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

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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. Multicollinerity 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 under dose 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 enterred 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 notreport 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, un availability 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 c ommittee; 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

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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 (100%)
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(100)
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 (100%)
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 (100%)
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 inAmharareferral hospitals, Amhara,Ethiopia, 2019

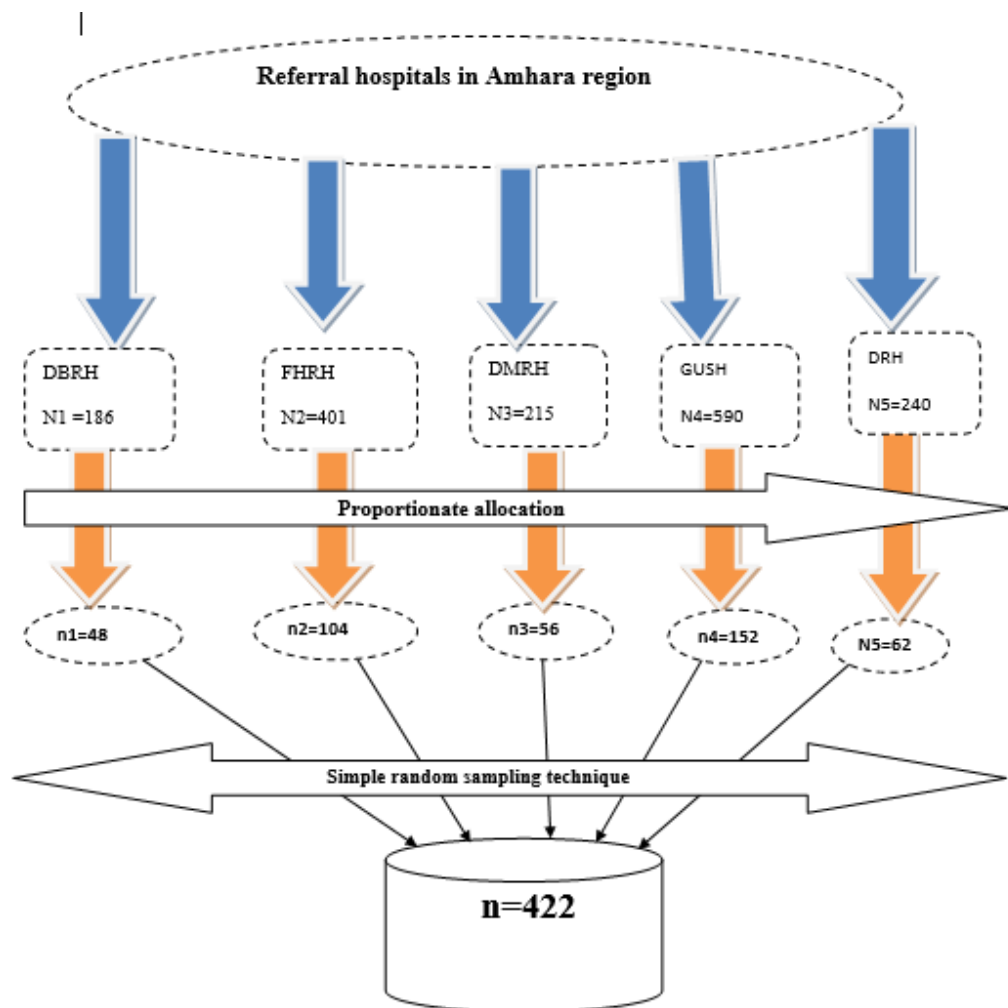| Variables		MAE		COR(95%CI)	AOR(95%CI)	P value
		Yes	No			
Took training	Yes	17	40	1.00	1.00	
	No	222	135	3.86(2.11-7.09)	**2.20(1.09-4.46)**	.027*
Have guideline	Yes	60	92	1.00	1.00	
	No	179	83	3.3(2.18-5.01)	**1.69(1.03-2.79)**	.037*
Interruption	Yes	153	59	3.49(2.32-5.27)	**3.37(2.15-5.28)**	000*
	No	86	116	1.00	1.00	
Have communication	Yes	101	132	1.00	1.00	
	No	138	43	4.19(2.73-6.44)	**3.31(2.04-5.37)**	000*
Failure to follow 10 rights	Yes	116	58	1.9(1.27-2.85)	**1.58(1.00-2.49)**	.046*
	No	123	117	1.00	1.00	

Figures

Figure 1

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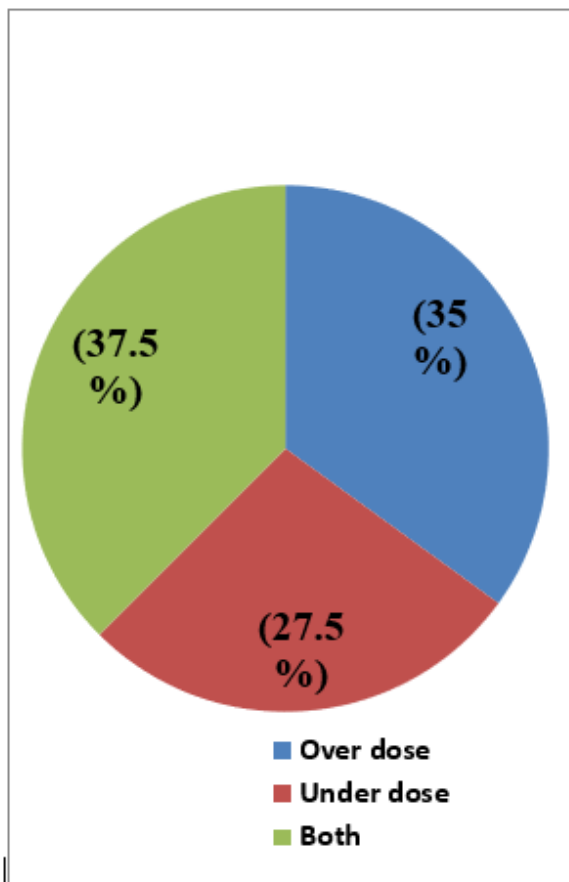
Figure 2

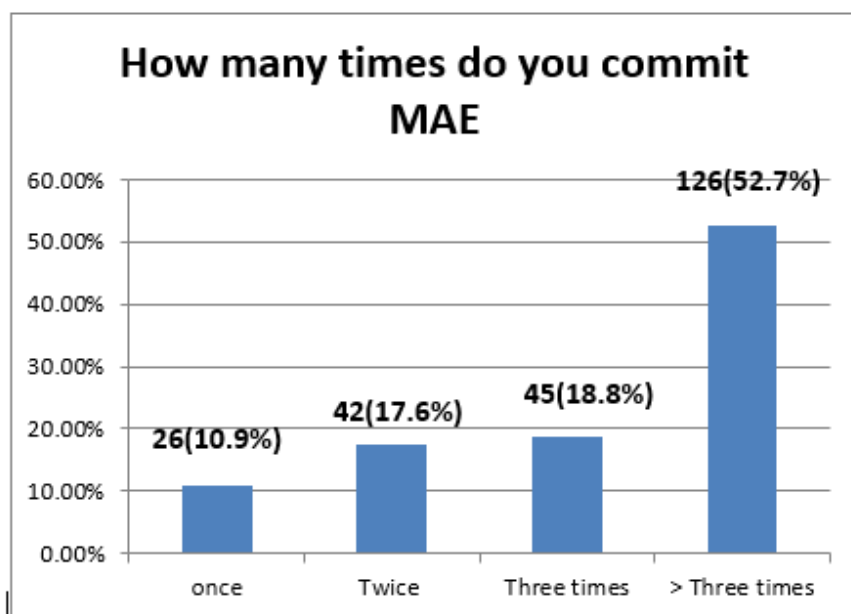Dose error type in Amhara referral hospitals, Amhara, Ethiopia, 2019 (n =414)

Figure 3

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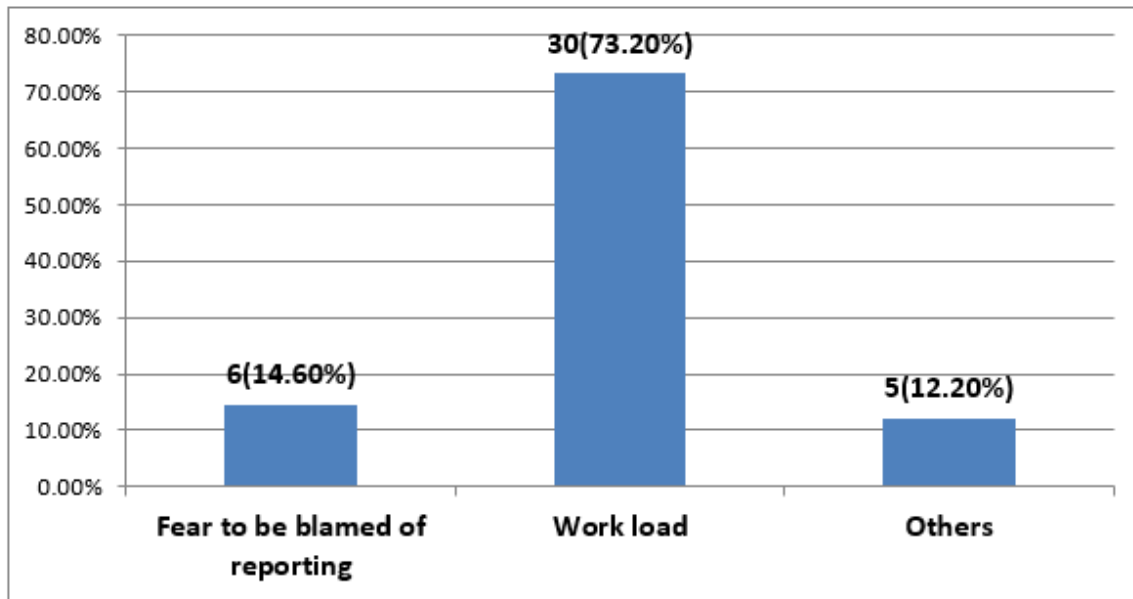
Figure 4

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