DOI: https://doi.org/10.53350/pjmhs2115123579

ORIGINAL ARTICLE

Measuring the Effect of Dimensional Analysis on Nurses' Level of Self-Efficacy in Medication Calculation Errors

TARIQ ULLAH[1], MUHAMMAD AFZAL[2], HAJRA SARWAR[3], ASIF HANIF[4], SYED AMIR GILANI[5], AMINA TARIQ[6]
[1]*MNS Scholar, Lahore school of Nursing, Institute of Allied Health Sciences, The University of Lahore*
[2]*Associate Professor, Head of Department/Principal, Lahore School of Nursing, Institute of Allied Health Sciences, The University of Lahore*
[3]*Assistant Professor, Lahore School of Nursing, Institute of Allied Health Sciences, The University of Lahore*
[4]*Associate Professor, Faculty of Allied Health Science the University of Lahore*
[5]*Dean, Allied Health Sciences, The University of Lahore*
[6]*Research coordinator, Research Cell, University College of Medicine and Dentistry, The University of Lahore*
Corresponding author: Tariq Ullah, Email id: tariqkhan868@gmail.com

ABSTRACT

Aims of The Study: The main aim of this study is to improve the calculation of medicines in nurses and develop a master plan for drug calculation competencies which will be yearly renewable.

Objective: To evaluate the effects of dimensional analysis on the self-efficacy levels of nurses, specifically regards to their medication calculation abilities.

Methodology: Quasi experimental study design was used in this study. This quasi-experimental study was conducted at the teaching hospital of the University of Lahore. It is a tertiary care hospital with 450-bedded capacities where almost 113 registered nurses are performing their duties in different shifts.

Results: the frequency and classification of gender, in which male were 22% and female were 78%, the classification of age in which 21- 25 years old participants were 12.45%, some participants age between 26-30 years were 28.3%, participants of 31-35 years were 37.2%, the participants whose age were 36-40 years were 15% and above 40 years participants age were 701%. Classification of education in which 16.8% participants were General Nurse, 36.3% participants were Post RN and 46.9% participants were Generic BSN. The classification of Designation also discusses such as, 47.8% participants were charge nurses, 32.7% were Shift In charge and 19.5% were unit In charge.

Conclusion: This study focusses to enhance the mathematical skills of the nurses and minimize the calculation errors of nurses during medication which is a challenging issue among nurses. This study is to extend focus on improving nurse's medication calculation accuracy. To accomplish the stated purpose, a single intervention dimensional analysis was used which provide a situation for health-care improvement and to find techniques for improving the rate of medication errors. Statistically 39.86% difference recorded in pre-and post-intervention data.

Keywords: Self Efficacy, Dimensional Analysis, medication calculation, mathematical calculation confidence level

INTRODUCTION

Patients' safety is the ultimate goal of nurses as well as other health care professionals. Many things can create issues in patients' safety at the hospitals, among which the diagnosis and medication are top ranking activities. It is a generally acknowledged observation that adverse events during medication administration causes a significant danger to overall safety among patients.[1] Safe medication administration requires several distinct skills and knowledge where drug dosage calculation is one such basic necessary skill for nurses. Accurate calculation of medication is a core skill among nurses which can enhance patients' safety.[2] In every part of the world, a well-developed medication dosage calculation skill is considered essential for competency in nursing.[3] Medication administration errors can lead to serious consequences in terms of morbidity and mortality among patients. Apart from patients, it can also affect the families as well as the health care providers with increased cost, prolonged stay and creating insecurity for health care services.[4]

According to dimensional analysis[5] "is a mathematical calculation method in which the units on the medication package are systematically converted to the units of the drug ordered". As noted earlier, one of the biggest problems in medication calculations is the ability to properly conceptualize, the problem, so this standardized conceptual model provides nurses with one method for solving each and every medication calculation by removing formulas and reducing the number of steps required to complete the problem.[5]

Accurate dosage calculation and safe medicine administration is a core function of professional nurses. Thus, the nurses are responsible and accountable to ensure safe and accurate drugs calculation while administering medications to patients. Literature suggests that medication administration errors cause morbidity and mortality which results due to wrong dose calculation.[6] Based on reviews and international studies where adverse drug events were studied, wrong dose calculation accounts for one third of all medication errors.[7]

One reason for increased medication errors among nurses is highlighted by the easy passing criteria of less than 100% score among different colleges. If the aim is to improve drug dosage calculation, the math's passing criteria must be a 100% passing score. A similar kind of medication calculation assessment is followed at colleges of nursing in Norway, where the students will be able to pass the course if there is no any error at all.[8]

A systematic review of the literature on drug errors in Iran also found that, reported incidence of medication administration errors holds the highest ranges that is from 14.3 to 70 % compared to 3–33.6 % for dispensing errors 29.8–47.8 % for prescribing errors, and from 10 to 51.8 % for transcription errors.[9]

A standard nursing handover was developed and implemented to improve the over process, and nursing error rates were calculated to find out the efficiency of the intervention. This potential intervention study has been tested using posttest pretest quasi-experimental design in the unit of in-patient in a health care setting. During the first intervention and post-intervention periods, the nursing failure rate per 100 applicants (P <.001) fell from 9.2 to 5.7 (95% confidence interval, 5.1-6.9).[10]

A study showed reported errors totaling 300. Nearly all of them (94.3%) had one defective type, for example "lack of intervention", "document errors" and "inattention" were the common error group. In reported errors, almost 40 errors contributed to irreversible loss or death for the patients in question, which show systemic factors 84% to 3% of total. Night shift has more errors than morning and evening shifts (42.7% 28 compared to 16.7 % 28.7% and 28.7% friends, respectively). There is a statistically important relationship between the detection of a supervisor's failure and this effect the patients ($p \leq 0$ .001).[11]

Another study in which 45.0 % was response rate (n = 429). Pharmacy staff realized that the structure of the services of the pharmacy contributed significantly to the distribution of errors, communication errors, efficiency issues and similar issues for all driver-related items through window collection duties. Mechanical systems of distribution were apparent to be less likely (P <0.05) to

contribute to the errors of distribution, errors of communication, productivity issues and physical movement. The apparent rate of distribution error was 0.057%, and the error of distribution number was positive and notably related to the prescribed volume (P <0.001). Errors of cognitive accounted for ~ 80% of errors of distribution.[12]

As multiple interventions were included in each study over the course of a semester, it was unclear as to which interventions were most effective. Therefore, dimensional analysis was the solving method taught in the workshop highlighted in this study. A cohort of spring 2017 nursing students who completed the workshop compared with their peers from the same cohort who did not attend the workshop. Additionally, these participants were compared with the prior semester cohort (fall 2016) as these students did not have access to this workshop.[13] The main aim of this study is to improve the calculation of medicines in nurses and develop a master plan for drug calculation competencies which will be yearly renewable. So, it was hypothesized that there will be an effect of dimensional analysis intervention on nurses' level of self-efficacy in medication calculation error.

MATERIAL AND METHODS

Setting: This quasi-experimental study was conducted at the teaching hospital of the University of Lahore. It is a tertiary care hospital with 450-bedded capacities where almost 113 registered nurses are performing their duties in different shifts. All nurses working at university of Lahore teaching hospital. A non-probability convenient sampling technique was applied to select the required sample from the registered nurses working at different departments of the Lahore University hospital.

Research Instrument: Data collection tools consist of self-efficacy questionnaires in the form of the Math NSE tool adopted from a study conducted by Veldman.[13] The demographic data include participants' gender, age, high school math course taken, and grade taken during medication calculation exam. The math questionnaire consists of 12 items, which was used to assess the efficacy level of nurses to complete the questionnaire. Responses measured on a five point Likert scale (five equal very high confidences and one equal very low confidence). The responses were summed up at the last to count the total score achieved by each participant. The Medication calculation exam was planned as a valid assessment and contextualized to nursing education. The test was used for several semesters and primarily made by expert faculty members who teach nurses at the nursing colleges and universities. The Med Calculation exam is a correct version of the mathematics or calculation needed in hospitals and clinical sittings. Psychometric or cognitive testing not done on this instrument; the aim of this study is to resolve whether the session and lectures improved scores on this test. Another tool of this ten-question exam is contextual in nature, and thus, the knowledge, information and calculations are housed within two case studies: (a) a five years old child with leukemia and (b) a postpartum patient. However, written permission for use of the instrument was obtained from the original exam authors of both tools.

Data Analysis Procedure: Data was analyzed through SPSS version 25. Results are presented in the form of frequencies and percentages to evaluate the level of medication self-efficacy among nurses of the university of Lahore teaching hospital before and after intervention.

RESULTS

The table 1 shows the frequency and classification of gender, in which male were 22% and female were 78%, the table also shows the classification of age in which 21- 25 years old participants were 12.45%, some participants age between 26-30 years were 28.3%, participants of 31-35 years were 37.2%, the participants whose age were 36-40 years were 15% and above 40 years participants age were 701%. The above table also shows the classification of education in which 16.8% participants were General Nurse, 36.3% participants were Post RN and 46.9% participants were Generic BSN. The classification of Designation also discusses in the above table such as, 47.8% participants were charge nurses, 32.7% were Shift In charge and 19.5% were unit in charge. The classification of experience on at work side show that 37.2% participants were 1- 5 years experiences, 44.2 % participants were 6-10 year experiences, 14.2% participants were 11-15 years experiences and 4.4% participants were above 15 years.

Table 1: Demographic Variables

Variables	Frequency (n)	Percentage
Gender		
Male	25	22
Female	88	78
Age:		
21-25 years	14	12.4
26-30 years	32	28.3
31-35 years	42	37.2
36-40 years	17	15
> 40 years	8	7.1
Education:		
General Nursing Diploma	19	16.8
Post RN	41	36.3
Generic BSN	53	46.9
Designation		
Charge Nurse	54	47.8
Shift In charge	37	32.7
Unit In charge	22	19.5
Experience:		
1-5 years	42	37.2
6-10 years	50	44.2
11-15 years	16	14.2
>15years	5	4.4

Very low confidence score of the participants about Compare two fractions and determine when one is larger (e.g. Compare 5/2, 2/3) was 8% (9), Low confidence score were 13.3% (15), Moderate confidence score were 24.8% (28), High confidence score were 29.2% (33) and Very High confidence score were 24.8% (28). The Very Low confidence score of the study participants to, add two large numbers (e.g. 9978799 + 897869) without using a calculator, were 8% (9), Low confidence score were 18.6% (21), Moderate confidence score were 45.4% (40), High confidence score were 28.3% (32) and Very High confidence score were 9.7%(11). Another statement Multiply two large numbers (e.g. 9865 × 8654) without using a calculator show that 11.5 %(13) participants score to very low confidence, 19.5%(22) participants score to low confidence, 29.2% (33) participants score to Moderate confidence, 22.1% (25) participants score to High confidence and 17.7% (20) participants score to Very High confidence. In this statement, divide one number with another (e.g. 3000 ÷ 8) without using a calculator show that 13.3%(15) participants score to very low confidence, 22.1%(25) participants score to low confidence, 20.4% (23) participants score to Moderate confidence, 18.6% (21) participants score to High confidence and 25.7% (29) participants score to Very High confidence.

The Very Low confidence score of the study participants to, convert a drug dose from gram to milligram (mg), were 11.5% (13) Low confidence score were 16.8% (19) Moderate confidence score were 31.9% (36) High confidence score were 23.0% (26) and Very High confidence score were 16.8% (19). Convert a fluid volume from liters (L) to milligram., were 14.2% (16),Low confidence score were 27.4% (31)Moderate confidence score were 28.3% (32), High confidence score were 14.2% (16) and Very High confidence score were 15.9%(18).In another statements which is Calculate IV drip rate (e.g. give 1000ml over 6 hours using a giving set with a drip factor of twenty drops/ml), the score of the participants to this question were, Very Low confidence were 11.5% (13), Low confidence were 21.2(24), Moderate confidence were 31.0% (35), High confidence were 20.4% (23) and Very High confidence 20.4 %(23). were very low confidence 12.4%(14), Low confidence score was 20.4%(23), Moderate confidence score was 29.2%(33) High confidence score was 20.4%(23) and Very High confidence

score was 17.7%(20). Another statement which is Solve "Determine the amount of medication (In mg) when the medication is labeled as a proration (e.g. 1:1000 adrenaline), were very low confidence15.0% (17), Low confidence score was 26.5% (30) Moderate confidence score was 23.0%(26), High confidence score was 15.0%(17) and Very High confidence score were 20.4%(23). Another statement which is Determine the number of tablets to be given when the medication stock available is of different strength (e.g. administer 0.25 mg of the drug from a medication stock of 62.5 mcg per tablet). show that 10.6%(12) participants score to very low confidence, 19.5% (22) participants score to low confidence, 29.2% (33) participants score to Moderate confidence, 23.0% (26) participants score to High confidence and 17.7%(20) participants score to Very High confidence

Table 2:

Statement	Very Low confidence	Low confidence	Moderate confidence	High confidence	Very High confidence
	% (n)	% (n)	% (n)	% (n)	% (n)
Compare two fractions and determine when one is larger (e.g. Compare 5/2, 2/3).	8 (9)	13.3(15)	24.8(28)	29.2(33)	24.8(28)
Add two large numbers (e.g. 9978799 + 897869) without using a calculator.	8(9)	18.6(21)	45.4(40)	28.3(32)	9.7(11)
Subtract two large numbers (e.g. 97865 -76854) without using a calculator.	15(17)	27.4(31)	23.0(26)	14.2(16)	20.4(23)
Multiply two large numbers (e.g. 9865 × 8654) without using a calculator.	11.5(13)	19.5(22)	29.2(33)	22.1(25)	17.7(20)
Divide one number with another (e.g. 3000 ÷ 8) without using a calculator.	13.3(15)	22.1(25)	20.4(23)	18.6(21)	25.7(29)
Convert a drug dose from gram to milligram (mg).	11.5(13)	16.8(19)	31.9(36)	23.0(26)	16.8(19)
Convert a fluid volume from liters (L) to milligram.	14.2(16)	27.4(31)	28.3(32)	14.2(16)	15.9(18)
Calculate IV drip rate (e.g. give 1000ml over 6 hours using a giving set with a drip factor of twenty drops/ml).	11.5(13)	21.2(24)	31.0(35)	20.4(23)	15.9(18)
Solve problems involving injection drug dose calculation (e.g. the volume of drug required to obtain 5mg from an ampoule that contains 20mg in 5 ml).	12.4(14)	24.8(28)	25.7(29)	15.9(18)	21.2(24)
Solve problems to determine the dosage of IV medication being administered per hour (e.g. Give 500 mcg of drug per hour from a drug solution with 5mg in 100ml).	12.4(14)	20.4(23)	29.2(33)	20.4(23)	17.7(20)
Determine the amount of medication (In mg) when the medication is labeled as a proration (e.g. 1:1000 adrenaline).	15.0(17)	26.5(30)	23.0(26)	15.0(17)	20.4(23)
Determine the number of tablets to be given when the medication stock available is of different strength (e.g. administer 0.25 mg of the drug from a medication stock of 62.5 mcg per tablet).	10.6(12)	19.5(22)	29.2(33)	23.0(26)	17.7(20)

DISCUSSION

Past research shows that the level of calculation of medication skill is a challenging issue among nurses. Globally they are facing difficulty and constantly struggling with a low sense of self-efficacy in math. The aim of this study is to create structure for more thoughtful instructional practices that may advance medication calculation in nurses. Reduce the medication errors and make an extra safety check to calculate medicines**.**

Patient safety is a tool to prevent harms to the patient during care. It is an important part of care to keep patient's safe from harm during and after hospital stay. Therefore, the world health organization promoted the safety of patient program in the World Health Assembly with the revelation of 'All patients receive health care which is safe, every time, all over the world. Safety of patients affected by consequences of different collective factors and condition.[14]

Convert a fluid volume from liters (L) to milligram., were 14.2% (16), Low confidence score were 27.4% (31) Moderate confidence score were 28.3% (32), High confidence score were 14.2% (16) and Very High confidence score were 15.9%(19).

A study conducted about medicine error in nurses.[15] Medication error is a serious problem in the world and one of the most common medical errors that endanger patient safety and can even lead to death. The aim of this study is to examine the causes of medication errors and prevention strategies in terms of nurses and nursing students. The results showed that the most common cause of medication errors in nursing was fatigue due to increased workload and that medication calculation (77.4%) in nursing students.[15] The most important way of preventing comments from nurses and nursing students was to reduce work pressure by increasing staff in proportion to the number and condition of patients and by creating a unit such as medication calculation.

In African hospitals, a systematic review of adverse drug accidents and drug errors has shown that 8.4% of hospital patients report adverse drug accidents and contribute to 2.8% of hospitals. Likewise, the rate of mortality attributable to harmful medicine accidents is 0.1%. In an observation, a study in Egypt showed that 0.77% of hospital patients are affected by MAEs and require long intervention or hospitalization. Additionally, 1.5% of patients in Ethiopia experienced real negative accidents related to drug errors.[16]

To concluded, this study focused to enhance the mathematical skills of the nurses and minimize the calculation errors of nurses during medication which is a challenging issue among nurses. This study is to extend focus on improving nurse's medication calculation accuracy. To accomplish the stated purpose, a single intervention dimensional analysis was used which provide a situation for health-care improvement and to find techniques for improving the rate of medication errors. Statistically 39.86% difference recorded in pre-and post-intervention data. This study helps to create structure for more thoughtful instructional practices that may advance medication calculation in nurses. Reduce the medication errors and make an extra safety check to calculate medicines.

REFERENCES

1. 1.Odberg, K. R., Hansen, B. S., & Wangensteen, S. (2019). Medication administration in nursing homes: A qualitative study of the nurse role. Nursing open, 6(2), 388.
2. 2.Guneş, U. Y., & Baran, L. (2016). Mathematical and drug calculation skills of nursing students in Turkey. International Journal of Caring Sciences, 9(1), 220.
3. 3. Basak, T., Aslan, O., Unver, V., & Yildiz, D. (2016). Effectiveness of the training material in drug-dose calculation skills. Japan Journal of Nursing Science, 13(3), 327.
4. 4. Sa'ed, H. Z., Khaled, S. M., Kawasmi, B. M., Habeba, A. M., Hamadneh, A. T., Anabosi, H. H., . . . Al-Jabi, S. W. (2019). Knowledge about the administration and regulation of high alert medications among nurses in Palestine: a cross-sectional study. BMC nursing, 18(1), 11.
5. 5. Price, R., Makasa, E., & Hollands, M. (2015). World Health Assembly Resolution WHA68. 15:"strengthening emergency and essential surgical care and anesthesia as a component of universal health coverage"—addressing the public health gaps arising from lack of safe, affordable and accessible surgical and anesthetic services. World journal of surgery, 39(9), 2119.
6. 6. Alsulami, Z., Conroy, S., & Choonara, I. (2017). Medication errors in the Middle East countries: a systematic review of the literature. European journal of clinical pharmacology, 69(4), 1005.

7. 7. Foss, B., Løkken, A., Leland, A., Stordalen, J., Mordt, P., & Oftedal, B. F. (2014). Digital Game-Based Learning: a supplement for medication calculation drills in nurse education. E-learning and Digital Media, 11(4), 349.
8. 8.Sorra, J., & Nieva, V. F. (2017). Hospital survey on patient safety culture: Agency for Healthcare Research and Quality.
9. 11.Szeinbach, S., Seoane-Vazquez, E., Parekh, A., & Herderick, M. (2007). Dispensing errors in community pharmacy: perceived influence of sociotechnical factors. International Journal for Quality in Health Care, 19(4), 207.
10. 13. Kohtz, C., & Gowda, C. (2016). Teaching drug calculation in nursing education: A comparison study. Nurse Educator, 35(2), 84.
11. 14. Pierson, S., Hansen, R., Greene, S., Williams, C., Akers, R., Jonsson, M., & Carey, T. (2007). Preventing medication errors in long-term care: results and evaluation of a large scale web-based error reporting system. BMJ Quality & Safety, 16(4), 298.
12. 15. Organization, W. H. (2016). Medication errors: World Health Organization.
13. 18. Veldman, K. T. (2016). A quasi-experimental study measuring the effect of dimensional analysis on undergraduate nurses' level of self-efficacy in medication calculations. Lethbridge, Alta: University of Lethbridge, Faculty of Health Sciences,
14. 10. Eltaybani, S., Mohamed, N., & Abdelwareth, M. (2019). Nature of nursing errors and their contributing factors in intensive care units. Nursing in critical care, 24(1), 51.
15. 17. Turner, L. (2018). Improving Medication Calculation Competence in Nursing Students through Schema-Based Dimensional Analysis Instruction.
16. 16. Aronson, J. K. (2019). Medication errors: what they are, how they happen, and how to avoid them. QJM: An International Journal of Medicine, 102(8), 513-521.