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Medication administration behaviors in prelicensure nursing students: A longitudinal, cohort study☆

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ABSTRACT

Aim: This longitudinal study identified changes in safe medication administration behaviors in a single cohort of students followed over four semesters of nursing school.

Background: Over 40% of a nurse's shift is dedicated to the processes of medication administration, placing them in a position to interrupt costly medication errors. Yet, despite efforts to decrease medication errors, including electronic medical records, smart pumps, and standardized processes, 5% of hospitalized patients experience adverse drug events and the sequela costs billions of dollars annually. One cognitive aid first introduced in nursing school to help nurses administer medications safely is the rights method, including the foundational five (*patient, medication, dose, route,* and *time*). However, facility restrictions, complicated electronic health records, and high faculty-to-student ratios are limiting opportunities to apply these rights and develop safe medication administration competency. Although nursing faculty and clinical partners expect competency when initially licensed as professionals, graduating nursing students are not competent and new graduates feel ill prepared to deliver medications safely. Previous studies report findings on safe medication administration in different cohorts of nursing students, but none has followed the same cohort of students throughout nursing school.

Design: Using a non-experimental design, the same cohort of nursing students was followed over four semesters and observed independently administering medications in simulation scenarios.

Methods: Each semester, this cohort of students self-selected into 10–12 simulation groups. One student from each group was randomized to the role of primary nurse. Guided by the NLN/Jeffries simulation theory and the International Nursing Association for Clinical Simulation and Learning's Standards of Best Practice: Simulation[SM], students participated in four simulations that required the primary nurse to deliver medications as part of clinical care. A single investigator completed an observational checklist during the simulations on verification of the foundational five rights in these students.

Results: Verification of most rights varied each semester, but students consistently did poorly verifying right *dose.* One hundred percent of students observed in the first semester did not verify all five rights. At the time of graduation, 80% of students observed did not verify all five rights prior to medication administration.

Conclusions: These concerning findings align with previous research showing that students are not safely administering medications in patient care settings. Educators, administrators, and healthcare systems need to ensure that students receive consistent, high-quality experiences vital to training future nurses for competency in safe medication administration.

1. Introduction

Globally, nearly 5% of hospitalized patients experience an adverse drug event (ADE) (Craig et al., 2021), generally defined as "harm experienced by a patient as a result of exposure to a medication" (Agency for Healthcare Research and Quality, 2019, para 1). Despite strategies to decrease medication errors, including electronic medical records (Chan et al., 2019; Garber et al., 2019; Schiff et al., 2018), smart pumps, and standardized processes (Schneidereith, 2014; Teal et al., 2019), billions of dollars are spent annually on treatment of sequela resulting from adverse drug events (Schiff et al., 2018; Schneidereith, 2014; Teal et al., 2019). These sequelae include increased lengths of

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stay, increased morbidity, and death (Green, 2018; Kavanagh, 2017; Lee and Quinn, 2019).

Nurses, who spend approximately 40% of a shift (Fusco et al., 2021; Kavanagh, 2017) engaged in medication administration, are positioned to interrupt costly medication errors. This essential activity is a complex, complicated, and high-risk responsibility that requires application of specific knowledge, skills, and abilities (KSAs) (Asensi-Vicente et al., 2018; Blignaut et al., 2017; Kavanagh, 2017; Schiff et al., 2018; Schneidereith, 2014; Teal et al., 2019). It is expected that nurse educators prepare students to competently deliver safe, high-quality care upon graduation, including medication administration (Lee and Quinn, 2019). Medication administration is considered an Entrustable Professional Activity (EPA), defined as "tasks or responsibilities that can be entrusted to a trainee once sufficient, specific competence is reached to allow for unsupervised execution" (ten Cate, 2013, p. 6). Students are expected to increase KSA competency throughout nursing school and achieve behaviors consistent with safe, independent application of this EPA upon graduation (Al-Moteri, 2020; Bush et al., 2015). However, a survey of nurse leaders report dissatisfaction with the medication competence of new nurse graduates (Jarvill, 2020) and students themselves feel ill-prepared to deliver medications safely (Craig et al., 2021; Fusco et al., 2021; Green, 2018). The practical experiences needed to reinforce the psychomotor skills and cognitive requirements to become both confident and competent in safe medication administration are limited due to high faculty-to-student ratios, facility restrictions, and complicated Electronic Health Records (EHRs) (Amster et al., 2015; Bush et al., 2015; Chan et al., 2019; Jarvill, 2020; Kelly et al., 2018; Kuo et al., 2020). These limitations impede practice opportunities throughout nursing school which are necessary to gain medication administration proficiency (Craig et al., 2021).

For novice learners, medication administration utilizes rules and processes to guide situations in which they have no practical experience (Benner, 1982). Many nursing education programs teach the tenets of safe medication administration using the globally accepted organizational processes of the rights method (Green, 2018; Mortell, 2019). Although the fundamental five (*patient, medication, dose, time,* and *route*) provide simplistic foundations from which to learn safe medication administration, the complexity of healthcare has led to addition of six more rights: *documentation*, *assessment*, *reason*, *education*, *response*, and right *to refuse* (Green, 2018; Hanson and Haddad, 2020; Hendler, 2021a, 2021b; Martyn et al., 2019; van der Veen et al., 2017). Students are also expected to integrate clinical reasoning as they gain practical experience. This entails moving beyond rote processes and utilizing contextual knowledge for decision-making, including questioning orders and clarifying the appropriateness of medication administration (Mariani et al., 2017; Martyn et al., 2019; Rohde and Domm, 2018; Schneidereith, 2017). This expanded complexity requires repeated opportunities to marry theory with hands-on medication administration experiences, through application in clinical settings, simulation labs, and/or skills labs (Asensi-Vicente et al., 2018; Chan et al., 2019).

Simulation-based education (SBE) is one pedagogical strategy used to teach, review, and assess independent medication administration (Fusco et al., 2021; Konieczny, 2016; Sanko and Mckay, 2017; Schneidereith, 2015). The simulated setting can eliminate some of the restrictions encountered in healthcare settings to give students the opportunity to independently administer medications without risk of patient harm (Lee and Quinn, 2019; Mariani et al., 2017). Simulation also gives educators the opportunity to view independent medication administration behaviors, which may include errors, as students work without faculty oversight or intervention.

However, typical high-fidelity student simulation scenarios range between fifteen to twenty minutes (Craig et al., 2021; Fusco et al., 2021; Schneidereith, 2014) which can sometimes restrict inclusion of rights beyond the fundamental five of *patient, medication, dose, time,* and *route*. Depending on the learning objectives designed for the simulation (INACSL Standards Committee, 2016), time to measure an appropriate medication *response* or for delivery of appropriate patient *education* may not be possible. Additionally, students may not have access to a simulated EHR, limiting the ability to appropriately utilize this resource, as well as include right *documentation* (Chan et al., 2019). For this study, scenario design and learning objectives necessitated data collection on the fundamental five rights.

To date, the literature examining medication administration behaviors of prelicensure students in simulation compares separate cohorts of junior and senior students (Collins et al., 2003; Jarvill, 2020; Lee and Quinn, 2019; Schneidereith, 2014). Notably there are no longitudinal reports of medication administration behaviors in a single cohort of nursing students. This paper adds to the body of knowledge through findings reported on differences in medication administration behaviors in a single cohort of traditional undergraduate, prelicensure nursing students assessed over four consecutive semesters of nursing school.

2. Theoretical framework

The NLN/Jeffries Simulation Theory (Jeffries, 2015) and the International Nursing Association for Clinical Simulation and Learning's Standards of Best Practice: Simulation^{SM} (INACSL Standards Committee, 2016) guided the simulations implemented in this study. Using the systematic criteria of the Standards and components of simulation theory, the simulations included a psychologically safe setting, thorough pre-briefing, and guided debriefing. Course faculty provided students a patient overview prior to simulation lab arrival that included general learning objectives, as well as the patient's name, age, and admitting diagnosis. The debriefing discussions followed recommendations for two-times the length of the simulation scenario and generally lasted thirty minutes. The debriefing allowed for guided reflection on the thinking behind the actions.

3. Methods

The purpose of this study was to measure use of the five rights of medication administration during simulation experiences in a single cohort of undergraduate nursing students and identify performance differences over four consecutive semesters. A non-experimental study was conducted at a small, 4-year, primarily residential private Mid-Atlantic University with approximately 3800 students. The undergraduate nursing department has a 4-year curriculum with two years of general education and two years of clinical nursing courses. The students enroll in courses that follow a systematic progression and all receive scaffolded content at the same time. The students were primarily female (94%), Caucasian (84%), and between the ages of 21–24 years old (75%).

Over the course of four semesters, a single cohort of 78 students participated in one hi-fidelity simulation per semester (N = 4). These experiences were a familiar teaching strategy, incorporated into most nursing clinical courses, and required to successfully meet course outcomes. Scenarios previously pilot-tested and integrated within the curriculum were used for this study as each contained a scaffolded aspect of medication administration (described later). Following IRB approval, faculty who were not involved in the research project explained the study to the students and obtained informed consent. Within the informed consent, the purpose was defined as "measure student nurses' ability to safely deliver medications while assessing and performing interventions in a high-fidelity simulation experience". Students were reminded that participation in each of the simulations was mandatory for the course, but participation in the study and data collection was voluntary.

Each semester, this single cohort of students was divided into groups of eight and randomly assigned roles, including primary nurse, secondary nurse, and active observer. Ten simulations were needed each semester, except for the second semester when delayed progressions increased the number of enrolled students and required twelve groups.

Data were collected on the students randomized to perform in the role of primary nurse. Each semester, all students were allowed to sign-up for a preferred time and some may have scheduled simulation times with the same students from previous simulations. As the assignments were random, students may or may not have played the role of primary nurse in previous or subsequent semesters. The simulation scenarios were designed with increasing complexity and were conducted over 13–15 min in a room that was fitted with a one-way mirror for observation. Prior to every simulation, information was posted on the learning management system with general details on the patient's diagnosis and student learning objectives and students received a prebrief to set a psychologically-safe learning environment.

Briefly, the scenarios were as follows

First semester: Junior students cared for a 57-year-old male who required one intravenous (IV) antibiotic.

Second semester: Junior students cared for a pediatric patient who required an IV steroid infusion over 15-minutes. The IV pump required the student to program an hourly rate.

Third semester: Senior students cared for the same 57-year-old male, but the prescribed IV antibiotic had an embedded dosage error. The seniors were required to clarify and correct the prescription prior to medication administration.

Fourth semester: Senior students cared for the same pediatric patient, but were required to administer two IV medications prescribed for the same administration time. The patient had a single IV and the students had to prioritize whether to administer the medication with an infusion time of 15-minutes or the medication with a one-hour infusion time.

For this study, scenarios were 13–15 min each and examined only the foundational five rights of medication administration (*patient*, *medication*, *dose*, *route*, and *time*). Although the current list of rights exceeds the foundational five used within this study, time and resource limitations necessitated observation of only the five rights described in Table 1. The primary investigator, a Registered Nurse who was not a clinical instructor of the students in the study, completed a checklist of the five rights on all students randomized to primary nurse, throughout every simulation, from behind a one-way mirror. The dichotomous checklist was performance-based and contained five "yes" or "no" checklist items of behaviors identified for the five rights (Hendler, 2021b; Martyn et al., 2019) (Table 1). Face validity was addressed by survey and review of nurse educators within the institution.

4. Results

The behaviors of the rights were initially introduced in a stand-alone, first-semester dosage course and reinforced throughout the following three semesters. Although there were many complexities embedded in these scenarios, this report summarizes only verification of the five rights by the students randomized to the role of primary nurse in each of the simulations (N = 42).

Conventional frequencies for the sum of correctly verified rights per semester were calculated. Junior students were in semesters one and two, and senior students were in semesters three and four. The rights, in order from most to least verified over four semesters, were *time, route, medication, patient*, and *dose* (see Fig. 1).

Right Time: right time required students to ensure that drug was administered at the correct time and at the appropriate frequency (Hendler, 2021b). Right *time* was verified 100% for the last three semesters, with the exception of 70% in the first semester.

Right Route: right route required students to ensure that the medication provided was the same formulation as what was ordered (Hendler, 2021b). All ordered medications were either PO or IV doses. Right route was verified 100% every semester.

Right Medication: right medication required students to verify that the medication ordered was the medication supplied. This required comparing the prescribed order with the label on the supplied medication (Hendler, 2021b). Right *medication* was 90% in semester one, decreased 20% from semester two to semester three (100–80%), and returned to 100% for semester four.

Right Patient: right patient required students to check two unique patient identifiers (Hendler, 2021b). Most often, this included comparing the patient's name and date of birth with the patient's wrist band. There was a small decrease in right *patient* from 80% in the first semester to 70% in semester four. Right Dose: right dose required students to calculate the dose to ensure that it was within the safe dose range. Once calculated, students were expected to compare the calculated dose against the ordered dose (Hendler, 2021b). The right *dose* was 0% in the first semester, peaked during the third semester at 70%, then dropped precipitously to 30% during the last semester.

Five Rights: One hundred percent of students observed in the first semester did not verify all five rights. At the time of graduation, 80% of students observed did not verify all five rights prior to medication administration.

Table 1
Rights behaviors.

Right	Necessary Behaviors
Drug	Verify that the drug label is correct and in the prescribed form
Patient	Confirm identify using two patient identifiers (name, date of birth, medical record number).
Dose	Verify that the dose and form is appropriate for the patient (within safe dose range) and the label reflects the ordered dose.
Time	Ensure that the time is within the correct time frame.
Route	Verify that the route is correct for the patient and medication; reflects the ordered route.

Adapted from The eight "rights" of medication administration. (2021). In C. B. Hendler (Ed.), *Nursing 2021 Drug Handbook* (p. 18). Wolters Kluwer.

5. Discussion

Nurses are vital to safe medication administration, and it is the responsibility of nurse educators to ensure that students receive the training necessary for unsupervised execution of safe medication administration upon licensure. The process of safe medication administration is complex and requires development of KSAs through integration of experiences that create connections between theory and hands-on application. The fundamental five rights (Green, 2018; Martyn et al., 2019) provide a simplistic framework for novices and, while the number of rights has expanded to reflect the complexity of nursing practice (Bickel et al., 2020; Green, 2018; Kavanagh, 2017; Martyn et al., 2019), the five rights provide basic foundations for beginning nursing students that can be developed and expanded alongside clinical reasoning. Beyond a basic rights checklist, however, the complexity of patients' diagnoses, appropriate treatments, and clinical settings require integration of the nurse's knowledge, skills, and judgment (Rohde and Domm, 2018). While aspects of clinical reasoning are not described within these findings, the scenarios required senior students to use clinical judgment before, during, and after medication administration (Rohde and Domm, 2018) to determine priorities and avoid near-miss errors, yet there were repeated lapses.

This study extends the medication safety literature and identified changes in safe medication administration behaviors over time in a single cohort of nursing students (Fig. 1). The rights of *time*, *route*, and *medication* were most frequently verified throughout the simulations. During guided debriefing, students shared that information needed to verify these particular rights was a straightforward comparison. The simulations required medication timed for administration at the beginning of the scenario. There were no interruptions or additional patient

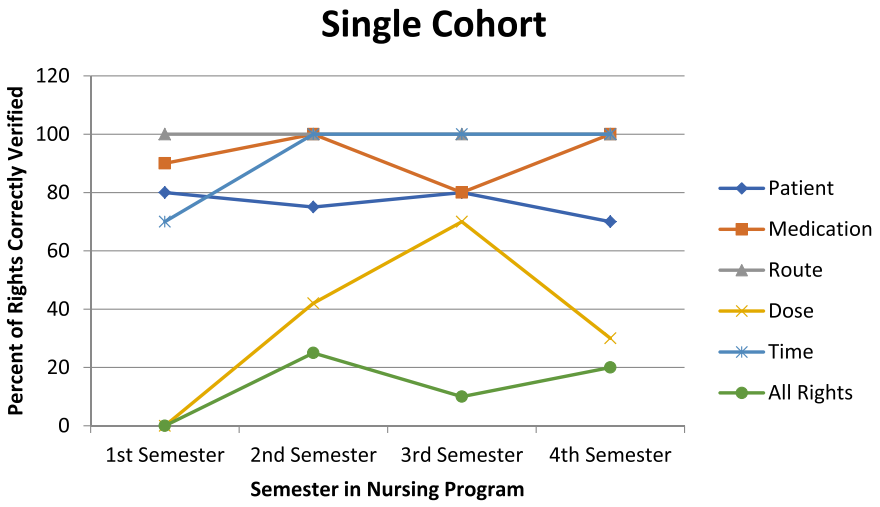

Fig. 1. Correctly verified rights during four semesters of the nursing program.

assignments that often pose challenges in real clinical settings (Martyn et al., 2019). The exception to consistent verification of right *time* was in the first semester at 70%. Three of the students did not explicitly confirm that the time was appropriate for administration. During debriefing, these students expressed confusion that, because the simulation scenario was short, the medication should be given right away. There was also an assumption that the time in simulation must automatically be appropriate for the medication. These assumptions were clarified and verification returned to 100% in subsequent semesters.

Verification of right *medication* decreased 20% from semester two to semester three (100–80%) but returned to 100% for semester four. These students did not explicitly compare the label of the medication to the order and expressed the assumption that the medication supplied within the simulation scenario was correct.

Students also acknowledged a lapse remembering The Joint Commission's requirement of at least two unique identifiers to verify right *patient* (The Joint Commission, 2020). According to these requirements, patients can verbally confirm the unique identifiers of name and date of birth on the wristband, and for pediatric patients, parents can confirm this information. Some students asked for only the patient's name, omitting verification of another unique identifier. This concerning lapse of verification was related to the presence of only one patient in the room and the assumption that this patient was the right *patient*. However, as students progressed through the program and became more familiar with the flow and expectations of simulation, the lapse was due to verbal confirmation of only one identifier. Students related this lapse to the absence of barcode scanning in simulation. In hospital settings, the students use barcode scanners prior to medication administration to verify right *patient* and no longer confirm verbally with the patient. Therefore, in simulation where no barcode scanning was available, they had forgotten to verify two unique identifiers.

The reliance on this technology is concerning, especially with the rise of cyberattacks on healthcare systems. Cyberattacks are an international threat to patient safety (Kamerer and McDermott, 2020) that increased 400% during the COVID-19 pandemic (Kamerer and McDermott, 2020; Kim, 2021). Cyberattacks can lead to interference and/or theft of private and confidential information within the EHR. In fact, on the black market, a medical record number is more valuable than a social security number due to the large amounts of information that can be retrieved from the EHR (Kamerer and McDermott, 2020). Therefore, criminals target healthcare systems, leading to ransomware interference on electronic healthcare records and subsequent administrative delays, delays in patient treatments, and patient death (O'Brien et al., 2021). Because of the potential for electronic interference, as well as other times when systems are unavailable, it is imperative that students practice processes that can be applied during the absence of electronic systems, including many of the rights.

Verifying right *dose* was alarmingly 0% in the first semester, peaked at 70% during the third semester, then dropped to only 30% during the semester of graduation. This right requires verifying safe dosing by independently calculating the safe dose using ranges found in a drug reference and comparing this information to the order (Green, 2018; Hendler, 2021b; Martyn et al., 2019) However, students in simulation did not consistently calculate safe dosages prior to administration. Interestingly, the peak at 70% correlated with the pediatrics course, where weight-based dosage calculations are expected prior to medication administration. Guided debriefing discussions highlighted an absence of this safety check by nurses in adult clinical settings which led to a perception by students that this check was unnecessary once practicing as a licensed professional. A common theme throughout debriefing was the expectation that "the order was correct" and meant that the nurse could give the medication without performing confirmatory calculations. Additionally, students differed on the behaviors necessary to complete this right and often stated that comparing the ordered dose to the supplied dose served as verification of right *dose*. It is possible that these differences are related to the variance of faculty operationalizing right *dose*. During discussions with faculty, many of the adult clinicians did not include calculating safe dose ranges as part of verifying right *dose*. Perpetuating this safety gap is misaligned with drug references, including the most recent edition of the *Nursing 2021 Handbook*, "Verify that the dose and dosage form to be given are appropriate for the patient and check the drug label with the prescriber's order" in (Hendler, 2021b, p. 18). This corrected message should be the expectation when instructing students about right *dose*.

Most concerning was the overwhelming absence of overall safe medication administration practices in graduating students. In the final semester of nursing school, 80% of students observed did not verify all five rights prior to medication administration. While many of the reasons behind these lapses were described above, this small dataset supports others who have found that students are not competent in safe medication administration at the completion of prelicensure education (Amster et al., 2015; Asensi-Vicente et al., 2018; Jarvill, 2020; Mariani et al., 2017; Schneidereith, 2014).

The deficiency of safe behaviors again raises the question of student learning within patient-care settings. The assumption that students learn and practice safe, evidence-based care in clinical settings (Hughes et al., 2020) is unfounded. Based on the empty systematic review by Leighton et al. (2021), belief that the traditional "gold standard" clinical model provides opportunities for students to achieve the KSAs necessary to become competent is unsupported (Leighton et al., 2021). The historical

apprenticeship models used for decades do not have evidence (Leighton et al., 2021) underlying this form of experiential learning on achievement of safe medication administration in patient-care settings. Furthermore, within clinical settings, students are not getting enough dedicated time to reinforce the correct psychomotor skills and cognitive requirements necessary for safe medication administration (Bush et al., 2015; Craig, 2021). Clinical faculty are unable to spend adequate time with individual students and 30% of the time exchanges spent with students in the clinical setting took place in ≤ one minute (Hughes et al., 2020; Ironside et al., 2014). When steps necessary for safe medication administration require more than one minute of clinical faculty's time, it is understandable that new nurses want more opportunities to practice medication administration before becoming independent (Fusco et al., 2021; Treiber and Jones, 2018).

Another impediment to safe medication practices is an absence of professional role modeling. Students begin to develop a professional identity in clinical settings alongside practicing safe patient care (Hughes et al., 2020), yet students are observing lapses and medication errors by other nurses who are avoiding the safety checks of the rights method in the clinical setting (Baldwin et al., 2013; Cullen et al., 2000; Ironside et al., 2014; Jones and Treiber, 2010; Keers et al., 2013; Wang and Blumberg, 1983).

Therefore, educators who rely on traditional patient-care settings for students to gain clinical hours and earn presumed experience must re-envision ways to ensure that students gain the KSAs necessary for medication competence. Simulation provides a pedagogical strategy to address specific needs related to lack of competence, as well as opportunities to gain practical experience and practice high-risk, low-volume situations (Craig et al., 2021; Fusco et al., 2021; Hughes et al., 2020; Jarvill, 2020; Schneidereith, 2014). The tenet of simulation fidelity, including physical, conceptual, and psychological conditions created to mimic the clinical environment, supports creation of settings for achievement of learning objectives (INACSL Standards Committee, 2016). This is important when considering the role of conditions in skill acquisition. Although simulation settings cannot account for all of the uncertainty found in traditional clinical settings (Al-Moteri, 2020), creating conditions that are similar to those experienced during skill acquisition allow for a higher level of performance when demonstrating specific motor skills (Keetch et al., 2008). Although these simulations were included every semester, the exposures did not appear to provide enough practical opportunities to positively influence acquisition of safe medication KSAs. Future research is recommended to identify simulation dosing that impact development and repeated demonstration of safe medication KSAs that can be transferred into clinical practice.

There were a few limitations noted in this study. This data were collected from a convenience sample at a single site, limiting the sample size, generalizability, and statistical analyses. The checklists were completed on the behaviors of the student in the role of primary nurse and randomization throughout four semesters may have resulted in the same student randomized to the role more than once. During the first semester, the prebrief was not explicit regarding elements of the fiction contract and may have caused confusion regarding right *time* and *patient*.

Additional recommendations for future research include comparing the same student cohort over time in simulated and traditional clinical settings. The research would seek to observe setting-related differences and longitudinal changes in medication administration behavior.

6. Conclusion

This study reports the findings of a longitudinal project on safe medication administration behaviors and adds to the literature demonstrating that nursing students are not prepared to independently administer medications safely (Fusco et al., 2021; Jarvill, 2020; Schneidereith, 2014). For nurse educators, this information is contrary to assumptions and program expectations and requires a call to action to increase the number of opportunities for safe, independent administration of medications upon licensure. For nurse administrators, maintaining enough qualified faculty able to provide necessary medication administration experiences in clinical settings must be a priority. Additionally, for healthcare systems, the professional responsibility of licensed nurses to role model safe medication administration practices must be reinforced.

As clinical environments become more complex, preparation of nursing graduates is imperative (Green, 2018). Members of the nursing profession should be mindful that the problems created by inadequate prelicensure medication administration experiences are carried into professional practice, leading to clinical error for new graduate nurses within the first year of practice (Chan et al., 2019). Reinforcing safe medication administration behaviors through consistent experiences is a professional responsibility of educators, administrators, and healthcare systems to help break the cycle of ADEs.

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Author statement

I am solely responsible for the research study and authorship of this manuscript.

Declaration of Competing Interest

I do not have any financial or personal relationships with other people or organizations that could inappropriately influence (bias) this work.

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