DOI: https://doi.org/10.53350/pjmhs2023173185

ORIGINAL ARTICLE

Effect of Structured Training Workshop on Nurses' Drug Dosage Calculation Competence at Tertiary Care Hospitals of Faisalabad

MEHREEN KOMAL, HAFIZA SABA JAVED, NAMRA
Department of EPH, University of Agriculture, Faisalabad
Correspondence to Hafiza Saba Javed, Email: alizaahemad789@gmail.com, Contact: +923414287908

ABSTRACT

Background: Drug administration is a major component of patient care provided by nurses at hospitals. Appropriate drug administration ensures patient safety, as incorrect or unsafe administration can result in adverse patient health and hospital outcomes. Drug dosage calculation errors are the most common, threatening patient safety, lengthening patients' hospital stay and increasing associated costs worldwide.
Aim: To evaluate the effectiveness of structured training workshop at enhancing nurses' competence in drug dosage calculations.
Methods: One group pre-test post-test quasi-experimental study was conducted on a convenient sample of 73 staff nurses working at public tertiary care hospitals of Faisalabad, Pakistan. Staff nurses aged 21-60 years who provide direct patient care, were included in the study.The study duration spanned over 04 months from July to October 2020. A structured questionnaire was used for the pre-test and post-test competency level of nurses in drug dosage calculations. The study intervention consisted of a structured training workshop focusing on basic mathematical skills for drug dosage calculation using the correct mathematical formula for unit conversions and linking the correct dose to the patient case scenario. SPSS version 26 was used for with-in group analysis employing t-test statistics.
Results: Pre-test results revealed common errors in the application of basic mathematical principles for drug concentration unit conversions and complex calculations involving patient-age, weight and other variables.Post-test results demonstrated a significant improvement in level of competence of participant nurses in this regard, indicated by significant difference (p-value 0.000). Structured training workshop was found effective in enhancing nurses' competency level in drug dosage calculations.
Practical implication
Conclusion: Structured training improved nurses' ability to identify drug calculation errors, understand the use of the correct formula, and calculate drug dosage accurately. This study emphasizes the importance of structured education and training of nurses aimed at reducing medication errors and improving patient health and hospital outcomes.
Keywords: Competence; Drug dosage calculation; Nurses; Quasi experimental study; Pakistan; Workshop.

INTRODUCTION

Patient safety is the basic tenet of health care at hospital. Its goal is to prevent and minimize risk, harm and errors that occur during healthcare provision. Medication management errors are among the most serious threats to patient safety, with incorrect dosage errors and omissions being the most common, globally (Blignaut et al, 2017; Gariel et al., 2018; Mulac et al., 2020). Every year, about 15 million people are harmed by medication errors with drug dosage calculation errors being the major contributor towards adverse consequences (Mugada et al, 2018). Aside from having a direct negative impact on the patient's health, drug dosage calculation errors also impose financial burden on health system in terms of prolonged hospitalization and associated health care costs (WHO, 2014).Errors in drug dosage calculation lengthen hospital stay by two days and increase costs by $2,000 to $2,500 per patient (Elden & Ismail, 2016).In addition, individual patients, their families and significant others are psychologically affected because it undermines their trust in hospital services (O'Hara et al., 2018). Therefore, preventing medication errors is critical to maintaining a safe and reliable healthcare system.

Nurses in hospitals play a critical role in medication process, ensuring secure and efficient drug administration to the patients (Bull, E.R. et al, 2017). To perform this important task, nurses must have sufficient knowledge of drugs, their actions, reactions and side effects, as well as skills in accurately calculating the dose and delivery via appropriate mode of administration (Islam et al, 2017). Common nurse-related drug administration errors involve drug dosage calculation errors, incorrect route of administration, incorrect time schedule, fast drug administration, extra drug dosage administration, administration of the drug to the wrong patient, misreporting of the administered drug and incorrect form or concentration of the drug delivered (Aydin & Dinc, L., 2017; Wondmieneh et al., 2020). Empirical studies indicate that

Received on 09-10-2022
Accepted on 09-02-2023

drug dose calculation errors are the most common because they require extra caution while considering the patient's age, weight, sometimes height and other factors (Zarea et al., 2018). Extra responsibility, time constraints, distracting circumstances, a deficit of resources, and insufficient training are all factors that give rise to drug dosage calculation errors (Sarraf, D. P. et al, 2020). Errors in drug dosage calculation not only have a direct impact on patient and health care system, but indirectly, they also harm nurses' confidence in practice abilities and their professional standing (Athanasakis et al., 2019). The psychological trauma caused by an error can be overwhelming, and nurses may feel upset, guilty, or angry at both themselves and the system further decreasing the quality of care services (Robertson, J. J., & Long, B., 2018).

Drug dosage calculation errors by nurses have been identified as the most common type of error affecting patient safety and the most common single preventable cause of adverse consequences for the patient, health care system and nurses themselves. The Joint Commission's patient safety goals for nurses include accurately calculating dosages, double-checking, labelling, administering safely, and correctly passing on patient medications to the next shift (Rodziewicz, et al., 2022). Despite agreement that preventing medication errors is critical to patient safety, high incidence of drug dosage calculation errors, particularly in developing countries, is raising concerns about whether nurses have the knowledge and skills necessary to calculate drug dosages correctly.Pakistan, a resource-constrained country with a high disease burden and no system for reporting, has seen a large number of deaths caused by medication errors with inability to correctly calculate the drug being a major contributor (DAWN, 2017). Literature from Pakistan witnessed inadequacies in knowledge and skills among nurses regarding safe and accurate drug dosage calculations (Kumar et al., 2022; Salman et al., 2020; Mangrio et al., 2020). Building on previous research, this study aimed to enhance the nurses' competence in

drug dosage calculations in clinical practice. It was expected that having the knowledge and skills about how to accurately calculate drug dosages would give a nurse more confidence in her abilities as a healthcare worker, while also ensuring patient safety and improving the quality of care services at hospital.

METHODS

One group pre-test post-test quasi experimental study design was used. The study population included staff nurses working at two public tertiary care hospitals in Faisalabad, Pakistan. Staff nurses aged 21-60 years, who were directly involved in bedside patient care were included whereas, head nurses, clinical instructors and student nurses not directly involved in patient care, were excluded. The study duration spanned over 04 months from July to October 2020. A non-probability convenient sampling technique was used to recruit study participants. A sample size of 73 was calculated by using Raosoft sample size calculator at 5% marginal error and 95% confidence level. The study was approved by The University of Faisalabad (TUF)'s institutional review board (IRB), and written permission for data collection was obtained from Medical Superintendents of the study hospitals. The purpose of the study was explained to the nurses who participated and written consent was obtained. Pre-test was conducted on a validated structured questionnaire borrowed from Simpson, C.M. et al, (2009). The questionnaire was divided into two parts: the first contained questions on sociodemographic profile (age, gender, qualification, and work experience) and the second contained 12 items on drug dose calculation case scenarios. Participants were given 30 minutes to complete the questionnaire. Following pre-test, participant nurses were exposed to the study intervention consisting of a structured face to face teaching and training workshop delivered by principal investigators (MK & N). The workshop was held in lecture theatre of TUF over a period of 03 hours. The contents of the workshop involved (1) taught session on basic principles of mathematics such as fractions, percentage, ratio and equivalence, (2) theoretical and practical demonstration on unit conversions and drug dose calculations for various dosage forms (suspension, syrup, tablets and injections) and conditions (age, weight, height, health status) and (3) practice exercises on identifying drug calculation errors and calculations of drug dosages built in clinical case studies. Post-test was administered after wash out period of two weeks, using the same questionnaire that was used in pre-testing. Confidentiality of the study participants was maintained throughout the data collection. Following data collection, pre-test and post-test questionnaires were graded, with one point awarded for correct answers and zero for incorrect or missing answers. The total number of correct answers were summated and mean pre-test and post-test scores were computed. The data was coded and entered into statistical package for social sciences (SPSS) version 26. Descriptive statistics frequency and percentage were calculated. In inferential statistics, paired t t-test was used to compare the mean scores of pre-test and post-test. Statistical significance was defined as P-value less than 0.05.

RESULTS

Table 1: Socio-demographic and practice characteristics of the participants

Question	%age
How old are you?	
21-30	63 (86.3%)
31-40	10 (13.7%)
What is your nursing qualification?	
Diploma in Nursing	35 (49.9%)
BS Nursing (Post RN)	25 (34.2%)
BS Nursing (BSN)	13 (17.8%)
What is your gender?	
Female	73 (100%)
Your work experience?	
<6 months	10 (13.7%)
< 5 years	50 (68.5%)
5 -10 years	9 (12.3%)
>10 years	4 (5.5%)

All participant nurses were female. The majority (86.3%) of the participants' age was between 21 to 30 years with a mean age of 24.89 and standard deviation (SD) of 2.75. About half (49.9%) of the participants were having qualification diploma in Nursing. Mostly (68.5%) participants had less than 5 years of experience in nursing (Table 1).

Pre-test response rate was 100%. Pre-test results revealed that 92% of participants (67 out of 73) scored less than 50% (less than 6 answers correct). Only 22(30%) of those who scored more than 50%, correctly answered 75% of the questions. According to pre-test results, the majority of participant nurses knew simple drug concentration unit conversions from milliliter (ml) to milligram (mg) and vice versa, mg to microgram (mcg), and mcg to ml. In contrast, participant nurses lacked knowledge and skills in patient age and weight-bound concentration unit conversions, as well as complex calculations.

The post-test response rate was also 100%. Post-test results showed that all of the participating nurses scored more than 50%, with approximately 58(80%) answering more than 75% questions, correctly. Furthermore, post-test scores on complex calculations questions showed that nurses' knowledge and skills of patient age and weight-bound drug dosage calculations was significantly improved (Table 2).

To compare the mean pre-test and post-test scores, the t test statistics were used, with a p-value of ≤0.05 indicating a statistically significant difference. Table 3 shows that the p value is 0.000, representing a significant difference. Outcome comparison thus, demonstrates that the teaching and training workshop was found effective.

Table 2: Pre-test and Post-test Results

Question	Pre-test	Post-test
Lignocaine is available in 20ml vials of 1%. How much lignocaine, in milligrams (mg) is in the vial?		
150mg	1 (1.4%)	1 (1.4%)
200mg (correct answer)	71 (97.3%)	71 (97.3%)
230mg	1 (1.3%)	00
200ml	00	1(1.3%)
Your doctor plan to suture an 80kg patient. Given the maximum safe dose of lignocaine is 3mg/kg, what is the maximum safe volume in ml of 2% lignocaine solution that can be given?		
12ml (correct answer)	50 (68.5%)	67(91.8%)
21ml	12 (16.4%)	3 (4.1%)
12mg	6 (8.2%)	3 (4.1%)
12mcg	5 (6.8%)	00
A 20ml ampule containing 0.25% bupivacaine contains how many milligrams per milliliter (mg/ml) of bupivacaine?		
25mg/ml	13 (17.8%)	7 (9.6%)
2.5mg/ml (correct answer)	32 (43.8%)	62 (84.9%)
5.2mg/ml	8 (11.0%)	1 (1.4%)
2.5mcg/ml	20 (27.4%)	3 (4.1%)
A 25kg girl is being treated with the femoral fracture requiring a femoral nerve block. The maximum safe dose of bupivacaine is 2mg/kg. what is the maximum safe volume of 0.25% of bupivacaine, in ml?		
5ml	20 (27.4%)	2 (2.7%)
10ml	23 (31.5%)	1 (1.4%)
15ml	8 (11.0%)	3 (4.1%)
20ml (correct answer)	22 (30.1%)	67 (91.8%)
How many ml of 1:10000 solutions would you need to obtain 1mg of adrenaline?		
10ml (correct answer)	36 (49.3%)	58 (79.5%)
100ml	11 (15.1%)	3 (4.1%)
1000ml	15 (20.5%)	10 (13.7%)
None of above	11 (15.1%)	2 (2.7%)
How many micrograms (mcg) of adrenaline are there in a 10ml ampoule of 0.25% bupivacaine with adrenaline 1:400000 solution?		
25mg	5 (6.8%)	3 (4.1%)
25ml	8 (11.0%)	2 (2.7%)
25mcg	16 (21.9%)	6 (8.2%)
2.5mcg (correct answer)	44 (60.3%)	62 (84.9%)
You are attending the cardiac arrest of a 60-year-old male. How many ml of 1:1000 adrenalines do you need to give a dose of 1 mg of adrenaline?		
0.1ml	9 (12.3%)	11 (15.1%)
100ml	7 (9.6%)	3 (4.1%)

0.9ml	11(15.1%)	59 (80.8%)
1ml (correct answer)	46 (63.0%)	5 (6.8%)
A 4-year –old on your ward is in cardiac arrest. He weighs 16kg. The dose of intravenous adrenaline in pediatric arrest is 10mcg/kg. How many ml of 1:10000 adrenaline will you need to draw up for a single dose?		
0.6ml	21 (28.8%)	6 (8.2%)
60ml	13 (17.8%)	3 (4.1%)
1.6ml (correct answer)	28 (38.4%)	59 (80.8%)
16ml	11 (15.1%)	5 (6.8%)
Atropine "Mini-Jets" are found on emergency trolleys in your hospital. Each 10ml Mini-jet contains 1mg of atropine. What is the concentration, in mg/ml, of this solution?		
0.1mg/ml (correct answer)	29 (39.7%)	62 (84.9%)
0.01mg/ml	28 (38.4%)	10 (13.7%)
1.2mg/ml	12 (16.4%)	1 (1.4%)
2.5mg/ml	4 (5.5%)	00
A 45 kg female patient develops symptomatic bradycardia. Your doctor elects to treat this with atropine, 20mcg/kg, given intravenously. How many ml of an atropine "Mini-Jet" (1mg in 10ml) will be required?		
90ml	10 (13.7%)	2 (2.7%)
9ml (correct answer)	39 (53.4%)	64 (87.7%)
50ml	12 (16.4%)	3 (4.1%)
70ml	12 (16.4%)	4 (5.5%)
Your doctor is doing an emergency intubation on a 15kg child using suxamethonium. The dose of suxamethonium in children is 2 mg/kg. Suxamethonium is supplied in vials of 100 mg in 2ml. To prepare this drug for use, one vial of suxamethonium is diluted with normal saline to 10 ml total volume. How many ml of this solution are required for a single dose? (3ml)		
13ml	11 (15.1%)	3 (4.1%)
35	10 (13.7%)	2 (2.7%)
30	12 (16.4%)	6 (8.2%)
3ml (correct answer)	40 (54.8%)	62 (84.9)
You plan to sedate a 25 kg child with midazolam. A vial of midazolam has 15mg in 3ml. the intravenous sedation dose of midazolam for children is 0.1mg/kg. How many ml will you need to draw up? (0.5)		
0.5ml (correct answer)	33 (45.2%)	65 (89.0%)
50ml	12 (16.4%)	3 (4.1%)
1.5ml	12 (27.4%)	5 (6.8%)
500ml	8 (11.0%)	00

Table 3: Outcome comparison (t-test statistics)

	Pre-test scores	**Post-test scores**
N	73	73
Minimum	2	9
Maximum	7	11
Mean	4.5	10
Standard Deviation (SD)	2.89	1.67
P value	.000	

DISCUSSION

Medication administration and nursing are inextricably connected. For a long time, there has been a concern about nurses' ability to calculate drug dosages accurately and consistently. The goal of this study was to see how a structured training workshop affected nurses' competency level in drug dosage calculations. The study findings confirmed that in pre-test, majority of the nurses were unable to perform drug dosage calculations while taking the patient's age, weight, and other parameters into account, but there was a significant improvement in their competence in post-test (two weeks after study intervention). Sarraf, D. P. and colleagues in 2020 observed similar results, stating that nurse students' ability to calculate drug doses was poor prior to the intervention but improved afterwards (Sarraf, D.P. et al., 2020). Likewise In 2018, Kahriman et al. evaluated the efficacy of theoretical and practical simulation training on nurse students' knowledge and skills in relation to medical errors. Theoretical education increased students' knowledge of medication errors, while practical training reduced medication calculation errors by improving their skills (Kahriman et al., 2018). Similarly, Grugnetti et al. in their study also witnessed that skills training workshop improved comprehension of complex mathematical calculations and encouraged the development of drug-dosage calculation skills among nursing students (Grugnetti et al., 2014). These findings emphasize the importance of providing nurses with education in the form of refresher guides to help them improve their medicinal drug calculating abilities. Low pre-test scores on questions of complex level concentrations unit conversions & dosage calculations and relatively higher post-test scores after administration of the intervention in this study, suggest that nurses may benefit from regular trainings on drug calculation as part of in-service education or continuous professional development. Frequent and mandatory mathematical and drug calculation trainings may alleviate the problem of knowledge decay and reduce any potential patient safety issues.

CONCLUSION

This study concludes that nurses' competency in drug dosage calculation was low on the pre-test but improved significantly after the intervention. Structured training improved nurses' ability to identify drug calculation errors, understand the use of the correct formula and calculate drug dosage accurately. This study emphasizes the importance of structured education and training of nurses aimed at reducing medication errors and improving patient health and hospital outcomes.

Conflict of interest: The authors declare no conflict of interest.
Funding: This study was not funded by any public or private sector organization.

REFERENCES

1. Athanasakis, E. (2019). A meta-synthesis of how registered nurses make sense of their lived experiences of medication errors. *Journal of Clinical Nursing*, 28(17-18), 3077-3095.
2. Aydin, A. K., &Dinç, L. (2017). Effects of web-based instruction on nursing students' arithmetical and drug dosage calculation skills. *CIN: Computers, Informatics, Nursing*, 35(5), 262-269.
3. Blignaut, A. J., Coetzee, S. K., Klopper, H. C., & Ellis, S. M. (2017). Medication administration errors and related deviations from safe practice: an observational study. *Journal of clinical nursing*, *26*(21-22), 3610-3623.
4. Brotto, V. (2020). Administering medications. *Professional Nursing and Midwifery Practice [Custom Edition for Monash University]*, 110.
5. Bull, E. R., Mason, C., Junior, F. D., Santos, L. V., Scott, A., Ademokun, D., .& Cavanagh, S. M. (2017). Developing nurse medication safety training in a health partnership in Mozambique using behavioural science. *Globalization and health*, *13*(1), 45.
6. Elden, N. M. K., & Ismail, A. (2016). The importance of medication errors reporting in improving the quality of clinical care services. *Global journal of health science*, 8(8), 243.
7. EscriváGracia, J., Brage Serrano, R., &FernándezGarrido, J. (2019). Medication errors and drug knowledge gaps among critical-care nurses: a mixed multi-method study. *BMC health services research*, *19*(1), 1-9.
8. Farhan, Y. M. (2018). Medical assistants' knowledge about preparation and administration of intravenous admixtures in the teaching hospitals of Alanbar governorate. *International Journal of Pharmaceutical and Phytopharmacological Research*, *8*(5), 31-34.
9. Grugnetti, A. M., Bagnasco, A., Rosa, F., &Sasso, L. (2014). Effectiveness of a clinical skills workshop for drug-dosage calculation in a nursing program. *Nurse education today*, 34(4), 619-624.
10. Islam, M. M., Iqbal, U., Walther, B. A., Nguyen, P. A., Li, Y. C. J., Dubey, N. K., ... & Syed-Abdul, S. (2017). Gender-based personalized pharmacotherapy: a systematic review. *Archives of Gynecology and Obstetrics*, *295*(6), 1305-1317.
11. Kumar, P., & Rehman, S. (2022). Missed dose error among nurses working at tertiary care hospitals, Karachi. *Journal of University Medical & Dental College*, 13(1), 294-298.
12. Luokkamäki, S., Härkänen, M., Saano, S., &Vehviläinen- Julkunen, K. (2020). Registered Nurses' medication administration skills: a systematic review. *Scandinavian Journal of Caring Sciences*.
13. Mangrio, A. R., Jokhio, P. B., & Mahar, S. U. (2020). Evaluating nurses' knowledge regarding dosage calculation at Civil Hospital, Karachi.
14. Mugada, V., Devineni, R. C., Pendyala, R. M., Vempati, D., &Kuchi, S. (2018). Categorization, Appraisal, and Reporting of Medication Errors Ascertained in Medical Ward of Tertiary Care Hospital. *Journal of Applied Pharmaceutical Science*, *8*(05), 109-114.
15. O'Hara, J. K., Reynolds, C., Moore, S., Armitage, G., Sheard, L., Marsh, C., ... & Lawton, R. (2018). What can patients tell us about the quality and safety of hospital care? Findings from a UK multicentre survey study. *BMJ quality & safety*, 27(9), 673-682.

16. Rahayu, M. H., Haryanti, F., &Mulatsih, S. (2020). Nursing experience in pediatric medication safety. *The Malaysian Journal of Nursing (MJN)*, *12*(1), 73-79.
17. Rai, D. R., & Devi, N. S. (2019). The knowledge regarding pediatric drug calculation among the staff nurses.
18. Robertson, J. J., & Long, B. (2018). Suffering in silence: medical error and its impact on health care providers. *The Journal of emergency medicine,* 54(4), 402-409.
19. Rodziewicz, T. L., Houseman, B., &Hipskind, J. E. (2022). Medical error reduction and prevention. StatPearls [*Internet*].
20. Salman, M., Mustafa, Z. U., Rao, A. Z., Khan, Q. U. A., Asif, N., Hussain, K., ... & Rashid, A. (2020). Serious inadequacies in high alert medication-related knowledge among Pakistani nurses: findings of a large, multicenter, cross-sectional survey. *Frontiers in pharmacology*, 11, 1026.
21. Sarraf, D. P., Karn, B. K., & Shrestha, E. (2020). Evaluation of Drug Dose Calculation Ability of Nursing Students: An Interventional Study.
22. Simonsen, B. O., Daehlin, G. K., Johansson, I., &Farup, P. G. (2014). Improvement of drug dose calculations by classroom teaching or e-learning: a randomised controlled trial in nurses. *BMJ open*, 4(10), e006025.
23. Simpson, C. M., Keijzers, G. B., & Lind, J. F. (2009). A survey of drug- dose calculation skills of Australian tertiary hospital doctors. *Medical Journal of Australia*, *190*(3), 117-120.
24. Soomar, S. M., Raees, R., & Abbas, K. M. (2019). Medication Errors in Neonatal Intensive Care Unit and Strengthening Education of Registered Nurses. *Journal of Pediatrics, Perinatology and Child Health*, *3*(3), 130-139.
25. Sultana, N. (2017). An evaluation of drug dosage calculation knowledge and proficiency among newly hired nurses in Private Tertiary Care Hospital, Islamabad, Pakistan. *TexilaInt J Clin Res*, *4*, 1-15.
26. Sarraf, D. P., Karn, B. K., & Shrestha, E. (2020). Evaluation of Drug Dose Calculation Ability of Nursing Students: An Interventional Study.
27. Thomas, B., Paudyal, V., MacLure, K., Pallivalapila, A., McLay, J., El Kassem, W., ... & Stewart, D. (2019). Medication errors in hospitals in the Middle East: a systematic review of prevalence, nature, severity and contributory factors. *European journal of clinical pharmacology*, *75*(9), 1269-1282.
28. Truter, A., Schellack, N., & Meyer, J. C. (2017). Identifying medication errors in the neonatal intensive care unit and paediatric wards using a medication error checklist at a tertiary academic hospital in Gauteng, South Africa. *South African Journal of Child Health*, *11*(1), 5-10.
29. Wondmieneh, A., Alemu, W., Tadele, N., &Demis, A. (2020). Medication administration errors and contributing factors among nurses: a cross sectional study in tertiary hospitals, Addis Ababa, Ethiopia. *BMC nursing*, 19(1), 1-9.
30. World Health Organization. (2017). Patient safety: making health care safer (No. WHO/HIS/SDS/2017.11). World Health Organization.
31. Zarea, K., Mohammadi, A., Beiranvand, S., Hassani, F., &Baraz, S. (2018). Iranian nurses' medication errors: A survey of the types, the causes, and the related factors. *International journal of Africa nursing sciences*, 8, 112-116.