ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF EMERGENCY MEDICINE

ASSESSMENT OF MAGNITUDE OF MEDICATION ADMINISTRATION ERROR AND ASSOCIATED FACTORS IN ADULT INTENSIVE CARE UNITS OF FEDERALLY ADMINISTERED PUBLIC HOSPITALS IN ADDIS ABABA, ETHIOPIA 2019.

By: Sheganew Fetene (MSC candidate)

THESIS RESULT SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, DEPARTMENT OF EMERGENCY MEDICINE AND CRITICAL CARE FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS DEGREE OF MASTERS SCIENCE IN EMERGENCY MEDICINE AND CRITICAL CARE NURSING.

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Addis Ababa, Ethiopia

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Declaration

I, the signers, declare that this is my original work and that all sources of materials used for this thesis are duly acknowledged.

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i. Acknowledgement

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ii. Acronyms and abbreviation

AA**:** Addis Ababa

ADE**:** Adverse Drug Effect

BSC**:** Bachelor of Science

GCS: Glasgow Comma Scale

ICU**:** Intensive Care Unit

JUSH: Jimma University Specialized Hospital

MAE**:** Medication Administration Error

ME**:** Medication Error

MSC**:** Master of Science

TASH**:** Tikur Anbesa Specialized Hospital

USA: United States of America

WHO**:** World Health Organization

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vi. Abstract

Introduction: Medications are the basis of care provision. Despite the best effort, increased use of technology and high standards of invasive and non- invasive monitoring in critical care, medication errors continue to occur even at the best centers worldwide.

Objective: To assess magnitude of medication administration error and associated factors in adult intensive care units of federally administered public Hospitals in Addis Ababa, April 4-April 27, 2019 GC.

Methods: Institutional based cross sectional study was used. A probability sampling method specifically simple random sampling was employed to collect data.

Result: Based on this study medication administration error in federally administered public hospitals adult intensive care unit of Addis Ababa city was 61.1% with the most frequent error of technical error (59.7%), followed by wrong time (52.3%) and documentation error (24.8%). Nurse to patient ratio, shift of medication administration, polypharmacy and nurse experience were associated factors with medication administration error.

Conclusion and recommendation: In conclusion medication administration errors in adult intensive care unit of federally administered public hospital of Addis Ababa were highly prevalent. Medication administration protocol and procedure, training for new staff and making nurse to patient ratio one to one were recommended.

Key words: *Medication error, ICU*

1. Introduction

1.1. Back ground

Medicines are chemical compounds administered for the purpose of diagnosis, treatment, and prevention. Hence all medication has toxic effects, all medications are expected to be administered carefully to attain desired outcome, and to avoid adverse drug reactions. Nurses administer almost all medication in hospitals especially those in Critical care unit(1).

Medications are the basis of care provision. Even though safe use of medications can improve and save the lives of millions errors in the use of these substances can lead to equally significant consequences(2).

Although the process of delivering medications to patients encompasses a number of steps requiring collaboration between medical practitioners, registered nurses and pharmacists, it is the main responsibility of nurses to ensure the safe administration of medication.(3).

Medication administration is one of basic nursing responsibility, which needs specialized knowledge, decision making, and skill based on the principles of pharmacology but unfortunately, errors can lead in serious consequences for patients and legal impacts for nurses (4).

According to USA National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) medication error can be defined as “any preventable event that may cause or lead to inappropriate medication use or patient hurt while the medication is in the control of the health care professional, patient, or consumer. Such events can be related to professional practice, health care products, procedures, and systems, comprising prescribing, order communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use”. it can occur at any stage of the medication use process, including prescription, dispensing, preparation and administration (5).

Administration error occur when a discrepancy occurs between the drug received by the patient and the drug therapy intended by the prescriber or manufacturers' preparation and administration instructions(6).

1.2. Statement of the problem

Medication error can cause at least one death every day and injuries approximately 1.3 million people annually in United States of America alone. While low and middle income countries are expected to have comparable rates of medication related adverse events to high income countries. However many countries lack good data, which will be gathered as part of quality health care initiative (28).

Away from damaging people physically, psychologically, and in some cases taking their lives, medication errors result in a massive cost burden, globally the cost associated with medication errors has been estimated $42 billion annually almost 1 % of total global health expenditure, and approximate cost of $17-$29 billion per annum in USA (2, 28).

Patients in ICU are at a high-risk for medication errors because of the following reason: 1) Critically ill patients receive almost twice as many medicines as hospital patients outside the intensive care unit (ICU), 2) most of ICU medications are given parenterally and involve calculations for bolus and continuous infusion and 3) ICU patients are often sedated, and cannot detect possible errors by themselves(10).

Despite the best effort, increased use of technology and high standards of invasive and non-invasive monitoring in anesthesia and critical care, medication errors continue to occur even at the best centers worldwide (12).

As far as my search in our country Ethiopia only one descriptive study was done about intensive care unit medication administration error, at Jimma University Specialized Hospital Intensive care unit and it concluded 51.8% of medication administrations were leveled as an error (12).

Even though most of specialized hospitals with ICU in Ethiopia, located at Addis Ababa there is no study done in Addis Ababa about medication administration error therefore this study was intended to assess medication administration error and associated factors in federally administered hospitals ICU of AA city.

1.3. Significance of the study

Patient safety is an important health care issue because of the impacts of iatrogenic injuries. Critical care Unit has one of the highest incidences of medication administration error than any other specialized units. This is believed to be related to the rapidly changing patient status, complex diagnoses and treatment(9,1). Identifications of the most common error types, drugs associated with errors, factors contributing to errors, and serious consequences of errors, is necessary to guide focused efforts to prevent medication errors(13). In fact, there are few studies about medication error but researchers have not yet paid enough attention to critical care unit. This study was intended to identify magnitude of medication administration error and associated factors in adult intensive care units of federally administered public hospitals in AA. The result would be important for national policy maker, local managers and for health professional to promote safe medication administration practice. In addition to this the finding would have significant effect to prevent mortality, morbidity and adverse drug effect related to medication administration error. Furthermore, the finding would be used as a reference for other researchers who are interested to conduct study related to this problem.

2. Literature review

2.1. Magnitude of medication administration error

Medication safety issues are an important portion of the medication use process in hospitals. Medication Administration Errors (MAEs) are the most common medical errors in health care settings. They harm patient safety, mortality rates, duration of hospital stays, and related costs (5,13).

Estimating the prevalence of medication errors globally is difficult due to the varying definitions, classification systems employed and lack of good data in many countries, which will be gathered as part of quality health care initiative(5).

A Literature reviewed systematically on medication administration errors in United States of America concluded proportion of medication error that reach to the patients ranges between 58% and 79% (14). Recent study in USA discovered 84.7% of medication errors occurred during medication administration and 6.2% occurred during monitoring stage, wrong time, wrong dose, and documentation errors were the most frequent inaccuracies noted during medication administration (15).

A study conducted by American Association of Critical-Care Nurses in 2011 revealed incidence of medication administration error in critical care unit were estimated in range 3.3% to 72.5% with most prevalent error of wrong dose, drug omission and wrong time administration(16).

An estimated 237 million medication errors occur at some point of medication process in England over one year. This were the sum of the errors occurring at all stages of medication use with administration error of 54.4% (17).

In a study conducted at two Dutch hospital ICUs medication administration error were 44.6% with a specific error prevalence of wrong time administration(39.55%), administration technique error(28.75%), wrong dose(17.8%%), omission error(9.5%) and unordered drug error(4.1%) respectively(16).

Prospective observational study conducted on six ICU wards of two Vietnamese hospitals showed prevalence of medication preparations and administrations error were 39.1% with the most frequent errors of wrong administration technique (23.5%), followed by wrong preparation technique(15.7%), omission(2.3%), and wrong dose(1.8%) respectively (18).

According to a study conducted at large teaching hospital of Iran the incidence of medication error in ICU were 9.8% with the most prevalent medication error occurring at administration and prescription stage respectively(19).

A systematic literature revised in Southeast Asian countries reported medication administration error range from 15.22% to 88.6% with the most frequent error of wrong time, omission error and wrong dose respectively(2).

According to a study conducted in southern India frequency of medication administration errors were found as 15.24% with specific error of omission error 33.02%, wrong dose 17.43%, wrong drug 05.50%, wrong route 01.83%, wrong rate: too fast 08.25%, and wrong time 12.84% (32).

Medication error is relatively common in Africa setting, a systematic literature reviewed on 9 countries of Africa Hospital conclude at least one medication administration error has been reported in a median of 56.4% (IQR: 39.5–87.5%) of all medication administration observations(9).

According to South Africa Critical Care Society report in 2014 nurse related medication errors in ICU were 12.49% with specific error of missed or incorrect doses (6.21%) and wrong medication administration 5.28% (33).

A study conducted at Kenyatta national hospitals critical care unite of Nairobi showed that 43% of nurses were experienced medication administration with the most prevalent error of drug omission(64.1%), wrong patient(28.1%) and un ordered medication (23.2%) respectively(1).

In Ethiopia study discovered higher prevalence of medication administration error. The study conducted in west Ethiopia at Nekmet referral hospital pediatrics ward concluded 75.1 % of pediatrics patients were exposed to medication errors, from those 4.6 % patients developed ADEs(20).

Recent study conducted in northern Ethiopia of Tigray public hospital among pediatrics patient prevalence of medication administration error were 62.7% with specific prevalence of wrong dose(85.4%), administering in wrong time(55.1%), medication omission(2.3%), administering to wrong patient(0.6%), administering via a wrong route(0.5%), administering un-prescribed medication(0.3%) and administering wrong drug(0.1%)(21)

According to a study conducted at Felege Hiwot hospital in Bahir Dare the incidence of medication administration error were 56.4 %, with majority 87.5 % of medications having documentation error, followed by technique error 73.1 % and time error 53.6 % respectively(22).

A study conducted in two public hospitals of southern Ethiopia concluded 71% nurses committed MAE within 12 month duration prior to the study. 46% of them committed it at least four times while 35% of them committed it two or three times during the specified period. But 99.3% of directly observed nurse while they administer medication were committed at least one type of error with most frequent error of documentation, time and route error respectively (23).

A study conducted at Jimma University Hospital ICU concluded 51.8% medications were labeled as medication administration errors with a common error of wrong timing (30.3%), omission due to un- availability (29.0%), and missed doses (18.3%) (12).

2.2. Factors associated with medication administration error

Medication errors are human actions, it essential to understand the mechanism that errors develop and conditions that influence error occurrence to develop intervention that deal with this phenomena (24).

Lack of therapeutic training, inadequate drug knowledge and experience, overworked or fatigued health care professionals, Patient characteristics(complexity of clinical case, including multiple health conditions, polypharmacy and high-risk medications), distractions and interruptions (by both primary care staff and patients), lack of standardized protocols and procedures, insufficient resources and lack of accuracy of patient records were the key factor associated with MAE described by WHO in 2016 (5).

Study conducted in United States of America showed lack of knowledge (39%), lack of resource availability (7%), nurse-patient ratio (37%) destruction of Nurse during time of medication administration, lack of experience and working prolonged time(more than 12 hour) were the major cause of medication administration error (14). Other study conducted by American associations of critical care suggested distractions, high workload and lack of drug knowledge may contribute to medication errors (13).

According to a study conducted at governmental hospitals of Malaysia the three top causes of medication administration error were heavy workload, complicated orders and new staff (25).

Study in Vietnamese Hospitals ICU showed much higher error rates were observed for intravenous medications than for oral ones (73.2% vs. 11.8%), and within IV medication higher error rates were observed for medications involving complex preparation procedures than for simple intravenous ones (90.2% vs. 53.9%)(18).

According to a study conducted in Iran insufficient staff management, inadequate number of nurses, increased working shifts, stress and heavy work load, multiple underline patient condition, interruptions during medication administration, lack of the nurse's pharmaceutical knowledge, lack of physician and nurses' communication with patients or their families were identified as a cause of medication administration error in ICU(34).

A systematic literature revised in Southeast Asian countries concluded top factor associated with MAE were staff shortage/high workload, nurse/doctor distraction, incorrect interpretation of prescription/medication chart, lack of knowledge and lack of experience(2).

According to a study conducted in southern India Lack of Lighting, high Noise level, frequent interruptions & distractions, lack of training, lack of staffing, were found to institutional factor causing medication administration error and nursing factor associated with medication administration error were knowledge deficit, stress, fatigue/ lack of sleep and poor communication among health care professionals(32).

A study conducted at kenyatta national hospital general critical care unit of Nairobi showed delay in receiving medication from pharmacy (91.1 %), lack of medication (90%), lack of equipment's like infusion pumps (88.9 %), taking care of more than one patient (66.7%) and single nurse medication administration 60%, were perceived as the major factors that affect medication administration practice, nurse with BSc degree and above were less likely to be encountered with new medications in their line of practice than diploma holders, institutional medication administration processes, Patient characteristics and Nurses experience and qualifications have moderate effect on medication administration(1).

A study conducted at Felege Hiwot Hospital revealed age of the respondents and the patient, nurse's working experience, interruption of the nurses at the time of medication administration, shift of medication administration, and nurse to patient ratio were found to be significantly associated with medication administration error, Nurses with the age group of 18–25 years and 26–40 years were 3 times and 2 times more likely to make medication administration error respectively as compared to those with the age greater than 40 year(22).

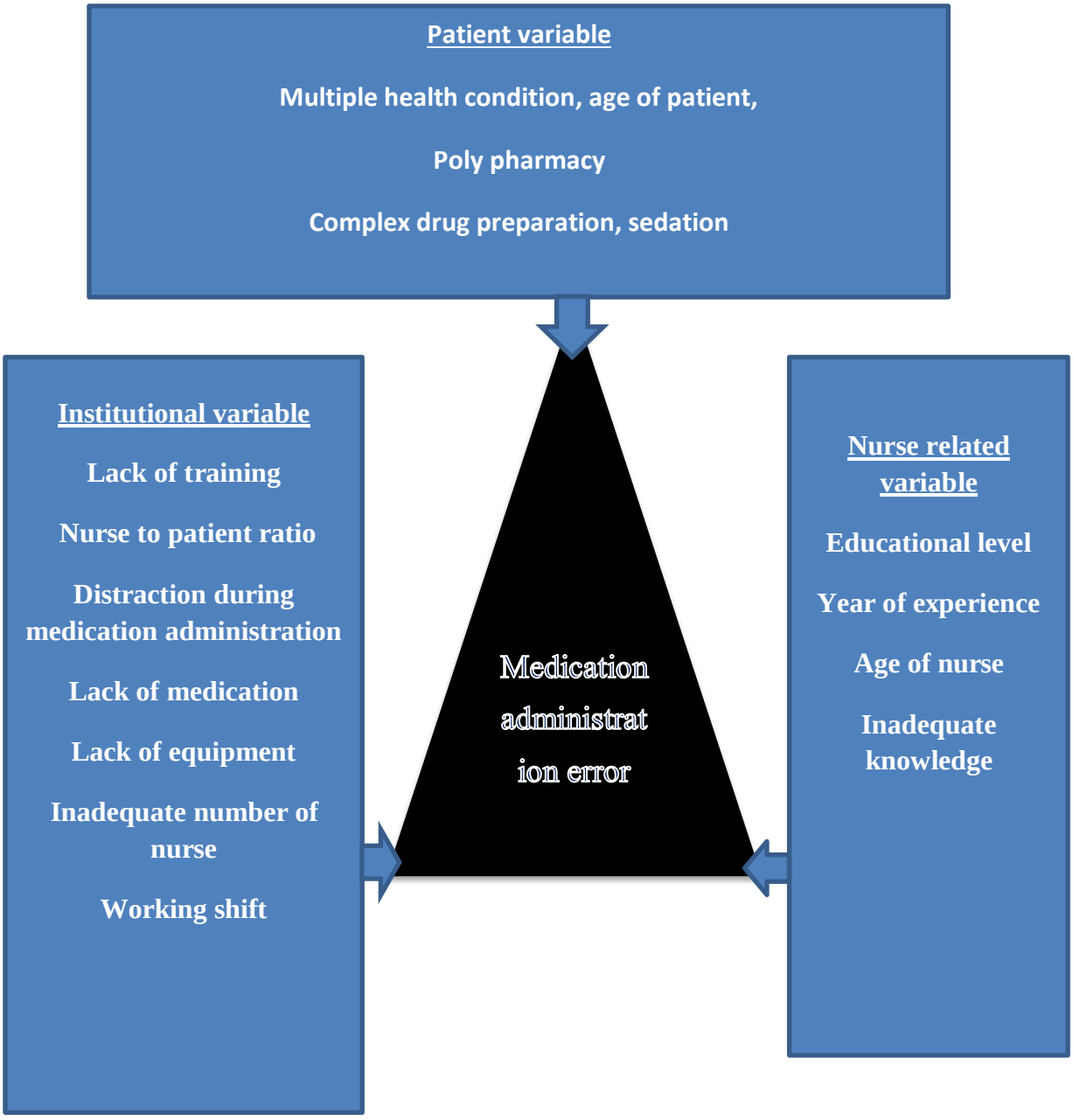
Nurses who had work experience of less than or equal to 10 years were 2 times more likely to make an error when compared to those who had experience greater than 10 years. Nurse to patient ratio was also found to be one of the strong indicators of MAE. Respondents who had nurse to patient ratio of 7–10 and greater than 10 were 2 times and 3 times more likely to make an error respectively when compared to nurse to patient ratio of 1–6 (22).

Nurses who face interruption during medication administration were 2 times more likely to make medication administration error as compared to those who administered without interruption. In addition, nurses who were administering medication at night were 3 times more likely to made medication administration error when compared to those who were administering medication during the day(22).

Patients less than 18 years of age were 2 time more likely to face medication administration error than as compared to those with the age greater than or equal to 18 years (22).

A study conducted in two public hospitals of southern Ethiopia concludes lack of sufficient training (68.5%), inadequate staffing (66.9%), and distraction (50.8%) were the three most commonly listed factors for medication administration error(23).

Factor related with medication administration error from the previous similar studies is used to conceptualize the whole research process and to help for development of tool (1, 2, 5, 13, 14, 18, 22, 25, 32 & 34).



Fg. 1. Conceptual frame work of the study

3. Objectives

3.1. General objective

The general objective of the study was to assess magnitude of medication administration error and associated factors in adult intensive care units of federally administered public Hospitals in Addis Ababa.

3.2. Specific objectives

To determine magnitude of medication administration error in adult intensive care units of federally administered public hospitals in AA.

To identify factors associated with medication administration error in adult intensive care unit of federally administered public hospitals of AA.

4. Material and method

4.1. Study area and study period

The study was conducted at public hospitals in AA city. Addis Ababa is the capital city of Ethiopia and seat for Africa Union. It is the largest city in Ethiopia, with a population of 3,475,952 according to the 2007 population census with annual growth rate of 2.7 %. Its area is estimated to be 530Km2 with altitudes ranging from 2200 to 3000m above sea level, average temperature of 22.8C° and average rainfall of 1,180.4mm. People from different regions of Ethiopia populate the city. Addis Ababa has 41 hospitals (14 public and 28 NGO and private)

Out of 14 public hospitals: five (Tikur-Anbessa Specialized hospital(TASH), St. paul's hospital, Addis Ababa Burn, Emergency and Trauma hospital, St. peteros hospital and Alert hospital) which are administered by federal institution was included in this study.

The study was conducted from April 4- April 27 2019 GC.

4.2. Study design

An institution based cross-sectional study was conducted in adult ICU of federally administered public hospitals of AA.

4.3. Source and study populations

4.3.1. Source Populations

For this study the source populations were all medication administration intervention to patient admitted in adult ICU of federally administered public hospitals in AA.

4.3.2. Study Populations

The study populations were all medication administration intervention to patient admitted in adult ICU of randomly selected federally administered public hospitals in AA.

4.4. Inclusion and exclusion criteria

4.4.1. Inclusion criteria

All medication administration intervention to the patient admitted in adult ICU of federally administered public hospitals in AA.

4.4.2. Exclusion criteria

Over countered drugs

4.5. Sample Size Determination and sampling procedure

4.5.1. Sample Size Determination

The actual sample size for the study was determined by using the formula of single population proportion formula.

$$\mathbf{n} = \frac{(Z\,\alpha/2)^2 * p\,(1-p)}{d^2}$$

Where n = estimated sample size

Z = Confidence level (alpha, α)
P = prevalence
d = marginal error

To determine sample size the following assumption was used.
Prevalence of medication administration error was taken from a previous related study which was conducted at Jimma University specialized Hospital ICU P=51.8% (12).

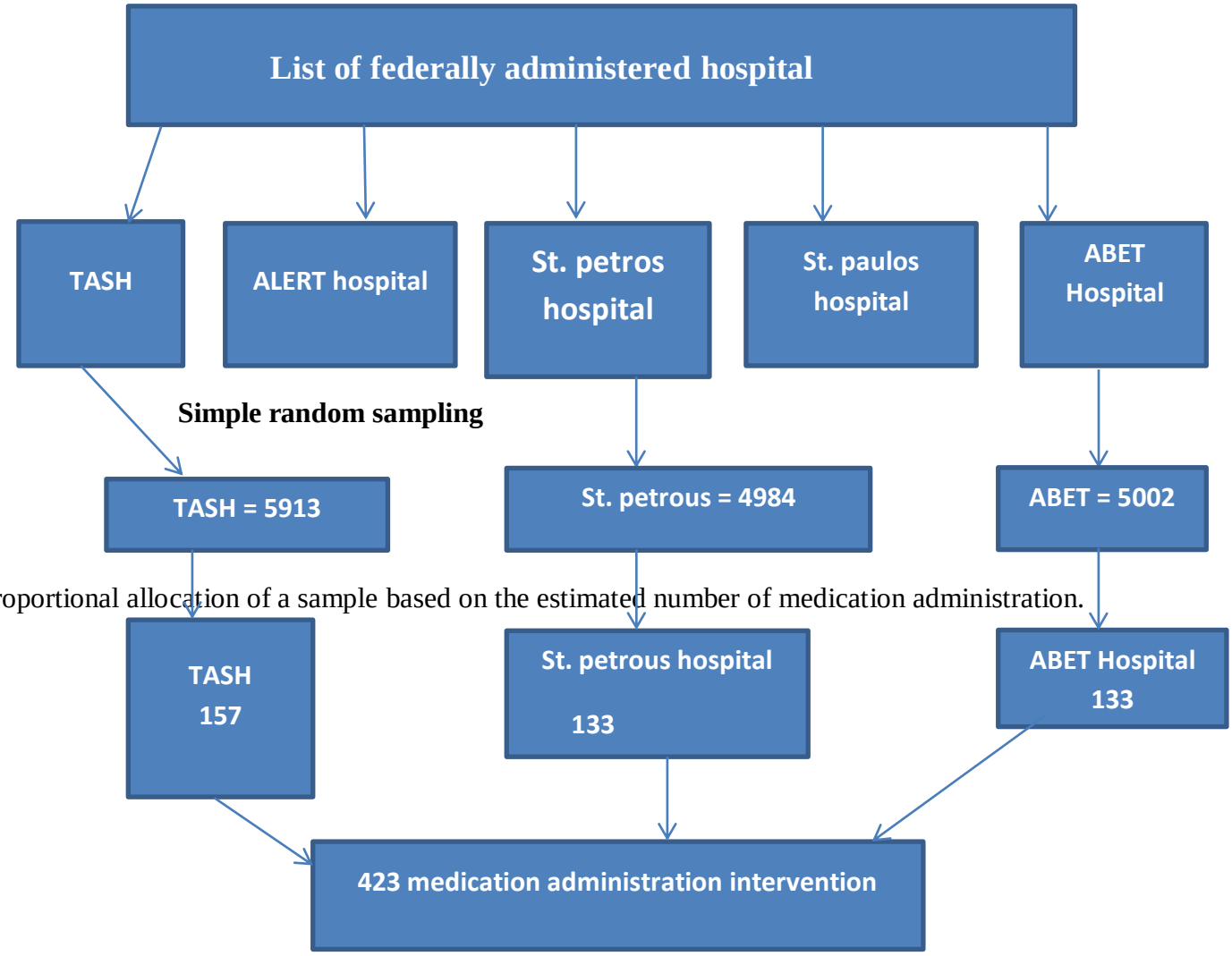
A 95% confidence level, margin of error (0.05)

$$n = \frac{(1.96)^2 * 0.518\,(1-0.518)}{(0.05)^2} = 383.86 \approx 384$$

With 10% non-response rate = 422.4 ≈ 423 medication administration intervention

4.5.2. Sampling procedure

Out of five hospitals which administered by federal institutions three (TASH, St Petrous and ABET) were selected randomly then based on the estimated medication administration intervention sample were assigned proportionally for each hospital. A total of 15899 medication administration intervention were counted from prior month based on this sample were assigned proportionally finally sampling unit were taken using simple random sampling.



Fg. 2. Sampling procedure of the study

4.6. Data collection tool and procedure

Data on medication administration were collected by directly observing nurse while administering medication using checklist supplemented with self-administered questionnaire to gather nurse socio-demographic and experienced related data and by reviewing patient chart to gather patient related data. Immediately after observation, data on recorded observation were compared with the physicians order by referencing patient's chart. The content of data collection formats were design to record nurse's demographics and work experience and all data regarding the patient's medication intervention, date and time that specific drug was prescribed and administered, including the name of the drug, dosage given, frequency, and route of medication administration. Data were collected through 24 hours both in working time and night duty time. Questionnaire and checklist were developed from previous studies conducted at Kenya, feleg hiwot hospital, British journal of nursing and fundamental of nursing skill lab manual prepared by Ethiopian public universities, with slight modification(1, 25, 26, 27,). Data collection was by 6 BSC nurse and supervision were carried by 2 MSC nurse.

4.7. Study variables

4.7.1. Dependent variable

Medication administration error

4.7.2. Independent variable

Socio-demographic characteristics of nurse

- Age,
- Experience
- Educational level

Patient related variable

Complexity of clinical case

- Polypharmacy,
- Complex drug preparation
- Decreased level of consciousness(GCS $\leq$ 8)

Work environment related variable

- Workload
- Nurse to patient ratio
- Distractions and interruptions (by both primary care staff and patients)
- Lack of standardized protocols and procedures
- Insufficient resources
- Working shift

4.8. Operational definition

Medication: a chemical substance intended for use in the diagnosis, treatment, cure, mitigation, or prevention of a disease. Commonly known as drugs.

Medication administration: The process of preparing, giving, and documenting medicines. In administration, the nurse ensures that right dose of the right drug is administered to the right patient at the right time by the right route.

Medication administration error: a discrepancy between the drug received by the patient and the drug therapy intended by the prescriber.

Adverse drug Reaction: unintended response, which includes intolerance, and abnormal reaction, Characterized by rash, itching, Fever, and if severe can lead to organ damage and death.

Poly pharmacy: patient taking 5 or more medication at a time.

Omission error: Drug ordered and not administered.

Unordered drug error: Drug administered but not ordered.

Wrong route error: Drug given by wrong route of administration, for example, a parenteral drug given intravenously instead of intramuscularly.

Wrong administration technique error: Drug administered using the wrong technique, for example too rapidly or too slowly.

Wrong dose error: Dose too high or too low than ordered dose.

Wrong time error: Drug given ≥30 Minutes earlier or later (35).

Decreased level of consciousness: patient with GCS score $\leq$ 8.

4.9. Data processing and analysis

Data were entered into EPI-data version 4.1 computer programs and exported for analysis to SPSS version 25. Cleaning, analyzing was done by SPSS. To explain the study population in relation to relevant variables, descriptive statistics such as frequencies and percentages were calculated. Logistic regression analysis was done to identify the association between dependent and independent variables.

4.10. Data quality assurance

The quality of data was assured through careful design and pretesting of questionnaire. Before the actual work, provision of intensive training for one day about the objective of the study, checklist, procedures of observation, methods of reporting to supervisors and principal investigator were carried out. Before collection of the actual data questionnaire were tested for appropriateness on 5% of the sample in adult ICU of minillic II hospital. Data were checked frequently during collection, collected questionnaire and checklist were examined for completeness and consistency at the end of each day of the data collection.

4.11. Dissemination of results

The study result would be presented to Addis Ababa University, college of health science, department of emergency medicine and critical care. After presentation the document would be disseminated to each federally administered public hospital and ministry of health. Furthermore, the finding would be presented on appropriate seminars, conferences and workshops and will be published with scientific journals.

4.12. Ethical Consideration

Ethical clearance was obtained from departmental research ethical review committee of Addis Ababa University, college of health science, department emergence medicine and critical care prior to beginning of the study. Letter of cooperation to secure permission of access was given to selected hospital ICU Nursing department head. Names and other identifying data of respondents were eliminated throughout the study process to maintain confidentiality.

5. Result

5.1. Socio-demographic characteristics of the study participants

A total of 419 medication administration interventions by 97 nurses were observed making a response rate 99%. More than half of the participants (52.6%) were male and 47.4% were female. The mean age of the respondents was 28.77 years with SD of 5.354 years. Majorities (83.5 %) of the respondents were BSC nurse, 13.4% diploma nurse and the remaining 3% were MSC nurse. They served for an average of 4.45 years in hospitals and 2.59 years in ICU with a standard deviation of 3.93 and 2.1 respectively. (Table 1)

Table 1: Percentage Distribution of the study participants by Socio Demographic Characteristics in federally administered hospital in AA, Central Ethiopia, 2019.

Variable		Frequency	Percent	Mean & SD	Minimum & maximum
Sex	**Male**	**51**	**52.6**		
	Female	**46**	**47.4**		
Age in year					
	18-25 years	**29**	**29.9**		
	26-30 years	**45**	**46.4**	**28.77 ± 5.35**	**21 & 52**
	30-40	**21**	**21.4**		
	>40	**2**	**2.1**		
Religion					
	orthodox	**64**	**65.98**		
	Muslim	**16**	**16.50**		
	Protestant	**13**	**13.40**		
	Other	**4**	**4.124**		
Educational status					
	Diploma	**13**	**13.40**		
	BSC degree	**81**	**83.51**		
	MSC	**3**	**3.09**		
CCN training					
	yes	**23**	**23.7**		
	No	**74**	**76.3**		
Type of training					
	BSC	**10**	**10.3**		
	MSC	**3**	**3.1**		
	Other	**10**	**10.3**		
Total service year					
	<10 years	**90**	**92.8**		
	>10 years	**7**	**7.2**	**4.45 ± 3.93**	**1 & 32**
ICU service year					
	<1 year	**13**	**13.4**		
	1-4 years	**72**	**74.2**	**2.599 ± 2.1**	**0.2 & 25**
	5-9years	**10**	**10.3**		
	10 & above	**2**	**2.06**		

5.2. Characteristics of patients who were included during the observation

Overall 41 patients were involved while the nurse administered their medication. Out of 41 patients, majorities 30 (73.2%) of them were male and the mean age of the patient was 41.61 years with SD of 18.36 years (Table 2). Thirty four (82.9%) of the patient admitted to ICU were exposed for at least one type of MAE.

Table 2: Sociodemographic characteristic of observed patient in federally administered adult ICU in AA public hospitals, AA, Ethiopia, 2019

No	Frequency	Percent	Mean & SD	Minimum & maximum
Sex				
Male	**30**	**73.2**		
Female	**11**	**26.8**		
Age				
<18years	**3**	**7.3**		
18-50years	**22**	**53.7**	**41.61 ± 18.36**	**15 & 77**
>50years	**16**	**39.2**		
GCS≤ 8				
Yes	**27**	**65.9**		
No	**14**	**34.1**		
Number of drug taken at a time				
<5	**32**	**78**		
5 & above	**9**	**22**		

5.3. Characteristic of the observed drugs

A total of 419 medication administration interventions were observed in randomly selected hospital adult ICU making a response rate 99%. Majority 268(64%) were observed at day time and the remaining 151(36%) were at night shift. Concerning their route of administration 259 (61.8%) were intravenous, 113(27%) oral, 35(8.35%) subcutaneous, 10(2.4%) IM and the remaining 2(0.477) were administered topically (fig 1).

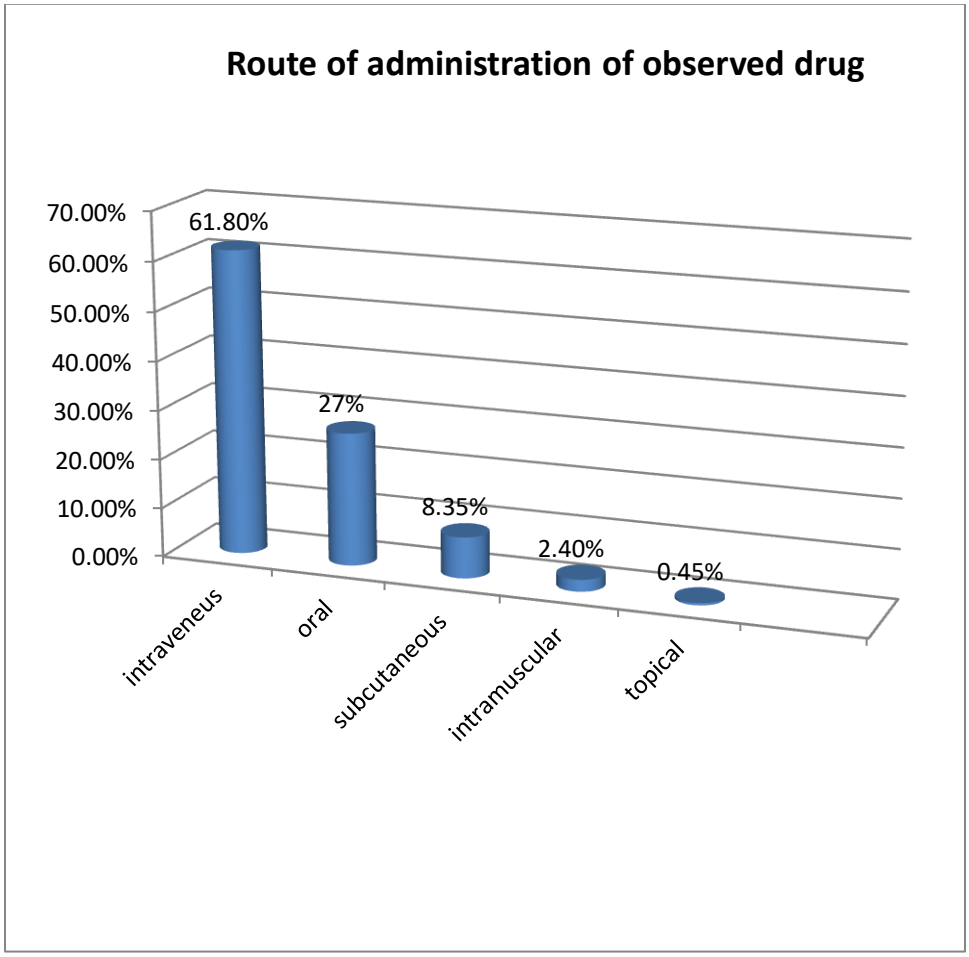


Fig 3 Route of administration of observed drugs in federally administered adult ICU public Hospitals in Addis Ababa, Ethiopia, 2019.

Most frequently observed drug was Paracetamol 41(9.8%), followed by Vancomycine 35(8.4%) and Heparine 34(8.1%) (Table 3).

Table 3, top ten observed drugs in federally administered adult ICU public Hospitals in Addis Ababa, Ethiopia, 2019.

Drugs	Frequency	Percentage
Paracetanol	41	9.8%
Vancomycine	35	8.4%
Heparine	34	8.1%
Tramadole	32	7.6%
Omeprazole	26	6.2%
Cimetidine/Ranitidine	23	5.5%
Metronidazole	18	4.3%
Meropenium	18	4.3%
Phenytoin	16	3.8%
ceftriaxone	16	3.8%
Other	160	38.2%

5.4. Magnitudes of medication administration error

Out of 419 observed medication administration intervention 256(61.1%) of medication administration were leveled as error. Forty-eight (11.46%) had at least one type of error, 115(27.45%) two type of error, 62(14.8%) three type of error and 31(1.4%) had more than three type of error. The most frequently observed error was technical error 250(59.7%) followed by wrong time error 219(52.3%), documentation error 102(24.8%) and wrong route error 29(6.9%).

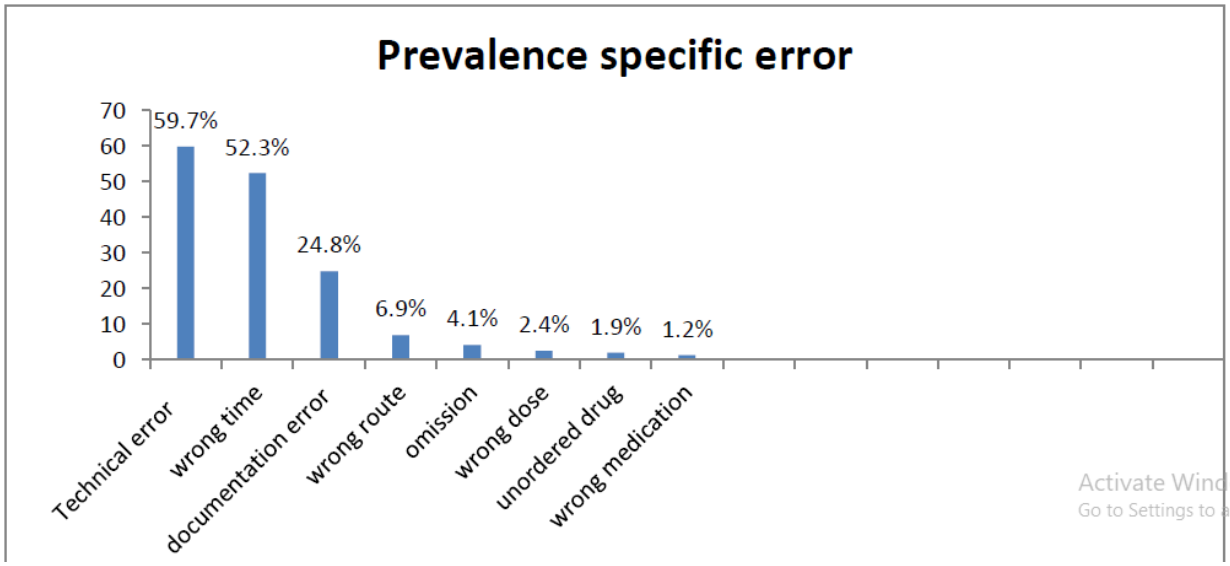


Fig 5. Category of medication administration error in federally administered adult ICU public hospitals of AA, Ethiopia, 2019.

Examples of medication administration errors in adult ICU of federally administered public hospital in AA are listed below.

S. no Examples of medication administration errors

1. The observer nurse was observed when ceftriaxone 1 g administered instead of 2g.
2. Vancomycine was administered at 4:15am instead of 6am.
3. Rate of administration of dopamine was 41 drops/min which was different from what was labeled on the IV fluid bag, i.e. 28 drops/min.
4. Morphine 5mg IV was administered but it was not ordered on patient chart.
5. Diazepam 10mg was administered but not documented on follow up sheet.
6. Heparin was administered intradermal instead of subcutaneously.
7. Paracetamol 1g was not administered to the patient but documented on follow up sheet.
8. Ceftazidine was not administered but it was ordered on the chart.

5.5. Factor associated with medication administration error

Based on the bivariate analysis, the factors found to be significantly associated with medication administration error were educational levels of the nurse; nurse's working experience in intensive care unit, interruption of the nurses during time of medication administration, shift of medication administration, number of medication administered at a time and nurse to patient ratio.

Out of variables which were entered to multiple logistic regressions, nurse's working experience in intensive care unit, interruption of the nurses during time of medication administration, shift of medication administration, number of medication administered at a time and nurse to patient ratio were found to be significantly associated with medication administration error at p-value of< 0.05.

Nurses with ICU working experience <1 year were 10 times [AOR=10.3, 95%CI (3.94, 26.97)] and nurse with ICU working experience of 1-4 year were 9 times [AOR= 9.74, 95%CI (5.5, 18.79)] more likely to make medication administration error respectively as compared with a nurse who had working experience of five and above years.

Shift of medication administration were also found one of the stronger predictor for medication administration error, drug administered at night were four times [AOR=4.75, 95% CI (2.65, 8.41)] more likely to prone for medication administration error.

In addition to the above factors interruption of a nurse during the time of medication administration were other institutional factor associated with MAE; drug administered with interruption were three times [AOR 3.4 95%CI (1.64, 7.04) more likely to have an error than those drugs administered without interruption.

Nurse to patient ratio was also found to be one of the strong predictors of MAE, respondents who had nurse to patient ratio of 1:4 were 18 times [AOR = 18.21, 95 % CI (7.59, 43.69)], nurse to patient ratio of 1:3 13 times [AOR = 13.67, 95 % CI (6.25, 29.99)] and nurse to patient ratio of 1:2 were three times [AOR= 3.42 95% CI (1.43, 8.41) more likely to make an error as compared to nurse to patient ratio of one to one respectively.

Poly pharmacy were also associated with medication administration error, patient taking 5 and above drug at a time were two times [AOR=2.29, 95%CI(1.26, 4.16)] more likely to expose for medication administration error.

Table 4 Bivariate and Multivariate analysis of factors associated with medication administration error in adult ICUs of federally administered Addis Ababa public hospital, Addis Ababa, central Ethiopia, April 2019 (n = 419)

Variable	medication administration error		OR with 95% CI	
	Yes	No	Crude OR	Adjusted OR
Educational level				
Diploma	33	20	3.1(1.11, 8.59)	1.1 (0.39, 1.34)
BSC	215	128	3.15(1.19, 7.64)	1
MSC	8	15	1	1
Training				
Yes	39	48	1	
No	217	115	2.3(1.44, 3.75)	1
Interruption				
Yes	85	21	3.4(1.99, 5.7)	3.4(1.64, 7.04)**
No	171	142	1	
ICU work experience				
<1 year	35	11	4.8 (1.19, 8.0)	10.3(3.94, 26.97)**
1-4 year	216	128	2.8 (1.25, 5.95)	9.74(5.05, 18.79)**
5 and above year	11	18	1	
Shift of MA				
Day	92	125	1	1
Night	164	38	5.9(3.8, 9.1)	4.75(2.65, 8.41)**
Nurse to patient ratio				
1 to 1	60	112	1	1
1 to 2	46	16	5.4(2.8, 10.3)	3.42(1.43, 8.41)*
1 to 3	65	16	7.6(4.0, 14.3)	13.67(6.25, 29.99)**
1 to 4	85	19	8.4(4.6, 15.0)	18.21(7.59, 43.69)**
Number of medication administered at a time				
<5 medication	109	124	1	
5 and above	132	54	2.8(1.4, 4.0)	2.29(1.26, 4.16)*

NB p value <0.005=*, p value<0.001=** AOR=adjusted odd ratio, COR=crude odd ratio,

6. Discussion

Medication safety issues are an important portion of medication use process in hospitals. Medication Administration Errors (MAEs) are the most common medical errors in health care settings. They harm patient safety, mortality rates, duration of hospital stays, and related costs (5, 13).

This study determined the prevalence of medication administration error occurred in federally administered adult ICU of Addis Ababa public hospitals, Ethiopia. From the total of 419 medication administrations interventions, 256(61.1%) had at least one type of medication administration error.

Medication administration errors in this study were higher as compared to a previous finding reported by a study involving 205 ICUs in 29 countries (46.0%) (27).

In addition this finding was relatively higher as compared to a study reported by Vietnam and England which were 39.1% & 54.4%(18, 17). Furthermore; the rate of medication administration errors in this study was extremely higher than the findings reported from south Africa and Iran which were 12.49 and 9.8% respectively(33, 19) %). The possible reason for this difference could be the sitting of the studies the above studies were done in a developed country in which computerized recording system, voluntary error reporting, and follow up were performed.

However this finding is within a range of finding reported by American Association of Critical-Care Nurses, south East Asian countries and nine African countries which were within a range of 3.3% to 72.5%, 15.22% to 88.6% and 56.4% (IQR: 39.5–87.5%) respectively (16, 2, 9).

This finding was higher as compared to a report from jimma University Hospital ICU (51.8%),(12). The possible explanation could be complexity of patient cases and highest number of drugs administration at a single time (polypharmacy) in those specialized and referral federally administered hospitals.

Additionally this finding was higher as compared to a report from felege hiwot hospital (56.4%) (22), the possible justification could be the sitting of the study, finding from felege hiwote hospital were conducted in general ward while this study was conducted in ICU which has complex drug preparation and administration.

According to this study finding Nurses working experience in ICU was a strong predictor of medication administration error this were also related factor reported from previous studies from29 countries and WHO 2016 report (27, 5). This could be described by the fact that new nurse are unfamiliar with the medication, environment, procedures or equipment. Nurses with more years work experience have greater knowledge and skills related to different types of medications and medication administration.

Based on this study nurse to patient ratio were also other forecaster factor for medication administration error this was also predictive factor reported from United States of America, USA and felege hiwote Hospital (13, 14, 22). The reason could be, as a number of patients assigned to a nurse increased the amount of medication administered at a time will increased leading to medication administration error. The other justification could be, in addition to medication administration, the nurses have too much number of duties for ICU admitted patients leading a nurse over loaded resulting MAE.

Polypharmacy (taking 5 and more drug at a time) were patient related factor related to MAE based on this finding, this was also a predictive factor listed by WHO in 2016 report (5). Obviously this could be justified as a number of drug increased the nurse will exposed to unfamiliar drug and would be loaded in combination with other duties leading medication administration error.

Interruption of the nurse at the time of medication administration was also contributes to MAE. This finding was consistent with the study reported by WHO, USA, India, Iran and from felege hiote referral hospital(5, 14, 32, 34, 22) This could be clarified by the fact that, since medication preparation and administration need concentration, interruptions in the course of these activities leads to cognitive failures between nurses in relation to working memory and alertness.

Based on this finding medication administered at night were 6 times more likely to expose for MAE, which is consistent with finding from felege hiote hospital general inpatient (22). The reason could be Nurses who work at night shifts can experience diurnal trouble resulting in disturbed sleep tiredness, and performance deficiency.

7. Conclusion and recommendation

7.1. Conclusion

In conclusion medication administration errors in adult intensive care unit of federally administered public hospital were highly prevalent. More than three fourth of the patient admitted to ICU were exposed for at least one type of MAE. Technical error was the most frequent error followed by wrong time and documentation error. Interruption during the time of medication administration, nurse to patient ratio and shift of medication administration were institutional factor predictive for medication administration. Polypharmacy and working experiences was patient related and nurse related factor associated with medication administration respectively.

7.2. Recommendation

For ministry of health

- Better to make police and protocol on medication administration
- Better to make medication administration error monitoring/auditing policy.

For health institution/hospitals

- Ensure adequate staffing of a nurse to make nurse to patient ratio one to one.
- Standard institutional medication administration protocol to minimize interruption of a nurse during medication administration like marked quiet zone in the medication area, placing no interruption signs on the walls and using protocol checklist.
- Provision of training for new staff about prevention of medication administration error and its consequence.

For nurse professional

- Nurses, who had experience in ICU, should teach their respective newly assigned colleagues about medication administration.

For researcher

- Further study about intensive care unit medication administration error using other study design.

8. Strength and Limitation of study

8.1. Strength of the study

- Study member participations were satisfactory with the response rate of 99%.
- Data was collected using observational checklist which is more reliable than questioner

8.2. Limitation of the study

- Cross sectional study design is less likely to identify cause effect relationship as compared to other study designs, so use of cross sectional study design in this study was a limitation.
- The study was done only in federally administered hospitals it was not included other governmental and privet hospitals.

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10. Annex

10.1. *Informed Consent*

Dear Participant,

Introduction

My name is Sheganew Fetene a post graduate student pursuing a Master Science in Emergency medicine and Critical Care Nursing, department of Emergency medicine at University of Addis Ababa. As one of the requirements for completion of this course, I am required to carry out a study in Addis Ababa public hospital intensive care unit.

Aim

The purpose of my study is to establish magnitudes of medication administration error and associated factors in Adult ICU of federally administered public hospitals in Addis Ababa.

Procedure

Your selection to participate in this study is because you are a key person in the practice of medication administration in this Department. I wish to request you to kindly allow me to take some of your time to answer this questionnaire. If you agree to participate in the study, I shall issue you with a questionnaire with structured questions. The questions will address the factors that may influence medication administration in federally administered public hospitals ICU. Totally you have the right not to answer the question or withdraw at any time if you are not confortable.

Risks

There are no risks to you in participating in this study. You are simply requested to answer the questions in the questionnaire in as much detail as you can, and you are not obliged to answer a question if you do not feel like. There are no risks for being observed during medication administration.

Benefits

There may be no direct benefits to you from this study. However, it is expected that the findings of this study will be used to come up with better plans to ensure safe medication administration in AA public hospital. This will lead to making the necessary interventions, and therefore improve patient outcome.

Confidentiality/Privacy

The information you give or the observations made in this study will be treated with utmost confidentiality during the study and thereafter. Your name will not be recorded anywhere. None of the information you give will be linked to you and it will only be used for the intended purpose.

Right to Refuse or Withdraw

Your participation in this study is voluntary. You are free to decline to participate in this study or withdraw at any point. You are free not to answer any questions that you are not comfortable with. Refusing to participate or withdrawing from the study will not be used in any way to infringe your constitutional rights.

Persons to contact In case of any complaints on any aspect of this study, kindly contact:

Name: Sheganew Fetene
Phone no: 0918511768
Email address: sheganewabeba@gmail.com

10.2. Questionnaire

Instructions

Please do not write your name on the questionnaire. Please tick your response on the boxes provided. (√) . Kindly attempt all the questions.

Date.....

SECTION A: social- demographic characteristics of a nurse (Tick in the appropriate box)

1. Age (in completed years)…….
2. Religion

a. ☐ Orthodox

b. ☐ Muslim

c. ☐ Protestant

d. ☐ Catholic

e. ☐ Other (specify) _____

3. Gender ☐ male ☐ female
4. What is your highest professional qualification?

a. ☐ Diploma

b. ☐ BSC degree

c. ☐ MSC degree

5. Are you trained in Critical care nursing?

a. ☐ yes

b. ☐ no

6. If yes what type of training is it

a. ☐ BSC degree

b. ☐ MSC degree

c. ☐ Other(specify)……

Section B: experience and working environment related question

7. Total work experience of as a nurse in (year or month)……
8. Work experience of a nurse in ICU (year or month)……
9. Are you usually trained on how to administer/ handle new medicines before prescription?

a. ☐ yes

b. ☐ no

Thank you for taking your time to answer this questionnaire

9.3. Observational checklist

Instruction: Please observe the nurse starting from medication preparation to administration and write the exact information of the medication (any errors) based on the medication administration checklist. Use one format for a single patient medication administration process

Checklist No.....Checklist completed by.....

Sr. No	Question	Response
1	Patient 's age	……in year
2	Patient sex	a. Male b. Female
3	Time in which medication administered (exact time of medication administration)	……
4	Shift of medication administration	a. Day time b. Night duty
5	List of medication in use	…… …… …… …… ……
6	No of medication to be administered at time	…….
7	Nurse to patient ratio	1 to……
8	Is there any interruption during medication administration?	a. Yes b. No
10	If yes what was it??	a. talking with other staffs nurse b. talking with clients c. talking with physician d. .other…….
9	Patient GCS≤ 8?	a. Yes b. No

Section 1: Core competencies check lists to assess technique errors of medication administration

no	Checklist	Yes	No
1	Medication administered is prescribed		
2	All medication to administer are available		
3	All required equipment/items available All		
4	Identify right patient		
5	Check patient medication history for allergies		
6	Identify right medication		
7	check expiration date		
8	Select right route		
9	Drug is administered at the right time that is not ≥30 min earlier or later		
A	**For intravenous Injections:/iv push**	Yes	No
	Select right site		
	Clean the site		
	Administer right dose		
	Inject at 25 degree		
	Right documentation		
	Name of the drug	……..	
B	**For intravenous iv infusion**	Yes	No
	Select right site/assess cannula		
	Check for compatibility of medication and IV fluid		
	Calculate appropriate amount of fluid		
	Administer right dose		
	Mix drug with fluid appropriately		
	Level the fluid		
	Connect drug/fluid with cannula		
	Name of the drug	……..	
C	**For oral/nasogastric tube medication**	Yes	No

	Dilute drug properly		
	Check NG tube patency		
	Administer right dose		
	Slowly push through nasogastric tube		
	Name of the drug	……	
	If the patient is self-medicated		
	Teach the patient how to take		
	Observe the patient at time of swallowing		
D	**For Intramuscular Injections:**	Yes	No
	select right site		
	Administer right dose		
	Cleanse site appropriately		
	Injects at 90 degree angle		
	Aspirates to check blood		
	Injects appropriately		
	Withdraw the syringe appropriately		
	Right documentation		
	Name of the drug	……	
E	**For subcutaneous Injections**:	Yes	No
	select right site		
	Cleanse site appropriately		
	Administer right dose		
	Injects at 45 degree angle		
	Injects appropriately		
	Withdraw the syringe appropriately		
	Right documentation		
	Name of the drug	……	

Common antibiotic and the appropriate standard amount of diluents to be added for IV injections and its rate of administrations (Used for assessing technique error)

no	Name of the drug	Preparation	Amount of diluents for Iv injection	Rate of administration time
1	Ceftriaxone	250 mg 500 mg 1 gm 2 gm	2.4ml 4.8ml 9.6ml 19.2ml	Slowly over 6-7 minute
2	Cloxacilin	250 mg 500 mg	3-5ml 3-5ml	Slowly over 3-4 minute
3	Chloroamphnical	500mg 1gm	5ml 10ml	Over 1 minute
4	Cry. pencline	1MIU	2ml	Slowly over 3 minute
5	Ampcline	250mg 500mg 1gm	1ml 1.8ml 3.8ml	Slowly over 3-5 minute
6	Vancomicine	500mg 1gm	100ml N/S 200ml N/S	30 minute 60 minute7
7	Cephaziden	1 gm	10ml	Slowly 3 minute