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# COMPARISON BETWEEN TWO TEACHING STRATEGIES FOR PEDIATRIC DRUG DOSAGE CALCULATION AMONG UNDERGRADUATING NURSING STUDENTS

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**Abstract**

**Background:** Calculation of medication dosages can be the challenging for nursing students. Nurse educators are able to design and develop effective methods that consider the cognitive structures and how the mind processes information to teach pediatric medication content to nursing students. **The aim of the study** was to compare between two teaching strategies for pediatric drug dosage calculation among under graduating nursing students **Research design:** A quasi-experimental study research design. **Sample**: Ninety nursing students in the third academic year who were studying pediatric nursing course who divided into two groups: low fidelity simulation (group I, or the study group) and traditional classroom (group II, or the comparison group). **Setting:** In the faculty of nursing in the South Valley University conducted this study. **The tool of data collection:** This study used one tool consisted of two parts: part 1 socio-demographic questionnaire and part 2: pre-dosage calculation test and post-dosage calculation test. **Results:** Increase mean score of knowledge among nursing students who included in the low-fidelity simulation experience (Group I) (6.69 ± 3.08; 12.71 ± 2.74) pre and posttest respectively as well as increase mean score of knowledge of nursing students who included in the traditional classroom experience (Group II) (3.20 ± 1.75; 11.58 ± 2.02) pre and posttest respectively, there was highly statistical significant **p<0.000.** Illustrate that more increase the mean score of performance among nursing students who included in the low-fidelity simulation experience (Group I) than another group 2.58 ± 2.08; 12.73 ± 2.67) pre and posttest respectively. **Conclusion:** Lack of knowledge of basic math principles before intervention with different teaching strategies but after intervention with different teaching strategies increase the score of knowledge among nursing students who included in the low-fidelity simulation experience (Group I) equals as the score of knowledge who included in the traditional classroom experience (Group II). While increase mean score of performing of nursing students who included in the low-fidelity simulation experience (Group I) better than who included in the traditional classroom experience (Group II) posttest. **Recommendations**: Replicate the study with a larger sample size of students within each demographic group. Conduct a longitudinal study to measure retention of skills. Research could be conducted to see if the actual rates of dosage calculation errors are decreased in the clinical setting.

**Keywords:** drug dosage calculation skills, simulation, traditional classroom method

## Introduction:

Patient safety is undermined by an increasing number of drug administration errors has raised concerns globally about whether nursing students develop the math skills required to calculate drug dosages **McMullan Jones, Lea, Mullan, Jones, Lea, (2010**).

Medication errors have been identified as the most common of error affecting patient safety and the most common single preventable cause of adverse events and they can occur as a result of mathematical calculation errors and conceptual errors **Fleming, Brady, Malone (2014**).

The most common errors reported during the preparatory phase of drug administration are: using a different drug from the one prescribed, wrong dosage or dilution, and setting the wrong speed of infusion **Wright, (2010); Grugnetti Bagnasco, Rosa, Sasso (2014**).

Many nurses and students do not have a full understanding of all the basic mathematical concepts (addition, subtraction, division, and multiplication) and are unable to apply these concepts to medication dosage calculation and use formulas **Wright, (2010**).

Nursing students need time to practice these skills in an environment that is safe and free of patient harm. Simulation can meet this need. Furthermore, simulation offers a unique opportunity whereby the learning activity can be structured to achieve specific learning objectives. This offers a distinct advantage over the clinical experience where the experience is not controlled **Suplee & Solecki (2011**); **Campbell (2013)**.

A simulated medication experience for pediatric patients was conducted by **Pauly-O'Neill (2009)**. The accuracy of the five rights of medication administration was measured during simulation. Student performance did improve following simulated practice in all categories with the exception of accurate dosage. Despite practice, the 25/30 students were unable to accurately calculate and draw up the appropriate dosage for a simulated patient. These findings support the use of simulation where mistakes can be made without the risk of patient harm **Campbell (2013)**.

Calculation of medication dosages has been identified as a deficit for many nursing students **Wolf, Hicks, & Serembus (2006)**. Incorporating medication administration into patient simulation scenarios offers numerous learning opportunities and benefits to students. Understanding of the rationale for medication use is enhanced as students are able to see how medications fit into the treatment of selected conditions. They have an opportunity to identify the appropriate drugs, determine safe dosages, calculate dosages, properly identify the patient, administer medications by a variety of routes, observe for side effects, and evaluate the effectiveness of medications. The simulation presents a realistic simulated clinical setting with inherent distractions that may interfere with safe medication administration **(Durham & Alden, 2008).**

Low-fidelity simulations include the use of case studies, role-play, or partial task trainers that help students develop psychomotor skills integral to patient care (**Hovancsek, 2007**).

Students need plenty learning opportunities wherever they can use the theoretical knowledge gained in the classroom, develop clinical thinking, and hold the ethical nature of nursing practice **Campbell, (2013); Benner, Sutphen, Leonard & Day (2010).**

Evidence supports simulation as a strategy to learn math calculations; nursing students can practice before entry to the clinical setting to elevate medication administration safety and decrease errors. Well-designed, realistic simulations that include distractions can provide a framework and structure for learning this complex intervention (**Pauly-O'Neill, 2009**). If the simulation is implemented early in the curriculum, it can give the student an excellent foundation and help students visualize the actual volume of the calculated medication that they plan to administer, thus decreasing risk to all patients **Miller, Robinson, Lubomski, Rink, & Pronovost, (2007); Wright, (2008). Costello (2011)** compared educational strategies that taught math calculation skills in a classroom and in a simulated setting **Zahara-Such, (2013**).

Medication dosing errors are a significant global concern and can cause serious medical consequences for patients. Pediatric patients are at increased risk of dosing errors due to differences in medication pharmacodynamics and pharmacokinetics **Al-Ramahi et al., 2017).**

In contrast to adult medication administration, there are few standardized dosing regimens for children. For instance, a standardized dose (one dosage) is not recommended for all children because of the wide range of body mass, differences in weight, metabolism, and excretion of various drugs compared with adults **Taketomo, Hodding, & Kraus, (2008).**

These physiological differences warrant special considerations for medication administration in pediatrics. Consequently, medication dosages must be calculated based on a child's weight or body surface area and the child's clinical condition **Ghaleb, Barber, Franklin, Yeung, Khaki, & Wong, (2006); Taketomo, Hodding, & Kraus (2008).**

Because all medication dosages for children are weight-based and require mathematical calculation, the possibility of dosing errors increases **Ghaleb et al., (2006)**. Incorrect medication dosages due to poor mathematical skills account for the majority of pediatric medication errors **(Hughs & Edgerton, 2005).** Therefore, accurate medication administration in pediatrics is critical to patient safety.

**The aim of the study:**

The aim of the study was to compare between two teaching strategies for pediatric drug dosage calculation among undergraduate nursing students.

**Research hypotheses:**

- There will be significant differences between two teaching strategies for pediatric drug dosage calculation among undergraduate nursing students.

**Subjects and Method**

**Research design:**

A quasi-experimental research design was utilized in this study.

**Study Duration:**

- Total time of the program was 3 months. Collection of data was started from the beginning of February 2016 to the end of April 2016.
- Post-test was conducted one month after application of the teaching modality designs.

**Setting**:

The study was conducted in the simulation lab and the classroom in the faculty of nursing, South Valley University in Qena governorate.

**Subjects**:

The study included convenience sample of ninety undergraduate nursing students in third-year who were enrolled in a pediatric nursing course faculty of nursing in the South Valley University was participating in this study. The study sample divided into two groups each group consists of forty-five undergraduate nursing students used teaching different strategies, the group one was used low-fidelity simulation within simulation lab while the group two was using the traditional case study experience within a classroom.

**The tool of data collection:**

In this study one tool of data collection was used consisted of two parts:

**Part 1: Socio-demographic data:**

This part consisted of items on personal and baseline characteristics of the subjects in relation to the name, age, sex, residence, academic achievement and liking of math.

**Part 2: Pre-Dosage Calculation Test and Post-Dosage Calculation Test**

- Conceptually defined, the Pre-/Post-Dosage Calculation Test was a 30-item self-administered the researcher-designed instrument that reflected the original medication administration dosage calculation instrument **Huse, (2010).**

- The items were divided into two categories – the first category contain 15 items on calculating medication administration dosages and the second category contain 15 items demonstrating the transfer of the calculated dosages to the actual equipment.
- The first item in a pair required a dosage calculation and then the second item in the pair required the student to illustrate the calculated dosage. Typically, when a student calculated an incorrect dosage then they were more likely to miss the illustration portion as well.
- The original tool was modified to test the accuracy of medication administration dosage calculation skills and the transfer of these calculated dosages into a realistic format for medication administration in pediatric level nursing students.
- The medications that were calculated were in pill form, liquid suspension, intramuscular injection (IM), the nasogastric tube (NGT), and intravenous pushes and infusions (IV). The items required the participants to understand the problem through interpretation of the physician's orders and the drug labels, devise a plan to solve the problem, and carry out the plan utilizing appropriate conversions when necessary and demonstrate a transfer of the calculated dosages into a realistic setting by filling in the correct dose on the appropriate equipment (i.e. tablets, medication cup, Kangaroo pump tube feeding bag, syringes, and electronic IV pumps).

Operationally defined, the Pre-/Post-Dosage Calculation Test was used to evaluate cognitive knowledge and content mastery pre- and post-educational experience. The Pre-/Post- Dosage Calculation Test forms of the instrument portrayed the actual medication and its constitution. Students had to use this information to gather the pertinent data to calculate the dosages correctly. The first category contains 15 items on calculating medication administration dosages. The questions were correct to take score (1) and the questions were incorrect take scored (0). The maximum possible score is 15and the minimum is 0. The second category contains 15 items demonstrating the transfer of the calculated dosages to the actual equipment. The demonstrating were correct take score (1) and the demonstrating were incorrect take scored (0). The maximum possible score is 15and the minimum is 0.

**Comparison of Teaching Modality Designs**

- The problem-solving framework was used as a guideline to develop the low-fidelity simulated scenario within a simulation lab (group 1) and the traditional case study experience in the classroom (group 2).

**Procedure:**

The following research will be conducted according to the following:

1- **Baseline assessment:**
Through pre-test will be conducted before teaching implementation by using the selected tools.

2- **The enhancement of teaching:**
Two teaching methods will be used to as a guideline to develop the low-fidelity simulated scenario experience in the simulation lab (group I) and the traditional case study experience in the classroom (group II). All of the participants in the (group II) who included in a

three-hour classroom experience. The low-fidelity simulated scenario group of students was divided into small groups of 15 students. Each small group attended three hours simulation experience one day weekly for two weeks.

- Demonstrate the basic mathematical concepts (addition, subtraction, division, and multiplication) and apply these concepts to medication dosage calculation and metric units, volume drug calculations, normal fluid requirements, dosages based on Body Surface Area, calculation of IV drip rates and IV Infusion Rates Formula.

**3- Evaluation phase:**

- Post-test was conducted one month after application of the teaching modality designs. All subjects will be reassessed through the same relevant tools upon termination of the program.
- The students had an hour to complete the test and the questionnaire, without using calculators. To ensure anonymity, student's names were substituted by a code number but were also given the opportunity to write their names on their test if they wished to so that they could have feedback on their math skills.

**Pilot study**

- The pilot study was conducted on 10% nursing students divided into two groups to test the clarity of the questions and identify any problems before the actual study conducted and test validity and reliability of the questionnaire and accordingly necessary modifications was been carried.

**Validity:-**

- To achieve validity five experts in the field of nursing (one professor of pediatric nursing, two assistant professors of Nursing Administration and two assistant professors of pediatric nursing) were selected to evaluate the content validity of the tool. Their suggestions and modifications were taken into consideration.

**Reliability:-**

- To ensure the reliability of tool, it was applied to participants on two separate occasions (one week). Cronbach's coefficient alpha was (0.74).

### Ethical Considerations

- Oral initial approval was obtained from the research ethics committee of the faculty of nursing, South Valley University. The researchers explained to students the aim of the study and informed that the information obtained would be confidential and only for the purpose of the study.

**Statistical Analysis of data:**

- Data were analyzed using statistical package for social sciences version 20. Data were presented using descriptive statistics in the form of frequencies. Quantitative data were presented by mean and standard deviation. A significance level was considered at $P < 0.05$.

## Results

**Table (1)** Shows that the majority of nursing students (55.6%) were females in group I and (66.7%) in group II while the mean age of group I, group II was (20.82 ± 0.54, and 20.96 ± 0.67) respectively. The majority of students of group I came from rural areas (62.2%). However, the second group represented nearly 1:1 of rural: urban ratio. They were an excellent academic year (73.3%) in group I but (53.3%) in group II and the majority of nursing students in two groups like math. There was an increase in the nursing students' knowledge calculation of drug dose who included in the low-fidelity simulation experience (Group I) after posttest and there was the statistically significant difference in **the table (2).**

**Table (3):** Shows statistical significant difference and there was improving in the nursing students' knowledge calculation of drug dose who attended the traditional classroom experience in Group II after posttest.

Demonstrates statistical significant difference in **the table (4)** and show improve the performance of nursing students who included in the low-fidelity simulation experience (Group I) who used instruments of calculation drug dose posttest.

Demonstrates statistical significant difference in the **table (5)** and show improve the performance of nursing students who included in the traditional classroom experience (Group II) that instruments forms were used by them of calculation drug dose posttest.

**Table (6):** Shows that increase mean score of knowledge among nursing students who included in the low-fidelity simulation experience (Group I) (6.69 ± 3.08; 12.71 ± 2.74) pre and posttest respectively as well as increase mean score of knowledge of nursing students who included in the traditional classroom experience (Group II) (3.20 ± 1.75; 11.58 ± 2.02) pre and posttest respectively, there was highly statistical significant **p<0.000.** Increase score of knowledge among nursing students who included in the low-fidelity simulation experience (Group I) nearly equals as the score of knowledge who included in the traditional classroom experience (Group II) posttest p< 0.476.

Illustrate that more increase means the score of performance among nursing students who included in the low-fidelity simulation experience (Group I) than another group 2.58 ± 2.08; 12.73 ± 2.67) pre and posttest respectively. Also, increase mean score of the performance of nursing students who included in the traditional classroom experience (Group II) (2.76 ± 1.67; 9.67 ± 2.74) pre and posttest respectively, there was highly statistical significant p<0.000. Increase mean score of the performance of nursing students who included in the low-fidelity simulation experience (Group I) better than who included in the traditional classroom experience (Group II) posttest p < 0.001* through demonstrate a transfer of the calculated dosages into a realistic setting by filling in the correct dose on the appropriate equipment.

**Figure (1):** Shows increase mean score of knowledge of nursing students about the calculation of drug dose posttest than pretest in two groups

**Figure (2):** Shows that the performance score calculation of drug dose of nursing students groups increased compared to pre-application of the simulation. Performance posttest score in group I was better than group II.

**Table (1):** Personal data of nursing students Group I: low-fidelity simulation and Group II: traditional classroom teaching. (Total number 90)

| Items | Group I (n= 45) | | Group II (n= 45) | | P-value |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| **Sex:** | | | | | 0.280 |
| Male | 20 | 44.4 | 15 | 33.3 | |
| Female | 25 | **55.6** | 30 | **66.7** | |
| **Age:** (years) | | | | | 0.339 |
| Mean ± SD | **20.82 ± 0.54** | | **20.96 ± 0.67** | | |
| Range | 20.0 – 22.0 | | 20.0 – 22.0 | | |
| **Academic achievement:** | | | | | |
| Excellent | 33 | 73.3 | 24 | 53.3 | 0.049* |
| Very good | 4 | 8.9 | 9 | 20.0 | 0.134 |
| Good | 0 | 0.0 | 5 | 11.1 | 0.056 |
| Pass | 0 | 0.0 | 5 | 11.1 | 0.056 |
| Failed | 8 | 17.8 | 2 | 4.4 | 0.044* |
| **Residence:** | | | | | 0.203 |
| Urban | 17 | 37.8 | 23 | 51.1 | |
| Rural | 28 | 62.2 | 22 | 48.9 | |
| **Math:** | | | | | 0.141 |
| Like | 31 | 68.9 | 37 | 82.2 | |
| Dislike | 14 | 31.1 | 8 | 17.8 | |

**P≤0.01* *** P≤0.000*

**Table (2):** Calculation of drug dose knowledge of nursing students who included in the low-fidelity simulation experience (Group I) n=45

| Drugs calculation dose | Pre-test | | | | Post-test | | | | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | Incorrect | | Correct | | Incorrect | | Correct | | |
| | No. | % | No. | % | No. | % | No. | % | |
| $Q_{1a}$ Zofran | 10 | 22.2 | 35 | 77.8 | 0 | 0.0 | 45 | 100.0 | 0.001* |
| $Q_{2a}$ Haldol | 24 | 53.3 | 21 | 46.7 | 4 | 8.9 | 41 | 91.1 | 0.000* |
| $Q_{3a}$ Lanoxin | 25 | 55.6 | 20 | 44.4 | 1 | 2.2 | 44 | 97.8 | 0.000* |
| $Q_{4a}$ Synthroid | 19 | 42.2 | 26 | 57.8 | 19 | 42.2 | 26 | 57.8 | 1.000 |
| $Q_{5a}$ Dilantin | 28 | 62.2 | 17 | 37.8 | 5 | 11.1 | 40 | 88.9 | 0.000* |
| $Q_{6a}$ Amikacin | 12 | 26.7 | 33 | 73.3 | 2 | 4.4 | 43 | 95.6 | 0.004* |
| $Q_{7a}$ Symmetrel | 17 | 37.8 | 28 | 62.2 | 11 | 24.4 | 34 | 75.6 | 0.172 |
| $Q_{8a}$ Heparin | 30 | 66.7 | 15 | 33.3 | 12 | 26.7 | 33 | 73.3 | 0.000* |
| $Q_{9a}$ Aminophylline | 15 | 33.3 | 30 | 66.7 | 6 | 13.3 | 39 | 86.7 | 0.025* |
| $Q_{10a}$ Vincristine | 44 | 97.8 | 1 | 2.2 | 16 | 35.6 | 29 | 64.4 | 0.000* |
| $Q_{11a}$ Insulin | 23 | 51.1 | 22 | 48.9 | 5 | 11.1 | 40 | 88.9 | 0.000* |
| $Q_{12a}$ Pulmocare | 45 | 100.0 | 0 | 0.0 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{13a}$ NS | 23 | 51.1 | 22 | 48.9 | 8 | 17.8 | 37 | 82.2 | 0.001* |
| $Q_{14a}$ Rantidine | 20 | 44.4 | 25 | 55.6 | 8 | 17.8 | 37 | 82.2 | 0.006* |
| $Q_{15a}$ D5NS | 39 | 86.7 | 6 | 13.3 | 6 | 13.3 | 39 | 86.7 | 0.000* |

**Table (3):** Calculation of drug dose knowledge of nursing students who attended the traditional classroom experience (Group II) n=45

| Drugs calculation dose | Pre-test | | | | Post-test | | | | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | Incorrect | | Correct | | Incorrect | | Correct | | |
| | No. | % | No. | % | No. | % | No. | % | |
| $Q_{1a}$ Zofran | 9 | 20.0 | 36 | 80.0 | 2 | 4.4 | 43 | 95.6 | 0.024* |
| $Q_{2a}$ Haldol | 34 | 75.6 | 11 | 24.4 | 12 | 26.7 | 33 | 73.3 | 0.000* |
| $Q_{3a}$ Lanoxin | 26 | 57.8 | 19 | 42.2 | 3 | 6.7 | 42 | 93.3 | 0.000* |
| $Q_{4a}$ Synthroid | 32 | 71.1 | 13 | 28.9 | 8 | 17.8 | 37 | 82.2 | 0.000* |
| $Q_{5a}$ Dilantin | 35 | 77.8 | 10 | 22.2 | 6 | 13.3 | 39 | 86.7 | 0.000* |
| $Q_{6a}$ Amikacin | 14 | 31.1 | 31 | 68.9 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{7a}$ Symmetrel | 41 | 91.1 | 4 | 8.9 | 13 | 28.9 | 32 | 71.1 | 0.000* |
| $Q_{8a}$ Heparin | 39 | 86.7 | 6 | 13.3 | 23 | 51.1 | 22 | 48.9 | 0.000* |
| $Q_{9a}$ Aminophylline | 43 | 95.6 | 2 | 4.4 | 13 | 28.9 | 32 | 71.1 | 0.000* |
| $Q_{10a}$ Vincristine | 45 | 100.0 | 0 | 0.0 | 40 | 88.9 | 5 | 11.1 | 0.056 |
| $Q_{11a}$ Insulin | 43 | 95.6 | 2 | 4.4 | 8 | 17.8 | 37 | 82.2 | 0.000* |
| $Q_{12a}$ Pulmocare | 45 | 100.0 | 0 | 0.0 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{13a}$ NS | 44 | 97.8 | 1 | 2.2 | 11 | 24.4 | 34 | 75.6 | 0.000* |
| $Q_{14a}$ Rantidine | 37 | 82.2 | 8 | 17.8 | 6 | 13.3 | 39 | 86.7 | 0.000* |
| $Q_{15a}$ D5NS | 44 | 97.8 | 1 | 2.2 | 9 | 20.0 | 36 | 80.0 | 0.000* |

**Table (4)**: Illustrate the calculated dosage of nursing students who included in the low-fidelity simulation experience (Group I) n=45

| Drugs calculation dose | Instruments | Pre-test | | | | Post-test | | | | P-value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Incorrect | | Correct | | Incorrect | | Correct | | |
| | | No. | % | No. | % | No. | % | No. | % | |
| $Q_{1b}$ Zofran | Syringes | 35 | 77.8 | 10 | 22.2 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{2b}$ Haldol | Syringes | 36 | 80.0 | 9 | 20.0 | 4 | 8.9 | 41 | 91.1 | 0.000* |
| $Q_{3b}$ Lanoxin | Tablets | 36 | 80.0 | 9 | 20.0 | 1 | 2.2 | 44 | 97.8 | 0.000* |
| $Q_{4b}$ Synthroid | Tablets | 27 | 60.0 | 18 | 40.0 | 19 | 42.2 | 26 | 57.8 | 0.092 |
| $Q_{5b}$ Dilantin | Capsule | 35 | 77.8 | 10 | 22.2 | 5 | 11.1 | 40 | 88.9 | 0.000* |
| $Q_{6b}$ Amikacin | Syringes | 39 | 86.7 | 6 | 13.3 | 2 | 4.4 | 43 | 95.6 | 0.000* |
| $Q_{7b}$ Symmetrel | medication cup | 41 | 91.1 | 4 | 8.9 | 11 | 24.4 | 34 | 75.6 | 0.000* |
| $Q_{8b}$ Heparin | Syringes | 40 | 88.9 | 5 | 11.1 | 12 | 26.7 | 33 | 73.3 | 0.000* |
| $Q_{9b}$ Aminophylline | medication cup | 25 | 55.6 | 20 | 44.4 | 6 | 13.3 | 39 | 86.7 | 0.000* |
| $Q_{10b}$ Vincristine | Syringes | 45 | 100.0 | 0 | 0.0 | 16 | 35.6 | 29 | 64.4 | 0.000* |
| $Q_{11b}$ Insulin | electronic IV pumps | 38 | 84.4 | 7 | 15.6 | 5 | 11.1 | 40 | 88.9 | 0.000* |
| $Q_{12b}$ Pulmocare | Kangaroo pump tube feeding bag | 45 | 100.0 | 0 | 0.0 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{13b}$ NS | electronic IV pumps | 38 | 84.4 | 7 | 15.6 | 8 | 17.8 | 37 | 82.2 | 0.000* |
| $Q_{14b}$ Ranitidine | electronic IV pumps | 39 | 86.7 | 6 | 13.3 | 8 | 17.8 | 37 | 82.2 | 0.000* |
| $Q_{15b}$ D5NS | mL/hr will infuse | 40 | 88.9 | 5 | 11.1 | 5 | 11.1 | 40 | 88.9 | 0.000* |

**Table (5):** Illustrate the calculated dosage of nursing students who attended in the traditional classroom experience (Group II) n=45

| Drugs calculation dose | | Instruments | Pre-test | | | | Post-test | | | | P-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Incorrect | | Correct | | Incorrect | | Correct | | |
| | | | No. | % | No. | % | No. | % | No. | % | |
| $Q_{1b}$ | Zofran | Syringes | 17 | 37.8 | 28 | 62.2 | 4 | 8.9 | 41 | 91.1 | 0.001* |
| $Q_{2b}$ | Haldol | Syringes | 38 | 84.4 | 7 | 15.6 | 17 | 37.8 | 28 | 62.2 | 0.000* |
| $Q_{3b}$ | Lanoxin | Tablets | 28 | 62.2 | 17 | 37.8 | 5 | 11.1 | 40 | 88.9 | 0.000* |
| $Q_{4b}$ | Synthroid | Tablets | 33 | 73.3 | 12 | 26.7 | 10 | 22.2 | 35 | 77.8 | 0.000* |
| $Q_{5b}$ | Dilantin | Capsule | 35 | 77.8 | 10 | 22.2 | 8 | 17.8 | 37 | 82.2 | 0.000* |
| $Q_{6b}$ | Amikacin | Syringes | 18 | 40.0 | 27 | 60.0 | 3 | 6.7 | 42 | 93.3 | 0.000* |
| $Q_{7b}$ | Symmetrel | medication cup | 45 | 100.0 | 0 | 0.0 | 26 | 57.8 | 19 | 42.2 | 0.000* |
| $Q_{8b}$ | Heparin | Syringes | 40 | 88.9 | 5 | 11.1 | 27 | 60.0 | 18 | 40.0 | 0.002* |
| $Q_{9b}$ | Aminophylline | medication cup | 43 | 95.6 | 2 | 4.4 | 15 | 33.3 | 30 | 66.7 | 0.000* |
| $Q_{10b}$ | Vincristine | Syringes | 45 | 100.0 | 0 | 0.0 | 40 | 88.9 | 5 | 11.1 | 0.056 |
| $Q_{11b}$ | Insulin | electronic IV pumps | 43 | 95.6 | 2 | 4.4 | 18 | 40.0 | 27 | 60.0 | 0.000* |
| $Q_{12b}$ | Pulmocare | Kangaroo pump tube feeding bag | 44 | 97.8 | 1 | 2.2 | 0 | 0.0 | 45 | 100.0 | 0.000* |
| $Q_{13b}$ | NS | electronic IV pumps | 45 | 100.0 | 0 | 0.0 | 26 | 57.8 | 19 | 42.2 | 0.000* |
| $Q_{14b}$ | Ranitidine | electronic IV pumps | 42 | 93.3 | 3 | 6.7 | 28 | 62.2 | 17 | 37.8 | 0.000* |
| $Q_{15b}$ | D5NS | mL/hr will infuse | 35 | 77.8 | 10 | 22.2 | 13 | 28.9 | 32 | 71.1 | 0.000* |

**Table (6):** Means scores calculation of drug dose and means scores illustrate the calculated dosage of nursing students who included in two groups pre-posttest. (Total number=90)

| | Pre-test (n= 45) | Post-test (n= 45) | P-value[1] |
|---|---|---|---|
| | **Mean ± SD** | **Mean ± SD** | |
| **Knowledge score:** | | | |
| Group I | 6.69 ± 3.08 | 12.71 ± 2.74 | 0.000* |
| Group II | 3.20 ± 1.75 | 11.58 ± 2.02 | 0.000* |
| **P-value[2]** | 0.000* | 0.476 | |
| **Performance score:** | | | |
| Group I | 2.58 ± 2.08 | 12.73 ± 2.67 | 0.000* |
| Group II | 2.76 ± 1.67 | 9.67 ± 2.74 | 0.000* |
| **P-value[2]** | 0.001* | 0.001* | |

**Fig (1): Means scores calculation of drug dose of nursing students who included in two groups pre-post test**

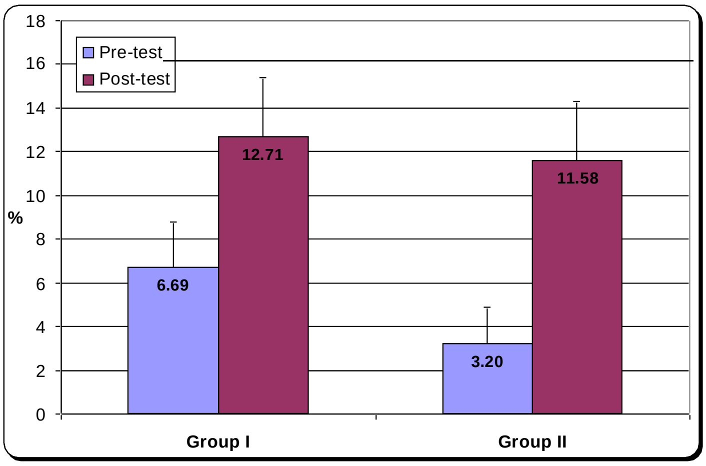
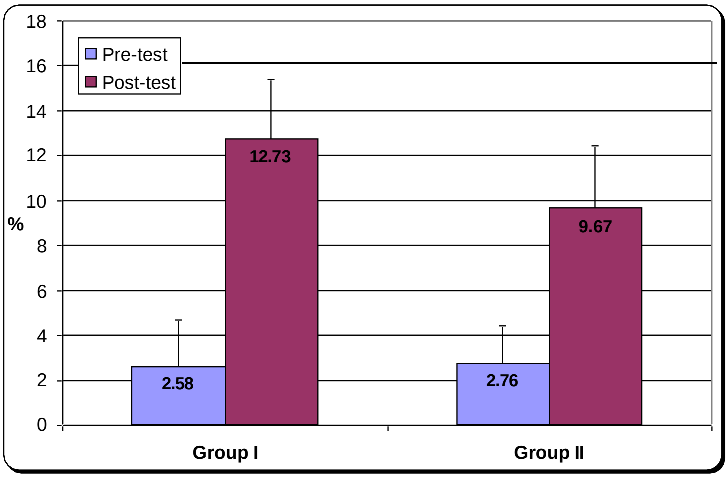



**Fig (2): Means scores illustrate the calculated dosage of nursing students who included in two groups pre-post test**




**Discussion**

Most nurses' students don't have a full understanding of all the basic mathematical concepts and are unable to apply these concepts to drug dosage calculation and use formulas.

The purpose of this research compared between two teaching strategies for pediatric drug dosage calculation among under graduating nursing students

Our entire student sample, lack knowledge for pediatric calculation of drug dose among nursing students in two groups (means: 6.69; 3.20) respectively. Lack performance of calculation of pediatric drug dose among nursing students in two groups (means: 2.58; 2.76) respectively before intervention from of 15 questions.

These results confirmed by other studies (**Bagnasco, Galaverna, Aleo, Grugnetti, Rosa, Sasso 2016; Wright, 2009; Coben, Hutton, Hall, Rowe, Sabin, Weeks, Woolley 2010; Hutton, Coben, Sabin, Hall, Rowe, Weeks, Woolley 2010),** which report that the deficiency of knowledge about maths principles in students includes difficulties performing maths calculations. The 3rd year students were answered correctly to all of the 32 questions, on the basis of the principle that errors in drug dosage calculation are not acceptable in clinical practice (**Weeks, Hutton, Young, Coben, Clochesy, Pontin, 2013; Macdonald, Weeks, Moseley, 2013).** This showed that the most common difficulties for the students were the interpretation of information, conversion of units of measure, and the conceptualization of calculations (**Arkell and Rutter, 2012)**. With regard to the infusion rate solutions calculations, our findings confirmed those obtained by other studies (**Arkell and Rutter, 2012**).

The use of patient simulators in nursing education is a relatively new instructional methodology. The rationale for using simulation as an educational strategy includes the absence of risk to a live patient; the ability to provide standardization of cases; the promotion of critical-thinking, clinical-decision making, and psychomotor skills; the provision of immediate feedback, and the integration of knowledge and behavior. Through patient simulation scenarios, essential elements of patient safety can be emphasized, such as prevention of medication errors, promotion of effective communication, and the importance of teamwork. Learners can be exposed to critical care scenarios and have the opportunity to respond without fear of harming a live patient **(Durham & Alden, 2008).**

The current study **in Table (4)** Showed statistical significant difference in the means of performance of nursing students who included in the low-fidelity simulation experience (Group I) use instruments of calculation drug dose pre and posttest. The medications that were calculated were in pill form, liquid suspension, intramuscular injection (IM), the nasogastric tube (NGT), and intravenous pushes and infusions (IV). The items required the participants to understand the problem through interpretation of the physician's orders and the drug labels, devise a plan to solve the problem, and carry out the plan utilizing appropriate conversions when necessary and demonstrate a transfer of the calculated dosages into a realistic setting by filling in the correct dose on the appropriate equipment (i.e. tablets, medication cup, Kangaroo pump tube feeding bag, syringes, and electronic IV pumps).

The simulation experience is in accordance with **Huse, 2010; Wright, 2008)** studies**,** that included a drug calculations skills session that emphasized calculating drug dosages from ampules, conversions between different drug measurements, and calculations of drip rates for both manually and electronically administered IV fluids.

Results from the current study also support findings from **Pauly-O'Neill (2009)**. In that study, intense simulation experience was shown to enhance the accuracy and safety of nursing students' medication administration.

Recent papers address the importance of including conceptual (understanding the problem), calculation (dosage computation) and technical measurement (dosage measurement) competence in teaching nurses in vocational mathematics, with models to help them understand the 'what', the 'why' and the 'how' in dosage problem-solving **Cohen & Weeks ( 2014); Weeks, Hutton, Young, Coben, Clochesy, Pontin (2013).**

The current study increase mean score of performance of nursing students who included in the low-fidelity simulation experience (Group I) better than who included in the traditional classroom experience (Group II) posttest $p < 0.001$* through demonstrate a transfer of the calculated dosages into a realistic setting by filling in the correct dose on the appropriate equipment.

**Sears, Goldsworthy, & Goodman, (2010)** confirm our study that suggests prior medication practice in a simulated setting can reduce medication errors in clinical practice by nursing students.

Others have also documented that a combination of different learning and teaching strategies do result in better retention of drug calculation skills compared with lectures alone **Cohen & Weeks, (2014).** Further studies of the effect of the introduction of drug dose calculation apps would also be of interest, as well as more authentic observation studies in a high fidelity simulation environment as reported from a Scottish study **Sabin, Weeks, Rowe, et al., (2013).**

Human patient simulation is state-of-the-art technology that assists the nurse to learn skills. Simulation improves acquisition and retention of knowledge. Nurses are able to perform nursing skills quicker and more accurately when using simulation during training. A simulation is an important tool used to remediate nurses in the acquisition of clinical skills. The nurse is given a short realistic scenario. In the simulated environment, the nurse is able to perform the skill as many times as needed to become proficient **Bremner, Aduddell, Bennett, & VanGeest, (2006**).

**Harris, Pittiglio, Newton, & Moore, (2014)** conducted a quasi-experimental pilot study to determine if simulation teaching methods were effective in improving medication calculations and administration skills. One group of participants attended a didactic medication review session, while the other group of participants included in a medication administration simulation review. Results revealed that the simulation group scored significantly higher (m=95 percent, SD=6. 8) and, the didactic group scored lower (m= 90, SD= 12.9).

**Ferguson, Delancey, & Hardy (2014)** conducted a study to determine if teaching medication administration using simulation helped to decrease the incidence of medication errors. This experiment was conducted using 51 first semester nursing students. The findings of this experiment revealed a reduction in the number of medication errors compared to previous classes taught without simulation. If simulation helps decrease medication errors in students who have limited knowledge, the simulation may also be an effective learning strategy for nurses working in healthcare facilities.

Literature exists that supports the premise that allowing nursing students time to manipulate medication administration equipment will help deepen their understanding of the concepts related to actual medication administration **Pauly-O'Neill, (2009**). Simulation can go beyond simple exposure to manipulation of medication administration equipment.

In our study, there was a significant difference in mean dosage calculation posttest scores of pediatric nursing students in two different strategies effectiveness. Other studies uniformly agree with our finding quasi-experimental research **Glaister, (2007)** and the dissertation **Huse, (2010)** compared math calculation strategies; posttests were administered to nursing students to ascertain the strategies' effectiveness. The theoretical article **Shanks &Enlow, (2011)** stated that new methods need to be developed to teach and assess math calculation skills. The importance of providing nursing students with opportunities for deliberate repetitive practice through simulation was stressed. The simulation provided safe, real-life medication calculation examples and allowed students to develop critical thinking skills. The phenomenological study by **Krautscheid, Orton, Chorpenning, & Ryerson, (2011)** interviewed nursing students to identify what activities best prepared them for safe medication administration. This study provided students' perspectives related to the best way to learn math calculation skills and become prepared for safe medication administration.

These results are similar to findings in a previous study that used simulation method for medication review **Huse, (2010); Wright, (2008)**. In that quasi-experimental approach, the effectiveness of a variety of strategies aimed at improving retention of drug calculation skills over time.

## Conclusions

Lack of knowledge of basic maths principles before intervention with different teaching strategies but after intervention with different teaching strategies increase the score of knowledge among nursing students who included in the low-fidelity simulation experience (Group I) nearly equals as the score of knowledge who included in the traditional classroom experience (Group II). While increase mean score of the performance of nursing students who included in the low-fidelity simulation experience (Group I) better than who included in the traditional classroom experience (Group II) posttest

## Recommendations

Based on the findings, the current study recommended that:

1. Replication of the study with a larger sample size of students within each demographic group is needed.
2. Conducting a longitudinal study is recommended to measure retention of skills.
3. Further research should be conducted to see if the actual rates of dosage calculation errors are decreased in the clinical setting by using simulation as a teaching strategy.

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