Medication Administration Error and Associated Factors among Nurses in Referral Hospitals, Amhara region, Ethiopia, 2019

CURRENT STATUS: UNDER REVIEW

DOI:
10.21203/rs.2.21564/v1

SUBJECT AREAS
Nursing

KEYWORDS
Medication errors, magnitude, medication administration, Debre Markos
Abstract

Background: Medication administration error is a failure in the treatment process resulting in potential harm to the patient. Medication errors are the leading causes of mistrust in the healthcare system, inducing corrective therapy and prolonged hospitalization thereby producing extra costs and even death. These errors are most common and can occur through failures in any of the ten rights of medication administration. About 10% of the overall preventable harm to hospitalized patients is attributed to the wrong use of medications. However, there is limited data regarding the magnitude and determinants of medication administration errors both nationally and in the study area in particular.

Methods: A multicenter hospital based, cross-sectional study design was employed on a sample of 422 nurses selected by simple random sampling technique. Pre-tested structured questionnaire and observational checklist were used for data collection from March 1-30/2019. The collected data were cleaned, coded and entered into Epi-data version 4.2 and exported to STATA version 14. Binary logistic regression model was considered and those variables with P<0.25 in the bivariable analysis were included in to final model after which statistical significance was declared at P< 0.05 using adjusted odds ratio at 95% confidence interval. The study findings were presented using tables and figures. Multicollinerinity was diagnosed using standard error and correlation matrix.

Result: From the overall nurses, 239 (57.7%) of them made medication administration error in the last 12 months. Lack of training [AOR=2.20; 95% CI (1.09, 4.46)], unavailability of guideline [AOR=1.65; 95% CI (1.03, 2.79)], poor communication while facing problems [AOR=3.31; 95% CI (2.04, 5.37)], interruption [AOR = 3.37, 95% CI (2.15, 5.28)] and failure to follow medication administration rights [AOR=1.647; 95% CI (1.00, 2.49)] were significantly associated with medication administration errors.

Conclusion and recommendation: Medication administration error was high in Amhara
referral hospitals. Therefore, interventions like developing guideline, providing training and developing strategies to minimize distracters should be given much emphasis by different stakeholders to decrease the burden of medication error.

**Background**

A medication administration error is a failure in the treatment process resulting in dangerous harm for the patient to the extent of disability and even death. It can also affect human relationships and threaten trust in the healthcare system as a whole (4, 5). Errors in medication administration can occur through failures in any of the ten rights which are right patient, right medication, right time, right dose, right route, right education/advice, right to refuse, right assessment, right evaluation/response and documentation (8, 9). Health workers can make mistakes during the processes of ordering, prescribing, dispensing, preparing or administering medication (2, 7).

Globally, medication errors are leading causes of different injuries and avoidable harms in the health care system attributing to about 10% of the overall preventable harm for hospitalized patients (11, 12). In 2017, World Health Organization reported that the annual global cost associated with medication errors has been estimated to reach US($) 42 billion accounting for 0.7% of the total health expenditure (13). Moreover, in 2018, a British report on the prevalence and burden of medication errors estimated the occurrence of 237 million medication errors at all stage of medication administration (14) and in Finland 700 to 1,700 people died each year from medication related errors(15). Similarly, in USA, medication errors caused the death of about 7,000 patients and about 400,000 cases of avoidable patient harm per year, which cost US($)3.5 billion. In low and middle income countries, the impact is about twice as much in terms of the number of years of healthy life lost (2, 16).

Having consistent reporting system and providing care based on guidelines could prevent
75% of the occurrence of harm to the hospitalized patients (17). Medication administration errors can also be prevented by the use of technology like barcoding for medications and patients, smart infusion pumps for intravenous administration, single-use medication packages, and package design features and minimizing interruptions during the medication administration process (18).

Medication error, mainly the administration phase, is accounted to be the most common cause of disability and death throughout the world (19, 21). It can also prolong patients’ hospital stay resulting in increased healthcare cost for patients, families, and health professionals (16). From the researchers’ clinical experience at different public health hospitals observed, some nurses commit errors during medication administration. However, to the researchers’ searching effort, the magnitude of medication administration error and contributing factors in these hospitals is left unknown and even prior studies were merely on the six rights of medication administration. Hence, this study was also aimed in addressing the rest four rights of medication administration.

Methods

Study area and period

The study was conducted among nurses working at referral hospitals of Amhara regional state which are Debre Birhan, Felegehiwot, Debremarkos, Gondar and Dessie referral hospitals from March 1-30, 2019. Debrebirhan, Felegehiwot, Debremarkos, Gondar and Dessie referral hospitals are found 130 km, 564km, 299km, 748and 400 km away from the capital city of Ethiopia, Addis Ababa respectively. According to data obtained from 2019 health management information system team of each hospital, there are 147, 295, 181, 453 and 170 BSc and 39, 106, 34, 137, and 78 diploma nurses working in Debrebirhan, Felegehiwot, Debremarkos, Gondar and Dessie referral hospitals respectively.
Study Design

A multicenter hospital based cross sectional study triangulated with observation was conducted.

Study participants

All nurses who were working at referral hospitals of Amhara region were considered as Source Population whereas those nurses who were randomly selected from Amhara referral hospitals during the study period were regarded as Study population.

Eligibility criteria

Nurses with a minimum of six month working experience and involved in direct patient care were included whereas those nurses who were not involved in medication administrations practice and the ones serving in administrative positions were excluded.

Sample Size Determination

Using single population proportion formula, 95% confidence interval, 5% margin of error, a reasonable estimate for the proportion of medication administration error from a prior study (51.8 %)[19] and adding 10% non-response rate, a sample of 422 nurses was reached. For the observational part of the study, 10% of the sample size (42) nurses were involved.

Sampling Procedure

To select 422 nurses from the total five referral hospitals in Amhara region, all hospitals were first listed down with their respective nurse number after which sample size was proportionally allocated to each hospital. Then, the sampling frame was prepared for each hospital by having lists of nurses from the hospitals’ nursing director and human resource management. Finally, eligible nurses of each hospital were selected by simple random sampling technique (Figure 1).
Operationally defined terms

**Medication administration error**: is any kind of error in ten rights (right patient, medication, dose, route, time, assessment, education, to refuse, evaluation and documentation(wrong performance)) that can harm patient and its occurrence can be prevented and controlled by health professionals by checking the ten rights of MAE.

**Wrong medication error**: Medication administered to the patients that were not on the patient's medication chart.

**Wrong dose error**: Medication dose or quantity different from that of the standard dose.

**Over dose**: a drug or substance in quantities greater than the standard dose.

**Under dose**: a drug or substance in quantities less than the standard dose.

**Wrong time error**: Administration of medications 30 minutes earlier or later from its scheduled administration time.

**Wrong route error**: The actual route of medication administration differs from the recommended route of medication administration.

**Wrong patient error**: Patient misidentification during medication administration.

**Wrong education error**: Administering medication without informing patient about the medication being administered.

**Wrong right to refuse error**: no acceptance when legally responsible person has refused of the medication being administered.

**Wrong assessment error**: not assessing the patient and not testing the result to determine safeness and appropriateness of medication.

**Wrong evaluation error**: after medication is administered, the patient is not assessed for any adverse effect and effectiveness of medication.

**Wrong documentation error**: Incorrectly and incompletely documented in medication administration record sheet, and there is a mismatch between what is being documented
and administered.

Current working unit: the unit that nurses is working during data collection.

Duration in specific unit: length of stay in the current working unit.

Poor communication: no communication about the time when the next dose is due and while facing problems during medication administration.

Data collection procedures

A semi structured self-administered questionnaire was used to collect data on nurses’ socio demographic characteristics (salary, institution where the nurse earned educational award, year of experience, etc), work related factors (nurse to patient ratio, lack of written guideline for medication administration, poor communication with other nurses while facing problems, current working unit, lack of reporting mechanism to medication errors and duration in specific unit), professional related factors (lack of training and inability to follow ten rights of medication administration practice) and other factors contributing for MAEs (Unclear verbal order, illegible physicians hand writing, wrong prescription and dispensing, look like drugs, nurses’ prescription in place of physicians, nurse administer medication prepared by another nurse and physicians’ frequent alteration of their orders). Moreover, prevalence of MAE, reporting trends of nurses about medication error and types of MAEs were considered. Ten trained diploma nurses were involved in collecting data from the questionnaire.

Using a structured observation checklist, five diploma nurses working in other units of each hospital observed nurses to gather data on their adherence to the directly observable nine rights of medication administration. Observation was made on medications given at times from 5:00 am to 7:00 am. After observation, patients’ medical record was reviewed to get a record of ordered medication with its dose, route, time and other profile of the patient.
Data quality control

In order to assure data quality, the questionnaire and observational checklist were adapted from previous studies (5, 9, 26). Before two weeks of actual data collection, both the questionnaire and observational checklist were pretested on 21 nurses working at Funeteselam General Hospital after which some modifications were made accordingly. To minimize bias, the nurses weren’t informed of being observed while medicating their patients. Moreover, one day training and clear orientation was provided for data collectors and supervisors on the process of data collection. During data collection, data collectors were closely monitored and guided by five BSC nurse supervisors for complete and appropriate collection of the data and reporting to the principal investigator was done on a daily basis. The collected data were double entered into Epidata version 4.2 by two data clerks for validation purpose. The entered data were multivariate analyzed for statistical adjustment of possible confounders.

Data processing and analysis

The collected data were cleaned manually, coded and entered into Epi data version 4.2 and exported to STATA Version 12 statistical software for data transformation and further analysis. Descriptive statistics like frequencies, proportion, and summary statistics (mean, median, IQR and standard deviation) were used to describe the study population in relation to relevant variables and presented in tables and graphs. Multi-collinearity between the study variables was diagnosed using standard error and correlation matrix. The assumptions for binary logistic regression model were first checked and then bivariable analysis was carried out to identify candidate variables (p<0.25) for multivariable analysis. Using these candidate variables, multivariable analysis was performed to investigate statistically significant independent predictors of medication
administration error by adjusting for possible confounders. Finally, variables whose p-value less than 0.05 (p<0.05) from multivariable analysis were declared as statistically significant. Adjusted odds ratio with 95% CI was considered to identify the strength of association between medication administration error and its predictors.

Ethical consideration

A formal letter of ethical clearance and approval was obtained from DMU, health Sciences College of ethical clearance. Then official letter was written from administrative bodies of each hospital to each unit of respective hospitals. The respondents were not requested to write their name, to answer the questions alone and by assuring individual response were not reported. Data collection was made after written voluntary consent is taken from each participating nurse after informing about study. The observational study was conducted after the administrators of the hospitals gave their consent to do so and the data collecting nurses interfered during observation of medication administration when error was perceived as life threatening.

Result

Socio-demographic characteristics

Totally, 414 nurses participated in this study, with 98.1% response rate. The median age of the respondents was 30 years with IQR (28-34) years. Near to half (46.6%) of them were in the age group (26-30) years and 56% of respondents were married. Regarding to the educational level, majority of the respondents (83.8%) had BSc qualification in nursing. In addition, most (83.3%) of them got their current education from governmental institution. The median work experience of respondents was 5 years (IQR 4-9) years (Table 1).

Prevalence and types of medication administration error
Out of 414 total respondents, 57.7% nurses made MAE in the last 12 months and 30.4% of them made it more than three times during the specified period (Figure 2.) Wrong time (38.6%) was the most frequently perpetuated MAE followed by wrong assessment (27.5%) and wrong evaluation (26.1%) (Table 2). From the total dosage errors done, both overdose and underdose accounted (37.5%) (Figure3) whereas totally forty route errors were made and all of these were parenteral route type. And majority of respondents (77.5) checked expiry date of the medication before medication administration.

**Work, managerial and professional related factors**

Near to one forth (26.1%) of respondents were working in medical ward and (72.2%) of them had working experience of more than six months in their unit. The median of nurse to patient ratio was 10 with inter quartile range of 4. Most of respondents (88.4%) did not take training on safe medication administration practice and (43.7%) did not communicate with other nurses when faced doubt during medication administration or about the time when the next dose is due. Almost half (51.2%) of nurses faced interruption during medication administration. Near to one third (36.7%) of nurses had medication administration guidelines and among them, (70.4%) were using the guideline. Even though 19.6% respondents had system for MAE, (10.43%) of them did not report MAE in the last 12 months (Table 3) due to different reasons (Figure 4).

**Other factors contributing to medication administration error**

The participants were asked to list contributing factors based on their experience to the MAEs. Accordingly, a lack of sufficient training (78.7%), physician change prescription frequently (75.1%) and nurse provide medication prepared by another nurse (71.5%) were the three most commonly listed contributing factors for the MAEs (Table 4.)

**Observational checklist results**
In order to triangulate the result of self-administered questionnaire, observational data were collected by observing nurses when administering medication at a time. The single medication administered by a nurse was considered as a single dose and totally (109) doses of medications were observed. The result revealed that only (11%) of the 109 directly observed doses of medication were administered without any breach in any of the nine directly observed rights of medication administration. Nurses’ failure to educate or inform patients before administering medication was the most (88%) observed type of error followed by failure to assess (74%) and evaluate (66.9) patients after medicating them (Table 5).

Factors associated with medication administration error

To identify factors associated with medication administration errors, binary logistic regression was done. In bivariate logistic regression analysis, nurse’s sex, marital status, working unit, year of experiences, nurse to patient ratio, lack of training, unavailability of guideline, faced interruption during medication administration, poor communication when faced doubt, absence of reporting system for medication administration error, failure to follow rights of medication administration error, nurse write prescription in place of physician, and physician change order frequently had an association with medication administration error. All variables that have an association with the outcome variables in bivariate logistic regression analyses were entered in the multivariate logistic regression analysis models by using backward likelihood ratio method. Then in multivariable logistic regression analysis factors that were significantly associated with MAEs were lack of training, unavailability of guideline for medication administration, interruption during medication administration, poor communication with another nurse when faced problem and failure to follow rights of medication administration.

The odds of medication administration error were two times higher among nurses who
didn’t take training on safe medication administration as compared to those nurses who had taken the training [AOR=2.20; 95%CI (1.09, 4.46)]. Similarly the odds of medication administration error were almost two times higher among nurses without guideline for medication administration than those with guideline [AOR=1.65; 95% CI (1.03, 2.79)]. Also nurses interrupted during medication administration were three times more likely to do medication administration error than those nurses who weren’t interrupted [AOR =3.37, 95 % CI (2.15, 5.28)]. Nurses who did not communicate with another nurse while facing problem also were three times more prone to do medication administration error than among nurses who communicate [AOR=3.31; 95% CI (2.04, 5.37)]. Finally, nurses who did not follow the ten rights of medication administration committed an error almost one and half times more than nurses who did follow the ten rights of medication administration [AOR=1.647; 95% CI (1.00, 2.49)] (Table 6).

Discussion

The administration of medication is predominantly an important part of nursing practice that has a dimension of quality of care and organizational performance. However, the finding of this study showed that the magnitude of medication administration error was 57.7% with 95% CI (53–63).The prevalence of MAE in this self-reported study was relatively consistent with studies conducted at Felege Hiwot referral hospital and a research done in Kenya (25, 30). The finding was much higher than a study conducted in teaching hospitals in west Iran(21). The difference might be due to the fact that the previous study was done in developed country where a computerized prescribing and recording system, high quality of health care institutions, voluntary error reporting and follow up are conducted. Also this finding was higher than studies conducted in intensive care unit in Jimma university specialized hospital, Adegrat and Mekele university hospitals, and university of Gondar referral hospital (19, 28, 29).The difference might be
due to variation in the constituents of MA rights considered in the studies: this study considered ten rights while the previous studies did not.

On the other hand, the result of this finding was lower than studies conducted in two public hospitals of Southern Ethiopia, pediatrics ward at JUSH and teaching hospitals in Australia (23, 26, 27). The difference might be due to the variation in the number of hospitals, clinical units, and setting in which the above study were done only by involving smaller study setting and clinical units, unlikely this study involved five hospitals and more clinical units. Furthermore, some of the previous studies used observational check list to collect data and even used smaller sample size.

While looking at directly observed study, a total of 109 doses of medication administrations were observed. From those, 89% of the administered medication experienced at least one type of MAE. This finding was much less than a study conducted in two public hospitals in Southern Ethiopia (26). The difference is likely to be due to variation in the constituents of medication administration errors (the previous study did not consider the ten rights). On the contrary, the result of this study was higher than a study conducted in Australia (23).

The difference might be due to variation in the study settings, in which the previous study was conducted in developed country where high quality of services was giving.

Additionally, this study is conducted in five hospitals of the entire ward and inculcated nine out of ten observable rights whereas the previous study involved only six rights.

The findings of both self-reported and direct observed studies showed that medication administration errors were a common health problem in the hospitals under study. This result indicated that some participants made medication administration error but did not report in the self-reported questionnaire. Only (6.5%) nurse reported the error to the concerned body. This finding is lower than a study conducted in Iran (21). The difference
might be due to the fact that variation in the willingness of nurses to report the errors, the availability of a system for reporting errors, and the extent of administrative support given to the nurses to report the error.

According to this study, near ten third of the medications were not administered at their regular scheduled time (right time) that leads the patient to develop toxicities or resistance to the drugs. This finding was lower than studies done in two public hospitals in Southern Ethiopia(26). The difference may be due to the number of setting used in the study where the previous study was done only in two hospitals, whereas this study involved five hospitals. Additionally, there was also a difference in sample size in which this study used higher sample size. Unlikely, the result of this study was higher than study done in teaching hospitals in west Iran(21). This can be explained by the fact that the previous studies were conducted in developed countries, in which high quality of health care services are being given. Wrong assessment error was the second most and frequent type of MAE committed by nurses followed by wrong evaluation error. Since these are recently added type of rights, they are not studied as a constraint of medication administration error in the previous studies.

Nurses were asked to list possible contributing factors based on their experience to errors. Based on that, a lack of sufficient training was the first one. This is supported by a research done in African hospitals(31). Physician change prescription frequently was the second type and was supported by research done in medical and surgical units of MOI teaching and referral hospital (25).

The third most type was nurse provide medication prepared by another nurse which was similar to a research done on factors contributing to medication errors in Turkey(36).

In this study, there were factors which had significant association with medication administration error. The first one was lack of training. The finding was supported by a
research done in African hospitals (31). Similarly institution-based, cross-sectional study conducted in two public hospitals in Southern Ethiopia indicated that lack of sufficient training was common factors for medication administration errors (26). The implication is that training is mandatory for medication error reduction because there is the discovery of the new disease, new medication, and new administration techniques. So to combine nursing practice with evidence, training may serve as a bridge. The second factor significantly associated with medication administration error was poor communication with other nurses when faced problem. The result was similar with a study conducted in South Korea to assess factors contributing to the error (35). Effective communication and collaboration between healthcare providers, such as open communications, error reporting and team accountability among healthcare providers, should be facilitated and considered as a rule. Nurses should communicate about the time when the next dose is due, and whatever the problem they face while medicating the patient.

Interruption during MA was the third factor significantly associated with medication administration error. The finding is supported by a research done at Felege Hiwot referral hospital, a systematic review in African hospitals and two public hospitals in Southern Ethiopia (26, 30, 31). Medication administration needs concentration. Interruption occurs when a nurse is performing an intervention and before finishing it leads to error. Interruption of this activity may lead to cognitive failure in relation to working memory and attentiveness. Fourthly, unavailability of guideline was significantly associated with medication administration error which was supported by a research conducted in Egypt (34). One of WHO strategy in 2017 was to provide guidelines and strengthen health professional’s capacity through skill building. Availability of guideline for medication administration may
improve the quality of nursing care and reduce medication administration errors.

The last and fifth factor associated significantly with medication administration error was failure to follow ten rights of medication administration. This was supported by a study conducted on Korean nurse’s perception of medication error working in 7 hospitals (35). This indicates that unless nurses follow the ten rights of medication administration, they may perpetuate errors.

Conclusion And Recommendations

Medication administration error was high in Amhara referral hospitals. Administering medication in a wrong time was the most common type of error followed by wrong assessment and evaluation respectively. Lack of training, unavailability of guideline for medication administration, interruption during medication administration, poor communication while facing problems and failure to follow ten rights of MA were factors significantly associated with MAEs.

Recommendation: Based on result of the study, the authors forwarded the following recommendations:

**To Ethiopian nursing association (ENA):**

The association should alarm the nursing professionals to practice based on the principles or rights of medication administration.

**To Amhara health bureau (AHB):**

To develop guideline for safe medication administration practice and provide training for nurses on safe medication administration.

**To hospital administrator:**

Hospitals in collaboration with ward coordinators, it is better to provide training for newly graduated nurses, in collaboration with nurses head, should develop strategies to minimize distracters during medication administration; like no talk, make phone switch
off, instruct attendants to leave the room, should develop guideline for safe medication administration and distribute to all departments, strengthening the hospital demonstration room that already initiated by ministry of health, to have a functioning demonstration room in every hospital to provide opportunity of medication administration procedure before going to real patient.

**To nurses:**

Nurses should comply with the ten rights of medication administration.

**LIMITATION OF THE STUDY**

This study used cross-sectional nature of the study design and hence doesn’t confirm definitive cause and effect relationship between the variables. During observation, the study participants might have also changed their usual way of medication administration practices (hawthorn effect). Furthermore, concerning the reporting of medication administration errors, wrong answers might have been obtained due to fear of outcome or likelihood of socially desirable answers.

**Abbreviations**

AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude odd ratio; DBRH: Debrebrhan referral hospital; DMRH: Debremarkos referral hospital; DMU: Debremarkos University; DRH: Dessie referral hospital; FHRH: Felegehiwot referral hospital; GUSH: Gondar University specialize hospital; IRERC: Institutional research ethical review committee; JUSH: Jima University specialize hospitals; IM: Intramuscular; IV: Intravenous; MAE: Medication Administration Error; ME: Medication error; OPD: Outpatient Department; OR: Operation Room; SAQ: Self-administered questionnaire; SPSS: Statistical package for social science; UK: United Kingdom; USA: united States of America

**Declarations**
Ethical approval and consent to participate: Ethical approval was obtained from Debre Markos University, College of Health and Medical Sciences, Institutional Health Research Ethics Review Committee (IHRERC). An informed and voluntarily signed written consent was obtained from all the eligible nurses.

Consent to publication: Not applicable

Availability of data and materials: Data will be available upon request from the corresponding author.

Competing interests: The authors declare that they have no competing interests.

Funding: This research didn’t receive any grant from any funding agency in the public, commercial or not-for-profit sectors.

Authors’ Contribution: DT, the corresponding author, worked on designing the study, training and supervising the data collectors, interpreting the result and preparing the manuscript. The co-authors namely GA, ZT and WA played their role in analyzing and interpreting the result. Moreover, the co-authors wrote the manuscript. All authors were involved in reading and approving the final manuscript.

Acknowledgment: The author acknowledged directors of the studied public health institutions, data collectors, supervisors and data entry operators. The authors are also deeply indebted to the Institutional Health Research Ethics Review Committee (IHRERC) of Debre Markos University for working on the ethical perspectives of the proposal and letting do this study. Last but not least, the respondents deserve sincere thanks for their kind responses.

References

1. Definition of medication [cited 2018 Dece 24]. Available from: https://www.merriam-webster.com/dictionary/medication.

2. Bennett S. WHO launches global effort to halve medication-related errors in 5 years.
3. Patel I, Balkrishnan R. Medication error management around the globe: an overview. Indian journal of pharmaceutical sciences. 2010;72(5):539-45.

4. Case-Lo C. Medication Administration: Why It’s Important to Take Drugs the Right Way. 2016 November 21. Report No.

5. Ten right of medication admonstration and management 2016 [cited 2018 Dec 24]. Available from: https://ucedd.georgetown.edu/DDA/documents/NursingRTMarch2016.pdf.

6. Elliott RA, Camacho E, Campbell F, Jankovic D, James MMS, Kaltenthaler E, et al. PREVALENCE AND ECONOMIC BURDEN OF MEDICATION ERRORS IN THE NHS IN ENGLAND. February 2018.

7. WHO. The third WHO Global Patient Safety Challenge: Medication Without Harm 2018 [cited 2018 dec 31]. Available from: https://www.who.int/patientsafety/medication-safety/en/.

8. Medication Administration Errors: patient safty network; 2018 [updated sep 17; cited 2018 dec 31]. Available from: https://psnet.ahrq.gov/primers/primer/47/Medication-Administration-Errors.

9. Edwards S, Axe S. The 10 ‘R's of safe multidisciplinary drug administration. Nurse Prescribing. 2015;13(8):398-406.

10. Salmasi S, Khan TM, Hong YH, Ming LC, Wong TW. Medication Errors in the Southeast Asian Countries: A Systematic Review. PloS one. 2015;10(9):e0136545.

11. Grissinger M. Measuring up to Medication Safety In Hospitals. P & T : a peer-reviewed journal for formulary management. 2009;34(1):10-50.

12. Cousins DD, Heath WM. The National coordinating council for medication Error reporting and prevention: promoting patient safety and quality through innovation
and leadership. The Joint Commission Journal on Quality and Patient Safety. 2008;34(12):700-2.

13. Whitaker D. Medication Without Harm: The third WHO Global Patient Safety Challenge March 2017 [cited 2008 dec 31]. Available from: http://newsletter.esahq.org/medication-without-harm-third-global-patient-safety-challenge/.

14. Harkanen M, Vehvilainen-Julkunen K, Murrells T, Rafferty AM, Franklin BD. Medication administration errors and mortality: Incidents reported in England and Wales between 2007 2016. Research in social & administrative pharmacy : RSAP. 2018.

15. Mohajan HK. Medical Errors Must be Reduced for the Welfare of the Global Health Sector. International Journal of Public Health and Health Systems. 2018;3(5):91-101.

16. Veselik Z. Personalised, predictive and preventive medication process in hospitals—still rather missing: professional opinion survey on medication safety in Czech hospitals (based on professional opinions of recognised Czech health care experts). EPMA Journal. 2014;5(1):7.

17. Grol R, Wensing M, Eccles M, Davis D. Improving patient care: the implementation of change in health care: John Wiley & Sons; 2013.

18. Medication Administration Errors: patient safety network; 2018 [cited 2018 dec 25]. Available from: https://psnet.ahrq.gov/primers/primer/47/Medication-Administration-Errors.

19. Agalu A, Ayele Y, Bedada W, Woldie M. Medication administration errors in an intensive care unit in Ethiopia. International archives of medicine. 2012;5(1):15.

20. Huynh N, Snyder R, Vidal JM, Sharif O, Cai B, Parsons B, et al. Assessment of the nurse medication administration workflow process. Journal of healthcare engineering. 2016;2016.
21. Fathi A, Hajizadeh M, Moradi K, Zandian H, Dezhkameh M, Kazemzadeh S, et al. Medication errors among nurses in teaching hospitals in the west of Iran: what we need to know about prevalence, types, and barriers to reporting. Epidemiology and health. 2017;39.

22. Vazin A, Zamani Z, Hatam N. Frequency of medication errors in an emergency department of a large teaching hospital in southern Iran. Drug, healthcare and patient safety. 2014;6:179.

23. Westbrook JI, Rob MI, Woods A, Parry D. Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. BMJ Qual Saf. 2011;20(12):1027-34.

24. Oshikoya KA, Oreagba IA, Ogunleye OO, Senbanjo IO, MacEbong GL, Olayemi SO. Medication administration errors among paediatric nurses in Lagos public hospitals: an opinion survey. The International journal of risk & safety in medicine. 2013;25(2):67-78.

25. Simiyu KN, El-Banna HM, Fattah MA, Omondi LA. Nurses’ Medication Administration Errors at Medical Surgical Units. American Journal of Nursing. 2018;7(3):88-99.

26. Alemu W, Belachew T, Yimam I. Medication administration errors and contributing factors: A cross sectional study in two public hospitals in Southern Ethiopia. International journal of Africa nursing sciences. 2017;7:68-74.

27. Yemisirach F, Biniyam G. Medication administration errors involving paediatric in-patients in a hospital in Ethiopia. Tropical Journal of Pharmaceutical Research. 2010;9(4):401-7.

28. Fekadu T, Teweldemedhin M, Ersael E, Asgedom SW. Prevalence of intravenous medication administration errors: a cross-sectional study. Integrated pharmacy research & practice. 2017;6:47.
29. Bifftu BB, Dachew BA, Tiruneh BT, Beshah DT. Medication administration error reporting and associated factors among nurses working at the University of Gondar referral hospital, Northwest Ethiopia, 2015. BMC Nurs. 2016;15:43.

30. Feleke SA, Mulatu MA, Yesmaw YS. Medication administration error: magnitude and associated factors among nurses in Ethiopia. BMC nursing. 2015;14(1):53.

31. Mekonnen AB, Alhawassi TM, McLachlan AJ, Jo-anne EB. Adverse drug events and medication errors in African hospitals: A systematic review. Drugs-real world outcomes. 2018:1-24.

32. Ojerinde AC, Olabisi P, Adejumo R. Factors associated with medication errors among health workers in University College Hospital, Nigeria. IOSR Journal of Nursing and Health Science (IOSR-JNHS). 2014;3(3):22-33.

33. Nkurunziza A, Chironda G, Mukeshimana M. Perceived contributory factors to medication administration errors (MAEs) and barriers to self-reporting among nurses working in paediatric units of selected referral hospitals in Rwanda. International Journal of Research in Medical Sciences. 2018;6(2):401.

34. Tehewy, Fahim, Gad, Gafary, Rahman. Medication Administration Errors in a University Hospital. J Patient Saf. 2016;12(1):34-9.

35. Kim KS, KWON SH, KIM JA, Cho S. Nurses’ perceptions of medication errors and their contributing factors in South Korea. Journal of Nursing Management. 2011;19(3):346-53.

36. Güneş ÜY, Gürlek Ö, Sönmez M. Factors contributing to medication errors in Turkey: nurses' perspectives. Journal of nursing management. 2014;22(3):295-303.

37. Mahran SM, Ibrahim SAEA. Patient Safety Culture and Application of Medication Safety Rules as Perceived by Nurses. American Journal of Nursing Science April 2016;5(2):52-8.
38. Sadat-Ali M, Al-Shafei BA, Al-Turki RA, Ahmed SE, Al-Abbas SA, Al-Omran AS.

Medication administration errors in Eastern Saudi Arabia. Saudi medical journal.
2010;31(11):1257-9.

Tables

Table 1: Socio-demographic characteristics of nurses in Amhara referral hospitals, Amhara, Ethiopia, 2019

| Variables           | Response   | Frequency(n=414) | Percentage(100) |
|---------------------|------------|------------------|-----------------|
| Age (years)         | 25 and less| 34               | 8.2             |
|                     | 26-30      | 193              | 46.6            |
|                     | 31-35      | 98               | 23.7            |
|                     | 36-40      | 64               | 15.5            |
|                     | 41 and more| 25               | 6               |
| Sex                 | Female     | 225              | 54.3            |
|                     | Male       | 189              | 45.7            |
| Marital status      | Single     | 175              | 42.3            |
|                     | Married    | 232              | 56              |
|                     | Others     | 7                | 1.7             |
| Educational status  | Diploma nurse| 61             | 14.7            |
|                     | BSc nurse  | 347              | 83.8            |
|                     | MSC nurse  | 6                | 1.5             |
| Educational award   | Government | 345              | 83.3            |
|                     | Private    | 69               | 16.7            |
| Work experience     | 4 and less | 164              | 39.6            |
|                     | 5-9        | 150              | 36.2            |
|                     | 10-14      | 69               | 16.7            |
|                     | 15 and more| 31               | 7.5             |

Table 2: Types of medication administration error in Amhara referral hospitals, Amhara, Ethiopia, 2019
| Variables                              | Response | Frequency (n=414) | Percentage |
|----------------------------------------|----------|------------------|------------|
| Right patient                          | Yes      | 409              | 98.8       |
|                                        | No       | 5                | 1.2        |
| Right Medication                       | Yes      | 401              | 96.9       |
|                                        | No       | 13               | 3.1        |
| Right dose                             | Yes      | 374              | 90.3       |
|                                        | No       | 40               | 9.7        |
| Right route                            | Yes      | 352              | 85         |
|                                        | No       | 62               | 15         |
| Right time                             | Yes      | 254              | 61.4       |
|                                        | No       | 160              | 38.6       |
| Right assessment                       | Yes      | 300              | 72.5       |
|                                        | No       | 114              | 27.5       |
| Right education                        | Yes      | 307              | 74.2       |
|                                        | No       | 107              | 25.8       |
| Right to refuse                        | Yes      | 310              | 74.9       |
|                                        | No       | 104              | 25.1       |
| Right evaluation                       | Yes      | 306              | 73.9       |
|                                        | No       | 108              | 26.1       |
| Right documentation                    | Yes      | 317              | 76.6       |
|                                        | No       | 97               | 23.4       |
| Medication error during preparation    | Yes      | 110              | 26.6       |
|                                        | No       | 334              | 73.4       |

Table 3: Work-related characteristics of nurses in Amhara referral hospitals, Amhara, Ethiopia, 2019
| Variables                          | Response    | Frequency(n=414) | Percentage |
|-----------------------------------|-------------|------------------|------------|
| Working unit                      | Medical     | 108              | 26.1       |
|                                   | Gynecology  | 36               | 8.7        |
|                                   | Surgical    | 74               | 17.9       |
|                                   | Emergency   | 100              | 24.2       |
|                                   | Pediatrics  | 65               | 15.7       |
|                                   | Others      | 31               | 7.5        |
| Duration in the current unit      | 3 and less  | 32               | 7.7        |
|                                   | 4-5         | 83               | 20         |
|                                   | 6 and more  | 299              | 72.2       |
| Nurse to patient ratio            | 7 and less  | 96               | 23.2       |
|                                   | 8-10        | 137              | 31.1       |
|                                   | 11 and more | 181              | 43.7       |
| Take training in MA practice      | Yes         | 57               | 11.6       |
|                                   | No          | 366              | 88.4       |
| Have guideline for MA             | Yes         | 152              | 36.7       |
|                                   | No          | 262              | 63.3       |
| Faced interruption during MA      | Yes         | 212              | 51.2       |
|                                   | No          | 202              | 48.8       |
| Communicate with another nurse when faced doubt | Yes | 233 | 56.3 |
|                                   | No          | 181              | 43.7       |
| Presence of reporting system for MAE | Yes     | 63               | 15.2       |
|                                   | No          | 351              | 84.8       |
| Reporting MAE                     | Yes         | 38               | 46.92      |
|                                   | No          | 43               | 53.08      |

Table 4: Factors contributing to medication administration errors in Amhara referral hospitals, Amhara, Ethiopia, 2019
| Variable                                                                 | Response | Frequency (n=414) | Percentage |
|-------------------------------------------------------------------------|----------|------------------|------------|
| Lack of sufficient training                                             | Yes      | 326              | 78.7       |
|                                                                         | No       | 88               | 21.3       |
| Year of experience                                                      | Yes      | 216              | 52.2       |
|                                                                         | No       | 298              | 47.8       |
| Insufficient staffing (nurse to patient ratio)                          | Yes      | 293              | 70.8       |
|                                                                         | No       | 121              | 29.2       |
| Failure to follow the rights of medication administration               | Yes      | 174              | 42         |
|                                                                         | No       | 240              | 58         |
| Look like/ sound like drugs                                             | Yes      | 190              | 45         |
|                                                                         | No       | 224              | 54.1       |
| Wrong prescription                                                      | Yes      | 177              | 42.8       |
|                                                                         | No       | 237              | 57.2       |
| Unclear verbal order                                                    | Yes      | 204              | 49.3       |
|                                                                         | No       | 210              | 50.7       |
| Illegible handwriting by prescribers                                    | Yes      | 220              | 53.1       |
|                                                                         | No       | 194              | 46.9       |
| Wrong dispensing                                                        | Yes      | 196              | 47.3       |
|                                                                         | No       | 218              | 52.7       |
| Interruption during medication administration                            | Yes      | 262              | 63.3       |
|                                                                         | No       | 152              | 36.7       |
| Nurses administer medication prepared by another nurse                  | Yes      | 296              | 71.5       |
|                                                                         | No       | 118              | 28.5       |
| Nurses write a prescription in place of physicians                      | Yes      | 267              | 64.5       |
|                                                                         | No       | 147              | 35.5       |
| Physicians change order frequently                                      | Yes      | 311              | 75.1       |
|                                                                         | No       | 103              | 24.9       |

Table 5: Direct observation of nurses’ adherence to the directly observable nine rights of medication administration in Amhara referral hospitals, Amhara, Ethiopia, 2019.
| Variables                  | Response | Frequency(n=109) | Percentage |
|---------------------------|----------|-----------------|------------|
| Right patient             | Yes      | 105             | 96.3       |
|                           | No       | 4               | 3.7        |
| Right Medication          | Yes      | 97              | 89         |
|                           | No       | 12              | 11         |
| Right dose                | Yes      | 101             | 92.6       |
|                           | No       | 8               | 7.4        |
| Right route               | Yes      | 96              | 88         |
|                           | No       | 13              | 12         |
| Right time                | Yes      | 62              | 56.8       |
|                           | No       | 47              | 43.2       |
| Right assessment          | Yes      | 28              | 25.6       |
|                           | No       | 81              | 74.4       |
| Right education           | Yes      | 24              | 22         |
|                           | No       | 85              | 88         |
| Right evaluation          | Yes      | 36              | 33         |
|                           | No       | 73              | 66.9       |
| Right documentation       | Yes      | 53              | 48.6       |
|                           | No       | 56              | 51.4       |

Table 6: Multivariable logistic regression analysis of factors associated with MAE in Amharareferral hospitals, Amhara, Ethiopia, 2019

| Variables                  | MAE       | COR(95%CI)     | AOR(95%CI)   |
|---------------------------|-----------|----------------|--------------|
|                            | Yes       | No             |              |
| Took training              | 17        | 40             | 1.00         | 1.00         |
|                           | 222       | 135            | 3.86(2.11-7.09) | 2.20(1.09-4.46) |
| Have guideline             | 60        | 92             | 1.00         | 1.00         |
|                           | 179       | 83             | 3.3(2.18-5.01) | 1.69(1.03-2.79) |
| Interruption               | 153       | 59             | 3.49(2.32-5.27) | 3.37(2.15-5.28) |
|                           | 86        | 116            | 1.00         | 1.00         |
| Have communication         | 101       | 132            | 1.00         | 1.00         |
|                           | 138       | 43             | 4.19(2.73-6.44) | 3.31(2.04-5.37) |
| Failure to follow 10 rights| 116       | 58             | 1.9(1.27-2.85) | 1.58(1.00-2.49) |
|                           | 123       | 117            | 1.00         | 1.00         |

Figures
Figure 1

Schematic representation of sampling procedure in five referral hospitals, Amhara region, 2019 (n=422).
Figure 2

Dose error type in Amhara referral hospitals, Amhara, Ethiopia, 2019 (n = 414)
Figure 3

Frequency of medication administration error in Amhara referral hospitals, Amhara, Ethiopia, 2019 (n = 414)
Figure 4

Reason for not reporting medication administration error in Amhara referral hospitals, Amhara Ethiopia, 2019. (n=414)