Errors were analyzed and
classified within the context of the four parts of drug prescription: superscription (missing information on a patient’s demographics); inscription (missing information on dosage form, strength, and duration of medicine); subscription (missing information on direction for drug use, dispenser's signature, date of prescription, and illegible handwriting); and signature (missing information on prescriber’s signature). The study revealed a high rate of medication prescribing errors, as follows: (a) in regard to superscription errors, 72% (n=648) and 32.66% (n=297) of prescription had missed information on the patient’s age and gender, respectively; (b) regarding inscription errors, around 45% of prescriptions (n=405) had incomplete information on doses; (c) regarding subscription errors; 100% (n=900) and 44% (n=396) of the prescriptions had missing information on the date of dispensing and dispenser's signature, respectively. Approximately 46% of prescriptions (n=414) had missed instructions or directions on drug use; and (d) 4% (n=36) of prescriptions missed the health care provider’s signature.

In Israel, Lustig (2000) reviewed 14,385 prescriptions ordered in a general hospital. They found a prescribing error rate of 60.6% among 160 total MEs detected. The most common prescribing errors reported were wrong drugs and dosages.

In Egypt, Sabry, Farid, and Aziz (2009) conducted a prospective observational study to reveal the frequency of medication related problems in a teaching hospitals. Among 2,286 medications ordered for 220 Intensive Care Unit (ICU) patients; drug related prescribing problems were reported in 97% of patients, with dosing related error representing 55.5% of the total MEs detected. Lack of pharmacological knowledge about rational prescription was responsible about vast majority of errors.

**Administration errors.** Some studies identified in this review (Al-Shara, 2011; Fahimi, Ariapanah, Faizi, Shafaghi, Namdar, & Ardakani, 2008; Mrayyan et al., 2007) defined
administration error using the definition previously defined by Allan and Barker (1990) and Anon (1982) as “a deviation from the prescriber's medication order as written on the patient's chart, manufacturers' preparation/administration instructions, or relevant institutional policies” (as cited in Keers, Williams, Cooke, & Ashcroft, 2013, p. 238). The remaining studies summarized below considered administration errors generally as an error occurring from violation of any of the six rights of medication administration, which includes the correct patient, drug, time, route, dose, and documentation (Goodstone & Goodstone, 2013; Hughes & Blegen, 2008). Eighteen studies addressed the problem of administration errors in Middle Eastern countries; 13 of them concerning drug administration errors among nurses while the others (n=5) concerned nursing students’ MEs. These studies will be summarized within the context of: (a) origin of study; (b) type of study; (c) population of interest; (d) sample; (e) setting; and (f) type and frequency of error.

In Saudi Arabia, with an aim to identify Saudi nurses’ perception about medication administration errors, Aboshaiqah (2014) conducted a descriptive, correlational, cross-sectional study among a sample of 309 nurses from two regional hospitals. An important finding was that the average perceived rate of MEs among nurses was 1.4 times/month and the most common types of administration error reported was wrong timing. Ahmed, Al-Abbas, Al-Omran, Sadat-Ali, Al-Shafei, and Al-Turki (2010) collected and reviewed incident reports documented by nurses and physicians for over one year (2008-2009) in a teaching hospital. Their review found 38 medication incident reports among 23,957 admissions. Errors were noted in the rights of medication administration with missed medication and wrong time being the most common ones (Ahmed et al., 2010).

All studies done in Jordan measured Jordanian nurses’ perception about rate and type of
MEs. Al-Shara (2011) revealed that the rate of MEs reported among 126 Jordanian nurses was (48%); and (b) incorrect patient (26%), wrong dosage (22%), and a wrong drug (12%) were the leading types of errors. Mrayyan et al. (2007) found that, among a sample of 799 Jordanian nurses recruited from 24 hospitals, each nurse committed approximately 2.2 MEs over the entire span of their nursing careers, which averaged about 3.5 years. Mrayyan (2012) collected data from 212 nurses working in four Jordanian teaching hospitals’ ICUs and wards. Results revealed an incidence rate of MEs of 35% (36.4% in ICUs compared to 33.8% in wards). Mrayyan and Al-Atiyat (2011) compared MEs between two university- and two non-university-teaching hospitals. The study sample consisted of 269 nurses. They ended up with results yielding significant differences between the two types of hospitals regarding to the rate, causes, and reporting of MEs, with more MEs reported in non-university hospitals than in university hospitals (43.1% vs. 33.9%, respectively).

In Iran, several descriptive (self-report survey) studies were conducted to investigate the type and frequency of medication administration errors among Iranian nursing students in different health care settings. Koohestani and Baghcheghi (2008) found that administration errors had occurred in 10% of the sample (n=60), with incorrect rate (28.6%), incorrect dose (17.1%), and incorrect medication (14.3%) being the most prevalent types of errors (as cited in Alsulami et al., 2013 & Mansouri, Ahmadvand, Hadjibabaie, Kargar, Javadi, & Gholami, 2013). Koohestani, Baghcheghi, and Khosravi (2008) found that administration errors had occurred in 17% of the sample (n=76), with incorrect dose (20.0%), incorrect medication (20.3%), and incorrect rate (18.6%) being the most prevalent types of errors (as cited in Alsulami et al., 2013 & Mansouri et al., 2013). Ebrahimi Rigi Tanha, Baghaei, and Feizi (2012) concluded that MEs among Iranian nursing students (n=54) was high, with wrong time (20.6%) and omission
(11.4%) were the most common administration error reported by them (as cited in Mansouri et al., 2013). Mohammadnejad, Hojatti, Sharifnia, and Ehsani (2010) found that incorrect dose (24.3%), incorrect medication (18.9%), and incorrect infusion rate (16.2%) were the most common medication administration error reported among a sample of 78 Iranian nursing students (as cited in Mansouri et al., 2013).

To my knowledge, only one direct observational study has been conducted in Iran and reported to understand the type, rate, and causes of MEs committed by Iranian nursing students. Baghchechi and Koohestani (2008) observed 52 nursing students while preparing and administering intravenous medication in different hospital units. Results revealed the following: (a) 153 (41.1%) MEs were observed among 372 observations; (b) wrong diluents and wrong dose represented approximately 5% of the total preparation errors detected (13.4%); and (c) wrong bolus and infusion rate and wrong route represented approximately 24% of the total administration errors detected (27.8%) (as cited in Mansouri et al., 2013).

A descriptive (self-report questionnaire) study conducted by Eslamian, Taheri, Bahrami, and Mojdeh (2010) for the purpose of revealing the rate and type of medication administration errors among randomly selected nurses and head nurses (n=239) working in different hospitals in Iran. They found that 100% of the sample committed at least one ME during their entire work experience. The most prevalent type of administration errors reported were: (a) lack of reviewing patient’s medical history and lab tests (60%); and (b) administering the drug at a wrong time (27.5%).

Three observational studies carried out by Iranian researchers to investigate type, rate, and ramifications of MEs among Iranian nurses. Vazin and Delfani (2012) found that the majority of MEs occurred most frequently during administration phase (61.0%) with incorrect
technique (20.4%), time (10.0%), and wrong dose (7.7%) being the most common ones. Fahimi et al. (2008) identified 380 intravenous MEs out of 4040 opportunities for error among Iranian ICU nurses. Of those, 66.4% were related to the administration process. Another observational study was conducted by Fahimi, Sistanizad, Abrishami, and Baniasadi (2010) to estimate the type and rate of MEs associated with IV pumps in a teaching hospital ICU. Administration errors (incorrect dose, n=14) were observed while nurses were administering 43 doses with 258 opportunities for error (Fahimi et al. 2010).

Mansouri et al. (2013) performed a literature review to clarify the incidence and types of MEs in Iranian healthcare settings. The review included 18 articles focused on MEs that happened in all stages of the medication process. Results indicated that: (a) the estimated incidence of MEs across all studies ranged between 14.3%-70.0%; and (b) the most common types of MEs reported were administration errors.

**Transcribing errors.** This type of ME has been described as any discrepancy that resulted during the transfer of medication information from an order sheet to other medical records, a mistake usually made during data entry or at times due to an electronic error (Alsulami et al., 2013). Discrepancies often occur in the drug name, route of administration, dose, time, patient, drug formulation, etc. Only one study (prospective observational studies) on transcription errors was conducted in the Middle East. The study was conducted in Iran by Fahimi and colleagues (Fahimi et al., 2009). They detected 289 transcription error in 287 medical records. Omission errors—where the patient does not receive the medications as ordered—and wrong dose represented 52% and 18% of the total transcription error, respectively.

**Causes of and factors contributing to MEs.** Several studies were conducted in the Middle East to uncover causes and factors contributing to MEs, as perceived by physicians,
nurses, and nursing students. The majority of these studies were performed by Jordanian, Saudi, Iranian, and Israeli researchers. These studies will be summarized within the context of the following: (a) origin of study; (b) type of study; (c) population of interest; (d) sample; (e) causes of MEs; and (f) factor contributing to MEs.

In Jordan, two descriptive (self-report survey) studies carried out by researchers for the purpose of revealing the causes of and factors contributing to MEs among Jordanian nurses. The first study conducted by Al-Shara (2011) and concluded that nurses' heavy workload (41.4%) and lack of experience among new staff (20.6%) were the leading causes of MEs, as perceived by 126 nurses. In the second investigation, Mrayyan (2012) revealed that some of the highest perceived causes of MEs among 212 nurses, recruited from four Jordanian teaching hospitals intensive care units and wards, were inadequate or altered labeling ($\text{Median} = 6$, Interquartile Range [IQR] = 3-9), setting up an IV infusion pump incorrectly ($\text{Median} = 5$, IQR = 3-8), and failure to check the patient’s identification band (ID) with the MAR ($\text{Median} = 5$, IQR = 3-8). This is consistent with an emerging call for additional educational strategies to enhance medication knowledge, skills, and accuracy in order to decrease MEs.

In Saudi Arabia, Aljadhey et al. (2014) conducted a qualitative study with nurses and other health professionals, on factors contributing to MEs and recommendations for improving safe medication practices. Round-table discussions were transcribed and analyzed and revealed that limited use of health information technology like Computerized Physician/Provider Order Entry (CPOE), lack of medication safety measures, and nonadherence to a medication protocol were major factors in undermining medication safety. Other researchers using quantitative methods found 3963 prescribing errors among 2627 medical records for adult hospitalized patients in a general hospital (Dibbi et al., 2006). They concluded that human factors (both
knowledge and performance deficits) were the major cause contributing to prescribing errors. Meanwhile, Al-Dhawailie (2011) found a prescribing error rate of 7.1% out of 1580 medication orders in a teaching hospital. Similar to Dibbi and colleagues, Al-Dhawailie et al. indicated that human factors (knowledge deficit on prescribing skill) was the most common cause contributing prescribing errors.

An observational study conducted by Baghcheghi and Koohestani (2008) in Iran to better understand the causes of MEs committed by 52 Iranian nursing students while preparing and administering intravenous medication in several different hospital units. They observed 153 (41.1%) MEs among 372 observations and indicated that a lack of pharmacologic knowledge was the main cause of errors. Vaismoradi, Jordan, Turunen, and Bondas (2014) conducted a qualitative descriptive study using a content analysis to describe 24 Iranian nursing students' perspectives of the causes of MEs. All students agreed that their programs’ emphasis on theoretical content instead of practical application resulted in inadequate preparation to administer and manage medications safely. Additional quantitative descriptive and observational studies (Koohestani & Baghcheghi, 2008; Koohestani et al., 2008; Ebrahimi Rigi Tanha, et al., 2012; Mohammadnejad et al., 2010; Baghcheghi & Koohestani, 2008) indicated that MEs among nursing students continue at an alarming rate. These studies attributed the high prevalence of MEs to the continued reliance on traditional methods for teaching medication administration. This again is consistent with the emerging narrative that calls for additional investment in innovative and experiential teaching methods in order to better prepare future nurses.

In Israel, Vaknin, Wingart-Emerel, and Stern (2003) indicated that violation to standardized procedure guidelines on the part of nurses and physicians was the most common cause contributing to MEs. Bar-Oz et al. (2008) found that lack of experience was the most
common cause contributing to prescribing errors among 627 physicians working in community and hospital settings in Israel.

**Reporting of MEs.** Several studies conducted in the Middle East investigated reasons for underreporting MEs, particularly among nurses. These studies will be summarized within the context of (a) origin of study; (b) type of study; (c) population of interest; (d) sample; and (e) reasons for not reporting MEs.

Mrayyan (2012) investigated the willingness of Jordanian nurses to report MEs in four Jordanian teaching hospitals ICUs and wards. Mrayyan collected data from 212 nurses utilizing a self-report survey. Results indicated that administrative responses such as fear from their managers negatively respond to MEs (70.0%), fear of punitive and/or disciplinary action (46.2%), and fear from the reaction they might receive from their coworkers (71.8) were some of the top barrier affecting Jordanian nurses’ willingness to report MEs.

Several studies have indicated that ME rates in Saudi Arabia are still underreported (Alshaikh, Mayet, & Aljadhey, 2013; Hemida, Al Hawawi, Al Awwad, & Al-Salam, 2011). For example, Almutary and Lewis (2012) examined RN’s willingness to report, and barriers to the reporting of, MEs. They collected data from 62 RNs utilizing self-report questionnaires and revealed that nursing administration concerns (80%) was the most reported barrier that affected RN’s willingness to report medication administration errors. Consistent with the aforementioned study, Al-Youssif, Mohamed, and Mohamed (2013) surveyed 253 nurses working at a general hospital, and concluded that negative administrator reaction (50.3%) and fear of adverse consequences (63.8%) such as negative attitude from the patient or family were the main reasons cited for not reporting MEs.

In Iran, Koohestani and Baghcheghi (2009) carried out a descriptive, cross-sectional
study to investigate barriers to not reporting MEs among 240 nursing students in their second semester or later. They found that every student committed approximately two medication administration errors during his/her academic period. Further, they indicated that administrative barrier (no positive feedback) and fear of affecting their evaluation score were the main reasons for not reporting MEs to their instructor.

**Intervention studies on MEs.** Without interventions in this area, the problem of MEs may become an even more significant problem. To date, little attention has been given by Middle Eastern countries to alleviate the magnitude of this issue, despite the clear, emerging theme of several practitioners not being well-educated in how to avoid MEs. The following summarizes a variety of intervention studies within the context of the origin of the study, type of study, population of interest, sample, and the nature of interventions to reduce MEs.

In Saudi Arabia, Aljadhey et al. (2014) suggested several strategies to improve medication safety practices such as continuous education for healthcare providers on medication safety and increased investment in technology to decrease MEs (e.g., simulant-based education strategies). Qureshi, Neyaz, Khoja, Magzoub, Haycox, and Walley (2011) assessed the effectiveness of a variety of intervention programs on 61 Saudi physicians’ prescription practices. Their intervention consisted of prescription training and administrative and regulatory guidelines for promoting rational prescribing. The results revealed an improvement in the quality of drug prescriptions; stating patient's age, diagnosis, and drug dosage and frequency were noted in 100% of prescriptions following the interventions ($p < 0.001$).

A group of researchers from Israel indicated that the use of a CPOE system in medication ordering processes can reduce misinterpretations and transcription errors resulting from handwritten medication orders (Oliven, Michalake, Zalman, Dorman, Yeshurun, & Odeh, 2005;
Oliven, Zalman, Shilankov, Yeshurun, & Odeh, 2002). Other Israeli researchers indicated that adding an advanced Clinical Decision Support (CDS) system into CPOE can reduce (Kadmon, Bron-Harlev, Nahum, Schiller, Haski, & Shonfeld, 2009) or eliminate (Vardi et al., 2007) MEs.

In Iran, a group of researchers indicated that incorporating CDS into CPOE can enhance CPOE functionality in detecting MEs; errors were significantly reduced from 53% to 34%, \( p < 0.001 \) (Kazemi et al., 2011).

In Egypt, Alagha, Badary, Ibrahim, and Sabri (2011) conducted a pre–post study on prescribing error rates in a pediatric ICU. They noticed a significant decrease in the rate of prescribing errors (78.1% to 35.2%, \( p < 0.001 \)) after the implementation of several ME reducing measures, including physician education, well-structured medication order chart, and performance feedback.

In United Arab Emirates, a group of clinical pharmacists developed training and educational materials and handouts on medication safety for 370 nurses (Elnour, Ellahham, & Al Qassas, 2008). They utilized self-reported questionnaire to collect data. Results revealed an improvement in their knowledge and awareness about MEs (57.4% ± 8.2 vs. 68.9 ± 10.3, \( p < 0.05 \), pre and post questionnaire respectively).

Summary

Despite the studies presented above, there is still limited data available about MEs in the Middle East, particularly regarding MEs by nursing students. This review revealed that evaluation of MEs is difficult due to: scarcity and poor quality of included studies; heterogeneity in ME definitions; variations in study methods; different populations; different measurement of MEs; and variations in the reported incidence. These findings are in line with the findings of the systematic review of MEs in Middle Eastern countries (Alsulami et al., 2013).
MEs can happen in any clinical setting at any phase in the medication cycle. The majority of studies indicated that most MEs occur during the medication administration phase (Al-Shara, 2011; Fahimi et al., 2008; Fahimi et al., 2010; Mansouri et al. 2013; Vazin & Delfani, 2012). Medication administration errors are prevalent amongst nurses (Aboshaiqah, 2014; Al-Shara, 2011; Fahimi et al., 2008; Mrayyan, 2012; Mrayyan et al., 2007; Vazin & Delfani, 2012) and nursing students (Baghcheghi & Koohestani, 2008; Ebrahimi Rigi Tanha, et al., 2012; Koohestani & Baghcheghi, 2008; Koohestani et al., 2008; Mohammadnejad et al., 2010, as cited in Mansouri et al., 2013). This creates an emerging call for additional strategies to improve medication knowledge and skills in order to decrease MEs in the Middle East.

Administration errors commonly happen in the “rights” of medication administration including to wrong patient (Al-Shara, 2011), wrong drug (Al-Shara, 2011; Koohestani & Baghcheghi, 2008, as cited in Alsulami et al., 2013; Koohestani et al., 2008, as cited in Alsulami et al., 2013), wrong dose and infusion rate (Al-Shara, 2011; Baghcheghi & Koohestani, 2008, as cited in Mansouri et al., 2013; Koohestani & Baghcheghi, 2008, as cited in Alsulami et al., 2013; Koohestani et al., 2008, as cited in Alsulami et al., 2013; Vazin & Delfani, 2012), wrong route (Baghcheghi & Koohestani, 2008, as cited in Mansouri et al., 2013; Vazin & Delfani, 2012), and wrong time (Aboshaiqah, 2014; Ahmed et al., 2010; Ebrahimi Rigi Tanha, et al., 2012 as cited in Mansouri et al., 2013; Esamian, et al., 2010; Vazin & Delfani, 2012). The review revealed that the primary contributing factors to MEs were as follows: (a) lack of experience (Al-Shara, 2011); (b) knowledge and performance deficit (Al-Dhawailie, 2011; Baghcheghi & Koohestani, 2008; Dibbi et al., 2006); (c) nonadherence to the medication administration protocol (Mrayyan, 2012; 70, Vaknin et al., 2003); and (d) fragility of teaching methods in nursing education (Baghcheghi & Koohestani, 2008; Ebrahimi Rigi Tanha, et al., 2012; Vaismoradi et al., 2014). Hence,
initiatives on education and skills proficiency levels are needed to improve safe medication administration (Baghcheghi & Koohestani, 2008; Ebrahimi Rigi Tanha et al., 2012; Fahimi et al., 2008; Koohestani & Baghcheghi, 2008; Mrayyan, 2012; Mrayyan & Al-Atiyyat, 2011; Mrayyan et al., 2007; Vaismoradi et al., 2014). Universities in Middle Eastern countries should consider the inclusion of evidence-based educational strategies to improve nursing students’ competency regarding drug administration skills and improve patient safety (Baghcheghi & Koohestani, 2008; Ebrahimi Rigi Tanha et al., 2012; Vaismoradi et al., 2014).

MEs are typically still under-reported among nurses and nursing students due to fear of punitive, disciplinary and administrative actions (Aboshaiqah, 2014; Almutary & Lewis, 2012; Al-Youssif et al., 2013; Koohestani & Baghcheghi, 2009; Mrayyan, 2012). This suggests that the rates of MEs, which are alarming, are likely underreported. Without direct intervention, the scope of MEs problem may continue to threaten the lives and well-being of patients. Interventional studies on MEs in the Middle East are scarce (Alsulami et al., 2013; Mansouri et al. 2013). Most interventions centered on the ability of CPOE system to reduce MEs and improve safety (Kadmon et al., 2009; Kazemi et al., 2011; Oliven et al., 2002; Oliven et al., 2005; Vardi et al., 2007). No interventional studies in the undergraduate programs concerning nursing students and MEs in Jordan as well as in Middle Eastern countries have been undertaken yet. This study focused on utilizing HFS as an innovative teaching method to determine its effect on MEs among Jordanian undergraduate nursing students.

**Medication errors in the U.S.**

Providing safe and competent care is a vital concern of any healthcare delivery system. Safe and accurate administration of medicine is considered one key indicator of the quality of health care (Benjamin 2003). But the problem is that MEs continue to threaten the safety of
patients in health care institutions due to high prevalence rates. This section will summarize some studies that have been conducted on medication administration errors in the U.S. hospitals and among nursing students. The included studies were selected with respect, to a certain extent, to the violations of the rights of medication administration.

**MEs in U.S. hospitals.** Study results have indicated that MEs are still prominent and threaten patient safety in American hospitals. Using the 1992 American Hospital Association database and the 1992 National Clinical Pharmacy Services database, Bond, Raehl, and Franke (2001) found that MEs were common among the 1116 US hospitals that report specific information on MEs. The study revealed that the mean MEs reported per year per hospital was ($M = 385.83 \pm 466.96$) with an average of one ME every 19.73 admissions. These findings are consistent with findings from an observational study conducted by Barker et al. (2002). Trained raters observed 3216 medication administration activities in 36 US health care facilities. They found a ME rate of 19% (n=605; at the rate of 1 ME of every 5 doses) with wrong time (43%), omission (30%), and incorrect dose (17%) being the most frequent errors observed. Another recent systematic review of 91 direct observational studies on ME found that administration error remain one of leading threats to patient safety (Keers, Williams, Cooke, & Ashcroft, 2013).

**Nursing students MEs.** Review of literature revealed a limited number of studies concerning nursing students MEs. Wolf et al. (2006) conducted a descriptive, retrospective, secondary analysis study to investigate the characteristics of 1,135 student-made MEs reported to the MEDMARX—the U.S. ME-reporting database—over a five-year period. They found that (a) 1,208 out of 1,305 records (92.5%) were associated with a type of ME, with wrong dose (improper/extra) (n=408, 31.25%), omission error (n=248, 19%), wrong time (n=221, 17%), and
wrong patient (n=120, 9%) were the common types of error; (b) students’ performance deficits (n=579, 51%) and violation to medication administration protocol (n=362, 32%) were the most prevalent cause of error; and (c) students' inexperience (n=593, 77.7%) and distraction (n=153, 20%) were the chief factors leading to the errors. The study findings indicated that medication administration errors are prevalent among nursing students and may be more widespread if not actually treated. Therefore, faculty should consider innovative teaching methods that ensure the safe development of medication administration skills throughout each course in nursing major courses.

Cooper (2014) studied 26 medication administration errors reported by baccalaureate nursing students during a period of five semesters. Cooper found that violation to the Five Rights of medication administration [wrong time, route (site of injection), and dose)] accounted for 46% the error, while knowledge deficit (e.g. not considering the results of laboratory tests before administering medications) and system factors (e.g. medication electronic record issues) accounted for 39% and 15%, respectively. Another retrospective review of 77 MEs made by nursing students conducted by Harding and Petrick (2008) revealed that violation of the rights of medication administration (e.g. failure to check a patient’s ID band), system factors (e.g. errors resulted from the interaction with the MAR), and knowledge deficits were the major factors contributing to MEs. The study raised the importance of incorporating experiential teaching strategies such as HFS into the teaching of medication administration to improve patient safety.

**Summary**

Studies included in this review indicated that MEs are prevalent in the U.S. hospitals (Barker et al., 2002; Bond et al., 2001; Keers et al., 2013) and among nursing students (Cooper, 2014; Harding & Petrick, 2008; Wolf et al., 2006). The major finding was that violation the
rights of medication administration was widely reported (Cooper, 2014; Harding & Petrick, 2008; Kim & Bates, 2013; Stetina et al., 2005; Wolf et al., 2006) and appeared to be influenced by the challenges facing faculty to provide nursing students with sufficient teaching in-put and adequate practicum experiences that ensure gaining the necessary knowledge and skills to handle and give medicine in a safe and authentic approach (Cooper, 2014; Harding & Petrick, 2008; Wolf et al., 2006). Therefore, teaching strategies that incorporate experiential learning should be in place to account for the complexity and high-risk activity of this task (Harding & Petrick, 2008).

Using Simulation to Improve Medication Related Knowledge, Skills and Errors.

Simulation has been defined by Lopreiato et al. (2016) as “a technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions” (p. 33). Several types of simulations have been used in nursing education and related health professions, such as anatomical models, static mannequins, task trainers, role playing, standardized patients, virtual reality (e.g., Second Life™), and low- to high-fidelity simulation (Nehring & Lashley, 2009). Fidelity refers “to the degree that the object mimics reality” (Nehring & Lashley, 2009, p. 536). Low-fidelity simulator (LFS) represents a selected part of the human body with no physiological signs or parameters, such as breath and heart sounds, voice, or any interactive features (Nehring & Lashley, 2009). HFS utilizes a digitalized high-tech real life looking mannequin that can be programmed to cope with real-life physical patient states and to be able to realistically respond to expected relevant participant interactions (Nehring & Lashley, 2009). Nurses have utilized low-fidelity static mannequins for years to gain knowledge and to teach basic skills. The addition of medium- and high-fidelity human simulators in
undergraduate nursing education programs appeared in the late 1990s and accelerated in the mid-
2000s (Nehring, 2010). This acceleration appears when nursing instructors grew aware that
simulations afforded students a great chance to put skills learned in the classroom into practice,
expand critical thinking, gain needed practice, and make necessary decisions about interventions
in a non-threatening setting. This section contains a literature review pertaining to the use of
different types of simulation to improve medication related knowledge, skills, and errors among
nurses and nursing students

**Search Strategy.** A review of the literature pertaining to the use of simulation-based
learning to 1) teach medication related knowledge and skills; and 2) identify MEs in nursing was
conducted (September 2015). The search strategy was restricted to peer-reviewed studies in
English. It did not include any restriction to a population of interest, type of study, and type of
simulation. Databases including CINAHL, Cochrane, PubMed, ERIC, MEDLINEplus, Web of
Science (ISI), and Google Scholar, were utilized. Eligible articles were manually searched for the
purpose of identifying additional relevant articles. The time span was between 2005 and
September 2015.

Multiple keywords were used to search the above databases and combined using both
“AND” and “OR” as follows: [medication(s) OR medication error(s) OR medication mistake(s)
OR drug mistake(s) OR administration error(s) OR administration mistake(s) OR administration
skill(s) OR administration competence] AND [nurse(s) OR nursing student(s) OR nursing
education OR nurse education] AND [simulation OR simulator OR human patient simulator OR
low fidelity simulation OR low fidelity simulator(s) OR medium fidelity simulation OR medium
fidelity simulator(s) OR intermediate fidelity simulation OR intermediate fidelity simulator(s)
OR high fidelity simulation OR high fidelity simulator(s) OR standardized patient simulation OR
simulated patient(s)].

The initial search identified 138 studies that might be related. After reading the titles, abstracts, and the full-text of the article, 14 studies were identified as relevant and eligible studies for review; none of them were from the Middle East. Relevant studies were summarized in the form of an in-depth, annotated bibliographic essay in which focus was paid to the most significant works in order to reveal the gap(s) in the literature related to the use of different types simulation to improve medication administration skills and reduce MEs among nursing students.

**Using simulation to improve medication related knowledge, skills, and errors among nurses.** Ford et al. (2010) investigated the effectiveness of traditional didactic lecture and simulation-based training on coronary care unit and medical intensive care unit nurses' MEs rate. A ME has been described as a dissimilarity between the ordered dose and the administered dose (p. 1528). Any deviation form a hospital’s preparation/administration instructions, or relevant policies were also considered MEs. A prospective, single-center, parallel-group, controlled design was used to compare the following two types of the study interventions with n=24 nurses (n=12 per group): 1) traditional didactic lecture format, and 2) HFS. The content of the educational sessions was evaluated for content validity by three experts. Two instruments were used in data collection: direct observation and pre-test/post-test evaluation. Two pharmacists, who were assessed for inter-rater reliability, observed medication administration performance by the subjects at three time points: baseline, 1–4 weeks after intervention, and 8–12 weeks after intervention. A pretest-posttest was used to assess nurses' knowledge before and after each educational session. Data were analyzed using Chi-square, Fisher’s exact and Mann–Whitney U tests, revealed that, for the HFS group, the observed ME rate at the baseline was 30.8% (48 doses out of 156 doses identified as MEs). The observed error rates significantly \( p < 0.001 \) decreased
in 1–4 weeks post-intervention to 4.0% (6 doses out of 149 doses identified as MEs) and in 8–12 weeks post-intervention to 6.2% (6 doses out of 97 doses identified as MEs). Lecture participants demonstrated no significant difference between the baseline and initial (1–4 weeks) post-intervention. However, the observed error rate was significantly increased in the final (8–12 weeks) post-intervention to 36.7% (54 doses out of 147 doses identified as MEs) compared to the 20.8% baseline error rate (33 doses out of 159 doses identified as MEs) ($p < 0.001$). A significant improvement in the mean pre/post quiz scores was noted in both groups. Limitations to this study include (a) lack of randomization; (b) lack of theoretical framework; (c) collecting data from only two units in the hospital; and (d) the observers were not blinded to the intervention.

Coombes, Heel, Stowasser, Reid, Henderson, and Mitchell (2005) conducted a prospective study over a two year period (2003-2004) to assess the ability of the newly employed registered nurses (n=591) to identify MEs. They asked nurses to administer medication (in groups of two or three) to six patient simulation scenarios as a part of their standard orientation program. All medication scenarios contained an embedded prescribing error and had the potential to have a harmful effect on a simulated or standardized patient (nurse trained to act as a real patient) if the error was not detected and corrected. Before joining the scenario, nurses were instructed to identify MEs and discuss with the instructor the appropriate attitudes that they can employ for preventing harm and enhancing safety. Results revealed that 38% of newly employed nurses were new graduates and 62% have had experiences that varied between 1 and 8 years. Thirty six percent to 85% of nurses self-reported their abilities to detect the error in all six scenarios and take the appropriate attitudes to prevent harm. More experienced nurses were significantly ($p < 0.001$) able to detect the errors and act accordingly in only three out of six simulation scenario. The results of this study supported the fact that MEs are prominent among
nurses, and therefore medication risk awareness training programs (e.g., simulation) are critical
and should be considered to all nurses at all levels particularly at undergraduate level.
Limitations include: (a) the use of descriptive feedback utilizing a self-reported incidence of
detection of errors rather that objective assessment; and (b) lack of base line data and control
group (comparable group), which make the design inadequate for establishing causality or
ascertain if the results were due to the simulation intervention or to any external source of
variation (e.g. previous experience) (Portney & Watkins, 2009).

**Using simulation to improve medication related knowledge, skills, and errors among
nursing students in a simulated environment.** Pauly-O’Neill (2009) conducted an
interventional study to examine the efficacy of simulation training on pre-licensure master’s
degree entry nursing students’ ability to correctly administer pediatric medication. Students
(n=59) were first observed administering medicine in a pediatric simulation setting. The twenty
medication administration observations that were taken by a single observer using a checklist
pointed out a dire need for improved preparation of students in this vital skill. Only 4 out of 18
attempts (22%) were correctly administered. Areas of weakness appeared in calculating IV flow
rates, setting the IV pump too fast, selecting appropriate needle size, administering medication in
the correct IV port, checking patient for drug allergies, self-identification, and explaining
procedure for the patient. In regard to the adherence to the five rights: (a) the most success was
appeared in choosing the correct patient, which took place 95% of the time; (b) right time, right
dose, and right route recognition occurred 90%, 85%, and 88% of the time, respectively; (c) the
least success appeared in choosing the correct medication, which occurred 30% of the time.
Subsequently, the student took part in the intervention, which mainly consisted of lecture on
pediatric medication administration and participating in complex pediatric simulation scenarios.
Following the intervention, observers rated 30 medication administration made by students in the simulation setting. Overall, the results revealed improvement in medication administration skills. Right patient, right medication, and right route recognition occurred 100% of the time. Recognition of right time occurred 96% of the time and no improvement happened in identifying right dose. Drug-allergy checking, correct dilution of IV medication, and correctly setting up an IV pump increased to 90%, 96%, and 88%, respectively. Limitations include (a) lack of control group (comparable group), which makes the design inadequate for establishing causality (Portney & Watkins, 2009); (b) utilizing mixed intervention that involved lecturing and simulation, which makes it difficult to ascertain whether the findings of the study were the result of simulation or lecture interventions; (c) lack of theoretical framework; (d) evaluating students’ medication administration competency in a simulation setting not in an actual clinical setting; (e) no validity and reliability measures on the data collection checklist were reported; and (f) observing small number of medication administration (20 medication administration were observed pre-intervention and 30 post-intervention).

Schneidereith (2014) conducted a nonexperimental pilot study to investigate changes between 43 junior and senior level nursing students’ performance in verifying or adherence to the “rights” of drug administration as they move through BSN program over one academic year (first and second semesters). Each group (junior group and senior group) received two HFS scenarios during two consecutive semesters (one scenario per semester). Data were collected by the author using a checklist designed to measure student's adherence to the rights of medication administration. Data were analyzed using conventional frequency and paired sample t tests. Results revealed no differences in adherence to the correct route among junior and senior class students (100% among both classes). Verifying the right time differed among junior class
students as they progressed through the program (70% in the first semester to 100% in the second semester), whereas it remained constant among senior class students (100% in both semesters). Verification of the right medicine increased among junior class students as they progress from the first semester to the second semester (90% to 100%, respectively), whereas it decreased among senior class students (100% to 91%, respectively). Verifying patient identity decreased among junior class students as they move from the first- to the second-semester (80% to 75%, respectively), whereas it decreased significantly among senior class students (70% to 9%, respectively; \( p < 0.05 \)). Adherence to the right dose increased significantly among junior class students (0% to 42%; \( p < 0.05 \)), whereas it decreased significantly among senior class students (90% to 45%; \( p < 0.05 \)). The results demonstrated that students become more careless in verifying the five rights of medication administration (i.e., they actually become less safe) as they progress through the nursing program or curriculum. Therefore, the researcher concluded that nursing students should be educated about safe medication administration behaviors early in the program. This could be achieved by investing in additional teaching pedagogies like HFS in improving safe medication administration practice. Limitations of this study include the following: (1) the use of nonexperimental design (developmental, within subjects design), resulting in lack of causal evidence (Portney & Watkins, 2009); (2) the study measured students’ adherence to the five rights in a simulation environment not in a real care setting; (3) no validity and reliability measures on the data collection checklist were reported which might impacted the interpretation of the findings and become a potential bias in drawing a conclusion (Portney & Watkins, 2009); and (4) the study followed two separate cohorts instead of following one cohort from junior to senior year.

Stanley, Philips, and Galatzan (2014) conducted a pilot study to examine the ability of
HFS to increase the level of 47 BSN students’ competency with administering medicine to a simulated limited English proficiency (LEP) patients. This investigation utilized a non-experimental quantitative approach. The intervention contained only one LEP-HFS scenario administered to all students. The researchers used a valid and reliable instrument called the MASAT to assess nursing students’ competency in practicing the six rights of medication administration during simulation. The results didn’t demonstrate proficiency in the six rights among the study participants [only 219 out of 376 attempts were scored successful; the probability of success $p = \frac{219}{376} = 0.58$]. Students’ scored low in the categories of right patient, right drug, right dose, and right documentation. The limitations of this study include the following: (a) the use of weak design which resulted in weak evidence of causality; (b) conducting the study in a simulation environment not in a real care setting; and (c) the majority of students had previous experience with simulation and prior clinical exposure to medication administration which make it hard to measure the true effectiveness of HFS on medication administration skills.

Harris, Pittiglio, Newton, and Moore (2014) utilized a pilot quasi-experimental study to compare the effectiveness of traditional didactic lecture and simulation in improving BSN students' medication administration and calculation skills. Data collection encompassed a paper-and-pencil medication administration exam (MAE). This exam is usually offered to BSN student at the beginning of their junior year (3rd year). A review session on medication administration and calculation was delivered to two separate cohort of junior-level BSN students (n=158). The control group (n = 79) was composed of a first cohort who attended a traditional didactic review session. Whereas the experimental group (n = 79) was composed of a second cohort who offered a simulation review session. Quantitative data were analyzed using an independent t-test was and
revealed that the simulation group had a significantly larger mean MAE score ($M = 95.0$, $SD = 6.80$) than the lecture group ($M = 90.0$, $SD = 12.90$); $t(118) = 2.92$, $p = 0.004$. Limitations of Harris et al. study included the following: (a) the students were not randomly allocated to the intervention and control groups; (b) the study intervention was not based on theory; (c) the study aimed only at evaluating the effect of simulation experience on paper-and-pencil MAE and did not evaluate students’ performance in the simulation lab and in an actual patient setting. These limitations could limit the outcomes and generalizability of the findings. This research supports the need for studies that will address the effectiveness of simulation on students’ performance in an actual clinical setting.

Pauly-O'Neill and Prion (2013) conducted a pilot study aimed to investigate the influence of a mixed educational approach (lecture plus traditional clinical plus simulation education) on nursing student’s knowledge and self-confidence when administering intravenous (IV) medication to pediatric population. The sample was composed of junior level BSN students enrolled in a pediatrics course. All students were exposed to a three-hour lecture on pediatric medication administration covering topics regarding IV medication preparation, administration, and calculations. Right after the lecture, all students completed the self-confidence survey and the pediatric medication administration pretest; both developed by the author for the purpose of this study. After that, the students spent 50 clinical hours in an acute care pediatric settings plus 40 hours working with faculty in complex HFS pediatric scenarios. After the clinical and simulation rotation, all students completed the self-confidence survey and the pediatric medication administration posttest. Both instruments were graded by the clinical instructors. Using a paired sample $t$-test, results revealed significant improvements in both self-confidence and knowledge when administering intravenous medications to the pediatric population. A
Cohen’s $d$ of 1.3 and 1.0 were observed, indicating greater differences between paired presurvey- and postsurvey confidence scores and paired pre- and posttest knowledge scores, respectively. Limitations of Pauly-O’Neill and Prion study include (a) sample size was not reported; (b) the study did not attribute the changes to simulation experience only, but rather to the lecture, clinical, and simulation experiences. This mask the contribution or the individual role of simulation in pediatric medication administration; (c) the study collected quantitative data without a control group to provide comparison; (d) lack of theoretical framework; (e) the use of self-report measures to collect data rather than objective measures; and (f) no validity and reliability measures on the data collection instrument was reported.

Ferguson, Delaney, and Hardy (2014) conducted a descriptive research to study the perceptions of 51 ADN students regarding medication administration following the implementation of an automated medication dispensing system called the Demo Dose medDISPENSE system. The Demo Dose system is a simulation tool incorporated into a simulated client care setting and consists of a computer touch screen, medication drawers, and scanner to scan the medication’s barcode. Data collection encompassed a self-report survey—developed by the author—distributed to the students before and after utilizing the system. The survey mainly evaluated students’ perceptions regarding error prevention, knowledge about the rights of medication administration, and comfort level. Results revealed that students’ perceived level of comfort increased from 60% to approximately 85%. Additionally, all students expressed reinforcement of their knowledge about the rights of medication administration. Around 98% reported a lesser likelihood to make MEs after utilizing the system. These findings support the use of this automated tool as an innovative teaching strategy in nursing. Limitations for this study include (a) the descriptive nature of the study; (b) the data consisting of self-reported
information only; (c) the study did not mention any baseline data (data before utilizing the
system) regarding error prevention and knowledge about the rights of medication administration
which confuses somewhat the impact of this simulated technology on nursing students; (d) lack
of theoretical framework; (e) no validity and reliability measures on the data collection
instrument was reported; and (f) studying students’ perception in laboratory setting not in an
actual clinical setting.

Bearnson and Wiker (2005) conducted an exploratory, descriptive study aimed at examining the benefits as well as the limitations of using HFS as an alternative for one clinical
day. The sample consisted of first-year BSN students. All students participated in three different
HFS experiences. Data was collected utilizing a 7-item survey, composed of 4-item using a four-
point scale and 3 open-ended responses. The survey completed by the students and designed to
measure students’ perception at the end of the three simulated medication administration
encounters. Analysis of the quantitative data, using descriptive statistics, revealed that the mean
score of student perception ranged from (3.00 – 3.31), indicating that students perception were
positive with simulated clinical experiences. The remaining three open-ended questions were
analyzed and categorized for common themes. The themes that emerged indicated that students’
confidence, critical thinking, and team work increased after simulated medication administration
experience. Limitations of Bearnson and Wiker study include: (a) lack of baseline data and
comparison group, resulted in weak evidence of causality (Portney & Watkins, 2009); (b) sample
size was not reported; (c) lack of power analysis, which make it difficult to ascertain that the
study had enough power to identify a true significant difference (Katz, 2011; Portney & Watkins,
2009); (d) the use of a self-report instrument rather than objective assessment; (e) the absence of
prior validity and reliability assessment on the measurement survey developed by the author, and
this could impact the interpretation of the findings; and (f) no data were reported on ME rates; thus, no comparison could be made whether simulation impacted learner outcome. The author concluded that further studies with strong design are needed to determine the impact of HFS on safe medication administration practice.

Thomas, McIntosh, and Allen (2014) created a medication distraction simulation to help a group of senior level BSN students identify, understand, and overcome the environmental distractions to provide error-free and safe medication administration practice. All students participated in preparing and administering 10 simulated medications with sounds and visual distractions (personal and professional conversations, music, telephone ringing, and other environmental noises). Once the simulation was completed, faculty reviewed and debriefed all students’ performance while administering medication in a distracting environment. Results of the study concluded that this type of medication simulation provides nursing students with a valuable learning experience. All students realized that environmental distractions in any form can divert attention from the desired task and then contaminate the medication preparation and administration process. All students expressed becoming more aware and conscious of different sources of distractions they might encounter in practice. While this study is helpful, the descriptive nature of this investigation limits the utility of this study.

Transfer of medication related knowledge, skills, and errors learned in a simulation setting to the clinical practice setting. Sears et al. (2010) hypothesized that second year undergraduate Canadian students’ experience in the simulation laboratory would reduce potential MEs in the clinical area (maternal and medical-surgical units). Their investigation utilized a posttest-only randomized controlled group design. Nursing students (n=54) were allocated randomly to the treatment (n=24) and control (n=30) groups. The treatment group was exposed
to simulated case scenarios in place of some traditional clinical hours while the control group received all clinical hours as scheduled. Data collection included a survey utilized by trained clinical instructors and was designed to measure the number of and factors contributing to MEs. Chi-square tests revealed a significant decrease in the number of MEs among intervention group; only 7 errors among the treatment group compared to 24 errors among the control group, \( p < 0.05 \). The limitations of Sears et al. study include (a) small sample sizes and lack of power, and this increase the likelihood of encountering type II errors (Katz, 2011; Portney & Watkins, 2009); (b) the design didn’t use a pretest. Lack of a pre-test, made it difficult to analyze and interpret the posttest results, determine that both group were equal at the start of the experiment, and attribute causation to the intervention (Portney & Watkins, 2009); (c) lack of theoretical framework; (d) no internal consistency reliability on the data collection instrument was reported; (e) the raters (clinical instructors) weren't masked to the intervention, and this might indicate that bias came into play during data collection (Portney & Watkins, 2009); and (f) two different hospitals were used for clinical placements which in turn could result in more variances between study groups, and varying risks for mistakes in administering medicines.

A quasi-experimental design utilized by Campbell (2013) aimed at investigating the effect of HFS on second-semester diploma/ADN students’ performance during live medication administration. The sample composed of 27 students. The treatment group (n=15) was exposed to four high-fidelity medication administration scenarios in addition to traditional practice in medical-surgical inpatient unit, whereas the control group (n=12) was exposed only to traditional practice in medical-surgical inpatient unit. Quantitative data was collected utilizing (a) student satisfaction and self-confidence in learning survey, a 13-item instrument using a five-point scale, completed by the experimental group, and designed to measure students self-confidence and
satisfaction at the end of simulated patient encounters; (b) an author-developed medication clinical confidence scale, a 15-item instrument using a four-point scale (1 = not confident to 4 = very confident), completed by the experimental and control groups, and designed to measure students confidence during live patient encounters; (c) an author-developed safe medication administration grading rubric, a 22-item instrument with a dichotomous response (met, unmet), rated by clinical faculty, and designed to measure whether student’s medication administration skills gained during HFS translated into a real clinical setting. The quantitative data were analyzed using descriptive statistics and revealed that the mean student satisfaction and self-confidence scores ranged from (4.53 – 4.87), indicating that students were satisfied and confident with simulated clinical experiences. No significant difference was found between the mean ‘medication clinical confidence scale’ scores of the control and experimental groups. Furthermore, the results did not show any enhancement in the medication administration competency to real patients among the treatment group compared to the control group. This reflects a questionable impact of whether simulation improves learner outcome. Limitations of Campbell (2013) quasi-experimental study include: (a) insufficient sample size and lack of power analyses, and this increase the likelihood of encountering type II errors (Katz, 2011; Portney & Watkins, 2009); (b) the design lack a pre-test. Lack of a pre-test, made it difficult to analyze and interpret the posttest results, determine that both group were equal at the start of the experiment, and attribute causation to the intervention (Portney & Watkins, 2009); (c) the absence of prior validity and reliability assessment on the two measurement rubric developed by the author, and this could impact the interpretation of the findings; (d) the degree of agreement among raters (inter-rater reliability) was not assessed, which creates inconsistency and subjectivity in grading the rubric (Portney & Watkins, 2009); and (e) the raters (clinical
instructors) weren't masked to the intervention, and this might indicate that bias came into play during data collection (Portney & Watkins, 2009). The author concluded that further research is needed to determine the effect of HFS on safe medication administration practice.

Ross (2011) utilized a two-group, repeated measures (T1\text{pretest}, T2\text{posttest one}, T3\text{posttest two}), quasi-experimental design to compare the effectiveness of two teaching strategy (scenario-based LFS vs traditional clinical skills practice) to improve intramuscular (IM) medication administration skills competency among 37 BSN students. Data collection for all tests encompassed a valid and reliable task-specific checklist for evaluating IM medication administration competency, and measured by trained research assistants. The study was conducted over multiple phases:

Phase one: 54 traditional 4-year BSN students enrolled in a fundamentals of nursing laboratory course were pretested under a standard learning laboratory setting using a task trainer in spring 2010. Experimental group participants (n = 13) were asked to practice for 30 minutes in the LFS scenario session whereas those in the control group (n = 10) were asked to practice for 30 minutes in the traditional clinical skills practice. Only 23 subjects completed the pretest and interventions. This forced the PI to recruit students from another cohort to increase the total sample size.

Phase two: 36 accelerated second-degree BSN students enrolled in a medical/surgical adult health practicum course were pretested, as described above, in summer 2010. Only 16 participants in the control group and 16 participants in the experimental group (n=32) completed the required interventions as described above.

Phase three: Both accelerated second-degree (n = 32) and traditional four year baccalaureate nursing programs (n = 23) were post tested (post-test one) on IM injection
competence during summer 2010 and fall 2010, respectively. Posttest one was conducted in a traditional skills lab using task trainers. There were 3 students missing data for post-test one and the PI did not include them in the analysis.

Phase four: During fall 2010, both groups from both nursing programs (n = 52) were post tested (posttest two) in a flu clinic. All subjects were instructed to administering an IM influenza vaccine to real patients. There were 15 students didn’t complete the second posttest and therefore the PI did not include them in the analysis. Only 37 subjects (control group n = 18, experimental group n = 19) were included in the final analysis.

All participants were allowed for independently practice of extra IM injection outside the course of the study. These extra practice attempts were embedded in the design as a covariate. Data were analyzed using RM-ANCOVA and revealed the following:

- There was a significant effect for time (F (2, 70) = 17.38, p < .001). For those who received LFS-based training, the IM injection competency score increased from time 1 (estimated marginal mean = 27.05, SE = 1.84) to time 2 (estimated marginal mean = 36.00, SE = 1.16) and time 3 (estimated marginal mean = 36.26, SE = .87). On the other side, for those who did not receive LFS intervention, the IM injection competency score was also increased from time 1 (estimated marginal mean = 30.33, SE = 1.89) to time 2 (estimated marginal mean = 34.11, SE = 1.95) and time 3 (estimated marginal mean = 35.44, SE = .89). The gain in IM injection competency from time two (posttest one) to time three (posttest two) was higher among subjects who did not receive LFS (+1.33) compared to those who received LFS intervention (+0.26), indicating that LFS did not improve skill transfer to real bedside patient care.

- There was a nonsignificant effect for group (F (2, 70) = 0.026, p = .873), where IM
injection competency score did not differ across participants who received LFS-based training vs. those who didn’t receive simulation,

- The time × group interaction was nonsignificant (F (2, 70) = 2.101, p = 0.13).

Limitations of this investigation include (a) small sample size; (b) the observed power was low (0.418) with a $\eta^2_p$ value of 0.057 (medium effect size). Some underpowered studies can inflate effect sizes and type II error rates (Katz, 2011; Portney & Watkins, 2009); (b) the study recruited subjects from two cohorts. It is believed that accelerated second-degree students tend to have more knowledge and motivation and this might influence their learning; (c) the raters (clinical instructors) weren't masked to the intervention, and this might indicate that bias came into play during data collection (Portney & Watkins, 2009); (d) time between administration of treatment and collection of data (tests sequencing) was different between the two programs, which might affect the validity and the probability of correctly detecting an effect; and (e) the data were not analyzed based on intention to treat analysis approach: the least biased method of analysis for evaluating the effectiveness of an intervention (Katz, 2011; Portney & Watkins, 2009).

**Summary**

A gap exists in the literature pertaining to nursing MEs and simulation. Most of this work is descriptive in nature (Bearnson & Wiker, 2005; Coombes et al., 2005; Ferguson et al., 2014; Pauly-O'Neill & Prion, 2013; Thomas et al., 2014). More importantly, there are only three nursing studies in the literature that investigated the impact of simulation-based learning on directly observed medication administration skills and errors in the real-world setting (Campbell, 2013; Ross, 2015; Sears et al., 2010). The literature shows mixed results in the ability of simulation to improve medication administration skills and reduce MEs in the clinical setting;
however, these results must be reviewed with caution because these studies had significant limitations such as: (1) small sample size (Campbell, 2013; Ross, 2015; Sears et al., 2010); (2) lack of pre-test (Campbell, 2013; Sears et al., 2010); (3) lack of randomization (Campbell, 2013); (4) lack of theoretical framework (Campbell, 2013; Sears et al., 2010); (5) lack of blinding (Campbell, 2013; Ross, 2015; Sears et al., 2010); (6) lack of a valid and reliable measurement tool (Campbell, 2013; Sears et al., 2010); or (7) lack of power (Campbell, 2013; Ross, 2015; Sears et al., 2010). Poorly conceived, underpowered, and less rigorous empirical designs do not allow for establishing causality and thus limit the practical significance of findings (Mertens, 2015). Use of more rigorous strong research using a randomized, two-group, observer-blind, repeated measures with one pre-test and two post-test experimental design, and a theoretically-driven framework would generate clearer findings in this area. Such an investigation would enrich the body of nursing knowledge, and provide the needed support for evidence-based education using simulation. Moreover, there are no studies in the Middle East exploring the use of simulation in teaching medication-related knowledge, skills, and errors in any of the healthcare students and professions. This reveals the need for further research in this field. The proposed study can help fill the gap in the literature which targets reduction of MEs.
CHAPTER THREE

METHODS

Purpose of the Study

The overall aim of this dissertation study was to compare the effectiveness of High Fidelity Simulation (HFS) to the traditional lecture in order to improve the medication administration competency skills of second-year baccalaureate nursing students in Jordan.

Research Questions

The research questions that guided this investigation are:

Q1: Are there significant within-group changes in the mean score of medication error (ME) on the Medication Administration Safety Assessment Tool (MASAT) across three measurement occasions (T1 pretest, T2 posttest one, T3 posttest two)?

Q2: Is there a significant between-group difference (lecture group vs. HFS group) in the mean score of ME on the MASAT among 2nd year nursing students in Jordan?

Q3: Is there a significant interaction between time (three measurement occasions) and group (Lecture versus HFS) on mean values of MASAT?

Specific Aims

1. Describe the key demographic and baseline characteristics of the sample.

2. Examine within-group changes in the mean score of ME on the MASAT across three measurement occasions (T1 pretest, T2 posttest one, T3 posttest two).

3. Examine between-group differences (lecture group vs. HFS group) in the mean score of ME on the MASAT at three discrete measurement occasions.

4. Examine the interaction between time (three measurement occasions) and group (Traditional lecture, HFS) by mean values of ME on the MASAT.
Research Design

A randomized, two-group, observer-blind, repeated measures (T1: pretest, T2: posttest one, T3: posttest two) experimental design was utilized to compare the effectiveness of HFS and traditional lecture methods to decrease the medication administration errors on the MASAT in a sample of 89 Jordanian second-year undergraduate nursing students (see Appendix A for study design).

This research design is specified for the research questions and specific aims. Experimental design is generally considered the highest standard in scientific inquiry, the gold standard for demonstrating a cause-and-effect relationship between independent and dependent variables, and the superior method for other research strategies in evaluating the effects of treatment (Mertens, 2015, p. 123; Portney & Watkins, 2009, p. 161, 220). Moreover, experimental design is considered one of the best research methods for questions aimed at improving practice (Portney & Watkins, 2009, p. 220) and evaluating education innovations (Slavin, 2002, as cited in Mertens, 2015, p. 123). Thus, the investigator chose this design for the current investigation which was designed to directly inform educational practices in an effort to decrease MEs by nursing students in the real-world setting.

Variables

This two-group experimental design with one repeated-measure (Portney & Watkins, 2009, p. 197, 212) outcome had two categorical independent variables and one continuous dependent variable. The first independent variable of the teaching method was operationalized at two levels: HFS-based training and traditional lecture intervention. The second independent variable was time, which was repeated across all participants. In this case, the variable of time was considered a repeated factor with three levels because all participants was exposed to its
three measurements; all participants were tested three times. Participants were assessed once before the intervention, and twice afterward. The continuous dependent variable was the mean ME score on the MASAT by nursing students in an actual medical/surgical setting. This design is also called a two-way design with one repeated-measure, or a 2 X 3 mixed design (Portney & Watkins, 2009, p. 212) with the repeated measure on the second factor. By incorporating repeated measures within this design, the researcher can determine if the effect of an intervention changes over time and not just present immediately following completion of the intervention (Portney & Watkins, 2009, p. 212).

Setting

This investigation took place at a public university in Jordan: The Jordan University of Science and Technology, often abbreviated JUST. The baccalaureate nursing program at JUST is a four-year requiring 135 credit hours to graduate. English is the language of instruction. The program is accredited both nationally and internationally.

The HFS group received the HFS intervention in the JUST-Clinical Simulation Lab. The lab, located in the nursing building, includes HFS mannequins and equipment that students usually face in the hospital setting (e.g., IV infusion pump). The simulation lab contains different rooms (simulation, control and debriefing rooms) that are equipped with one-way glass to allow the individual in the control room (simulation instructor and faculty) and debriefing room (students) to observe simulation sessions without distracting the people in the simulation room. The rooms are also equipped with four high-fidelity mannequins that include: two of adults, one of a birthing mother, and one of an infant produced by METI® (version 6) and Laerdal Patient Simulator. Not only do the high-fidelity mannequins resemble humans, but they can be programmed to mimic human actions (e.g., chest rising and falling with respiration; heart sound;
palpable pulse; blood pressure; lung and bowel sounds; reactive pupils; voice; and responds to an induced pharmacological intervention, etc.). The mannequin is also able to realistically respond to expected relevant participant interactions. The simulation room is equipped with three cameras to capture each stage of the running scenario. Simulation lab instructors are prepared with a master’s degree and trained in the U.S. to teach simulation. Lab participants can perform many common procedures related to basic and advanced nursing skills before interacting with actual patients. For example, it provides a simulated clinical setting for provision of medications, where students are given the chance to identify the correct drug and associated dose, properly identify the patient, administer the medication using the right method, monitor for possible side effects, judge the effectiveness of medications administered, and demonstrate effective communication (Durham & Alden, 2008). The simulation lab enables students to train in a simulated comfortable environment that allows them to work in small groups with no obstacles. In the other arm of the trial, students who participate in traditional methods of instruction, including a lecture on medication administration that took place in one of the college of nursing classrooms.

The primary outcome variable (mean score of ME on the MASAT) was measured at adult male and female medical/surgical departments in a teaching hospital affiliated with JUST, called “King Abdullah University Hospital” (KAUH), and “Princess Basma Teaching Hospital” (PBTH). KAUH is the largest medical structure in the north of Jordan. KAUH is Joint Commission International accredited, with a capacity of approximately 683 beds. PBTH is one of the Ministry of Health hospitals with capacity of about (300) beds (Ajlouni, 2006). It is the second largest medical structure in the north of Jordan. It is a general hospital and also considered a referral hospital for the north region of Jordan (Ajlouni, 2006). The two clinical
settings had been chosen by the faculty due to the large number of students enrolled in NUR228: Adult health nursing II practicum course (n=89). Both hospitals have five adult male and female medical/surgical departments (medical male, medical female, surgical male, surgical female, private medical/surgical). Both hospitals departments are still using paper-based medication records, and use lock-and-key medication dispensing cabinets. Further, both hospitals environment are similar to one another with regards to medication administration processes, guidelines, and equipment. This would prevent the heterogeneity between the groups, and varying risks for mistakes in administering medicines.

Sampling

The sample for this current work was a convenience sample of BSN students enrolled in NUR228: Adult health nursing II clinical in fall of 2016 at JUST. After IRB approval was obtained at WSU (IRB Number #15309-001), JUST/KAUH (Ref #: IRB/6/4/2016, date 13/6/2016), and Jordanian Ministry of Health (MOH) (No: Development/Plans/5521), the investigator approached the dean of the college of nursing, the chair of adult health department, and the course coordinator and instructors and provided them with the study proposal and/or abstract in order to obtain permission to recruit students. The investigator is a Jordanian registered nurse and an international doctoral student at Washington State University in the U.S. He was a full-time lecturer at the undergraduate nursing level with prior experience in simulation and medical-surgical and critical psychomotor skills education at JUST-College of Nursing. The investigator managed the study, obtained consent from participants, monitored the study, analyzed the data, reported findings, and disseminated the research results.

A total of 89 students were registered for NUR228 course in fall 2016 at JUST-College of Nursing. Faculty gathered students from all sections in a large hall to orient them to the course
and the clinical ground rules on the first day of class. The investigator arranged in advance with faculty members to exploit part of the orientation lecture for recruiting study participants. The investigator asked the course coordinator and clinical instructors to leave the classroom so that students do not feel that they were under any pressure to participate in the study. The investigator held a PowerPoint presentation and provided the students with hardcopy information about the study, including the study’s aims, what was expected of them in the research activity, incentives for taking part in the study, and the time it took to complete the entire study (see Appendix B sample recruitment script). Students were notified that taking part in the study was voluntary and were also able to withdraw at any time without penalty and without affecting their course grade or class standing. Students’ participation was encouraged by informing them that their voluntary participation was not going to increase the work load expected from them in the NUR 228 course and by the incentives that they were received at the completion of the study (each students were entered into a drawing to win one of thirty $20, equivalent to 14 Jordanian Dinar, grocery cards at the completion of the study). The investigator further explained how the confidentiality of data was maintained during the course of the study. Confidentiality was strictly maintained by giving each participant a unique identifier in the form of numbers to protect the confidentiality of their collected data. Students were assured that their scores on ME’s would not be shared with any clinical instructors. The investigator then responded to any questions or concerns raised by prospective participants. The investigator also provided students with his contact information and his allocated work office address. This was especially important for follow-up questions and for shy individuals who felt not comfortable to ask a question on front of the class.

Immediately after explaining the study, the investigator screened participants who were interested to take part in the research for inclusion and exclusion criteria. Inclusion criteria were
1) baccalaureate nursing student enrolled in NUR228 for the first time, 2) scheduled for placement in medical/surgical environments, and 3) 18 years of age or older. Exclusion criteria were 1) current course represented a repetition of the NUR228 course, 2) bridging from an associate’s degree (ADN) to a baccalaureate degree (BSN), 3) students who had received a “Cardiopulmonary Resuscitation” (CPR) and “Advanced Cardiac Life Support” (ACLS) training or certification, and 4) students who had had any previous experience with medication administration simulation. Inclusion and exclusion criteria were explained in two slides from the aforementioned PowerPoint presentation. The investigator answered any questions and clarified any misconceptions raised by participants. All students (89 students) enrolled in NUR228 course were eligible for inclusion, and expressed their willingness to take part, in this study. Once all questions and concerns were addressed satisfactorily, the investigator provided informed consents (IC) approved by the IRB at WSU (IRB Number #15309-001), JUST/KAUH (Ref #: IRB/6/4/2016, date 13/6/2016), and Jordanian MOH (No: Development/Plans/5521) (see Appendix C for a copy of the informed consent). The IC was administered in English language since English is the official language in university education. The consenting took place in a private room at JUST-College of Nursing Labs, and completed within three days of the first week of the academic semester (September 26 - 28, 2016). The investigator asked each participant to read the consent, take as much time as s/he needs, and ask questions or express concerns regarding their participation in the study. The investigator clarified all potential benefits and risks. Maintaining the confidentiality of data during the study was also explained. After that, each student was asked to sign the form on front of the investigator and was provided with a copy of the written consent form.

Once the consent form was signed, the investigator asked the participants to fill out the
demographic sheet (see Appendix D for a copy of the demographic sheet). The demographic sheet included information identifying the participant's gender, age, highest level of completed education, overall and nursing grade point average (GPA), and e-mail address. Students were encouraged to ask or discuss any concerns about the study with the investigator at any time through the investigator’s contact information provided on the IC or in person. All students’ information (master list and demographic sheets) were kept in a locked cabinet in the CON dean’s office at JUST for the purposes of data security and privacy.

Students who met the inclusion criteria and signed the IC had already taken: MED130: Anatomy for nursing; MED230A: Human physiology; NUR102: Fundamentals of nursing theory; NUR103: Fundamentals of nursing lab; NUR221: Adult health nursing I theory; and NUR223: Adult health nursing I clinical. Nursing students had been familiarized in the first adult health nursing theory class (NUR221) with material about (a) pre-operative assessment and post-operative care; (b) fluid and electrolyte balance and disturbances; and (c) assessment and management of patients with cardiac, vascular, respiratory, endocrine, and digestive disorders. However, they didn’t receive any training regarding medication administration in the first adult health nursing I clinical class (NUR223) and fundamentals of nursing lab class (NUR103).

Teaching medication administration skills begins when students enrolled in the second adult health nursing clinical class (NUR228). Students in this novice stage (had no experience with simulation and medication administration) and meeting the inclusion/exclusion criteria had been selected in order to measure the true effectiveness of HFS and traditional lecture on medication administration skills of BSN students.

**Power analysis and sample size determination.** Shin, Park, and Kim (2015) conducted the first meta-analysis to derive comprehensive results on the effectiveness of simulation-based
learning in nursing education. Shin et al (2015) revealed that, compared with no intervention or traditional didactic approach, simulation could improve various learning outcomes, particularly outcomes in the psychomotor domain, with a medium-to-large effect size (Cohen’s $d = 0.71$). Because this study was the first in the Middle East to evaluate the effectiveness of HFS and traditional classroom lecture to improve medication administration skills among baccalaureate nursing students, a medium effect size [Cohen's $d = 0.5$, equivalent to a Cohen's $f = 0.25$ (Cohen, 1988)] was used for a priori power analysis using the G*Power 3.1.9 software (Faul, Erdfelder, Lang, & Buchner, 2007). This was done in order to be conservative and to help ensure an appropriately powered investigation.

For the 2x3 mixed ANOVA experiment, we examined power for 3 different effects: between-subjects effect, within-subjects effect, and the interaction (i.e. between*within) effect.

- For the main effect of group, i.e., the between-group effect, a medium effect size (Cohen's $f = 0.25$) was utilized. Statistical power level was set at 0.80 and the alpha threshold for statistical significance was set at 0.05. Consequently, the required sample size for this study aim was n=86 (Table 1).

- For the main effect of time, i.e., the within-group effect, a medium effect size (Cohen's $f = 0.25$) was utilized. Statistical power level was set at 0.80 and the alpha threshold for statistical significance was set at 0.05. The correlation ($r$) among the repeated measures was set at 0.5. Consequently, the required sample size for this aim was n=32 (Table 1).

- For the interaction effect, i.e., the between*within effect, a medium effect size (Cohen's $f = 0.25$) was utilized. Statistical power level was set at 0.80 and the alpha threshold for statistical significance was set at 0.05. The correlation ($r$) among the repeated measures was set at 0.5. Consequently, the required sample size for this aim was n=32 (Table 1).
A final, planned sample size of n=86 was needed to test specific aims of the study. However, a total of 89 students registered for NUR228 course were eligible and expressed their willingness to take part in this study, giving a final sample size of n=89, which is still well above the 86 targeted in the power analysis. The study was conducted in conjunction with the NUR 228 clinical requirements—a core course that students had to take—and this created little chance of losing participants during the course of the study. The study also used monetary incentives to reduce attrition.

Table 1. *A Priori Power Analysis for Sample Size Estimation.*

<table>
<thead>
<tr>
<th>Effect Size</th>
<th>ANOVA RM Within-Factors</th>
<th>ANOVA RM Between-Factors</th>
<th>ANOVA RM Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>n = 32</td>
<td>n = 86</td>
<td>n = 32</td>
</tr>
<tr>
<td>0.30</td>
<td>n = 24</td>
<td>n = 62</td>
<td>n = 24</td>
</tr>
<tr>
<td>0.40</td>
<td>n = 14</td>
<td>n = 36</td>
<td>n = 14</td>
</tr>
</tbody>
</table>

**Randomization**

The 89 participants were randomly assigned to the lecture group (n = 44) and HFS group (n = 45) using Microsoft Excel's RAND function. Randomization creates an equal distribution of the measured and unmeasured confounders between the groups and assumes that both groups are balanced at the start of an experiment (Portney & Watkins, 2009, p. 163). This was done to draw valid comparisons and to guarantee that any differences between the groups had been distributed as a function of chance.

Baccalaureate nursing students enrolled in NUR228 were scheduled for placement in medical surgical environments at KAUH and PBTH. Each hospital has five adult male and
female medical/surgical departments (medical male, medical female, surgical male, surgical 
female, private medical/surgical), giving a total of 10 medical/surgical departments. Students 
generated to the hospital in groups of 9 to 10, 7 hours a day (7:30 am – 2:30 pm), two days a week, 
for 15 weeks. Therefore, the 45 participants in the HFS group were divided into 5 groups; each 
group consisted of 9 students. The 44 participants in the traditional lecture group were also 
divided into 5 groups; four groups consisted of 9 participants each and one group consisted of 8 
students. The investigator worked with the NUR228 coordinator and clinical instructors to assign 
the HFS groups and the traditional lecture groups (10 groups) to the ten medical/surgical 
departments at KAUH and PBTH. The five HFS groups were assigned to three of the five 
medical/surgical departments at KAUH and two of the five medical/surgical departments at 
PBTH. On the other side, the five traditional lecture groups were assigned to the remaining 
medical/surgical units at both hospitals (two of the five medical/surgical departments at KAUH 
and three of the five medical/surgical departments at PBTH). Further, the groups were given 
written flow sheets outlining groups' rotations within the medical/surgical departments at each 
hospital, which took place every three weeks. The rotations within the hospital's medical/surgical 
units took place every three weeks. This was done to allow each group to gain experiences from 
all medical/surgical units of the assigned hospital. All the students must be in their assigned 
medical-surgical units picking their patient assignments by 7:30 am. Although, each group had a 
different clinical instructor, all clinical instructors were obligated to walk through a 
predetermined, standardized, and well defined syllabus to ensure the consistency so that every 
student received the same clinical experience. The students were informed of their group 
assignments into HFS and traditional groups after the pretest, thus randomization didn’t affect 
their pretest scores.
Instrumentation

Two data collection tools were used to achieve the aims of this investigation:

- Demographics form: the researcher designed a demographic form to collect demographic information about the study participants. The form consists of a checklist and open-ended questions on variables such as gender, age, GPA (overall and nursing), and email address (see Appendix D for a copy of the demographic sheet).

- The Medication Administration Safety Assessment Tool (MASAT): The raw data (number of medication administration errors) was collected by observers (trained RN’s) using a valid and reliable data collection instrument developed by Lori Goodstone, Ed.D, & Michael Goodstone, Ph.D. (2013) called the MASAT (see Appendix E). The English version of the MASAT was used because English is the official language of instruction at all nursing schools in Jordan. The MASAT is an eight-item checklist with dichotomous responses (Yes/No) measuring nursing students’ competencies in practicing the six rights of medication administration, including right medication, right patient, right route, right dose, correct rout of administration, and correct documentation (Goodstone & Goodstone, 2013). This tool is designed to be used by a clinical instructor or supervisor who rate a student while administering medicine in a simulation laboratory as well as in a real clinical setting (Goodstone & Goodstone, 2013). Permission to utilize the MASAT was obtained from the tool’s developer: Dr. Lori Goodstone Ed.D, R.N. Farmingdale State College, NY 11735-1021, USA. Email: lori.goodstone@farmingdale.edu (see Appendix F).

Reliability and validity. The MASAT is a valid and reliable tool for measuring students' competencies in practicing the six rights of medication administration (Goodstone & Goodstone,
It is a psychometrically sound performance measure developed to answer the urgent call raised by Kardong-Edgren, Adamson, and Fitzgerald (2010) and Adamson, Kardong-Edgren, and Willhaus (2012) to introduce valid and reliable tools for both simulation and clinical evaluation. The MASAT is also considered a high-level participant evaluation tool according to the classifications raised by Adamson et al. (2012) in terms of translational science research and the framework of Kirkpatrick (1994) for categorizing simulation evaluation. It measures Translation Phase 1 (what students learned in the simulation laboratory), Translation Phase 2 (transfer of learning gained from a simulation setting to a hands-on, actual clinical setting), Kirkpatrick’s level 2 (how simulation experience improved student’s knowledge and skills) and Kirkpatrick’s level 3 (extent to which the students transfer knowledge and skills acquired through simulation to real clinical settings) (Goodstone & Goodstone, 2013).

The content validity of the MASAT was supported by conducting an extensive literature review and by having 10 nursing faculty (Subject Matter Expert) score each item in terms of its importance to the rights of medication administration (Goodstone & Goodstone, 2013). Results revealed strong agreement that the 8 items adequately sample the content domain of the six rights of medication administration (Goodstone & Goodstone, 2013). Pilot testing of the tool was conducted through recruiting students from ADN and BSN degree nursing programs. The pilot students were instructed to administer medication via various routes at various times. All medication administration attempts were videotaped and four independent nursing instructors viewed each videotape and scored the MASAT. Results revealed high levels of interrater reliability among four raters (0.83 to 0.90) and a Cronbach’s alpha of 0.84 (Goodstone & Goodstone, 2013). Although the instrument has been only recently developed, it is psychometrically sound and has been successfully used in other previous study (Stanley, Philips,
Scoring scheme. The eight items of the MASAT correlate to each of the six rights of medication administration mentioned above. Based on subject matter expert, there are a total of 8 items in the checklist. Only the student’s first attempt was scored. The rater observed the student administer medication ordered in the medication administration record (MAR) and then rated student’s medication error rate on each item by placing a tick (✓) for YES and (X) for NO. The investigator provided the raters with written definitions of the two scoring levels (Yes, No) to ensure accurate and consistent use of the MASAT. “Yes” denotes mastering a task correctly or in a way that don't result in any harm to a patient. "No" denotes mastering a task incorrectly or in a way that cause harm to a patient, didn't master a task, or needs practice (e.g., use of some, but not all of each recommended sub-tasks). The MASAT doesn't have ‘NA’ response option because opportunities exist to demonstrate competency on all items. Raters might add any necessary comments that might supplement the evaluation such as patient's medical diagnosis, given medication, and allergy. Each item was scored as either "Yes" counted as 0 point or "No" as 1 point. As there are 8 items, the scores ranged from 0 to 8, with higher scores indicating poor competence in practicing the six rights of medication administration and consequently higher number of medication error (Goodstone & Goodstone, 2013). The completed tool involved the number of ME for each participant. Mean ME scores on the MASAT was computed for each group at each measurement occasion.

Reliability Assessment

When working with an observation-based assessment such as the MASAT, error can be introduced by the raters. Reliability measures can be used to assess the degree to which multiple raters are consistent and consensus in their ratings (DeVellis, 2012). Reliability is a function of
the observed score, true score, and measurement error (DeVellis, 2012). Reliability reflects the extent to which any differences in participants’ test scores (observed variance) are a result of their true differences (true variance), and not measurement error. (DeVellis, 2012). In this study, the observed score represented a student’s scores on the MASAT; the true score referred to a "gold standard" that an expert rater assigned the students' performance using the MASAT; and measurement error represented anything other than student’s true scores that might affect his/her score on the MASAT. Detecting the true variance would help the research team to conclude that any differences in students’ MASAT scores are a function of their true differences, and not measurement error (DeVellis, 2012; Portney & Watkins, 2009). Reliability was examined using inter-rater reliability (Absolute Agreement) and intra-rater reliability.

**Inter-rater reliability (Absolute Agreement).** Inter-rater reliability (Absolute Agreement) represents the extent to which multiple raters make accurate and consensus decisions about the rated subject (Portney & Watkins, 2009). Prior to the start of this investigation, inter-rater (Absolute Agreement, or within-individual reliability) among the five raters (RNs) was assessed for the following reasons: a) ensure that raters could obtain the same results for the dependent or outcome variable (mean score of ME on the MASAT); (b) ensure accurate and consensus ratings on the rating instrument; (c) decrease a potential raters’ subjectivity that might result in bias; and (d) that the measurements generated by raters are representative of the student’s true score (Portney & Watkins, 2009, p. 87, 88).

The investigator started with the first step for conducting this type of reliability by identifying how many raters and simulation scenarios are needed to achieve an acceptable level of reliability. There is only one study (doctoral study) conducted in the nursing field that indicated the number of raters and simulation scenarios needed—in an observation-based
assessment study—to achieve sufficiently high reliability (acceptably high level of reliability at of .80 or greater) (O’Brien, 2014). O’Brien (2014) used generalizability theory as a guidance to investigate the contribution of different sources of measurement error or variability. These sources of variability are as follows: the effect of rater which reflects the disagreement among rater; the effect of scenario which represents variation in scenario difficulty across raters; the effect of an item that represents variation in item difficulty across raters; and their interactions with each other to the total observed variance. O’Brien (2014) examined that through conducting various Decision studies in which the number of raters and scenarios were increased simultaneously and discretely with the purpose of comparing their effects on reliability. O’Brien found that five scenarios and nine raters are required to reach a reliability level of .80—the minimum reliability level recommended in the literature. However, O’Brien’s contribution was based on nine raters scored three videotape scenarios using a 40-item multidimensional nursing competency measure. It is anticipated that using scenarios and an instrument that address different nursing competency levels may increase the measurement error associated with both items and scenarios across raters, and thus increase error variance attributable to raters. This would likely increase the number of raters and scenarios needed in order to reach consensus.

Unlike O’Brien’s study, this investigation was intended to measure only one nursing competency (students’ competencies in the six rights of medication administration) using the MASAT. The MASAT is an eight-item, fairly straightforward, unidimensional checklist, reflecting an explicit process (key actions) for the six rights of medication administration that are known for every nurse. It was anticipated that using videotape scenarios and an instrument that contribute to measurement of only one construct (competency in practicing the rights of medication administration) might decrease the measurement error associated with both items and
scenarios across raters, and this might create more agreement among raters. Based on these reasons, the investigator decided to use five videotape scenarios and five raters to reach a minimum reliability level of .80.

The investigator started the recruitment of five raters by contacting them via email (see Appendix G). The inclusion criterion included being a registered nurse (RN) for at least two years in a medical/surgical unit. The five registered nurses voluntarily agreed to assist. Once the five RNs were identified and agreed to act as raters, they were asked to participate in a training session. Raters training help reduce the effect of rater-related variance (error variance or measurement error) and thus improve reliability (O’Brien, 2014). Therefore, all five raters underwent a 2-hour training session on August 15, 2016 at JUST College of Nursing. Training included written definitions of the tool scoring levels to ensure accurate, consistent, and consensus use of the MASAT. After the completion of their training, the investigator provided five YouTube videos of students administering medicine via multiples routes for each rater to score. The investigator downloaded several medication administration videos from YouTube using a software called (Internet Download Manager). All videos were available free to the public and provided for educational purposes. The investigator chose five YouTube videos that are consistent with the purpose of the study. All videos' content were about students administering medicine via multiples routes. The investigator contacted three nursing experts with experience in adult medical/surgical nursing education and simulation in order to establish the face validity for the five YouTube videos. The expert team reviewed the videos and provided constructive feedback. They indicated that all videos adequately addressed the 8 items of the MASAT. However, they suggested deletion of some segments in the videos which were time consuming and deleting them didn’t affect the value content of the videos. They also suggested
deleting some other segments (e.g. checking the ID band for patient's name and DOB, checking medication dose, etc.) in order for the videos to demonstrate violations of the rights of medication administration to further evaluate rater accuracy. The investigator utilized a software called (4media video cutter version 2) to make changes to the videos per the expert team recommendations. After editing, the expert team again reviewed the edited videos. Their feedback was positive and the team agreed to use all revised videos.

All raters watched the five videos and scored each video using the MASAT on three separate occasions (August 15, 2016; August 30, 2016; and September 30, 2016). This took a total of approximately one and a half hours and was done on flexible time (during the month of August 2016) at flexible location at JUST College of Nursing. Total ratings on the MASAT were entered into SPSS statistics 24 for analysis. The SPSS dataset consisted of the total score of the MASAT given by each rater for each video at each measurement occasion. The within-individual reliability (inter-rater reliability) in scoring the MASAT per video was computed using Intra-Class Correlation Coefficient (ICC) statistic. The ICC can be used with data that are rated as a dichotomy (the presence or absence of a given trait) in cases where more than two raters are involved (Bennett, 2015; Portney & Watkins, 2009, p. 589).

The first decision taken in computing the ICC (absolute agreement) was the selection of an appropriate ICCs model. In SPSS, ICC has three models: One-Way Random, Two-Way Random, and Two-Way Mixed. These options allow the user to account for where the researcher thinks any errors or random effects might be coming from. For this investigation, the Two-Way Mixed model was used to establish that specific raters, rather than the entire population of potential raters, were reliable in their data collection. This model assumed that the exact same raters made ratings on every ratees (YouTube Video), and considered ratees as a random effect,
and considered rater as a fixed effect because raters were purposely (not randomly) selected (Portney & Watkins, 2009, p. 590). In this investigation, there were five RNs who each rate all videos.

The ICC output includes two different ICC estimates: the reliability of a single rater (Single Measure) and the reliability of raters’ mean (Average Measures). The investigator used the average of raters’ ratings (Average Measures) because the raters were not assigned to measure the pretest and posttests by group, however, they were rotated between the ten clinical groups. Rotating raters between groups might reduce some systematic differences (rater or measurement bias) that might exist among raters in case of attaching each rater to rate one group or assigning one rater to take three measurement for the same participant (Portney & Watkins, 2009). In this study, raters were also blinded to participants' scores, preventing their bias that might be influenced by their memory of the first score (p. 88). An ICC ranges from 0 to 1, in which the former value represents no reliability, while the latter value indicates perfect reliability with no measurement error (Portney & Watkins, 2009). Typically, researches like ICC value to be over 0.70, optimally would be greater than 0.8, excellent agreement between raters would be anything above 0.9, and a level of significance (p=.05) (Portney & Watkins, 2010). The value of ICC average measures of 0.9 means that 90% of the variance in the mean of the raters is real (represented the construct), and 10% represented random variation (Landers, 2015).

**Intra-rater reliability.** In this investigation, every participant was assessed by one of the five raters three times, once before the intervention and twice afterward, using the MASAT. Assigning raters over time speaks to intra-rater reliability. Intra-rater reliability (between-individual reliability), in this investigation, referred to the degree of agreement among repeated administrations of the MASAT performed by a single rater. Between-individual reliability was
measured through administration of the five videos for each rater to score using the MASAT on three separate occasions (August 15, 2016; August 30, 2016; and September 30, 2016) with approximately 2-week interval between the first and the second occasions and a one-month interval between the second and the third occasions. This was done to ensure that raters (RNs) were consistent with their own ratings across time (Portney & Watkins, 2009, p. 590). Intra-rater reliability was computed utilizing ICC Two-Way Mixed effects (Model 3) because the measurement of a single rater cannot be generalized to other raters (Portney & Watkins, 2009, p. 590).

**Intervention and Data Collection**

As usual, nursing students enrolled in NUR228 receive lecture on medication administration in the first week of class and start going to the clinical site at the beginning of the second week until the 15th Week. The first phase of this study was the pretest which conducted in the third week of NUR 228 clinical rotation. The study shifted the lecture that students supposed to take during the first week to the fourth and fifth weeks for traditional lecture group and replace it with HFS intervention for HFS group. Participants were then assessed twice after the intervention. Appendix P shows a flow diagram for study enrollment, allocation, and follow-up according to CONSORT. The following describes in detail how the study interventions and data collection were conducted.

Pretest. After screening for inclusion and exclusion criteria, signing the informed consent, providing brief demographical data, randomization, and de-identification, all students underwent the pretest on medication administration. Pretest, in this investigation, helped the investigator to determine how the outcome variable changed from pretest to posttest within each group and between groups and whether groups were comparable on the outcome variable at the beginning
of the experiment; thus reducing error variance (Portney & Watkins, 2009, p. 197).

Eighty nine students started their NUR228 clinical at the beginning of the second week. During the second week, students got oriented to the following: (a) the layout of a nursing unit and the environment in which the medication administration took place; (b) medication prescribing, preparing, transcribing, dispensing, and documenting systems; and (c) interaction with computerized medical record issues, particularly MAR. Stressing the importance of these system factors to nursing students plays a significant role in preventing MEs and improving safety (Harding & Petrick, 2008).

Students were involved in administering medication in an actual setting in the third week of NUR 228 clinical rotation (October 9th & 11th. 2016). Trained RN’s visited students at KAUH and PBTH medical/surgical departments and assigned each student to one of the following cases: postoperative care, heart failure (HF), hypertension (HTN), chronic obstructive pulmonary disease (COPD), or diabetes mellitus (DM). These cases had been chosen due to several reasons to be discussed later on in this chapter. Students were instructed to administer the assigned medication to a patient and were able to: (a) review patient chart containing the patient’s medical background data, physician orders, and laboratory and diagnostic tests results; (b) review medication forms that come with scheduled medications; (c) access medication, supply areas, and equipment (i.e., infusion pump); (d) access the necessary measure recommended by the IOM, Quality and Safety Education for Nurses (QSEN) for safe medication administration practice, and Wolf et al. (2006) such as using calculator, all necessary formulas, and drug dosage reference book; and (e) ask or discuss any concerns about the process.

The pre-test on medication administration was measured by trained RN’s using the MASAT. The observers (RNs) were passive and not in any way involved themselves with the
student’s duties. But, with any occasion where a possible ME could result in any possible harm to the patient or student in the observing RN’s judgment, the RN then instructed the student accordingly. Only the student’s first attempt was scored. Immediately following the pretest, the RN provided the student with a general and constructive feedback on his/her medication administration performance. For confidentiality purposes, students’ scores on medication administration were absolutely not shared with any faculty and participants did not learn what their scores were. This measurement served as the first measurement or a baseline measurement. Pretest demonstration took approximately 10-15 minutes. Patients being administered medicines were informed that the student was being graded on their competencies in administering medications for a research study. They were also guaranteed that they were not part of this study. In this experiment, all students completed the baseline measurement (pretest), and after that, they were notified of their group assignments to either HFS group or traditional lecture group. The investigator worked with both groups to schedule their attendance at simulation lab and lecture. HFS group was also given written flow sheets outlining group members’ rotations and time schedules to participate in the simulation laboratory.

**Intervention:** This two-group experimental design (Portney & Watkins, 2009, p. 197) incorporated two experimental arms that were formed by random assignment; one group received the new teaching strategy (HFS-based training) intervention while the other group received the conventional teaching method (traditional lecture) intervention. Two treatment groups had been chosen because the study addressed an interest in a difference between two interventions (Portney & Watkins, 2009, p. 197, 198). The study compared the effectiveness of a new treatment (HFS) with a standard or traditional one (traditional lecture) to decrease MEs on the MASAT among Jordanian BSN students. Although there was no traditional control group,
this design provided an experimental control because the investigator could establish initial equivalence between groups formed by random assignment. In this study, the traditional lecture group acted as a control for the HFS-based training group and vice versa; thus the investigator could attribute any improvement occurred in only one group to the fact that one treatment is more effective.

**HFS group:** All students who participated in this group (n=45) received no lectures. These students received the HFS intervention in the JUST Clinical Simulation Lab, using an adult high-fidelity simulator (METI Version 6). A HFS mannequin was utilized to replicate the patient encounter and physiological responses to medication administration. A HFS lab enables students to train in a simulated, controlled, safe, authentic, and comfortable learning environment that allows them to work in small groups with no obstacles (Jeffries, 2005). Therefore, the HFS group was divided into groups of four students for demonstration purposes, and were given written flow sheets outlining group members’ rotations and time schedules to participate in the simulation scenarios. Each group received two different HFS scenarios during the fourth and fifth weeks of NUR 228 clinical rotation (October 16-27, 2016). The first simulation scenario lasted approximately 55 minutes (10 minutes for orientation plus 30 minutes for running the scenario plus 15 minutes for debriefing), whereas the second simulation scenario lasted approximately 40 minutes (10 minutes for orientation plus 15 minutes for running the scenario plus 15 minutes for debriefing) (see Appendix O). Simulation scenarios were manually run by two lab instructors—who holds a master’s degree in acute adult health nursing and was trained in the U.S. to teach simulation—and were debriefed by both the investigator and lab instructors. The investigator attended and observed the student performance and rated the fidelity of the intervention’s delivery in all HFS groups. No variation occurred in the delivery of simulation
scenarios between the groups and that didn’t require the lab instructor to be retrained to minimize drift.

Each simulation involved observers and active participants. Therefore, a group of four students was divided into two groups: two students in the active participant group and two in the observer group. In each simulation, the same scenario was run twice. The active participant group was actively engaged in the first round of simulation while the other group acted as passive observers. After the completion of the first round of simulation, the active participant group became the observer group and the observer group became the active participant group. The second round of simulation was offered in a similar manner to the first round. This ensured that each group was actually engaged in simulation training.

As a preparation for each simulation, students were provided with a written document (preparation sheet) that describe the case, learning objectives, doctor orders, and simulation ground rules.

Upon arrival the group (four students) in the simulation lab and as a regular process of simulation, the lab instructor oriented students to the HFS. Orientation involved: signing a confidentiality agreement, which required students to treat a human patient simulator like a real patient; fostering the culture of zero error in simulation; made sure that what happened in simulations stayed in simulation; their debriefing following the simulation was nonjudgmental; and that they were not to discuss the scenarios outside the room, as the learning should be saved for others too. The lab instructor provided students with all information needed to complete the simulation scenario session [e.g.: learning objectives of the simulation exercise; a patient chart containing the patient’s medical background data and any physician orders; a bedside report; the manikin’s function and limitations; the set-up of the lab space; access to medication and supply
areas; equipment; and availability of time spent in the scenario and roles of the students and
instructor] (see Appendix O). Students had also access to their calculators, all necessary
formulas, and drug dosage reference book.

After that, the group of four students was divided into two active participants and two
passive observers. The active participant students who were assigned the role of nurse were
actively engage in the first round of simulation while the other group acted as observers. Those
active participant students reviewed the patient chart including physician's order and labs and
diagnostic tests results. Every student had the opportunity to interact with patients just as if they
would so in an actual clinical setting with actual patients where they assessed the patient,
reviewed the medication form with scheduled medications, obtained the medication,
demonstrated proper administration techniques, discovered errors, called a health-care provider
to remedy errors, and asked for additional tests or medications as appropriate. There were no
feedback given during the simulation session. The lab instructors and the study principal
investigator took notes when drug administration errors were made pertaining the MASAT. After
finishing the first round of simulation, the participants switched roles to complete the second
round of simulation, which was offered in a similar manner to the first round. This allowed each
student being involved as an active participant during simulation training. The lab instructors
stopped running the simulation scenario once the objectives were achieved. After that, the
simulation participants moved to the debriefing room.

In simulations, debriefing is a valuable tool to “reinforce the positive aspects of the
experience and encourages reflective learning” (Jeffries, 2005, p. 101). The investigator and lab
instructors facilitated a 15-minute structured debriefing session (see Appendix L). During this
session, students reflected on their experience during simulation, discussed and focused on points
that raised during the medication administration process gained via the simulation experience, received faculty and peer feedback on their medication administration performance, and encouraged to identify what areas needed improvement and suggested appropriate interventions. Students were offered the second simulation scenario—based on the flow sheets of their rotations and time schedules—in the same way that pursued in the first simulation scenario.

Simulation scenarios: Two adult medical/surgical nursing scenarios were developed for this investigation (see Appendix O). The scenario topics included: (1) patient suffering from HF, COPD, HTN, and DM; and (2) postoperative care (administration of pain medication). These cases had been chosen for the following reasons: (a) the high prevalence of these diseases among Jordanians; a literature revealed that nearly 50% of all deaths in Jordan are attributed to just 3 causes (cardio vascular diseases, chronic respiratory diseases, and diabetes), with cardiovascular diseases alone account for 35% of all deaths (WHO, 2014); (b) the most common cases that the students might encounter in the unit; (c) they were grounded on how three clinical professors perceived them as well as on the proven program-based competencies expected of those with a second-year clinical experience; and (d) students already had knowledge about these cases because they had already learned about them in material covered in their first adult health nursing theory class (NUR221). Based on the three clinical professors’ perspective, it was anticipated that choosing other medical diagnoses might create some differences among students abilities to administer medicine; students might have some strengths and weakness in some medical diagnosis than in others and this might affect their ability to display competence in regard to medication administration. The scenarios were organized, based on a scenario-writing template used by faculty at WSU College of Nursing, under the following sections: student learning outcomes, students’ roles, patient’s background and vital signs, doctor orders, MAR
(regular, PRN, and stat medications), laboratory tests, diagnostic test, and debriefing script. The structure of the scenario design included the following sections: shift report, run-time, SimMan settings and actions, and expected student actions/interventions. Learning outcomes for the two simulation scenarios were designed in a way that assist nursing students to demonstrate competency in administering medications to medical/surgical patients. Some scenarios contained behavioral samples of MEs (e.g., wrong order) to provide students with a valuable learning experience to understand the impact of not violating the "6 rights" on the medication administration process. Input and feedback on the scenarios were obtained from three experts, with a minimum of three years of experience and credentials in HFS and medical/surgical nursing education. The investigator started the recruitment of nurse experts by contacting them via email (see Appendix I). The experts were notified about the following: (a) their right to refuse to participate and withdraw their participation at any time; (b) the entire review process was expected to take one month (May, 2016) and their participation to provide feedback was expected to take a total of 3-4 hours; (c) had the right not to provide answer to any question with which they were not comfortable; and (d) maintaining their confidentiality during the course of the study. Once the nurse experts were identified, the two simulation scenario were sent to them with a feedback form adapted from Dr. O’Brien (2014) dissertation (see Appendix J). Permission to use the feedback form was obtained from the author: Janet O'Brien, PhD, RN, CHSE. Arizona State University, AZ 85004-0697, USA. Email: jeobrien@asu.edu (see Appendix K). The feedback form contained a detailed review and specific information on each component of the scenario and asked the expert team to review each component to determine (a) areas of agreement; (b) areas of disagreement; (c) areas that need revision; and (d) if additional relevant information are important to add. The investigator added one aspect to the feedback form.
regarding (if opportunities are available for nursing students to demonstrate competency on the 8 items of the MASAT) (see Appendix J) and permission to add this aspects was obtained from the original author. The experts were asked to return their feedback electronically (via email) to the investigator. The expert team revised the scenarios and provided constructive feedback. They suggested insertion, deletion, or editing some aspects in each scenario (medication name, administration route, math-measurement, case flow, lab test, etc.). The investigator received and reviewed the experts’ responses and then edited the scenarios accordingly to reach agreement and consensus on each component of the scenario. After that, the investigator provided the expert team with the edited scenarios and asked to agree or disagree with their recommended suggestions. Their feedbacks were positive and reached a majority agreement on each scenario.

Both scenarios had been tested twice before running it with students. The investigator and lab instructors met in the simulation lab one day and run the scenarios with other beginning students (Medical/Surgical I students) according to the scenarios written template. This was done to identify if any changes need to be made (cut the scenario down, clarify roles, or miss some important components) to the scenarios templates. The test did not reveal any required changes to the templates of both scenarios.

**Traditional lecture group:** For students who participated in traditional lecture method intervention, lecture on medication administration took place in one of the college of nursing classrooms during the 4th and 5th week of NUR228 clinical rotation (October 16-27, 2016). A total of 44 students who enrolled in the traditional lecture group received a one and a half hours lecture on medication administration. The lecture was given by a trained full-time lecturer at JUST College of Nursing in order to standardize the teaching content formats for all students. The contents of the educational lecture was drawn from fundamentals and medical surgical
nursing textbooks [(Brunner and Suddarth's textbook of medical-surgical nursing 13th edition) & (Kozier & Erb's fundamentals of nursing 9th edition)]. The content included: a PowerPoint presentation about medication administration (definitions; components of a drug order; types of medication orders; six rights of medication administration including dosage calculations; routes of administration; getting off the tablet medication; drawing up medication from a vial and an ampule; IM and SC injection sites; IM and SC injection volumes; angles of insertion; type of syringes & needles; infusion pumps; step by step administration of oral, IV, SC, and IM medications). The same scenarios that were offered for simulation group were displayed onto a projector screen and a discussion was encouraged between students and the lecturer in an effort to analyze cases and then suggest the appropriate intervention.

Content similar to that given to the HFS group was provided as well to participants in the traditional lecture group. The difference being that those participants in the traditional lecture group discussed with the lecturer and suggested an appropriate intervention without there being an opportunity to actually put into practice these interventions, like was possible in the situation of the HFS group. HFS group members used the appropriate intervention by telling the computerized manikin to do so and that effect was easily seen on the manikin, in a direct response to the suggested treatment method that the group participants selected to employ. Therefore HFS group participants easily observed the results of their intervention as they would on a real live patient.

Three doctorally- and masters-prepared nurses with an expertise in adult health nursing and simulation confirmed the equivalency of and content validity for the entire content presented in each method. Both of the instructional methods went over the exact same content in order to attribute any improvement to the fact that one treatment was more effective than another.
**Posttests.** After completing HFS and traditional lecture interventions, a first posttest was performed in the medical/surgical departments at KAUH and PBTH. A posttest was measured by the five raters (RNs) who were trained in the use of the MASAT (see Appendix B). Trained RNs were also kept blinded to group assignments and research hypothesis. In the 6th week of NUR 228 clinical rotation (October 30th & November 1st, 2016), trained RNs visited students at clinical settings and assigned each student to one of the following cases: patient suffered from HF, HTN, DM, COPD, or patient with postoperative care. Students were instructed to administer the assigned medication to a patient and were able to: (a) review patient chart containing the patient’s medical background data, physician orders, and laboratory and diagnostic tests results; (b) review medication forms that come with scheduled medications; (c) access medication, supply areas, and equipment (i.e., infusion pump); (d) access the necessary measure recommended by the IOM, QSEN for safe medication administration practice, and Wolf et al. (2006) such as using calculator, all necessary formulas, and drug dosage reference book; and (e) ask or discuss any concerns about the process. The raters (RNs) were passive and not in any way involved themselves with the student’s duties. But, with any occasion where a possible error could result in any possible harm to the patient or student in the observing RN’s opinion, the RN then instructed the student accordingly. Only the student’s first attempt was scored. A second posttest was performed one month after the first posttest, during the 11th week of NUR 228 clinical rotation (December 4th & 6th, 2016), by trained RN’s using the exact same checklist. Each posttest demonstration took approximately 10-15 minutes.

**Blinding.** Blinding assesses whether the participants, observers, analyzers, and investigators are masked from the identity of the control and treatment groups. This ensures that the behavior of persons involved in the study will not be altered by knowledge of the group...
assignment (Portney & Watkins, 2009, p. 170). The feasibility of such blinding techniques depends on the nature of the experiment (Portney & Watkins, 2009, p. 170). In this investigation, due to the nature of interventions and data analysis, it was impossible to hide the identity of group assignments from participants, from those who provided the intervention, and from those who analyzed the data. However, this study hid the identity of group assignments from the raters (RN’s) who measured the outcome variables to prevent bias during data collection, and thus, increased the validity of the study (Portney & Watkins, 2009, 170). Because blindness was imperative to be maintained throughout the length of the study, the investigator also kept those who provided the interventions and measured the outcomes blinded from the research hypothesis, so that they didn’t step into their roles with any preconceived expectations or knowledge that could affect their interactions with participants (Portney & Watkins, 2009, 171).

**Analysis Plan**

The nature of the dependent/outcome variable dictates the choice of analysis (Katz, 2011). This investigation had only one dependent variable and two independent variables. The dependent variable (ME on the MASAT) was a continuous variable because it was measured as a mean score. The first independent variable (teaching method) was a categorical variable with two levels or categories: HFS-based training vs. the traditional lecture. The second independent variable was time, which was repeated across all participants. In this case, the variable of time was considered to be a repeated factor with three levels because all participants were exposed to its three measurements through testing them three times: once before the intervention, and twice afterward. Repeated measures enhance the power by reducing the error term, resulting in the need for a fewer sample size (Mertler & Vannatta, 2013, p. 70).

When the study had one continuous dependent variable (mean score of ME), one
independent-measure factor (teaching method) with two levels (HFS vs. lecture), one repeated-measures factor (time), and then the investigator compared means across a within-subjects variable and a between-subject variable; the data then were analyzed using a two-way analysis of variance (ANOVA) with one repeated factor (also called mixed model ANOVA) (Mertler & Vannatta, 2013, p. 72; Portney & Watkins, 2009, p. 199, 213).

This 2 (Between: HFS vs. traditional lecture) x 3 (Within: T1pretest vs. T2posttest one vs. T3posttest two) ANOVA was analyzed as follows: the between-subjects (HFS vs. lecture) effects was analyzed like a one-way between groups ANOVA, while the within-subjects (time) effect was analyzed like a one-way repeated measures ANOVA (Mertler & Vannatta, 2013, p. 72, 73). These two types combined into one analysis, a mixed model ANOVA that incorporates both between and within-subject effects. This type of statistical analysis revealed three F-test results: main effects for each of the independent variables (time and group) and an interaction effect between the two variables (time x group). A follow-up post hoc tests (Bonferroni) was utilized to determine where specific time differences lay (Mertler & Vannatta, 2013, p. 87, 88).

Descriptive statistics (mean, standard deviation, percentage, and frequency) were used to characterize the sample. An independent samples $t$ test was conducted to assess if differences exist on continuous baseline variables (age, overall GPA, nursing GPA, pretest on ME) by groups (lecture, HFS). Chi-square test was used to examine if differences exist on a categorical baseline variable (gender) by groups (lecture, HFS). Fisher's exact test of independence was utilized to examine if differences exist on a categorical baseline variable (highest level of completed education) by groups (lecture, HFS). Fisher's exact test of independence was utilized because 50% of the cells had expected counts of less than 5. The investigator entered the raw and demographic data into Microsoft Excel spreadsheets for ease of manipulation and then screened
the data for accuracy through quadruple-checking the hard data against the soft (electronic) data. The study had no missing data. All data were analyzed using SPSS statistics 24. The alpha level was set at 0.05. Appendix P shows a flow diagram for study enrollment, allocation, follow-up, and analysis according to CONSORT.

**Data Management.**

Since the study was conducted in another country (Jordan), all hardcopy documents were stored in a locked cabinet in the CON dean's office at JUST. Data analysis files were stored on the researcher's personal laptop. The laptop was password protected, had firewall and spyware security software. No other personnel were able to get access to the data. All excel and SPSS files were exchanged with the dissertation committee chair and statistician through the secure, firewalled, password protected, college's web based intranet (WSU SharePoint). Additionally all names and other identifying words were removed from the uploaded documents. After finishing the study, the files were removed from the (WSU SharePoint) and destroyed according to WSU protocol.

**Validity**

**Internal validity.** High internal validity maximizes ability to conclude that the causal/independent factor produced the outcome variable (Mertens, 2015, p. 126). Therefore, any uncontrolled threat to internal validity can invalidate the experiment. Threats to internal validity include threats associated with participants and threats associated with measurements, which are as follows:

- History: history effect included students’ participation in traditional clinical practice. This threat was controlled by having a two group design because the threat occurred for both groups (simulation and traditional lecture), and thus its effect was assumed to balance out
and left only the effect of study intervention (Mertens, 2015, p. 126; Portney & Watkins, 2009, p. 181).

- Selection: this threat was controlled by recruiting students from one cohort (second-year BSN students) who were randomly allocated to the two treatment groups. Randomization was done to make sure that both groups were balanced at the start of an experiment to draw valid comparisons (Portney & Watkins, 2009, p. 127, 163). The investigator also made an extra work to ensure that both groups were equivalent at baseline through comparing the two groups on the pretest of ME scores and key demographic characteristics.

- Attrition: The study phases such as the pretest and posttests on medication administration were in conjunction with the NUR228 course requirements—a core course that students had to take—and this led to a zero percent attrition rate. The study also used monetary incentives to reduce attrition.

- Testing: this threat included the potential effect of repeated testing on the outcome variable (Mertens, 2015, p. 126; Portney & Watkins, 2009, p. 177). Instead of using a self-report measure, an objective measure was utilized and rated by trained RN’s who provided the students with a general feedback on their performance after each live medication administration. Students were not informed about the checklist items and did not know what their scores were. Furthermore, both groups were exposed to the pre-and posttests, therefore the effect of pretesting should balanced out (Mertens, 2015, p. 126; Portney & Watkins, 2009, p. 177).

- Instrumentation: this threat was controlled by using the same objective measure (MASAT) for the pretest and posttests. Furthermore, inter-and intra-rater reliability were
established to ensure the accuracy and consistency of the rating instrument (Mertens, 2015, p. 127; Portney & Watkins, 2009, p. 178).

- Regression: this threat was controlled by using a valid and reliable checklist. Also, participants were not recruited on the basis of extremely high or low ME scores (Mertens, 2015, p. 126; Portney & Watkins, 2009, p. 177).

- Design contamination: This threat was minimized by encouraging students not to discuss the intervention that they received with each other during the course of the study. Furthermore, each group was assigned to a different medical/surgical units to minimize the contamination between both groups and diffuse the treatment effect.

External validity. External validity reflects “the extent to which the results of a study can be generalized beyond the internal specifications of the study sample” (Portney & Watkins, 2009, p. 184). Threats to external validity, in this investigation, included threats to ecological validity and threats to population validity, which are as follows:

- Threats to ecological validity were controlled by (a) explicit description of the study interventions; (b) maximizing treatment fidelity through which the investigator attended and observed the lecture and simulation hours and rate the fidelity of the intervention’s delivery in all traditional lecture and HFS groups. Fortunately, no variation occurred in the delivery of the assigned intervention between the groups and that didn’t require the lab instructor to be retrained to minimize drift; (c) each group received only one intervention instead of multiple interventions; (d) the study used experienced observers (medical/surgical RNs) who directly observed students during their medication administration practices on the MASAT. The literature supported the conclusion that direct observation method is the most valid, reliable, sensitive, efficient, and accurate
method for identifying ME, compared to other types of measurements like incident reports, self-reports, and MAR review (Barker, Flynn, & Pepper, 2002; Flynn, Barker, Pepper, Bates, & Mikeal, 2002); and (e) by using a valid and reliable tool (MASAT) to measure the outcome.

**Statistical conclusion validity.** Threats to statistical conclusion validity were controlled through the following (a) using a adequate sample size (n=89) calculated using a priori G*Power 3.1.9 analysis; (b) using an appropriate statistical method that was contingent with the study’s specific aims; (c) using a reliable and valid data collection tool; and (d) using an intention to treat analysis approach (analyzing data based on the original assignment of participants to the HFS and traditional lecture groups) (Katz, 2011, p. 54; Portney & Watkins, 2009, 167, 169).

**Summary**

Medication errors adversely influence patients’ safety and nurses are at the forefront in trying to keep their patients from being negatively impacted by such errors. It is crucial that nursing students gain the necessary knowledge and abilities to help limit the occurrence of MEs. Unlike traditional lecture-style lessons, using HFS-based learning can enable nursing students to act and improve their medication administration skills in a safe, and to a large extent, realistic environment.

A randomized, two-group, observer-blind, repeated measures experimental design using a valid and reliable checklist was utilized for this investigation. Trained RNs observed nursing students while administering medications via various routes to patients in an adult male and female medical/surgical unit. All participants in both groups were tested by trained RNs who were blinded to group assignments and research hypothesis three times: once before the interventions and twice afterward.
Descriptive statistics were utilized to characterize the sample. An independent sample t-test, Chi-square test, and Fisher's exact test of independence were used to assess baseline comparability between groups. A two (group) by three (time) mixed ANOVA was utilized to compare the mean ME scores on the MASAT across a within-subjects variable (time) and a between-subject variable (group). This type of statistical analysis revealed three F-test results: main effects for each of the independent variables (time and group) and an interaction effect between the two variables (time x group). A follow-up post hoc tests (Bonferroni) was utilized to determine where specific time differences lay.
CHAPTER FOUR

RESULTS

Introduction

This study aimed to: (1) describe the key demographics and baseline characteristics of the sample; (2) examine within-subject changes in the mean score of ME on the MASAT across three measurement occasions; (3) examine between-group differences in the mean ME score on the MASAT at three discrete measurement occasions; and (4) examine the interaction between time (three measurement occasions) and group (Traditional lecture, HFS) by mean values of ME on the MASAT. This chapter begins by addressing the degree of agreement (inter-rater and intra-rater reliability) among the five raters (data collectors). As previously discussed, this was an essential step before beginning the primary experiment for this project. Following this presentation, I then present the statistical analysis findings to the four specific aims of the study.

Reliability Assessment

The observed level of agreement among raters in scoring the MASAT per video (inter-rater reliability, or within-individual reliability) and their consistent across time with their own ratings (intra-rater reliability, or between-individual reliability) were assessed using intra-class Correlation Coefficient (ICC) statistic.

The absolute agreement among the five raters in terms of how they rated the videos using the 8 items of the MASAT at the first, second and third occasions (inter-rater reliability) was computed utilizing the ICC Two-Way Mixed model. The results revealed high agreement among the five raters. The average of raters’ ratings at each measurement occasion are shown in Table 2 (see Average Measures).
Table 2

**Inter-rater Reliability - Intra-class Correlation Coefficient.**

<table>
<thead>
<tr>
<th></th>
<th>ICC</th>
<th>df1</th>
<th>df2</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Average Measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 1</td>
<td>0.976*</td>
<td>4</td>
<td>16</td>
<td>0.910</td>
</tr>
<tr>
<td>Time 2</td>
<td>0.979*</td>
<td>4</td>
<td>16</td>
<td>0.925</td>
</tr>
<tr>
<td>Time 3</td>
<td>0.990*</td>
<td>4</td>
<td>16</td>
<td>0.964</td>
</tr>
</tbody>
</table>

*Note.* ICC = Intra-class correlation coefficients (95% CI) using an absolute agreement definition and two-way mixed effects model. *Indicates significance at p < 0.001.

The degree of agreement among repeated administrations of the MASAT done by a single rater (between-individual reliability, or intra-rater reliability) was computed using ICC Two-Way Mixed effect model. Results ranged from 0.962 to 0.997 which demonstrated excellent intra-rater reliability (see Table 3). This indicated that raters were highly consistent across time (T1, T2, and T3) with their own ratings.

Table 3

**Intra-rater Reliability – Intra-class Correlation Coefficient**

<table>
<thead>
<tr>
<th></th>
<th>ICC</th>
<th>df1</th>
<th>df2</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Average Measures (Time 1,2,&amp;3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rater 1</td>
<td>0.979*</td>
<td>4</td>
<td>8</td>
<td>0.905</td>
</tr>
<tr>
<td>Rater 2</td>
<td>0.983*</td>
<td>4</td>
<td>8</td>
<td>0.920</td>
</tr>
<tr>
<td>Rater 3</td>
<td>0.962*</td>
<td>4</td>
<td>8</td>
<td>0.817</td>
</tr>
<tr>
<td>Rater 4</td>
<td>0.997*</td>
<td>4</td>
<td>8</td>
<td>0.988</td>
</tr>
<tr>
<td>Rater 5</td>
<td>0.970*</td>
<td>4</td>
<td>8</td>
<td>0.863</td>
</tr>
</tbody>
</table>

*Note.* ICC = Intra-class correlation coefficients (95% CI) using an absolute agreement definition and two-way mixed effects model. *Indicates significance at p < 0.001.
In conclusion, the analysis revealed a high degree of interrater and intrarater reliability among the five raters. This ensured accurate and consensus ratings on the rating instrument, decrease a potential raters’ subjectivity that might result in bias, and that the measurements generated by raters are representative of the student’s true score (Portney & Watkins, 2009, p. 87, 88). This in turn helps in improving internal and external validity of the current work.

**Specific Aim 1: Describe the key demographics and baseline characteristics of the Sample.**

**Demographic analysis.** Data were analyzed using SPSS Version 24 for Windows. Descriptive statistics were used to describe the demographics of the 89 BSN students who took part in the study. Of the 89 total subjects, 36 (40.4%) were male and 53 (59.6%) were female. Participant ages ranged from 19 to 24 years, with a mean age of 20.61 (SD = 1.01). The participants' mean overall GPA was 69.95 (SD = 6.60) and nursing GPA was 74.56 (SD = 6.24) (see Table 5). Most universities in Jordan have a different GPA scale than the US. The JUST—the university from which the study sample were taken—uses 100-point percentage grading scale with a passing grade of 60% as described in Table 4.

Table 4

**JUST - Grading System for Cumulative Average**

<table>
<thead>
<tr>
<th>Grading System for Cumulative Average</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>92 - 100</td>
<td>Distinguished</td>
</tr>
<tr>
<td>84 – Below 92</td>
<td>Excellent</td>
</tr>
<tr>
<td>76 – Below 84</td>
<td>Very Good</td>
</tr>
<tr>
<td>68 – Below 76</td>
<td>Good</td>
</tr>
<tr>
<td>60 – Below 68</td>
<td>Pass</td>
</tr>
</tbody>
</table>
Table 5

Demographic and Baseline Characteristics of Study Participants

<table>
<thead>
<tr>
<th>Sample Characteristics</th>
<th>Total Study Sample (n=89)</th>
<th>Lecture Group (n=44)</th>
<th>HFS Group (n=45)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (number, %)</td>
<td></td>
<td></td>
<td></td>
<td>0.931</td>
</tr>
<tr>
<td>Male</td>
<td>36 (40.4%)</td>
<td>18 (40.9%)</td>
<td>18 (40.0%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>53 (59.6%)</td>
<td>26 (59.1%)</td>
<td>27 (60.0%)</td>
<td></td>
</tr>
<tr>
<td>Age (mean, SD)</td>
<td>20.61 (1.01)</td>
<td>20.79 (1.02)</td>
<td>20.42 (0.96)</td>
<td>0.080</td>
</tr>
<tr>
<td>Overall GPA (mean, SD)</td>
<td>69.95 (6.60)</td>
<td>70.34 (7.49)</td>
<td>69.58 (5.67)</td>
<td>0.588</td>
</tr>
<tr>
<td>Nursing GPA (mean, SD)</td>
<td>74.56 (6.24)</td>
<td>74.32 (5.91)</td>
<td>74.81 (6.62)</td>
<td>0.713</td>
</tr>
<tr>
<td>Highest Level of Completed Education (number, %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>88 (98.9%)</td>
<td>44 (100%)</td>
<td>44 (97.8%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Community College</td>
<td>1 (1.1%)</td>
<td>0 (0%)</td>
<td>1 (2.2%)</td>
<td></td>
</tr>
<tr>
<td>ME-Pretest (mean, SD)</td>
<td>6.16 (.824)</td>
<td>6.20 (.851)</td>
<td>6.11 (.804)</td>
<td>0.596</td>
</tr>
</tbody>
</table>

**Baseline group comparability.** The 89 participants were randomly allocated to the traditional lecture group (n = 44) and HFS group (n = 45). An independent samples t test was utilized to assess if differences exist on continuous baseline variables (age, overall GPA, nursing GPA, pretest on ME) by groups (lecture, HFS). Several assumptions must be fulfilled before conducting an independent sample t test: normality of the distributions, independence of sample and equality of variances across groups (homogeneity of variance). To assume whether assumption of normality is acceptable or not for the current continuous baseline variables, a visual inspection and assessment of skewness and kurtosis values were evaluated. Visual inspection of the histograms and q-q plots of the continuous baseline variables revealed that the distributions of data were sufficiently normal to conduct an independent-samples t test. In regard to skewness and kurtosis, different researchers suggested cut-off values for skewness and
kurtosis that would signify no problematic deviations from normality. Kim (2013) suggested that the acceptable values of skewness and kurtosis for assuming normality range between ± 1.96, while others indicated that skewness and kurtosis values within ± 2 are considered acceptable to demonstrate normality (Field, 2013; George & Mallery, 2010; Gravetter & Wallnau, 2014). Hair, Black, Babin, and Anderson (2010) argued that normality can be assumed if the value of skewness and kurtosis fall between ± 2 and ±7, respectively. As shown in Table 6, all measures of skewness and kurtosis for age, overall GPA, nursing GPA, and pretest on ME were fall within an acceptable range (± 1); thus, the assumption of normality was assumed.

Table 6

<table>
<thead>
<tr>
<th>Baseline Demographics</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>0.840</td>
<td>0.996</td>
</tr>
<tr>
<td>HFS</td>
<td>1.739</td>
<td>4.015</td>
</tr>
<tr>
<td><strong>Overall GPA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>1.050</td>
<td>0.490</td>
</tr>
<tr>
<td>HFS</td>
<td>0.320</td>
<td>-0.743</td>
</tr>
<tr>
<td><strong>Nursing GPA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>0.344</td>
<td>0.741</td>
</tr>
<tr>
<td>HFS</td>
<td>0.043</td>
<td>-0.599</td>
</tr>
<tr>
<td><strong>Pretest-ME</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>0.059</td>
<td>-0.783</td>
</tr>
<tr>
<td>HFS</td>
<td>0.616</td>
<td>0.331</td>
</tr>
</tbody>
</table>

Equality of variances of continuous baseline variables across the groups (homogeneity of variance) was assessed using Levene’s test (Katz, 2011; Mertler & Vannatta, 2013). Levene’s test was not significant for all continuous baseline variables, indicating that the assumption of
homogeneity of variance holds (see Table 7). Based on the aforementioned, assumption testing indicated no gross violation of assumptions. The independent sample t-test revealed no statistically significant difference in age ($p = 0.080$), overall GPA ($p = 0.588$), nursing GPA ($p = 0.713$), and pretest on ME ($p = 0.596$) among the two treatment groups; indicating that the two treatment groups (traditional lecture, HFS) were homogeneous (see Table 7).

Table 7

Results of Independent Samples Test for Age, Overall GPA, Nursing GPA, and Pretest by Group

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Age</td>
<td>0.558</td>
<td>0.457</td>
</tr>
<tr>
<td>Overall GPA</td>
<td>2.116</td>
<td>0.149</td>
</tr>
<tr>
<td>Nursing GPA</td>
<td>1.328</td>
<td>0.252</td>
</tr>
<tr>
<td>Pretest</td>
<td>1.582</td>
<td>0.212</td>
</tr>
</tbody>
</table>

Note. $p < 0.05$

Chi-square test was used to examine if differences exist on a categorical baseline variable (gender) by groups (lecture, HFS). No statistically significant difference was observed in gender among the HFS and traditional lecture groups, $\chi^2(1, 89) = 0.008, p = 0.931$; indicating that the two treatment groups were homogeneous (see Table 8). Fisher's exact test of
independence was used to examine if differences exist on a categorical baseline variable (highest level of completed education) by groups (lecture, HFS). Fisher's exact test of independence was used because 50% of the cells had expected counts of less than 5 (Vannatta & Mertler, 2013) (see Table 9). The results revealed no statistically significant difference in the highest level of completed education among the two treatment groups ($p = 1.0$, two-tailed Fisher's exact test, phi = 0.105); indicating that the two treatment groups were homogeneous (see Table 9).

Table 8  
*Results of Chi-Square Test and Descriptive Statistics for Group by Gender*

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>18 (40.9%)</td>
<td>26 (59.1%)</td>
<td></td>
</tr>
<tr>
<td>HFS</td>
<td>18 (40.0%)</td>
<td>27 (60.0%)</td>
<td></td>
</tr>
</tbody>
</table>

*Note. p = 0.930, two-tailed Chi-square test, df = 1. Numbers in parentheses indicate rows percentages. *p < 0.05

Table 9  
*Results of Fisher's Exact Test and Descriptive Statistics for Group by Highest Level of Completed Education*

<table>
<thead>
<tr>
<th>Group</th>
<th>Highest Level of Completed Edu</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High School</td>
<td>Community College</td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>44 (100%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>HFS</td>
<td>44 (97.8%)</td>
<td>1 (2.2%)</td>
<td></td>
</tr>
</tbody>
</table>

*Note. p = 1.0, two-tailed Fisher's exact test, df = 1. Numbers in parentheses indicate rows percentages. *p < 0.05

In conclusion, the analysis revealed that both groups were balanced on key demographics and baseline characteristics (age, gender, level of education, overall GPA, nursing GPA, and the pretest of medication error scores). This allows potential differences in outcomes at the end of
the experiment to be attributed to the intervention (lecture, HFS) and not to pre-existing differences between the groups.

**Analysis of Specific Aims Two, Three, and Four**

A two (group) by three (time) mixed ANOVA was used to examine the rest of the aims of the study. Aim 2 examined the within group changes ($T_1^{\text{pretest}} - T_2^{\text{posttest one}} - T_3^{\text{posttest two}}$), Aim 3 between group difference, and Aim 4 the interaction between time and group.

Statistical assumptions for mixed ANOVA were screened before conducting the analysis. The assumptions are as follows: (1) normal distributions of dependent variable (mean scores of ME on the MASAT) at each measurement occasion; and (2) equality of variances across groups (homogeneity of variance) and within-group (Sphericity). Regarding normality, different researchers indicated that ANOVA is a robust statistical technique to violations of normality as long as group sample size is adequate (Gravetter & Willnau, 2008, as cited in Mertler & Vannatta, 2013, p. 76; Kim, 2013). Both visual inspection and assessment of skewness and kurtosis were used to screen for normality of the dependent variable. Visual inspection of the histograms and q-q plots of pretest, posttest one, and posttest two revealed that the distributions of data were sufficiently normal to conduct a mixed ANOVA test. Further, all skewness and kurtosis statistics for $T_1^{\text{pretest}}$, $T_2^{\text{posttest one}}$, and $T_3^{\text{posttest two}}$ were fall within ($\pm 1$) which is an acceptable range to demonstrate normality; thus, the assumption of normality was assumed (see Table 10).

Table 10

*Skewness and Kurtosis Statistics for $T_1^{\text{pretest}}$, $T_2^{\text{posttest one}}$, and $T_3^{\text{posttest two}}$ ME Scores on the MASAT*

<table>
<thead>
<tr>
<th>Baseline Demographics</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1^{\text{Pretest}}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Equality of variances across groups (homogeneity of variance) was assessed using Levene’s test (Katz, 2011; Mertler & Vannatta, 2013). Levene’s test was not significant for T1 pretest ($F = 1.582, p = 0.212$), T2 posttest one ($F = 0.039, p = 0.845$), and T3 posttest two ($F = 0.171, p = 0.680$) (see Table 11). This means that variances across groups were equal (variances of ME scores across the two treatment groups were equal). Hence, homogeneity of variance was assumed.

Table 11

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Pretest</td>
<td>1.582</td>
<td>1</td>
<td>87</td>
<td>0.212</td>
</tr>
<tr>
<td>T2 Posttest 1</td>
<td>0.039</td>
<td>1</td>
<td>87</td>
<td>0.845</td>
</tr>
<tr>
<td>T3 Posttest 2</td>
<td>0.171</td>
<td>1</td>
<td>87</td>
<td>0.680</td>
</tr>
</tbody>
</table>

Note. p < 0.05

Homogeneity of variance among the two treatment groups within a subject (sphericity) was evaluated using Mauchly’s Test of Sphericity (Katz, 2011; Mertler & Vannatta, 2013). The
test of sphericity was required to assure that correlations and variances across the measurements taken at different time points are equal and that within subjects there is equal variance of the measurements (Katz, 2011, p. 202). As can be seen in Table 12, Mauchly’s Test of Sphericity was significant \( \chi^2(2) = 6.51, p = 0.039 \), which indicates violating the assumption of sphericity. In this event, the Greenhouse-Geisser correction was used to overcome this violation (Katz, 2011). The Greenhouse-Geisser estimate of sphericity or Greenhouse-Geisser estimate epsilon (\( \epsilon \)) is a commonly used method of correction used when data does not meet the sphericity assumption (Katz, 2011). A Greenhouse-Geisser estimate of sphericity (\( \epsilon \)) of 1 indicates that the data completely meet the assumption of sphericity (Katz, 2011) and the correction essentially disappears and the final estimates defaults to the same estimate one would get without the correction. The further below 1 (\( \epsilon < 1 \)), the greater departure from sphericity (Katz, 2011) and the greater the correction. As shown in Table 12, the Greenhouse-Geisser epsilon value was 0.93 which didn’t indicate a serious violation of sphericity assumption. The Greenhouse-Geisser estimate of sphericity (\( \epsilon \)) corrects the degree of freedom associated with the corresponding F-ratio to produce a valid F-ratio. Further, this type of correction counteracts the increase in Type 1 error resulting from the violation of the sphericity assumption (Katz, 2011).

<table>
<thead>
<tr>
<th>Mauchly's Test of Sphericity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Subjects</td>
</tr>
<tr>
<td>Time</td>
</tr>
</tbody>
</table>

*Note. P < 0.05*

**Specific aim two. Examine within-group changes in the mean score of ME on the MASAT across three measurement occasions.** Table 13 represents the mean ME score at
pretest, posttest one, and posttest two for the total sample and by group (lecture, HFS). The repeated measures result of the Mixed ANOVA was used to examine within-group differences in the mean score of ME on the MASAT across three measurement occasions (T1\textsubscript{pretest}, T2\textsubscript{posttest one}, T3\textsubscript{posttest two}). As the data violated the assumption of sphericity, Greenhouse-Geisser row values, not sphericity assumed row values, were used. The analysis revealed a significant effect for time \[ F (1.86,162.17) = 445.44, p < 0.001, \text{partial eta squared} (\eta^2_p) = 0.84, \text{a very large effect} \] (see Table 14), where the mean ME score decreased from T1\textsubscript{pretest} (estimated marginal mean = 6.16, SE = 0.088) to T2\textsubscript{posttest 1} (estimated marginal mean = 3.71, SE = 0.095) and T3\textsubscript{posttest 2} (estimated marginal mean = 2.64, SE = 0.099) (see Table 15).

**Table 13**  
*Means (M) and Standard Deviations (SD) of ME score on the MASAT at T1\textsubscript{pretest}, T2\textsubscript{posttest one}, and T3\textsubscript{posttest two} for the Total sample and by Group (lecture, HFS).*

<table>
<thead>
<tr>
<th></th>
<th>Lecture (n=44)</th>
<th></th>
<th>HFS (n=45)</th>
<th></th>
<th>Total (n=89)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1\textsubscript{Pretest}</td>
<td>6.20</td>
<td>0.85</td>
<td>6.11</td>
<td>0.80</td>
<td>6.16 (0.82)</td>
<td></td>
</tr>
<tr>
<td>T2\textsubscript{Posttest 1}</td>
<td>5.14</td>
<td>0.93</td>
<td>2.29</td>
<td>0.87</td>
<td>3.71 (1.69)</td>
<td></td>
</tr>
<tr>
<td>T3\textsubscript{Posttest 2}</td>
<td>4.00</td>
<td>0.99</td>
<td>1.29</td>
<td>0.87</td>
<td>2.64 (1.65)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 14**  
*Mixed ANOVA - Within-Group Effect*

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
<th>\eta^2_p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>577.36</td>
<td>1.86</td>
<td>309.73</td>
<td>445.44</td>
<td>0.000</td>
<td>0.84</td>
<td>1.000</td>
</tr>
<tr>
<td>Error</td>
<td>112.76</td>
<td>162.17</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. SS = Sum of Squares, MS = Mean Squared, \eta^2_p = Partial eta squared, Observed power computed using alpha = 0.05*
Table 15

*Estimated Marginal Means for T1*<sub>pretest</sub>, *T2*<sub>posttest one</sub>, *and T3*<sub>posttest two</sub>*

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Pretest</td>
<td>6.16</td>
<td>0.088</td>
</tr>
<tr>
<td>T2 Posttest 1</td>
<td>3.71</td>
<td>0.095</td>
</tr>
<tr>
<td>T3 Posttest 2</td>
<td>2.64</td>
<td>0.099</td>
</tr>
</tbody>
</table>

*Note.* SE = Standard Error

To determine where specific significant differences lie, post hoc comparisons (simultaneous testing off all pairwise comparisons) using the Bonferroni correction was used (Katz, 2011; Mertler & Vannatta, 2013, p. 87, 88). The Bonferroni Correction is a statistical technique that conservatively adjusts for the familywise error that is produced when conducting multiple follow-up tests (Katz, 2011). This type of statistical correction prevents the inflation in Type I error when multiple pairwise comparisons are tested simultaneously (Katz, 2011). As can be seen in Table 16, post hoc tests using the Bonferroni correction revealed a significant difference in the mean ME score on the MASAT between T1<sub>pretest</sub> and T2<sub>posttest one</sub> (mean difference = 2.44, SE = 0.12, *p* < 0.001), T1<sub>pretest</sub> and T3<sub>posttest two</sub> (mean difference = 3.51, SE = 0.13, *p* < 0.001), and T2<sub>posttest one</sub> and T3<sub>posttest two</sub> (mean difference = 1.07, SE = 0.105, *p* < 0.001). The "Mean Difference column in Table 15 revealed a significant decrease in the mean ME scores on the MASAT from (T1: pretest to T3: posttest two).

Table 16

*Pairwise Comparisons Using the Bonferroni Correction*

<table>
<thead>
<tr>
<th>Pairwise Comparisons</th>
<th>Mean Difference</th>
<th>SE</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1&lt;sub&gt;pretest&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2&lt;sub&gt;posttest 1&lt;/sub&gt;</td>
<td>2.445</td>
<td>0.122</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Specific aim three: Examine between-group differences in the mean score of ME on the MASAT at three discrete measurement occasions. The between-group result of the Mixed ANOVA was used to examine between-group differences in the mean ME score on the MASAT at three discrete measurement occasions. The analysis revealed that there was a significant effect for group \[ F (1,87) = 222.79, p < 0.001, \text{ partial } \eta^2 = 0.72, \text{ a very large effect} \] (see Table 17), where ME differ across baccalaureate nursing students who received HFS vs. those who received lecture. The estimated marginal mean ME score for baccalaureate nursing students receiving HFS training on medication administration \( \text{EMM}_{\text{HFS}} = 3.23, \text{ SE} = 0.09 \) was significantly less than the estimated marginal mean ME score for baccalaureate nursing students who received lecture on medication administration \( \text{EMM}_{\text{Lecture}} = 5.11, \text{ SE} = 0.09 \) (see Table 18).

Table 17

Mixed ANOVA - Between-Group Effects

<table>
<thead>
<tr>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
<th>( \eta^2 )</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>4645.89</td>
<td>1</td>
<td>4645.89</td>
<td>4369.16</td>
<td>0.000</td>
<td>0.98</td>
</tr>
<tr>
<td>Group</td>
<td>236.90</td>
<td>1</td>
<td>236.90</td>
<td>222.79</td>
<td>0.000</td>
<td>0.72</td>
</tr>
<tr>
<td>Error</td>
<td>92.51</td>
<td>87</td>
<td>1.06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. SS = Sum of Squares, MS = Mean Squared, \( \eta^2 \) = Partial eta squared, Observed power computed using alpha = 0.05*

Table 18

Estimated Marginal Means of ME scores on the MASAT for Lecture and HFS Groups
Specific aim four. Examine the interaction between time (three measurement occasions) and group (Traditional lecture, HFS) by mean values of ME on the MASAT.

Mixed ANOVA was used to examine the interaction between time (T1 \text{pretest}, T2 \text{posttest one}, T3 \text{posttest two}) and group (Traditional lecture, HFS). As the data violated the assumption of sphericity, Greenhouse-Geisser row values were used. Table 19 represents the analyses for this aim and revealed that the interaction between group and time by mean values of ME on the MASAT was significant \[F(1.86,162.17) = 82.71, p < 0.001, \text{partial eta squared} (\eta^2_p) = 0.49, \text{a large effect}], indicating that the pattern of change in the mean ME score on the MASAT over time did differ for the lecture and HFS groups. A graphical representation of the interaction effect is displayed in Figure 2.

Table 19

\textit{Mixed ANOVA - Interaction Effects}

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
<th>\eta^2_p</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time * Group</td>
<td>107.12</td>
<td>1.86</td>
<td>57.51</td>
<td>82.71</td>
<td>0.000</td>
<td>0.49</td>
<td>1.000</td>
</tr>
<tr>
<td>Error</td>
<td>112.76</td>
<td>162.17</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textit{Note.} SS = Sum of Squares, MS = Mean Squared, \eta^2_p = Partial eta squared, Observed power computed using alpha = 0.05
Figure 2. The interaction of time and group on MASAT

Multiple comparisons using the Bonferroni Correction (see Table 20) were used for comparisons of mean ME values between the three measurement occasions for both the lecture and HFS groups. The results presented in Table 20 show that the means ME score on the MASAT for the lecture and HFS groups significantly decreases over time. However, the HFS group had a significantly larger decrease in the mean ME score on the MASAT at T2_{posttest one} and T3_{posttest two} ($M_{pretest} = 6.11$, $SD = 0.80$; $M_{post one} = 2.29$, $SD = 0.87$; $M_{post two} = 1.29$, $SD = 0.87$) compared to the lecture group ($M_{pretest} = 6.20$, $SD = 0.85$; $M_{post one} = 5.14$, $SD = 0.93$; $M_{post two} = 4.00$, $SD = 0.99$). The decrease in mean ME score from $T1_{pretest}$ to $T3_{posttest two}$ was higher among students who received HFS-based education (-4.82) compared to those who received traditional lecture (-2.20).

Table 20

Pairwise Comparisons of ME Means for Both Lecture and HFS Groups Across Three Measurement Occasions
<table>
<thead>
<tr>
<th>Group</th>
<th>Pairwise Comparisons</th>
<th>Mean Difference</th>
<th>SE</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>T1&lt;sub&gt;pretest&lt;/sub&gt; (6.21) - T2&lt;sub&gt;posttest one&lt;/sub&gt; (5.14)</td>
<td>1.07</td>
<td>0.17</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>T1&lt;sub&gt;pretest&lt;/sub&gt; (6.21) - T3&lt;sub&gt;posttest two&lt;/sub&gt; (4.00)</td>
<td>2.21</td>
<td>0.19</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>T2&lt;sub&gt;posttest one&lt;/sub&gt; (5.14) - T3&lt;sub&gt;posttest two&lt;/sub&gt; (4.00)</td>
<td>1.14</td>
<td>0.15</td>
<td>0.000</td>
</tr>
<tr>
<td>HFS</td>
<td>T1&lt;sub&gt;pretest&lt;/sub&gt; (6.11) - T2&lt;sub&gt;posttest one&lt;/sub&gt; (2.29)</td>
<td>3.82</td>
<td>0.17</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>T1&lt;sub&gt;pretest&lt;/sub&gt; (6.11) - T3&lt;sub&gt;posttest two&lt;/sub&gt; (1.29)</td>
<td>4.82</td>
<td>0.19</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>T2&lt;sub&gt;posttest one&lt;/sub&gt; (2.29) - T3&lt;sub&gt;posttest two&lt;/sub&gt; (1.29)</td>
<td>1.00</td>
<td>0.15</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Summary**

An independent sample t test, Chi-square test, and Fisher's exact test revealed that both groups were balanced for the demographics and baseline characteristics (age, gender, highest level of completed education, overall GPA, nursing GPA, and pretest scores on ME). A two (group) by three (time) mixed ANOVA revealed a significant effect for time, a significant effect for group, and a significant interaction between group and time. Multiple comparisons using the Bonferroni Correction were used for comparisons of mean ME values between the three measurement occasions for both the lecture and HFS groups. The results revealed that the means ME score on the MASAT for the lecture and HFS groups significantly decreases over time. However, the HFS group had a larger decrease in the mean ME score on the MASAT at T2<sub>posttest one</sub> and T3<sub>posttest two</sub> compared to the lecture group. These results will be discussed in the following chapter—the discussion chapter.
CHAPTER FIVE

DISCUSSION

Introduction

This chapter begins with a summary of the results. Discussion of the results, study’s strengths and limitations, implications of the findings, and recommendations for future research are also discussed.

Summary of Results

An independent sample t test, Chi-square test, and Fisher's exact test of independence were used to examine whether groups were comparable at baseline in regard to key demographics and baseline characteristics (age, gender, highest level of completed education, overall GPA, nursing GPA, and the pretest of medication error scores). The analysis revealed that both groups were balanced at baseline in regard to the key demographics and baseline characteristics.

A two (group) by three (time) mixed ANOVA was used to examine within group changes (T1 pretest – T2 posttest one – T3 posttest two), between group difference (lecture, HFS), and the interaction between time and group. Assumption testing indicated the violation of sphericity assumption, therefore, Greenhouse-Geisser row values, not sphericity assumed row values were used. The analysis revealed

- A significant effect for time, with both groups showing a reduction in the mean score of ME on the MASAT across the three time measurement occasions (EMM pretest = 6.16, EMM posttest one = 3.71, EMM posttest two = 2.64, SE = 0.099).

- A significant effect for group, where ME differ across baccalaureate nursing students who received HFS vs. those who received lecture (EMM HFS = 3.23, EMM Lecture = 5.11)
• A significant interaction between group and time. Multiple comparisons using the Bonferroni Correction were used for comparisons of mean ME values between the three measurement occasions for both the lecture and HFS groups. The results revealed that the means ME score on the MASAT for the lecture and HFS groups significantly decreases over time. However, the decrease of mean ME score on the MASAT from T1\text{pretest} to T2\text{posttest one} and T3\text{posttest two} was larger among baccalaureate nursing students who received HFS training on medication administration (M_{\text{pretest}} = 6.11; M_{\text{post one}} = 2.29; M_{\text{post two}} = 1.29) compared to those who received lecture on medication administration (M_{\text{pretest}} = 6.20; M_{\text{post one}} = 5.14; M_{\text{post two}} = 4.00). The decrease from T1\text{pretest} to T3\text{posttest two} was (-4.82) among HFS participants and (-2.20) among those who received traditional lecture.

• The observed power for main effect of group and time and the interaction between was substantially high (observed power = 1.00, \( p < 0.001 \)).

• The effect sizes, calculated by eta squared, were 0.84 for the main effect of time, 0.72 for the main effect of group, and 0.49 for the interaction effect. Using the commonly used guidelines proposed by Cohen (1988) (0.01 = small, 0.06 = moderate, 0.14 = large), the results suggest very large effect sizes.

Discussion of Results

The first aim of this dissertation study aimed to describe the key demographics and baseline characteristics of the sample. The results showed no significant differences between the two treatment groups. The findings support the homogeneity in gender, age, highest level of completed education, overall GPA, nursing GPA, and pretest scores on MEs variances at the baseline level. This allows potential differences in outcomes at the end of the experiment to be attributed to the study intervention (lecture, HFS) and not to pre-existing differences between the
groups. Further, the study showed that HFS and traditional lecture participants had high mean ME scores on the baseline MASAT, which reflects a low-level competency in practicing the six rights of medication administration. This was expected due to the nature of the students who took part in this study; participants were novice or had no experience with medication administration.

The findings of two (group) by three (time) mixed ANOVA revealed that both HFS and traditional lecture interventions demonstrated a positive effect on improving BSN students' MASAT competency scores in both the first and second posttests. However, the use of HFS-based education had a stronger impact in improving BSN students' MASAT competency skills at real bedside medical/surgical patient care, compared with the traditional lecture. These findings will be discussed within the theory that guided the study, the context of previous research, and nursing education in Jordan.

**Kolb’s experiential learning theory.** All students who participated in this study were considered novice or had no experience with simulation and medication administration. Simulation provides a rich learning opportunity where students can gain knowledge and practice through experiential learning (Jeffries, 2005). In this investigation, HFS participants participated in two simulation scenarios. In both scenarios, students administered medication to a high-fidelity mannequin, which is the concrete experience in Kolb’s theory. After completion of the simulation experience, students then took part in a debriefing session. This debriefing is the self-reflection part of Kolb's theory in which students reflect on their simulated clinical experience, discuss and examine what was learned via the simulation experience, and receive faculty and peer feedback on their performance. The third stage, in which the learners modify an existing concept, enabled the student to identify what aspects of their medication administration needed improvement, and to generate appropriate interventions. Finally, in the active experimentation
phase, students were able to incorporate their learned actions gained from the previous experience and reflection in order to ascertain how effective they are in actual medical/surgical settings, completing Kolb's theory cycle. According to Kolb's cycle of experiential learning, learners continue to refine and enhance their performance over time; as reflected in the repeated evaluation of student performance over time.

The results of the current investigation (main effects and interactions) were consistent with Kolb's theory. The mean ME score for students receiving HFS training on medication administration decreased from 6.11 (T1_{pretest}) to 2.29 (T2_{posttest one}) to 1.29 (T3_{posttest two}). This decrease was larger than the decrease in the mean ME score among students who received traditional lecture on medication administration (M_{pretest} = 6.20; M_{post one} = 5.14; M_{post two} = 4.00). This indicates that HFS students applied the new knowledge and practices gained from simulation and debriefing to the real-life nursing settings and continue to refine and enhance their performance over time. These consistent findings support the theoretical framework which guided this investigation. The findings also demonstrate the effectiveness of HFS-based experiential learning over lecture in improving baccalaureate nursing students’ competency in practicing the six rights of medication administration (MASAT competency skills).

Discussion of the results within the context of previous research. As mentioned in the second Chapter, there are, to my knowledge, only three studies (Campbell, 2013; Ross, 2015; Sears et al., 2010) that discussed the impact of simulation on directly observed student nurses’ medication administration errors in a real clinical setting.

The first study conducted by Sears et al. (2010) demonstrated a significant decrease in the number of MEs among Canadian BSN students who received simulated case scenarios in place of some traditional clinical hours (intervention group) compared to those who received normally
scheduled clinical hours (control group). Unlike the current study, Sears et al.'s study (a) had an insufficient sample size (n=54) and power, which can increase the likelihood of encountering type II errors (Katz, 2011; Portney & Watkins, 2009); and (b) utilized a posttest-only randomized controlled group design. Lack of a pre-test, made it difficult to analyze and interpret the posttest results, determine that both group were equal at the start of the experiment, and attribute causation to the intervention (Portney & Watkins, 2009). The Sears et al study also (c) lacked a theoretical framework; (d) did not report any data concerning the internal consistency reliability of the data collection instrument; (e) did not hide the identity of group assignments from the raters who measured the outcome variables. This might indicate that bias came into play during data collection (Portney & Watkins, 2009); and (f) focused on undergraduate nursing students competency in two different hospital units (maternal and medical-surgical units) which in turn could result in more variances between study groups, and varying risks for mistakes in administering medicines.

The second study conducted by Ross (2011) revealed that both groups (low-fidelity simulation-based learning scenario vs. traditional clinical skills practice) demonstrated improvement in IM medication administration skills competency. No significant differences were found between the two groups. Unlike the current study, Ross (2011) study had significant limitations that could significantly lead to misleading results and interpretation of findings. Limitations of Ross’s study include (a) the study was underpowered (0.418) and used a small sample size (n=37), and this can increase the likelihood of committing type II error (Katz, 2011; Portney & Watkins, 2009). A second limitation was that (b) the study recruited subjects from two cohorts (accelerated second-degree and traditional four year BSN students). It is believed that accelerated second-degree students tend to have more knowledge and motivation and this
might influence their learning. Other limitations included that (c) the data were collected by clinical instructors who were not masked to the intervention or study phase, and this might indicate that bias came into play during data collection (Portney & Watkins, 2009); (d) the time between administration of treatment and collection of data (tests sequencing) was different between the two programs, which might affect the validity and the probability of correctly detecting an effect; and (e) the data were not analyzed based on intention to treat analysis approach—the least biased method of analysis for evaluating the effectiveness of an intervention (Portney & Watkins, 2009). The Ross study also utilized low-fidelity simulation-based learning scenarios to improve only IM medication administration competency, unlike the current study that used HFS-based learning scenarios to improve the major four routes of medication administration (oral, IV, IM, SC).

The third study conducted by Campbell (2013) aimed at investigating the effect of HFS on 27 second-semester diploma/ADN students’ performance during live medication administration. The results did not show any enhancement in the medication administration competency to real patients among students who exposed to four high-fidelity medication administration scenarios in addition to traditional practice in medical-surgical unit (experimental group, n=15) compared to those who exposed only to traditional practice in medical-surgical unit (control group, n=12). These results contradict with the results of the current study. However, the results derived from Campbell (2013) study must be reviewed with caution because of methodological limitations. Limitations of Campbell (2013) quasi-experimental study include: (a) small sample sizes and lack of power analyses, and this increase the likelihood of encountering type II error (Katz, 2011; Portney & Watkins, 2009); (b) the design lacked a pre-test, which made it difficult to analyze and interpret the posttest results, determine that both
group were equal at the start of the experiment, and attribute causation to the intervention (Portney & Watkins, 2009); (c) the absence of prior validity and reliability assessment on the measurement rubric, and this could impact the interpretation of the findings (Portney & Watkins, 2009); (d) the degree of agreement among raters (inter-rater reliability) was not assessed, which creates inconsistency and subjectivity in grading the study rubric (Portney & Watkins, 2009); and (e) the raters (clinical faculty) were not blinded to the intervention. Furthermore, Campbell (2013) used a convenience sample drawn from diploma/ADN program, unlike this current study that used a convenience sample drawn from BSN program.

The above-mentioned studies showed conflicting results in the ability of simulation to improve medication administration skills and reduce MEs in the clinical setting. However, the results derived from these studies must be reviewed with caution because of their methodological limitations mentioned above. Poorly conceived, underpowered, and less rigorous empirical designs do not allow for establishing causality and thus limit the practical significance of findings (Mertens, 2015). The authors of the previous relevant studies concluded that further studies are needed to study the impact of HFS on safe medication administration practice. This current investigation demonstrated the effectiveness of HFS-based education over traditional lecture in improving baccalaureate nursing students’ MASAT medication administration competency skills. Unlike the previous studies, this current investigation used a randomized, two-group, observer-blind, a theoretically-driven framework, and repeated measures pre-test/post-tests experimental design. Such a rigorous design would enrich the body of knowledge in nursing education with clearer findings in this area and provide the needed support for evidence-based medication administration education using simulation.

In the current study, the main effect of group and time and the interaction between them
had high power (observed power = 1.00, \( p < 0.001 \)). This means that the study had 100% protection against type II error; or in other words, the study demonstrated a 100% accuracy in finding true statistical effects or differences if actual effects or differences exist (Katz, 2011; Portney & Watkins, 2009). This high power was mainly attributed to the use of a rigorous experimental design, sufficient sample size, absence of missing data in any of the study variables, equality of variances across groups, exercise sufficient control over the majority of extraneous variables or sources of contamination that add error variance, and large effect size (Katz, 2011; Portney & Watkins, 2009).

The effect size can be defined as the magnitude effect of the study intervention on the results (Katz, 2011; Portney & Watkins, 2009) or the magnitude of the difference in the mean ME score within- and between- group. The effect size in Mixed ANOVA represented by partial eta squared (\( \eta^2 \)) (Mertler & Vannatta, 2013). Partial eta squared (\( \eta_p^2 \)) reflects the proportion of variance in the outcome variable (mean score of ME on the MASAT) explained by the IV (teaching method, time, and their interaction) (Mertler & Vannatta, 2013, p. 78). The effect sizes in the current work, calculated by eta squared, were 0.84 for the main effect of time, 0.72 for the main effect of group, and 0.49 for the interaction effect. Based on the guidelines proposed by Cohen (1988) (0.01 = small, 0.06 = moderate, 0.14 = large), the results suggest very large effect sizes. The actual difference in mean ME scores between the HFS and traditional lecture groups was substantially high. The large effect size revealed in the current investigation was consistent with the first meta-analysis conducted by Shin, Park, and Kim (2015) to derive comprehensive results on the effectiveness of simulation-based learning in nursing education. Shin et al (2015) revealed that, compared with no intervention or traditional didactic approach, simulation could improve various learning outcomes, particularly outcomes in the psychomotor domain, with a
medium-to-large effect size [Cohen’s $d = 0.71$, equivalent to Partial eta squared ($\eta^2_{p2}$) = 0.1119 (Cohen, 1988)]. High power and large effect size suggested high practical significance of the findings.

**Discussion of the results within the Context of nursing education in Jordan.** There are no studies in Jordan as well as in Middle Eastern countries exploring the use of simulation in teaching medication-related knowledge, skills, and errors in any of the healthcare students and professions. This investigation helps to fill that gap in the literature.

The Jordanian undergraduate nursing students who participated in HFS intervention appreciated, in their debriefing session, the importance of HFS-based learning in their medication administration education. The majority of HFS participants expressed that, unlike traditional learning such as lecturing and application on static manikins, HFS enabled them to learn in a simulated environment that allows them to develop their abilities, get constructive feedback, and practice procedures in a safe environment.

The study reported alarming results about the number of MEs committed by both HFS and traditional lecture groups in the pretest (mean score of 6.16 out of 8 on the MASAT). This mean score decreased among both groups after receiving the study interventions. However, the study demonstrated the effectiveness of HFS over traditional lecture in improving BSN students' medication administration skills at real bedside medical/surgical patient care. Students who participated in the traditional lecture group had a much larger incidence ($M_{\text{post two}} = 4.00$) of medication errors compared to the HFS group ($M_{\text{post two}} = 1.29$). These findings raised an urgent call to transform Jordanian nursing education through introducing new educational strategies like HFS-based learning early in the program to enable nursing students to competently and safely carry out vital skills, including the administration of medicine. It is anticipated that integrating
HFS as an adjunct teaching strategy can provide students with a rich learning environment that is not readily available to them currently in clinical settings for learning safe medication administration.

**Implications of the Findings**

The findings of this study provide evidence that HFS-based training is more effective than the traditional education method (lecture-based teaching) in improving BSN students’ MASAT competency skills (competency in practicing the six rights of medication administration) at real bedside medical/surgical patient care. These findings have implications for nursing education, practice, research, and leadership.

**Implications for nursing education.** The use of HFS in nursing education in the Middle East and Jordan is relatively new. The findings of this study can contribute to a needed paradigm shift regarding the use of advanced educational methods in Jordan’s undergraduate nursing programs. The study’s findings can help to garner the attention of Jordanian faculty members to consider innovative and efficient methods like HFS for educating nursing students on medication administration. Furthermore, integrating HFS-based training into nursing curriculum can help improve nursing students’ skill competency in light of both the escalating number of nursing students and the training deficiencies that still hinder the chances for nursing students to gain meaningful experience in real-life settings.

**Implications for nursing practice.** One factor that can lead to MEs is the training deficiencies or lack of experience at the baccalaureate nursing degree level (Harding & Petrick, 2008; Wolf et al., 2009; Wolf et al., 2006). Nursing education aims to matriculate competent and skilled graduate nurses who provide safe, competent, and quality patient care. The study’s findings can help nurse educators and hospital administrator in adopting HFS as an advanced
educational methods to improve the education of health-care workers by permitting students and clinicians to be educated in a setting where errors are permitted but will not cause harm to real patients.

**Implications for nursing research.** Likewise, contemporary academic nursing literature includes a great evidence-based protocols for administering medicine; but there is a paucity of recent work examining effective teaching tools and methods for this vital psychomotor skill. Even though simulation is ubiquitous in nursing education, there remains limited empirical evidence to support whether the medication-related skills gained from simulation translated into actual patient care settings. Unlike the previous relevant literature, this current investigation used more rigorous experimental designs utilizing a randomized, two-group, observer-blind, a theoretically-driven framework, and repeated measures pre-test/post-tests experimental design. Such a rigorous design would enrich the body of knowledge in nursing education with clearer findings in this area and provide the needed support for evidence-based medication administration education using simulation. Moreover, there are no studies in the Middle East exploring the use of simulation in teaching medication-related knowledge, skills, and errors in any of the healthcare students and professions. This investigation help fill the gap in the literature.

**Implications for nursing leadership.** This investigation can provide valuable data for the WHO-EMRO, JNC, Jordanian Higher Education Accreditation Commission, and nursing administrators who often call for the integration of new educational approaches, particularly simulated learning, in education. The greater realization regulators get out of HFS and its effects on nursing education, the better they can initiate and develop effective nurse education courses and requirements in an effort to reduce the MEs made by nurses in Jordan and around the world.
**Study Strengths**

Using a robust and rigorous design was the major strength of this investigation. The study utilized a randomized, two-group, observer-blind, repeated measures experimental design with one pretest and two posttests (T1\textsubscript{pretest}, T2\textsubscript{posttest one}, T3\textsubscript{posttest two}). This research design is specified for the research questions and specific aims. Experimental design is generally considered the highest standard in scientific inquiry, the gold standard for demonstrating a causal relationship between independent and outcome variables, and the superior method for other research strategies in evaluating the effects of treatment (Mertens, 2015, p. 123; Portney & Watkins, 2009, p. 161, 220). Moreover, experimental design is considered one of the best research methods for evaluating education innovations (Slavin, 2002, as cited in Mertens, 2015, p. 123). The following are the major strengths of the study design:

**Two groups.** The study utilized two-group experimental design (Portney & Watkins, 2009, p. 197). Although there was no traditional control group, this design provided an experimental control. In this study, the traditional lecture group acted as a control for the HFS-based training group and vice versa.

**Random assignment.** The 89 participants were randomly assigned to the lecture group (n = 44) and HFS group (n = 45) using Microsoft Excel's RAND function. Randomization creates an equal distribution of the measured and unmeasured confounders between the groups and assumes that both groups are balanced at the start of an experiment (Portney & Watkins, 2009, p. 163). This was done to draw valid comparisons and to guarantee that any differences between the groups had been distributed as a function of chance.

**Pretest-posttest.** Pretest, in this current research, helped the investigator to determine how the outcome variable changed from pretest to the first and second posttests within each
group and between groups. It also helped to determine whether groups were comparable on the outcome variable (mean score of ME on the MASAT) at the beginning of the experiment; thus reducing error variance. The analysis revealed that both groups were balanced for the key demographics and baseline characteristics (age, gender, highest level of completed education, overall GPA, nursing GPA, and the pretest scores on ME). Hence, the investigator attributed the differences in the outcome variable at the end of the experiment to the study intervention and not to pre-existing differences between the groups.

**Repeated measures.** The repeated measures incorporated in the study design helped the investigator to determine if the effect of intervention changed over time and not just present immediately following completion of the intervention (Portney & Watkins, 2009, p. 212).

**Blinding.** In this investigation, the investigator hid the identity of group assignments from the raters (RN’s) who measured the outcome variables. This helped to ensure that bias was not came into play during data collection, and thus, increased the validity of the study (Portney & Watkins, 2009, 170). The investigator also kept those who provided the interventions and measured the outcomes blinded from the research hypothesis, so that they didn’t step into their roles with any preconceived expectations or knowledge that could affect their interactions with participants (Portney & Watkins, 2009, 171).

**Valid and reliable tool.** The study used a valid and reliable tool (MASAT) for measuring students' competencies in practicing the six rights of medication administration (Goodstone and Goodstone, 2013). The MASAT is a psychometrically sound performance measure. The MASAT is also considered a high-level participant evaluation tool according to the classifications raised by Adamson et al. (2012) in terms of translational science research and the framework of Kirkpatrick (1994) for categorizing simulation evaluation.
**Inter-rater and intra-rater reliability assessment.** When working with an observation-based assessment such as the MASAT, error can be introduced by the raters. Prior to the start of this investigation, inter-rater (Absolute Agreement) and intra-rater reliability among the five raters (RNs) were assessed to ensure that (1) raters could obtain the same results for the dependent or outcome variable (mean score of ME on the MASAT); and (2) raters were consistent with their own ratings across time. The analysis revealed a high degree of inter- and intra-rater reliability among the five raters. This ensured accurate and consensus ratings on the rating instrument, decrease a potential raters’ subjectivity that might result in bias, and that the measurements generated by raters were representative of the student’s true score, and not measurement error (Portney & Watkins, 2009, p. 87, 88).

**Sufficient sample size, high observed power, large effect size, and high practical significance.** A priori power analysis using the G*Power 3.1.9 software revealed a final ample size of n=86 was needed to test specific aims of the study. However, a total of 89 students registered for NUR228 course were voluntarily took part in this study, giving a final sample size of n=89, which is still well above the 86 targeted in the power analysis. Performing a priori power analysis is crucial so that a researcher do not miss an effect due to not having enough participants (Katz, 2011; Portney & Watkins, 2009). Furthermore, the study demonstrated high observed power and very large effect sizes and this suggested high practical significance of the findings.

**Novice participants.** In this investigation, novice nursing students (had no experience with simulation and medication administration) and meeting the study’s inclusion/exclusion criteria had been selected in order to measure the true effectiveness of HFS and lecture on students’ medication administration skills.
Measuring Students’ medication administration competency in an actual medical/surgical patient care setting. The literature consistently supports the use of simulation to enhance medication related knowledge, skills, and errors among nursing students. There is, however, very limited literature which addresses the impact of use of simulation on the transfer of medication related knowledge, skills, and errors learned in a simulation setting to an acute care inpatient settings. This study helps address that deficit in the literature. Further, measuring Students’ medication administration competency in actual patient care settings would improve the external validity of the study findings (generalizability of the study findings). Moreover, this study is the first study in Jordan as well as in Middle Eastern countries that addressed the use of HFS as an innovative teaching method in an undergraduate nursing course to decrease MEs in an actual medical/surgical patient care setting. The findings can help fill the gap in the literature which targets reduction of MEs.

Study Limitations

Although the study utilized a rigorous strong design, some limitations exist. The findings of this study should be interpreted with caution because the sample was taken from one Jordanian university, and this limits the generalizability of the findings. The findings are further limited because the study examined the effectiveness of HFS and traditional lecture to enhance only one outcome, that is, the medication administration skills on the MASAT. The students’ self-reported GPAs was another possible limitation; GPAs were not taken from the official university data, resulting in possible concern about the reliability and accuracy of this measure. Another limitation includes the inability to measure the long-term impact of HFS and traditional lecture on students’ medication administration competency on the MASAT as they progress through course work and practice as nurses following graduation.
The observer effect, where the MASAT results might potentially be affected from the presence of the observer, was another limitation of this study. In this investigation, it was impossible to use unobtrusive observation due to the nature of participants; all students who participated in this study were considered novice or had no experience with medication administration, and that ethically, the raters had to intervene if patients or students were put at risk. Despite the limitation concerning the observer effect, the literature supported the conclusion that direct observation method is the most valid, reliable, sensitive, efficient, and accurate method for identifying ME, compared to other types of measurements like incident reports, self-reports, and MAR review (Barker, Flynn, & Pepper, 2002; Flynn, Barker, Pepper, Bates, & Mikeal, 2002). The current study adopted some measures that would alleviate the impact of this external variable, which are as follows: (a) the study used experienced observers (medical/surgical RNs) who were trained how to be objective; (b) students were informed that their scores on the MASAT would not affect their course grade or class standing and also would not be shared with any clinical instructors; and (c) inter-rater (within-rater) and intra-rater (between-rater) reliability were also assessed and revealed a high degree of reliability among the five raters.

The final limitation of note may be attributed to the fact that BSN students’ medication administration competency was measured on a limited number of medical diagnoses. Raters assessed students’ medication administration competency on care of a patient receiving postoperative care, or experiencing care for HF, HTN, COPD, or DM. Based on the three clinical professors’ perspective, it was anticipated that choosing other medical diagnoses might create some differences among students abilities to administer medicine; students might have some strengths and weakness in some medical diagnosis than in others and this might affect their
ability to display competence in regard to medication administration.

**Recommendations for Future Research**

As mentioned earlier, Jordan and Middle East countries lack research effort in the area of simulation in nursing education. Future research that address the use of simulation as an innovative teaching method in a variety of undergraduate and graduate nursing courses (e.g., critical care, emergency, pediatric, maternity, community, etc.) to evaluate learning outcomes is urgently needed. This will provide more evidence on the effectiveness of simulation in order to be adopted as an adjunct teaching method in nursing education in these countries.

In regard to this current study, replication of this work on other populations of nursing students (ADN, BSN, MSN) or academic settings, would improve the usefulness and generalizability of the findings. Additional research that compare the effectiveness of HFS versus LFS or standardized patients to improve nursing students’ medication administration competency is also recommended. This study examined the short term impact of HFS and lecture on medication administration errors on the MASAT. Future research should look at the long term impact (beyond one month: 3 and 6 months after training) of HFS-based learning on students’ medication administration competency at the bedside. Jordanian undergraduate nursing students who were participated in HFS group appreciated the importance of HFS-based learning in their medication administration education. Therefore, further research on how nursing students perceived simulation is also needed.

Providing efficient health care management depends largely on the healthcare providers’ ability to collaborate and act together as a team and in highly effective ways. To instill the idea of inter-professional collaboration among health sciences students, health educators should initiate the concept of inter-professional education early in all undergraduate and graduate health
programs. These inter-professional practices may be improved through using simulation. One example is to invite health sciences students to take part in an in an inter-professional CPR or ACLS simulation. Therefore, future research in this area is needed.

**Conclusion**

This study utilized such a rigorous experimental design that would enrich the body of knowledge in nursing education with clearer and evidence-based findings regarding the use of HFS in teaching BSN students safe medication administration.

Jordanian BSN nursing students from a convenience sample were randomly allocated to HFS and traditional lecture groups. Students in the HFS group participated in a 1.5-hour HFS scenarios on medication administration, while students of the traditional lecture group participated in a 1.5-hour PowerPoint presentation on the same topic. All participants were measured by trained RN’s—who demonstrated high inter- and intra-rater reliability—using the MASAT at three time points: the third week (T1: pretest), sixth week (T2: posttest one), and eleventh week (T3: posttest two) of Adult Health Nursing II Clinical rotation. Students were evaluated during an actual patient encounter in medical/surgical settings.

Descriptive statistics (M, SD, percentage, and frequency) were used to characterize the sample. An independent sample t test, Chi-square test, and Fisher's exact test revealed that both groups were balanced for the key demographics and baseline characteristics (age, gender, highest level of completed education, overall GPA, nursing GPA, and the pretest scores on ME). The between-group differences (lecture vs. HFS), the within-subject changes (T1 pretest, T2 posttest one, T3 posttest two), and interaction between time and group were analyzed using a mixed-design ANOVA. The results revealed that both HFS and traditional lecture demonstrated a positive impact on improving BSN students' MASAT competency scores in both the first and
second posttests. However, the use of HFS had a stronger effect on BSN students' MASAT medication administration skills at real bedside medical/surgical patient care, compared with the traditional lecture. These results are consistent with some previous relevant literature (Sears et al., 2010), as it is also inconsistent with other previous relevant literature (Ross, 2011). The current study adopted a strong and rigorous experimental design that address most of the methodological limitations mentioned in the previous relevant studies.

To date, there are no studies in Jordan as well as in the Middle East exploring the use of simulation in teaching medication-related knowledge, skills, and errors in any of the healthcare students and professions. This investigation helps to fill that gap and contributes to the body of knowledge regarding the efficacy of HFS worldwide. This study can also contribute to a needed paradigm shift in Jordan’s nursing education, moving to more advanced educational method and high quality, experimental nursing education research.
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APPENDIX A

Study Design Diagram

Enrollment of Study Participants  \( n = 89 \)

Random Assignment

High Fidelity Simulation (HFS) Group  \( n = 45 \)

Pretest on Real Patient (Week 3)

HFS Training (Week 4 & 5)

Initial Posttest on Real Patient (Week 6)

Final Posttest on Real Patient (Week 11)

Traditional Lecture Group  \( n = 44 \)

Pretest on Real Patient (Week 3)

Traditional Lecture (Week 4 & 5)

Initial Posttest on Real Patient (Week 6)

Final Posttest on Real Patient (Week 11)

Early in the Fall of 2016 (Sept 26 – 28, 2016)

During the 1st week of NUR 228 clinical rotation (Sept 29, 2016)

During the 3rd week of NUR 228 clinical rotation (Oct 9th & 11th. 2016)

During the 4th & 5th week of NUR 228 class (Oct 16-27. 2016)

During the 6th week of NUR 228 clinical rotation (Oct 30th & Nov 1st. 2016)

During the 11th week of NUR 228 clinical rotation (Dec 4th & 6th. 2016)
APPENDIX B

Sample Recruitment Script

The sample for this study will be a convenience sample of BSN students enrolled in NUR228: Adult health nursing II clinical in fall of 2016 at Jordan University of Science and Technology (JUST). After IRB approval is obtained at WSU (IRB Number #15309-001), JUST (Ref #: IRB/6/4/2016, date 13/6/2016), and Jordanian Ministry of Health (No: Development/Plans/5521), the investigator will approach the dean of the faculty of nursing, the chairman of adult health department, and the course coordinator and instructors and provide them with the study proposal and/or abstract in order to obtain permission to recruit students.

Faculty gather NUR 228 students in a large hall to orient them to the course and the clinical ground rules on the first day of class. The investigator will arrange in advance with the course coordinator and instructors to attend part of the orientation lecture for recruiting study participants. The investigator will ask clinical instructors to leave the hall so that students do not feel that they are under any pressure to participate in the study. The PI will hold a PowerPoint presentation and provide the students with information about the study, including the study’s aims and procedures, the voluntary nature of participation, what is expected of them in the research activity, how the confidentiality of data will be maintained, incentives for participation, and the time it will take to complete the entire study.

Hello everybody, my name is Anas Mohammad. I am a doctoral student at WSU’s College of Nursing. I would like to invite you to participate in my dissertation research that was designed to enhance the education of Jordanian baccalaureate nursing students in the area of medication administration. The purpose of my research study is to determine the effectiveness of two instructional methods (High Fidelity Simulation and traditional teaching method) to decrease medication administration errors among second-year baccalaureate nursing students in an actual patient care setting in Jordan. This study has been reviewed and approved for human subject participation by WSU, JUST, and Jordanian MOH Institutional Review Boards.

In order to be eligible participants, you must meet the following criteria: (1) second-year baccalaureate nursing student, having completed your first year; (2) 18 years of age and older; (3) enrolled in your second adult health nursing clinical course (NUR228) for the first time and scheduled for placement in medical surgical environments; (4) have no valid or expired Cardiopulmonary Resuscitation (CPR) or Advanced Cardiac Life Support (ACLS) certification; and (5) have no prior experience with simulation or medication administration in a clinical setting; and (6) students who were not bridging from an associate’s degree (AND) to a baccalaureate degree (BSN). If you meet the above criteria, you are eligible to participate.

Participation in this study is strictly voluntary and will in no way affect any course grades or class standing. You also can withdraw at any time before, during, or after the study without penalty. If you agree to participate, you will be randomly assigned to one of the two study groups (simulation and lecture based). Your participation in HFS group will involve
The investigator will answer any questions and clarify any misconceptions raised by prospective participants. Once all questions and concerns are addressed satisfactorily, and eligible participants expressed their willingness to take part in the study, the investigator will ask them to sign up for the study and provide informed consent (IC). IC will be administered in English language since English is the official language of instruction in JUST. The consenting will take place in a private room at JUST (N2L1), and should be finalized within the first week of the academic semester. The investigator will asked each participant to read the consent, take as much time as s/he needs, and ask any questions or express any concerns about their participation in the study. The investigator will also clarify all potential benefits and risks of the study. Maintaining the confidentiality of data during the course of the study will also explained. After that, each participant will be asked to sign the form on front of the investigator and will be provided with a copy of the written consent form.

Once the consent form is signed, the investigator will ask the participants to fill out the demographic sheet. Students will be encouraged to ask or discuss any concerns about the study with the investigator at any time through the investigator’s contact information provided on the IC or in person in the investigator’s allocated office (N2L1).

Thank you for listening to me today. Do you have any questions? Please don’t hesitate to contact me if you have any question or concern about the research study. You can find my contact information on the first page of the consent form. Thank you.
APPENDIX C

WASHINGTON STATE UNIVERSITY
United State of America
College of Nursing
Research Study Consent Form

Study Title: HIGH-FIDELITY SIMULATION: A NEW METHOD FOR IMPROVING MEDICATION ADMINISTRATION SKILLS AMONG UNDERGRADUATE NURSING STUDENTS IN JORDAN

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You are being asked to take part in a research study carried out by Jo Ann Dotson and Anas Mohammad. This form explains the research study and your part in it if you decide to join the study. Please read the form carefully, taking as much time as you need. Ask the researcher to explain anything you don’t understand. You can decide not to join the study. If you join the study, you can change your mind later or quit at any time. There will be no penalty or loss of services or benefits if you decide to not take part in the study or quit later. This study has been approved for human subject participation by the Institutional Review Board (IRB) at the Washington State University (WSU).

What is this study about?

This research study is being done to compare the effectiveness of two instructional methods, High Fidelity Simulation and traditional lecture method, to decrease medication administration errors among second-year baccalaureate nursing students in an actual patient care setting in Jordan. You are being asked to take part because you are 18 years of age and older, a novice nursing student enrolled in your second adult health nursing clinical course (NUR228) for the first time, scheduled for placement in medical surgical environments, and could encounter a patient while working in a hospital setting.

You cannot take part in this study if you are not a student of nursing, if you were bridging from an associate’s degree (AND) to a baccalaureate degree (BSN), if you have a valid or expired Cardiopulmonary Resuscitation (CPR) or Advanced Cardiac Life Support (ACLS) certification,
or if you have had any experience with simulation or previous medication administration experience in a clinical setting.

Taking part in the study will take approximately one and a half hours for receiving the assigned intervention plus one hour for the three tests on medication administration, giving a total of two and a half hours

What will I be asked to do if I am in this study?

- Upon completion of this consent form, you will be asked to fill out a one page demographic questionnaire that includes questions about your gender, age, and overall cumulative average.
- You will then be randomly assigned by chance to one of two groups. You could be assigned to the group that will participate in two simulated patient care scenarios related to medication administration in the simulation lab of the College of Nursing. These simulations will be offered during the 4th and 5th week of NURS 228 class (October/November 2016). The two simulations will take approximately one and a half hours. During this simulation you will work with the lab instructor, the investigator, and one other student. You will be expected to act professionally and sign a confidentiality statement as required in the Jordan University of Science and Technology (JUST) nursing program. If you are assigned to the lecture group, you will participate in a one and a half hours lecture on medication administration that will take place in one of the JUST-College of Nursing classrooms during the 4th and 5th week of NURS 228 class (October/November 2016).
- Participation in this study also includes the completion of three medication administration skill demonstrations. These demonstrations will take place in the adult medical/surgical departments in King Abdullah University Hospital (KAUH) and, if needed, Ministry of Health hospitals. These demonstrations are in conjunction with NUR 228 clinical rotations. The first will take place during the third week of clinical rotation, the second will take place during the sixth week of clinical rotation, and the third will take place during the eleventh week of clinical rotation. In each skill demonstration you will be assigned to a one medical or surgical case by trained Research Assistants (Registered Nurses - RNs). You will be instructed to administer the assigned medication to a patient. Since you will be administering medicine to an actual person, patient safety is an important consideration. With any occasion where you are unsure of a step, misses a step, or begins to make a possible error that could result in any possible harm to you or to the patient in the observing RN’s opinion, the RN will then instruct you accordingly. Each demonstration will take approximately 15-20 minutes. The total time you can expect to spend on this study is approximately one and a half hours for receiving the assigned intervention plus 1 hour for the three demonstrations.

Are there any benefits to me if I am in this study?

Some nursing students feel that participating in health care simulations is a benefit because it gives them additional practice with patient care. A possible benefits from your being part of this study include: (1) increasing practice administering medicine and feedback on administration
performance; (2) improving patient safety; and (3) helping nursing faculty to design effective and meaningful curriculum to ensure competent future nurses in medication administration.

There is no direct benefit to you from being in this study; however, you will be entered in a drawing to win one of thirty $20 (14 Jordanian dinar; 1 dollar = 0.70 JD) grocery cards at the end of data collection which some students may consider a benefit.

**Are there any risks to me if I am in this study?**

There are minimal risks to participating in this study. Some students feel anxious or nervous during clinical simulations. You will participate in a debriefing after each simulation scenario to discuss any stress or anxiety you may have felt. Furthermore, your participation in this study is voluntary and you may withdraw from the study at any time.

Throughout the data collection procedure, the observer (trained RN’s) will be passive and not in any way involve him/herself with your duties during medication administration. But, with any occasion where a possible error could result in any possible harm, the RN will then instruct you accordingly.

Although no injuries are anticipated and no invasive medical tests are part of this study, if you experience an injury of any kind as a result of participating in this study you may contact Anas Mohammad 0775773939 (cell) or Dr. Jo Ann Dotson +1-509-324-7341 (office).

**Will my information be kept private?**

The data for this study will be kept confidential to the extent allowed by the U. S. federal and state law. No published results will identify you, and your name will not be associated with the findings. Under certain circumstances, information that identifies you may be released for internal and external reviews of this project.

- **Your data will be coded and the key to participant codes will be kept separate from the data collected under lock and key in the JUST-College of Nursing.**
- **No data collected in this study will be provided to or shared with any other participants in the study and faculty members at JUST.**
- **Your participation in this study will in no way affect any course grades.**
- **Data that is transferred to electronic format will be stored on a secure, firewalled, and password-protected computer. Data that is transferred in an electronic format will be de-identified and password protected. No identifying information such as name or email address will be part of the electronic data set.**
- **Data will be shared with the PI through the secure, firewalled, password protected, college’s web based intranet (WSU SharePoint). All names and other identifying words will be removed from the exchanged documents**
- **The following persons will have access to the information collected in the investigation: Dr. Jo Ann Dotson, Anas Mohammad, Research Assistants (Registered Nurses) trained by Anas Mohammad to help collect the data, and if necessary the IRB.**

The results of this study may be published or presented at professional meetings, but the identities of all research participants will remain anonymous. The data for this study will be kept for 3 years.
Are there any costs or payments for being in this study?

There will be no costs to you for taking part in this study. You will be entered in a drawing to win one of the thirty $20 (14 Jordanian dinar; 1 dollar = 0.70 JD) grocery cards after the data collection is complete as a compensation for taking part in this study.

Who can I talk to if I have questions?

If you have questions about this study or the information in this form, please contact the researchers Anas Mohammad at (0775773939, or anas.mohammad@wsu.edu), or Jo Ann Dotson at (+1-509-324-7261, or joann.dotson@wsu.edu), PO Box 1495, Spokane, WA 99201-1495. If you have questions about your rights as a research participant, or would like to report a concern or complaint about this study, please contact the Washington State University Institutional Review Board at (001) 509-335-3668, or e-mail irb@wsu.edu, or regular mail at: Albrook 205, PO Box 643005, Pullman, WA 99164-3005.

What are my rights as a research study volunteer?

Your participation in this research study is completely voluntary. You may choose not to be a part of this study. There will be no penalty to you if you choose not to take part. You may choose not to answer specific questions or to stop participating at any time.

What does my signature on this consent form mean?

Your signature on this form means that:
• You understand the information given to you in this form
• You have been able to ask the researcher questions and state any concerns
• The researcher has responded to your questions and concerns
• You believe you understand the research study and the potential benefits and risks that are involved.

Statement of Consent

I give my voluntary consent to take part in this study. I will be given a copy of this consent document for my records.

__________________________________________
Signature of Participant Date

__________________________________________
Printed Name of Participant
Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect. I certify that when this person signs this form, to the best of my knowledge, he or she understands the purpose, procedures, potential benefits, and potential risks of participation. I also certify that he or she:

- Speaks the language used to explain this research
- Reads well enough to understand this form or, if not, this person is able to hear and understand when the form is read to him or her
- Does not have any problems that could make it hard to understand what it means to take part in this research.

________________________________________
Signature of Person Obtaining Consent Date

________________________________________
Printed Name of Person Obtaining Consent Role in the Research Study
APPENDIX D

Demographic Questionnaire for Participants

Today’s Date __________________________
Name __________________________________ Study ID #: __________________________
Address ........................................................................................................
Phone (cell) ____________________ (other) _________________________________
E-mail address: _________________________________________________________
Year and semester in program _____________________________________________

Directions: Please provide answer to the following questions:

1) How old are you?

2) What is your gender?
   a. Male
   b. Female

3) What is your highest level of completed education?
   a. High School
   b. Community College
   c. Bachelor’s degree
   d. Master’s degree

4) What is your overall cumulative average? ____________

5) What is your nursing overall cumulative average? ____________

6) What courses are you currently taking? _________________________________
APPENDIX E

Medication Administration Safety Assessment Tool (MASAT)

Note: The English version of the MASAT will be used because English is the official language of instruction at JUST. Permission to utilize the MASAT was obtained from the tool’s developer: Dr. Lori Goodstone Ed.D, R.N..

Participant ID ______________                   Current year: 2nd __ 3rd__
Research Assistants Initials ________________

Instructions for rating:
The 8 items of the checklist correlate to each of the rights of medication administration: Right patient, Right drug, Right dose, Right route, Right time and Right documentation. Observe the student administer medications ordered in the Medication Administration Record (MAR). Rate student’s medication error rate on each of the steps below by placing a tick (✓) for YES and (X) for NO. “Yes” denotes mastering a task correctly and in a way that do not place the patient at risk for harm. "No" denotes mastering a task incorrectly or in a way that place patient at risk of harm, didn't master a task, or needs practice (e.g., use of some, but not all of each recommended sub-tasks). “Yes” counted as 0 point and "No" as 1 point. As there are 8 items, the scores ranges from 0 to 8, with higher scores indicating poor competence in practicing the six rights of medication administration and consequently higher number of medication error. You may add any necessary comments that might supplement the evaluation such as patient's medical diagnosis, given medication, and allergy. The completed tool will involve the total number of ME for each participant.

<table>
<thead>
<tr>
<th>“Items”</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student asked patient to state name and DOB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student checked name and DOB against MAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student checked patients ID band for name and DOB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student checked each medication from drawer against MAR for correct drug name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student checked each medication from drawer against MAR for correct drug dose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student administered each medication via correct route</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student administered each medication at correct time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student correctly documented all medications in MAR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: MAR = medication administration record; DOB = date of birth; ID = identification

© Lori Goodstone, Ed.D, R.N., Michael Goodstone, Ph.D

Total score: ____/8 possible
APPENDIX F

Permission to Use the Medication Administration Safety Assessment Tool

Lori Goodstone <goodstl@farmingdale.edu>
Sat 9/12/2015, 5:47 PM
Mohammad, Anas Ahamd

Anas,

You have my permission to use the MASAT. I would be happy to talk to you regarding your research. let me know times and days this week, Wednesday thru Friday, and I will try to reach you.

Lori

Lori Goodstone, DHEd, RN
Associate Professor of Nursing
Faculty Simulation Coordinator
Farmingdale State College
Gleeson Hall, Room 210
631-420-2131
goodstl@farmingdale.edu
Subject: Invitation to participate in my research doctoral study

Dear Medical/Surgical Clinicians,

This is Anas Mohammad and I am a nursing doctoral student at Washington State University, USA. I am conducting a doctoral study entitled: the effectiveness of two instructional methods to decrease medication administration errors among second-year baccalaureate nursing students in an actual medical/surgical setting in Jordan. This study has been reviewed and approved for human subject participation by WSU Institutional Review Board.

I am recruiting five Registered Nurses who have a minimum of two years experience in adult medical/surgical settings. If you agree to participate, you will be asked to: 1) attend an in-person training session on the use of the rating tool. The session is expected to last for about 2-hours. We will try to schedule the training at a time (during the month of July 2016) that does not conflict with your work; 2) Rate five different simulated videotapes of students administering medicine via multiples routes. This will take approximately one and a half hours and will be done on flexible time (during the month of August 2016) at flexible locations; and 3) Rate the students’ medication administration competency at medical-surgical departments in King Abdullah University Hospital (KAUH) and Princess Basma Teaching Hospital (PBTH), using a rating form. Your rating will occur three times at the 3rd, 6th, and 11th weeks of the Fall 2016 semester. You are expected to rate 10-15 students each time. Rating each student will take approximately 10-15 minutes.

Your participation in this study is completely voluntary and the confidentiality of your data will be maintained during the study.

Thank you very much for your time and consideration. Please do not hesitate to contact me at (0775773939) or (anas.mohammad@wsu.edu) if you have any questions or concerns about this study.

Sincerely,

Anas RN, MSc, PhD candidate
APPENDIX H

Training Materials for Research Assistants (Raters)

The Medication Administration Safety Assessment Tool (MASAT) Training: Pretest, Posttest one, and Posttest two

The data collection tool contains 8 items covering different aspects of medication administration, including right medication, right patient, right name, right route, right dose, and documentation. The tool has been developed by Dr. Lori Goodstone (2013). Permission to utilize the MASAT was obtained from the tool’s developer.

Participants will be administering medicines to real patients at adult medical-surgical departments in a teaching hospital affiliated with Jordan University of Science and Technology (JUST), called “King Abdullah University Hospital” (KAUH), and “Princess Basma Teaching Hospital” (PBTH). Your role as a rater is to rate their scores of medication error (ME) on the first medication administration using the MASAT. Please don’t write a participant's name on the data collection tool and use a participant’s study ID number instead. If a participant forgets or unsure of his/her study ID number, please contact me at telephone 0775773939 so I can come and retrieve the ID number of the participant.

In the 3rd, 6th, and 11th weeks of NUR 228 clinical rotation, you will assign each student to one of the following cases: HF, HTN, DM, COPD, or postoperative care. You will instruct student to administer the assigned medication to a patient. Students are able to: (a) review patient chart containing the patient’s medical background data, physician orders, and laboratory and diagnostic tests results; (b) review medication forms that come with scheduled medications; (c) access medication, supply areas, and equipment (i.e., infusion pump); (d) access the necessary information needed for safe practice such as using calculator, all necessary formulas, and drug dosage reference book; and (e) ask or discuss any concerns about the process. Patients being administered medicines will be informed that the student is being graded on their competencies in administering medications for a doctoral research study.

During medication administration process, you must be passive and not in any way involve yourself with the student’s duties; you must not review or demonstrate the use of the six rights of medication administration prior to the participant administering medicine. But, with any occasion where a possible ME could cause any possible harm to the patient or student in your observing judgment, you will then instruct the student and correct him/her before s/he proceeds and then mark the event on the MASAT as described below. Only the student’s first attempt will be scored. Immediately following the pretest, post-test #1, and post-test #2, you will provide the student with a general and constructive feedback on his/her performance.

Each item on the MASAT can be rated by placing a tick (✓) for YES and (X) for NO. “Yes” denotes mastering a task correctly or in a way that don’t result in any harm to a patient. "No" denotes mastering a task incorrectly or in a way that cause harm to a patient, didn't master a task, or needs practice (e.g., use of some, but not all of each recommended sub-tasks). Yes” counted as 0 point and "No" as 1 point. As there are 8 items, the scores ranges from 0 to 8, with higher
scores indicating higher number of medication error. You could ask students to actually tell you (verbalize) the steps while medication administration process. Students can also get credit if they finish the step without verbalizing it unless the step itself can’t be observed like the first step on the MASAT (student ask patient to state name and DOB). You may also add any necessary comments that might supplement the evaluation such as patient's medical diagnosis, given medication, and allergy. The completed tool will involve the number of ME for each participant. Some tasks have multiple sub-tasks to achieve. In order to master the task correctly, the participant must perform all related sub-tasks correctly. If not, a needs practice rating for the entire task should be checked (X).

Below are specific steps related to the MASAT:

Items 1, 2, & 3: Giving medication to the right individual. Participant will need to:
- Ask patient to state name and Date of Birth
- Checked patient name and Date of Birth against Medication Administration Record
- Checked patient Identification band for name and Date of Birth

Item 4: Giving the right medication. Participant will need to:
- Check each medication from drawer against Medication Administration Record for correct medication name. Included in this category are: (a) choosing the right medication form (e.g., plain aspirin vs. coated aspirin); and (b) checking for drug allergy.

Item 5: Giving medication in the right dose. Participant will need to:
- Check each medication from drawer against Medication Administration Record for correct dose. Correct strength, quantity, dilution, form, and number are all included in this category

Item 6: Giving medication by the right route. Participant will need to:
- Administer medications via correct route. Medication should also be administered in the correct site (e.g., lateralis site vs. dorsogluteal site vs. deltoid muscle)

Item 7: Giving medication at the right time. Participant will need to:
- Administer medications at correct time. Included in this category are: (a) administer medications within 30-minute prior to or after the requested administration time; and (b) checking when was the last dose given.

Item 8: Documentation. Participant will need to:
- Correctly document medications in Medication Administration Record.
APPENDIX I

E-mail Requests for Recruitment of Nurse Experts

Subject: Invitation to participate in my research doctoral study

Dear Nurse Experts:

This is Anas Mohammad. I am a nursing doctoral student at Washington State University, USA. I am conducting a dissertation research to compare the effectiveness of two instructional methods (High Fidelity Simulation and Traditional Lecture Method) to decrease medication administration errors among second-year BSN students in an actual medical/surgical patient care setting in Jordan. Two adult health, medical/surgical scenarios were developed for the simulation intervention in my investigation.

I am writing to invite you to participate in my research study. Three nurse experts with minimum of three years of experience and credentials in HFS and adult health nursing education are needed to be recruited in my research study. Your participation is completely voluntary and the confidentiality of your data will be maintained during the study. If you agree to participate, you will be asked to complete a feedback form on the content of the two simulation scenarios to be used in this study. I will send you the two simulation scenario with the feedback form to your email. Your feedback and other experts’ feedback will be collected, reviewed, and summarized. I will edit each scenario according to the feedback received. After that, I will send you the edited scenarios to ask you to agree or disagree with the edited version to reach agreement and consensus on each component of the scenario. The entire process is expected to take up to one month (June, 2016).

Please do not hesitate to contact me at (001 509 389 5964 USA cell) or (anas.mohammad@wsu.edu) if you have any questions about my doctoral research study.

Sincerely,

Anas RN, MSc, PhD candidate
APPENDIX J

Feedback Form

Adapted from: (O’Brien, 2014, p. 180). Competency assessment in nursing using simulation: A generalizability study and scenario validation process (Doctoral dissertation). Permission to use the feedback form has been obtained from the author.

ID # (please provide the ID # assigned on your instructions): _________________________

Use this feedback form along with the scenario and the MASAT instrument. Please check one of the columns (1-3) for each section. Do not leave any section blank. If you choose not to answer a question, the word “Skip” in Column 1 for that question. Feel free to use more space than is provided if needed.

Column 1: You are satisfied with the content as written. You do not feel any changes are needed. If you check column 1, do not complete columns 2 – 6.

Column 2: If you feel the content is partially or mostly acceptable, but needs some editing or changes, check column 2, “Accept With Changes”. Please describe the changes in column 4. Be as specific as possible. In column 5, include the evidence-based reference for any changes in treatment or management. Columns 4 and 5 are color coded blue to show they are completed if you check column 2.

Column 3: If you feel part of the content in a section needs to be deleted, rather than edited, please check column 3. Then, identify the content to be deleted in column 6 along with a rationale. Column 6 is color coded green to show it is completed if you check column 3.

Column 7: Please indicate whether or not the scenarios provide participants with opportunities to demonstrate competency for each of the 8 items on the MASAT.

164
<table>
<thead>
<tr>
<th>Section</th>
<th>Accept As Written</th>
<th>Accept With Changes (Please complete column 5 &amp; 6.)</th>
<th>Delete Content (please complete column 6.)</th>
<th>Changes to Content</th>
<th>Reference for Changes Noted in Column 5</th>
<th>Specify content to be deleted and rationale</th>
<th>Opportunities are available in the scenario to demonstrate competency of the 8 items on the MASAT</th>
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<td>Student Learning Outcomes:</td>
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<td>Background and Vital Signs</td>
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APPENDIX K

Permission to use Dr. Janet O'Brien's Feedback Form

Janet O'Brien <jebrien@asu.edu>
Thu 6/23/2016, 6:23 PM
Mohammad, Anas Ahamd ө

Action Items

Dear Anas,

I would be happy to have you use my feedback form in your validation process. Thank you for describing how you would modify it. I do not have a problem with your plans – and I would be very pleased to be cited. Please feel free to let me know when you are finished with your dissertation – I will enjoy reviewing it when it’s been published in ProQuest.

Good luck with your dissertation and defense.

Regards,

Janet

Janet O'Brien, PhD, RN, CHSE
Clinical Associate Professor
Coordinator, Standardized Patient Programs
College of Nursing and Health Innovation
Arizona State University
Mail Code 3020
Mailing Address: 550 N. 3rd St.
Location: 500 N. 3rd St.
Phoenix, AZ 85004-0997
602-496-1465
jebrien@asu.edu
APPENDIX L

Debriefing Script

State expectations for student role in debrief, i.e. engage in discussion and attempt to be self-reflective; want the students to reflect on the experience and identify how they felt about their ability to handle the medication administration situation. Instructor role is in the debriefing phase is facilitative only and resource in area of expertise as well and ensuring objectives are met. This is not the time to lecture/teach unless need to clarify something that occurred in the simulation.

The following questions were used to guide the debriefing session:

1) How do you think the scenario went?
2) What do you think went well?
   a) Did you identify the patient?
      • Did you ask patient to state name and Date of Birth?
      • Did you check patient name and Date of Birth against Medication Administration Record?
      • Did you check patient Identification band for name and Date of Birth?
   b) Was the right medication given?
      • Did you check each medication against Medication Administration Record for correct medicine name?
   c) Was the right dose of medicine given to the patient?
      • Did you check each medication from drawer against Medication Administration Record for correct drug dose?
   d) Was the correct route used?
      • Did you administer medication via correct route?
   e) Was the medication given according to the scheduled time?
      • Did you administer medication at correct time?
   f) Did you correctly document medication in Medication Administration Record?
3) What would you do differently next time?
List of Middle Eastern Countries

- Bahrain
- Egypt
- Iran
- Iraq
- Israel
- Jordan
- Kuwait
- Lebanon
- Oman
- Palestine
- Qatar
- Saudi Arabia
- Syria
- Turkey
- United Arab Emirates
- Yemen
APPENDIX N

MEs in Middle Eastern Countries: Origin and Classification of Included Studies

Prescribing Errors (n=10)

Bahrain (n=3)
Egypt (n=1)
Israel (n=1)
Oman (n=1)
Saudi Arabia (n=4)

Administration Errors (n=16)

Nurses MEs (n=11)
Jordan (n=4)
Iran (n=5)
Saudi Arabia (n=2)

Nursing Students MEs (n=5)
Iran (n=5)

Transcription Errors (n=2)

Iran (n=2)

Dispensing Errors (n=2)

Iran (n=1)
Saudi Arabia (n=1)

Causes of and Factors Contributing to MEs (n=13)

Among Nurses (n=9)
Jordan (n=2)
Iran (n=1)
Israel (n=2)
Saudi Arabia (n=3)

Among Nursing Students (n=4)
Iran (n=4)

Reporting of MEs (n=8)

Jordan (n=2)
Iran (n=1)
Saudi Arabia (n=5)

Interventional Studies on MEs (n=9)

Egypt (n=1)
Iran (n=1)
Israel (n=4)
Saudi Arabia (n=2)
UAEs (n=1)
APPENDIX O

HF/COPD/DM Simulation Scenario

Introduction to manikin and orientation to room: 10 minutes
Expected scenario time: 30 minutes
Expected debrief time: 15 minutes

Adam Ali, 64-year-old, DOB: Feb 5, 1951, Hosp MR# 1000777, Allergies: PCN
Adam is a 64-year-old male who was admitted to the medical floor yesterday night having been complaining of increased tiredness, SOB, and foot and ankle swelling.
Student actions will include: Pt. assessment; VS; oxygen therapy; medication administration; evaluate labs; and call provider using SBAR.

Student Learning Outcomes:

- Perform a basic assessment and any assessment necessary as is related to the medication(s)
- Assess your patient’s MAR.
- Administer the medication using the 6 rights of medication administration.
- Provide appropriate education to your patient regarding the medications you are about to administer.
- Evaluate patient status and determine if your patient is improving or deteriorating; determine possible interventions necessary.
- Demonstrate therapeutic communication
- Communicate effectively with the physician using SBAR technique

Critical Actions:

- Wash Hands/Introduce self
- ID patient using 2 identifiers
- Quick patient assessment/VS/ Respiratory assessment /I&0
- Implement physician orders
- Demonstrate mastery of the medication administration
- Communicate effectively with patient and other health care provider

Roles:
1) Student 1 (primary nurse)
2) Student 2 (Secondary nurse)
3) Student 3
4) Student 4

**Simulation Ground Rules:**
- Scrubs, stethoscopes, name badges, watch w/second hand, WSU CON
dress code
- Simulation is clinical time, same guidelines apply
- NO pens in simulation room; pencils are provided
- Hand wash before touching manikin/patient
- Gloves used whenever it would be appropriate on real patient
- Treat manikin like real patient
- What happens in simulation stays in simulation; confidentiality

**Orient to Room to refresh students:**
Monitor
Stethoscope
Blood pressure cuff
O2 abilities
Nebulizer
IV pump
Mannequin abilities
Pneumatic stockings
Urometer
Supplies
Meds

**Mannequin set up:**
Sim Man or vital sim
ID band: Adam Ali
1 IV sites (18 gauge)
Patient ID band with Hospital number
Allergy band: PCN
External condom catheter in place or Bedpan/ Urinal
O2 Nasal Cannula 2 L/min
Nebulizer
Simulation edema legs

**Supplies**
Pt Chart with doctor orders, progress notes, lab values, diagnostic imaging
results, I&O chart, (attached)
MAR (attached)
O2 delivery device (02 Nasal Cannula)
Nebulizer set up
Blood Glucose monitor (or glucometer)
Flush syringes (10 milliliter syringe)
Syringes for subcutaneous injections
IV piggy back
Normal saline
IV tubing
IV Pump
Clean gloves
Pen
Paper

Meds:
Drug reference book
Medication bottles and vials with appropriate labels
  • Aspirin 81 mg
  • Lasix 40mg
  • Enalapril 3mg
  • Singulair 10mg
  • Rocephin 1 gm
  • Protonix 40 mg
  • Clexane 40 mg
  • Nebulizer treatment: Ventolin 2.5/Atrovent 0.5
  • Tylenol 650mg
  • Mixtard Insulin pen and needles
  • Alcohol swabs

Sim Study Prep Sheet
Adam Ali

Adam is a 64-year-old male who was admitted to the medical floor yesterday night having been complaining of increased tiredness, SOB, and foot and ankle swelling.

Student Learning Outcomes:
  • Perform a basic assessment and any assessment necessary as is related to the medication(s)
  • Assess your patient’s MAR.
  • Administer the medication using the 6 rights of medication administration.
- Provide appropriate education to your patient regarding the medications you are about to administer.
- Evaluate patient status and determine if your patient is improving or deteriorating; determine possible interventions necessary.
- Demonstrate therapeutic communication
- Communicate effectively with the physician using SBAR technique

**Shift Report:**

<table>
<thead>
<tr>
<th>Current Day/Time</th>
<th>Monday morning, 0700. Medical floor, you are receiving report from Night-shift nurses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Data</td>
<td>Adam Ali, 64 yo male</td>
</tr>
<tr>
<td>Physician</td>
<td>Dr. Rayan Eid</td>
</tr>
<tr>
<td>Admission Info</td>
<td>Arrived yesterday night at 6 pm with increased tiredness, SOB, and foot and ankle swelling. His daughter brought him to the ER.</td>
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<td>Physical examination on admission revealed: T: 37.2 C; BP: 160/90; Pulse: 96; RR: 30; and pulse ox on 2L 89%; SOB; had wheezing and productive cough with green sputum; +2 pedal edema; abdomen round and soft; decreased strength in lower extremities.</td>
</tr>
<tr>
<td></td>
<td>Labs on admission: His first ABGs revealed respiratory acidosis and the second one was drawn at 12 midnight and the result was normal; Blood sugar was 150 mg/dl; the other labs were normal.</td>
</tr>
<tr>
<td>Past Medical Hx</td>
<td>COPD 2 years ago, DM 10 years ago, recently diagnosed with CHF.</td>
</tr>
<tr>
<td></td>
<td>Tonsillectomy and Adenoidectomy, smoker 1-4 cigarettes/day</td>
</tr>
<tr>
<td>Family Hx</td>
<td>+ CVD, HTN, COPD, DM</td>
</tr>
<tr>
<td>Social Hx</td>
<td>Married, construction worker, Live with his wife and 6 children</td>
</tr>
<tr>
<td>IV Status</td>
<td>18g cath, left arm</td>
</tr>
<tr>
<td>Allergies</td>
<td>Penicillin</td>
</tr>
<tr>
<td>Orders</td>
<td>External condom catheter, Bed rest, I &amp; O, Sequential</td>
</tr>
<tr>
<td>Sequential Compression Device OR Ted hose in place, O2 supply, Incentive spirometer</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Diagnostics</strong></td>
<td>CBC, KFT, Electrolytes, PT/INR, PTT, routine UA, ABGs, portable CXR, ECG, all resulted in patient’s chart.</td>
</tr>
</tbody>
</table>
| **Assessment** | Night shift RN giving report: Pt arrived on unit last night at 7:45 pm, last set of VS in one hour ago:  T: 37 C; BP: 135/85; Pulse: 90 regular in rhythm; RR: 26; and oxygen saturation by pulse oximetry of 94% on oxygen at 2L/minute by nasal cannula; SOB with activity; has scattered wheezes and a somewhat productive cough with green sputum; +1 pedal edema; abdomen round and soft; decreased strength in lower extremities; no pain.  
I & O: negative balance of 1000 ml. We just drew a second CBC, KFT, and electrolytes. An x-ray technician just took a second CXR. He has medications due at 08:00.  
Pt also did not take his breakfast yet, please check his blood sugar and give insulin accordingly |

**Physician orders:**

| **Patient Name:** | Adam Ali |
| **DOB:** | Feb 5, 1951 |
| **MR#** | 1000777 |
| **Height:** | 1.65 cm |
| **Gender:** | Male |
| **Wt:** | 85 kg |

| **Diagnosis:** | CHF/COPD/DM |

| **Allergies:** | PCN |

| **Time** | 9:00 pm |

| **Admit to Medical floor; Dx:** | CHF/COPD/DM |

<p>| <strong>Labs/Imaging:</strong> | On admission: CBC, KFT, electrolytes, Lipid profile, PT/INR, PTT, routine UA, ABG, ECG, portable CXR |</p>
<table>
<thead>
<tr>
<th><strong>Oxygenation</strong></th>
<th>Oxygen 2 L via NC to maintain O2 sats &gt;92%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diet</strong></td>
<td>Low-sodium, cardiac, diabetic diet</td>
</tr>
<tr>
<td><strong>Maintenance Fluids:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>I &amp; O</strong></td>
<td>External condom catheter</td>
</tr>
<tr>
<td></td>
<td>Check Intake and Output hourly</td>
</tr>
<tr>
<td><strong>Medication Orders:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aspirin 81 mg PO daily</td>
</tr>
<tr>
<td></td>
<td>Lasix 40mg IV daily</td>
</tr>
<tr>
<td></td>
<td>Enalapril 3mg PO daily</td>
</tr>
<tr>
<td></td>
<td>Singulair 10mg PO daily</td>
</tr>
<tr>
<td></td>
<td>Protonix 40 mg PO daily</td>
</tr>
<tr>
<td></td>
<td>Rocephin 1 gm IVPB q 12 hrs</td>
</tr>
<tr>
<td></td>
<td>Clexane 40 mg SC daily</td>
</tr>
<tr>
<td></td>
<td>Nebulizer treatment: Ventolin 2.5/Atrovent 0.5 q 4 hr</td>
</tr>
<tr>
<td></td>
<td>Blood Glucose monitoring: administer insulin SC 3x day with meals</td>
</tr>
<tr>
<td></td>
<td>Mixtard insulin: (07:00/12:30/18:30)</td>
</tr>
<tr>
<td></td>
<td>Blood Glucose:</td>
</tr>
<tr>
<td></td>
<td>0-119: 0 units</td>
</tr>
<tr>
<td></td>
<td>120-149: 4 units</td>
</tr>
<tr>
<td></td>
<td>150-199: 6 units</td>
</tr>
<tr>
<td></td>
<td>200-249: 8 units</td>
</tr>
<tr>
<td></td>
<td>250-299: 10 units</td>
</tr>
<tr>
<td></td>
<td>&gt;300 units: 12 units and call provider</td>
</tr>
<tr>
<td><strong>PRN Meds:</strong></td>
<td>Tylenol 650mg po q 4 hr prn for pain or fever</td>
</tr>
<tr>
<td><strong>Other orders</strong></td>
<td>Maintain bed rest</td>
</tr>
<tr>
<td></td>
<td>Check VS Q 4 hours (Notify physician if temp &gt; 38 C)</td>
</tr>
<tr>
<td></td>
<td>IV therapy: intermittent infusion device, flush q shift with 3 ml NS</td>
</tr>
</tbody>
</table>
Check Intake and Output hourly (pneumatic stockings) OR (Ted hose) in place Call MD for further questions

**Physician/Provider Signature:** R. Eid, MD

### Medication Administration Record (MAR)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Time</th>
<th>Date (Yesterday)</th>
<th>Date (Today)</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin 81 mg po daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lasix 40mg IV daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enalapril 3mg po daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singulair 10mg po daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protonix 40 mg PO daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocephin 1 gm</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVPB q 12 hr</td>
<td>8:00 PM</td>
<td>ER (Sarah, RN)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------</td>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clexane 40 mg SC daily</td>
<td>8:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer treatment: Ventolin 2.5/Atrovent 0.5 q 4 hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 MD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 MN Sarah, RN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 AM Sarah, RN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixtard insulin sc 3x day with meals (according sliding scale)</td>
<td>7:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:30 PM</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**PRN & stat Medications**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Medication</th>
<th>SIGNATURE/TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yesterday</td>
<td>6:30 PM</td>
<td>Lasix 60mg IV stat</td>
<td>Suzan, RN (ER)</td>
</tr>
<tr>
<td>Yesterday</td>
<td>6:30 PM</td>
<td>Mixtard insulin 6 units SC stat</td>
<td>Suzan, RN (ER)</td>
</tr>
<tr>
<td>Yesterday</td>
<td>6:20 PM</td>
<td>Nebulizer treatment: Ventolin 2.5/Atrovent 0.5 stat</td>
<td>Suzan, RN (ER)</td>
</tr>
<tr>
<td>Date</td>
<td>Time</td>
<td>Medication Details</td>
<td>Nurse</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>-----------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Yesterday</td>
<td>6:30 PM</td>
<td>Aspirin 81 mg PO stat</td>
<td>Suzan, RN (ER)</td>
</tr>
<tr>
<td>Yesterday</td>
<td>7:00 PM</td>
<td>Protonix 40 mg IV stat</td>
<td>ER (Suzan, RN)</td>
</tr>
<tr>
<td>Yesterday</td>
<td>6:30 PM</td>
<td>Singulair 10mg po stat</td>
<td>ER (Suzan, RN)</td>
</tr>
</tbody>
</table>

**Participants Information Needed Prior to Scenario:**

- Have been oriented to simulator
- Understand guidelines /expectations for scenario
- Have accomplished all pre-simulation requirements
- Understand their assigned roles
- Have been given time frame expectations

**Case flow / Run the simulation**
<table>
<thead>
<tr>
<th>SimMan State</th>
<th>SimMan Actions</th>
<th>Expected Student Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR 24</td>
<td>Hello, I am Mr Adam. Who are you all? I'm feeling much better than yesterday. I can breathe much better now. I forgot my medication at home! I usually take insulin and four pills in the morning, Would you please call my wife to bring my meds. Please don’t ask me so much questions cause you make me unable to breath well.</td>
<td>Wash hands, intro, ID pt., Assess VS, pitting edema, I &amp; O Use an appropriate patient positioning • High Flower’s position Assess respiratory status • Breath sounds over lung area, SPO2, O2 device Assess IV line • Alcohol swabs, flush with 3 ml NS</td>
</tr>
<tr>
<td>Blood sugar result: 130 mg/dl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is this insulin like the same insulin that I usually use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many units of insulin are you going to give me</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How fast will this insulin start to work?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Sugar testing using a glucometer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixtard insulin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-119: 0 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120-149: 4 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150-199: 6 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200-249: 8 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250-299: 10 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;300 units: 12 units and call provider</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Administer medication**

Student must check for all six rights every time s/he administer any drug (check for right patient, drug, dose, time, and route)

- Mixtard insulin 6 units SC
- Aspirin 81 mg PO
- Lasix 40mg IV (slowly over 1 to 2 minutes)
- Enalapril 3mg PO
- Singulair 10mg PO
- Rocephin 1 gm IV (1 g/50 ml IVPB over 30 min)
- Clexane 40 mg SC
- Nebulizer treatment: Ventolin 2.5/Atrovent 0.5

Documentation (student's signature)
<table>
<thead>
<tr>
<th></th>
<th>DATE: Yesterday</th>
<th>DATE: TODAY</th>
<th>DATE TIME</th>
<th>NORMAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEMATOLOGY</strong></td>
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</tr>
<tr>
<td><strong>CBC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RBC</td>
<td>4.3</td>
<td>4</td>
<td></td>
<td>4 - 6</td>
</tr>
<tr>
<td>MCV</td>
<td>85</td>
<td>90</td>
<td></td>
<td>80 - 98</td>
</tr>
<tr>
<td>MCH</td>
<td></td>
<td></td>
<td></td>
<td>27 - 31</td>
</tr>
<tr>
<td>MCHC</td>
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<td></td>
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</tr>
<tr>
<td>RDW</td>
<td></td>
<td></td>
<td></td>
<td>11.5 - 14.5</td>
</tr>
<tr>
<td>HEMOGLOBIN</td>
<td>14</td>
<td>14</td>
<td></td>
<td>12 - 18 g/dL</td>
</tr>
<tr>
<td>HEMATOCRIT</td>
<td>38</td>
<td>40</td>
<td></td>
<td>38 - 54 %</td>
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<tr>
<td>RETICULOCYTES</td>
<td></td>
<td></td>
<td></td>
<td>0.5 - 1.5</td>
</tr>
<tr>
<td>WBC</td>
<td>9,000</td>
<td>8,000</td>
<td></td>
<td>4,500 - 10,000</td>
</tr>
<tr>
<td><strong>DIFFERENTIAL %</strong></td>
<td></td>
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</tr>
<tr>
<td>NEUTROPHILS</td>
<td>65</td>
<td>60</td>
<td></td>
<td>50 - 70</td>
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<tr>
<td>SEG S</td>
<td>60</td>
<td>64</td>
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<td>50 - 65</td>
</tr>
<tr>
<td>BANDS</td>
<td>3</td>
<td>3</td>
<td></td>
<td>0 - 5</td>
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<tr>
<td>EOSINOPHILS</td>
<td>2</td>
<td>3</td>
<td></td>
<td>0 - 3</td>
</tr>
<tr>
<td>BASOPHILS</td>
<td>2</td>
<td>3</td>
<td></td>
<td>1 - 3</td>
</tr>
<tr>
<td>LYMPHOCYTES</td>
<td>30</td>
<td>30</td>
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<td>25 - 35</td>
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<tr>
<td>MONOCYTES</td>
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</tr>
<tr>
<td>PLATELETS</td>
<td>280,000</td>
<td>280,000</td>
<td></td>
<td>150,000 - 400,000</td>
</tr>
<tr>
<td>PT</td>
<td>12</td>
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<td>11 - 15</td>
</tr>
<tr>
<td>INR</td>
<td>0.9</td>
<td></td>
<td></td>
<td>1.0</td>
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<tr>
<td>aPTT</td>
<td>34</td>
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<td>24-36</td>
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</table>
## CHEMISTRY

<table>
<thead>
<tr>
<th></th>
<th>DATE: TODAY</th>
<th>DATE: TODAY</th>
<th>NORMAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TIME</td>
<td>TIME</td>
<td>TIME</td>
</tr>
<tr>
<td>ALBUMIN</td>
<td>3.6</td>
<td>3.5 - 5 g/dL</td>
<td></td>
</tr>
<tr>
<td>ALT</td>
<td>34</td>
<td>10 - 35</td>
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</tr>
<tr>
<td>ALK PHOS</td>
<td>130</td>
<td>42 - 136</td>
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</tr>
<tr>
<td>AMMONIA</td>
<td></td>
<td>15 - 45 µg/Dl</td>
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<tr>
<td>AMYLASE</td>
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<td>30 - 170</td>
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</tr>
<tr>
<td>AST</td>
<td>30</td>
<td>0 - 35</td>
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</tr>
<tr>
<td>BUN</td>
<td>17</td>
<td>5 - 25</td>
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</tr>
<tr>
<td>CREATININE</td>
<td>1.1</td>
<td>0.6-1.4</td>
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<tr>
<td>CALCIUM</td>
<td>9.0</td>
<td>9 - 11 mg/Dl</td>
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<tr>
<td>CHLORIDE</td>
<td>96</td>
<td>95 - 105 mEq/L</td>
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<td>199</td>
<td>&lt;200</td>
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</tr>
<tr>
<td>HDL</td>
<td>45</td>
<td>&gt;45</td>
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</tr>
<tr>
<td>LDL</td>
<td>130</td>
<td>&lt;130</td>
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</tr>
<tr>
<td>GLUCOSE</td>
<td>150</td>
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</tr>
<tr>
<td>MAGNESIUM</td>
<td>1.6</td>
<td>1.5 - 2.5 mEq/L</td>
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<tr>
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<td>3.5 - 5.3 mEq/L</td>
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<td>6.5</td>
<td>6 - 8 g/Dl</td>
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<td>SODIUM</td>
<td>142</td>
<td>135 - 145 mEq/L</td>
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<td>TRIGLYCERIDES</td>
<td>110</td>
<td>10 - 150 mg/Dl</td>
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## ABGs

<table>
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<tr>
<th></th>
<th>Date: Today</th>
<th>DATE</th>
<th>DATE</th>
<th>NORMAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time: 7:00 PM</td>
<td>12 MN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH</td>
<td>7.33</td>
<td>7.35</td>
<td></td>
<td>7.35 - 7.45</td>
</tr>
<tr>
<td>PaO2</td>
<td>92 mmHg</td>
<td>90 mmHg</td>
<td>80 - 100 mmHg</td>
<td></td>
</tr>
<tr>
<td>PaCO2</td>
<td>55 mmHg</td>
<td>45 mmHg</td>
<td>35 - 45 mmHg</td>
<td></td>
</tr>
<tr>
<td>HCO3</td>
<td>26 mmol/l</td>
<td>26 mmol/l</td>
<td>22 - 26 mmol/l</td>
<td></td>
</tr>
</tbody>
</table>
EKG @ 7:30 pm: Normal Sinus Rhythm (HR 90)

Chest X-Ray (AP) Performed Yesterday at 7:30 pm

Results: The chest X-ray shows hyperinflation of lungs (dark lung fields, low set diaphragm in 11th or 12th posterior rib, increased AP diameter)
References


HF/COPD/DM Simulation Scenario

Introduction to manikin and orientation to room: 10 minutes
Expected scenario time: 30 minutes
Expected debrief time: 15 minutes

Adam Ali, 64-year-old, DOB: Feb 5, 1951, Hosp MR# 1000777, Allergies: PCN

Adam is a 64-year-old male who was admitted to the medical floor yesterday night having been complaining of increased tiredness, SOB, and foot and ankle swelling.

Student actions will include: Pt. assessment; VS; oxygen therapy; medication administration; evaluate labs; and call provider using SBAR.

Student Learning Outcomes:

- Perform a basic assessment and any assessment necessary as is related to the medication(s)
- Assess your patient’s MAR.
- Administer the medication using the 6 rights of medication administration.
- Provide appropriate education to your patient regarding the medications you are about to administer.
- Evaluate patient status and determine if your patient is improving or deteriorating; determine possible interventions necessary.
- Demonstrate therapeutic communication
- Communicate effectively with the physician using SBAR

Critical Actions:

- Wash Hands/Introduce self
- ID patient using 2 identifiers
- Quick patient assessment/VS/ Respiratory assessment /
- Implement physician orders
- Demonstrate mastery of the medication administration
- Communicate effectively with patient and other health care provider

Topics to review prior to the simulation:
Health assessment: cardiac, respiratory, and endocrine

Roles:

1) Student 1 (primary nurse)
2) Student 2 (Secondary nurse)
3) Student 3
4) Student 4

**Simulation Ground Rules:**
- Scrubs, stethoscopes, name badges, watch w/second hand, WSU CON dress code
- Simulation is clinical time, same guidelines apply
- NO pens in simulation room; pencils are provided
- Hand wash before touching manikin/patient
- Gloves used whenever it would be appropriate on real patient
- Treat manikin like real patient
- What happens in simulation stays in simulation; confidentiality

**Orient to Room to refresh students:**
Monitor
Stethoscope
Blood pressure cuff
O2 abilities
Nebulizer
IV pump
Mannequin abilities
Pneumatic stockings
Urometer
Supplies
Meds

**Mannequin set up:**
Sim Man or vital sim
ID band: Adam Ali
1 IV sites (18 gauge)
Patient ID band with Hospital number
Allergy band: PCN
External condom catheter in place or Bedpan/ Urinal
02 Nasal Cannula 2 L/min
Nebulizer
Simulation edema legs

**Supplies**
Pt Chart with doctor orders, progress notes, lab values, diagnostic imaging results, I&O chart, (attached)
MAR (attached)
O2 delivery device (O2 Nasal Cannula)
Nebulizer set up
Blood Glucose monitor (or glucometer)
Flush syringes (10 milliliter syringe)
Syringes for subcutaneous injections
IV piggy back
Normal saline
IV tubing
IV Pump
Clean gloves
Pen
Paper

**Meds:**
Drug reference book
Medication bottles and vials with appropriate labels
- Aspirin 81 mg
- Lasix 40mg
- Enalapril 3mg
- Singulair 10mg
- Rocephin 1 gm
- Protonix 40 mg
- Clexane 40 mg
- Nebulizer treatment: Ventolin 2.5/Atrovent 0.5
- Tylenol 650mg
- Mixtard Insulin pen and needles
- Alcohol swabs

**Sim Study Prep Sheet**  
**Adam Ali**

Adam is a 64-year-old male who was admitted to the medical floor yesterday night having been complaining of increased tiredness, SOB, and foot and ankle swelling.

**Student Learning Outcomes:**
- Perform a basic assessment and any assessment necessary as is related to the medication(s)
- Assess your patient’s MAR.
- Administer the medication using the 6 rights of medication administration.
- Provide appropriate education to your patient regarding the medications you are about to administer.
- Evaluate patient status and determine if your patient is improving or deteriorating; determine possible interventions necessary.
- Demonstrate therapeutic communication
- Communicate effectively with the physician using SBAR technique

**Shift Report:**

<table>
<thead>
<tr>
<th>Current Day/Time</th>
<th>Monday morning, 0700. Medical floor, you are receiving report from Night-shift nurses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Data</td>
<td>Adam Ali, 64 yo male</td>
</tr>
<tr>
<td>Physician</td>
<td>Dr. Rayan Eid</td>
</tr>
<tr>
<td>Admission Info</td>
<td>Arrived yesterday night at 6 pm with increased tiredness, SOB, and foot and ankle swelling. His daughter brought him to the ER. Physical examination on admission revealed: T: 37.2 C; BP: 160/90; Pulse: 96; RR: 30; and pulse ox on 2L 89%; SOB; had wheezing and productive cough with green sputum; +2 pedal edema; abdomen round and soft; decreased strength in lower extremities. Labs on admission: His first ABGs revealed respiratory acidosis and the second one was drawn at 12 midnight and the result was normal; Blood sugar was 150 mg/dl; the other labs were normal.</td>
</tr>
<tr>
<td>Past Medical Hx</td>
<td>COPD 2 years ago, DM 10 years ago, recently diagnosed with CHF.</td>
</tr>
<tr>
<td></td>
<td>Tonsillectomy and Adenoidectomy, smoker 1-4 cigarettes/day</td>
</tr>
<tr>
<td>Family Hx</td>
<td>+ CVD, HTN, COPD, DM</td>
</tr>
<tr>
<td>Social Hx</td>
<td>Married, construction worker, Live with his wife and 6 children</td>
</tr>
<tr>
<td>IV Status</td>
<td>18g cath, left arm</td>
</tr>
<tr>
<td>Allergies</td>
<td>Penicillin</td>
</tr>
<tr>
<td>Orders</td>
<td>External condom catheter, Bed rest, I &amp; O, Sequential Compression Device OR Ted hose in place, O2 supply, Incentive spirometer</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>CBC, KFT, Electrolytes, PT/INR, PTT, routine UA, ABGs, portable CXR, ECG, all resulted in patient’s chart.</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Assessment</td>
<td>Night shift RN giving report: Pt arrived on unit last night at 7:45 pm, last set of VS in one hour ago:  T: 37 C; BP: 135/85; Pulse: 90 regular in rhythm; RR: 26; and oxygen saturation by pulse oximetry of 94% on oxygen at 2L/minute by nasal cannula; SOB with activity; has scattered wheezes and a somewhat productive cough with green sputum; +1 pedal edema; abdomen round and soft; decreased strength in lower extremities; no pain. I &amp; O: negative balance of 1000 ml. We just drew a second CBC, KFT, and electrolytes. An x-ray technician just took a second CXR. He has medications due at 08:00. Pt also did not take his breakfast yet, please check his blood sugar and give insulin accordingly</td>
</tr>
</tbody>
</table>

**Physician orders:**

<table>
<thead>
<tr>
<th>Patient Name:</th>
<th>Adam Ali</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOB:</td>
<td>Feb 5, 1951</td>
</tr>
<tr>
<td>MR#:</td>
<td>1000777</td>
</tr>
<tr>
<td>Height:</td>
<td>1.65 cm</td>
</tr>
<tr>
<td>Gender:</td>
<td>Male</td>
</tr>
<tr>
<td>Wt:</td>
<td>85 kg</td>
</tr>
<tr>
<td>Diagnosis:</td>
<td>CHF/COPD/DM</td>
</tr>
</tbody>
</table>

**Allergies:** PCN

<table>
<thead>
<tr>
<th>Time</th>
<th>Admit to Medical floor; Dx: CHF/COPD/DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 pm</td>
<td></td>
</tr>
</tbody>
</table>

**Labs/Imaging:**

On admission: CBC, KFT, electrolytes, Lipid profile, PT/INR, PTT, routine UA, ABG, ECG, portable CXR
Repeat CBC, KFT, electrolytes, portable CXR in AM
<table>
<thead>
<tr>
<th><strong>Oxygenation</strong></th>
<th>Oxygen 2 L via NC to maintain 02 sats &gt;92%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diet</strong></td>
<td>Low-sodium, cardiac, diabetic diet</td>
</tr>
<tr>
<td><strong>Maintenance Fluids:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>I &amp; O</strong></td>
<td>External condom catheter</td>
</tr>
<tr>
<td></td>
<td>Check Intake and Output hourly</td>
</tr>
<tr>
<td><strong>Medication Orders:</strong></td>
<td></td>
</tr>
<tr>
<td>Aspirin 81 mg PO daily</td>
<td></td>
</tr>
<tr>
<td>Lasix 40mg IV daily</td>
<td></td>
</tr>
<tr>
<td>Enalapril 3mg PO daily</td>
<td></td>
</tr>
<tr>
<td>Singulair 10mg PO daily</td>
<td></td>
</tr>
<tr>
<td>Protonix 40 mg PO daily</td>
<td></td>
</tr>
<tr>
<td>Rocephin 1 gm IVPB q 12 hrs</td>
<td></td>
</tr>
<tr>
<td>Clexane 40 mg SC daily</td>
<td></td>
</tr>
<tr>
<td>Nebulizer treatment: Ventolin 2.5/Astrovent 0.5 q 4 hr</td>
<td></td>
</tr>
<tr>
<td>Blood Glucose monitoring: administer insulin SC 3x day with meals</td>
<td></td>
</tr>
<tr>
<td>Mixtard insulin: (07:00/12:30/18:30)</td>
<td></td>
</tr>
<tr>
<td>Blood Glucose: 0-119: 0 units</td>
<td></td>
</tr>
<tr>
<td>120-149: 4 units</td>
<td></td>
</tr>
<tr>
<td>150-199: 6 units</td>
<td></td>
</tr>
<tr>
<td>200-249: 8 units</td>
<td></td>
</tr>
<tr>
<td>250-299: 10 units</td>
<td></td>
</tr>
<tr>
<td>&gt;300 units: 12 units and call provider</td>
<td></td>
</tr>
<tr>
<td><strong>PRN Meds:</strong></td>
<td>TYLENOL 650mg po q 4 hr prn for pain or fever</td>
</tr>
<tr>
<td><strong>Other orders</strong></td>
<td>Maintain bed rest</td>
</tr>
<tr>
<td></td>
<td>Check VS Q 4 hours (Notify physician if temp &gt; 38 C)</td>
</tr>
<tr>
<td></td>
<td>IV therapy: intermittent infusion device, flush q shift with 3 ml NS</td>
</tr>
<tr>
<td></td>
<td>Check Intake and Output hourly (pneumatic stockings) OR (Ted hose) in place</td>
</tr>
<tr>
<td></td>
<td>Call MD for further questions</td>
</tr>
</tbody>
</table>
**Physician/Provider Signature:** R. Eid, MD

**Medication Administration Record (MAR)**

<table>
<thead>
<tr>
<th>Suzan Sameer</th>
<th>Primary Practitioner: Rayan Eid, MD</th>
<th>Room No. 627</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission Date: 1 day ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allergies: Morphine</td>
<td>Birthdate: 7/1/1979 Gender: F</td>
<td>Height: 165 cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight: 75 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scheduled Medications</th>
<th>Time</th>
<th>Date (night shift)</th>
<th>Date (Day shift)</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous D5NS @ 125ml/hr</td>
<td>1:30 am</td>
<td>Saber, RN</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRN & stat Medications**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Medication</th>
<th>SIGNATURE/TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night shift</td>
<td>1:30 am</td>
<td>Pethidine 75 mg IM q 6 hrs PRN for severe pain</td>
<td>Saber, RN</td>
</tr>
</tbody>
</table>

**Participants Information Needed Prior to Scenario:**

- Have been oriented to simulator
- Understand guidelines /expectations for scenario
- Have accomplished all pre-simulation requirements
- Understand their assigned roles
- Have been given time frame expectations

**Case flow / Run the simulation**
<table>
<thead>
<tr>
<th>Time</th>
<th>Patient State</th>
<th>SIM MAN Actions</th>
<th>Possible Student Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 mins</td>
<td>RR 22 HR 89</td>
<td><strong>Oh, I'm in so much pain, my abdomen really hurts me, the pain is horrible, can</strong></td>
<td><strong>Wash hands, intro, ID pt., Assess VS, SPO2, bowel movement, cap refill, pain (pain scale)</strong></td>
</tr>
<tr>
<td></td>
<td>BP 110/70</td>
<td><strong>I get something for this pain?</strong></td>
<td><strong>Assess dressing (surgical site) but don’t change</strong></td>
</tr>
<tr>
<td></td>
<td>SpO2 98%</td>
<td>Pain scale (1-10): What does these numbers mean?</td>
<td><strong>Communicate with patient</strong></td>
</tr>
<tr>
<td></td>
<td>Temp 37.2 C</td>
<td><strong>Pain Medication:</strong></td>
<td><strong>Use an appropriate patient positioning</strong></td>
</tr>
<tr>
<td></td>
<td>Pain 9/10</td>
<td>- Is that what you gave me before?</td>
<td><strong>Assess IV fluid (D5NS @ 125ml/hr)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- I want a female nurse to give me the shot</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- How fast will this medication start to work?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Other medication:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- What are these drugs used for?</td>
<td></td>
</tr>
<tr>
<td>5-10 mins</td>
<td>RR 22 HR 89</td>
<td><strong>Administer medication.</strong></td>
<td><strong>Demonstrate mastery of the medication administration</strong></td>
</tr>
<tr>
<td></td>
<td>BP 110/70</td>
<td>Student must check for all six rights every time s/he administer any drug</td>
<td><strong>- Pethidine 75 mg IM</strong></td>
</tr>
<tr>
<td></td>
<td>SpO2 98%</td>
<td>(check for right patient, drug, dose, time, and route)</td>
<td><strong>- Flagyl 500 mg IVPB</strong></td>
</tr>
<tr>
<td></td>
<td>Temp 37.1 C</td>
<td><strong>Demonstrate mastery of the medication administration</strong></td>
<td><strong>- Cipro 400 mg IVPB</strong></td>
</tr>
<tr>
<td></td>
<td>Pain 9/10</td>
<td><strong>Documentation (student’s signature)</strong></td>
<td></td>
</tr>
<tr>
<td>10-15 mins</td>
<td>RR 17 HR 70</td>
<td><strong>Patient verbalizes a decrease in pain on a scale of 1 to 10 (2/10)</strong></td>
<td><strong>Reassess patient</strong></td>
</tr>
<tr>
<td></td>
<td>BP 110/70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SpO2 99%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temp 37.1 C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pain 2/10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DATE: Yesterday</td>
<td>DATE: TODAY</td>
<td>DATE</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>TIME 12:00 midnight</td>
<td>TIME 7:00 am</td>
<td>TIME</td>
</tr>
<tr>
<td><strong>CBC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RBC</td>
<td>4.3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MCV</td>
<td>85</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>HEMOGLOBIN</td>
<td>14</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td>HEMATOCRIT</td>
<td>38</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td><strong>WBC</strong></td>
<td>13,000</td>
<td>8,000</td>
<td></td>
</tr>
<tr>
<td>NEUTROPHILS</td>
<td>80</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>SEGS</td>
<td>60</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>BANDS</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>EOSINOPHILS</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BASOPHILS</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LYMPHOCYTES</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>PLATELETS</strong></td>
<td>280,000</td>
<td>280,000</td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INR</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aPTT</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEMISTRY</td>
<td>DATE: TODAY</td>
<td>DATE: TODAY</td>
<td>NORMAL RANGE</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>TIME</td>
<td>TIME</td>
<td>TIME</td>
</tr>
<tr>
<td></td>
<td>7:00 pm</td>
<td>7:00 am</td>
<td></td>
</tr>
<tr>
<td>ALBUMIN</td>
<td>3.6</td>
<td>3.5 – 5 g/dL</td>
<td></td>
</tr>
<tr>
<td>ALT</td>
<td>34</td>
<td>10 – 35</td>
<td></td>
</tr>
<tr>
<td>ALK PHOS</td>
<td>130</td>
<td>42 – 136</td>
<td></td>
</tr>
<tr>
<td>AST</td>
<td>30</td>
<td>0 – 35</td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td>9.0</td>
<td>9 – 11 mg/DL</td>
<td></td>
</tr>
<tr>
<td>CHLORIDE</td>
<td>96</td>
<td>95 – 105 mEq/L</td>
<td></td>
</tr>
<tr>
<td>GLUCOSE</td>
<td>110</td>
<td>105</td>
<td>70 – 120</td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td>1.6</td>
<td>1.8</td>
<td>1.5 – 2.5 mEq/L</td>
</tr>
<tr>
<td>POTASSIUM</td>
<td>5.0</td>
<td>5.0</td>
<td>3.5 – 5.3 mEq/L</td>
</tr>
<tr>
<td>PROTEIN</td>
<td>6.5</td>
<td></td>
<td>6 – 8 g/Dl</td>
</tr>
<tr>
<td>SODIUM</td>
<td>142</td>
<td>140</td>
<td>135 – 145 mEq/L</td>
</tr>
</tbody>
</table>

**Ultrasound performed yesterday at 12 midnight**

Results: Ultrasound image demonstrates a mildly dilated appendix (black arrows). No perforation.

References

APPENDIX P

Study Flow Diagram According to CONSORT

Enrollment

Assess for eligibility (n=89)

Excluded (n=0)

Randomized (n=89)

Allocated to the HFS intervention (n=45)
Received allocated intervention (n=45)

Lost to follow up (n=0)
Discontinued intervention (n=0)

Allocated to the lecture intervention (n=44)
Received allocated intervention (n=44)

Lost to follow up (n=0)
Discontinued intervention (n=0)

Analysis

Analyzed (n=45)

Analysis

Analyzed (n=44)