BMJ Open

Medication administration errors and associated factors among nurses in Addis Ababa federal hospitals, Ethiopia: a hospital-based cross-sectional study

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ABSTRACT

Objective This study was conducted to assess the magnitude and contributing factors of medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia.

Design A hospital-based cross-sectional study design was employed. Data on medication administration and associated factors were collected using a structured self-administered questionnaire. Multivariable binary logistic regression analysis was done to identify factors associated with medication administration errors on the basis of adjusted OR with 95% CI and a p value less than 0.05.

Setting This study was conducted in federal hospitals in Addis Ababa, Ethiopia.

Participants Four hundred and twenty-three randomly selected nurses participated.

Outcome measures The primary outcome variable is medication administration error, which was ascertained using the following errors: wrong medication, wrong dose, wrong time, wrong route, wrong patient, wrong drug preparation, wrong advice, wrong assessment and wrong documentations.

Results A total of 59.9% (95% CI: 55.0% to 64.8%) of the nurses in the federal hospitals in Addis Ababa committed one or more medication administration errors in the last 12 months prior to the survey. The most commonly reported medication errors were wrong time (56.8%), wrong documentation (33.3%), wrong advice (27.8%) and wrong dose (20.1%). Medication administration errors among nurses were significantly associated with short work experience (adjusted OR (AOR): 6.48, 95% CI: 1.32 to 31.78), night shift work (AOR: 5.0, 95% CI: 1.82 to 13.78), absence of on-the-job training (AOR: 3.16, 95% CI: 1.67 to 6.00), unavailability of medication administration guidelines in wards (AOR: 2.07, 95% CI: 1.06 to 4.06) and interruptions during medication administration (AOR: 2.42, 95% CI: 1.30 to 4.49).

Conclusion It was found that a high proportion of nurses in federal hospitals committed medication administration errors. Short work experience, night shift work, absence of on-the-job training, unavailability of medication administration guidelines and interruptions during medication administration explained the high magnitude of medication administration errors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study used structured and pretested data collection, and the data collection was closely supervised to increase quality of data and completeness of the questionnaire.

⇒ Study subjects were selected at random using a systematic random sampling technique so that all nurses in the federal hospitals in Addis Ababa had an equal chance to be included in the study, and findings of this study will be generalisable.

⇒ As a limitation, the self-reported data may not be reliable since the study subjects may make the more socially acceptable answers rather than being truthful, and they may not be able to assess themselves accurately.

INTRODUCTION

Healthcare workers commit mistakes during the processes of ordering, prescribing, dispensing, preparing or administering medication.[1–3] Medication administration errors are any preventable events that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professionals, patients or consumers.[1 4] Medication administration errors can occur through failures in any of the 10 rights of patients, which are right patient, right medication, right time, right dose, right route, right education/advice, right to refuse, right assessment, right evaluation/response and right documentation.[5]

Medication errors are remaining serious health problems in the developing and developed countries. Globally, medication errors are the leading causes of different injuries and avoidable harms in the healthcare system attributing to about 10% of the overall preventable harms for hospitalised patients.[6] Approximately 400 000 hospitalised patients experience some type of preventable harms each year, and medical errors in hospitals

and clinics result in approximately 100000 people dying each year.[7] In east Africa, medication administration errors, with rates ranging from 9.4% to 80%, are the most common types of adverse events for hospital-admitted patients and the most frequent causes of preventable deaths.[8]

Medication errors are undoubtedly costly to patients, their families, their employers, and to hospitals, healthcare providers, and insurance companies. Patients are the primary victims of medication errors, and medication administration errors have a significant impact on patients in terms of morbidity, mortality, adverse drug events, additional costs and increased length of hospital stay.[9] According to the 2017 WHO report, the annual global cost associated with medication errors has been estimated at US$42 billion, which accounts to 0.7% of the total health expenditures.[10]

Medication administration errors have multiple causes.[11–13] Some of the factors documented in literature can be grouped into professional factors (such as poor competency, experience, lack of training on parenteral medication administration, lack of communication skills), organisational factors (such as illumination system, high patient flow, work load, high nurse-to-patient ratio), work-related factors (such as work load, relation with other coworkers), personal factors (such as health condition of nurses, fatigue, lack of initiative on clarifying doubts regarding the medicine) and medication-related factors (such as medications that require mixing diluents and calculation has a higher risk of error).[14–16] However, these factors might be varied in different settings and contexts. Accordingly, this study was conducted to assess the magnitude and contributing factors of medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia.

METHODS
Study design and setting
An institution-based cross-sectional study design was employed among nurses working in federal hospitals in Addis Ababa City from July to August 2021. Addis Ababa City has 42 hospitals (14 public and 28 private). Out of 14 public hospitals, 5 hospitals, namely Black Lion Specialized Hospital; St Paul's Hospital; Addis Ababa Burn, Emergency and Trauma Hospital; St Pateros Hospital and Alert Hospital, are administered by the federal government.

Sample size determination and sampling procedures
The sample size was calculated using single population proportion formula with the following assumptions: prevalence of medication administration errors among nurses in Jimma University Specialized Hospital=51.8%,[17] 95% CI, 5% level of significance and 5% marginal error.

$$n = \frac{\left(Z_{\frac{\alpha}{2}}\right)^2 P(1-P)}{d^2} = \frac{(1.96)^2 0.518(1-0.518)}{(0.05)^2} = 384$$

Considering a 10% non-response rate, the final sample size became 423. We first randomly selected three federal hospitals out of five to recruit the study subjects. We then randomly selected 157 nurses from Black Lion Specialized Hospital; 133 nurses from St Pateros Hospital; and 133 nurses from Addis Ababa Burn, Emergency and Trauma Hospital using a simple random sampling technique. The number of nurses recruited in each hospital was proportionally allocated. All nurses who had a minimum of diploma qualification, a minimum of 1-year work experience and who provided patient care were included in the study.

Measurement of outcome variable
Medication administration error was the primary outcome variable of this study. A nurse was included if he or she practised medication administration errors, or if he or she performed one or more of the following errors in the last 12 months prior to the survey: administering medications that were not on the patient's medication chart (wrong medication), administering medications in wrong dose or quantity different from that of the standard dose (wrong dose), administering medications 30 min earlier or later from its scheduled time (wrong time), administering medications different from the recommended route of medication administration (wrong route), misidentification of patients during medication administration (wrong patient), formulating or manipulating drug products incorrectly before administration (wrong drug preparation), providing wrong medical information (wrong advice), wrong assessment of symptoms (wrong assessment), incorrectly or incompletely documenting administered medications (documentation error).[17 18] We used the contextual, modal and psychological classifications to classify medication administration errors as Ferner and Aronson[19] and Aronson[20] discussed.

Data collection procedures
Data were collected using a self-administered structured and pretested questionnaire adopted from other published research works.[21] The questionnaire was organised into four sections: the first section was sociodemographic characteristics of study participants, the second section was about work-related information, the third section was about medication errors and the fourth section was about contributing factors to medication errors. The questionnaire was pretested on 5% of the sample size prior to the actual data collection at a selected government hospital, which was not included in the study. Five trained diploma-holder nurses facilitated and supervised the data collection and checked the completeness of the questionnaire.

Data processing and analysis
Data were entered into Epi-Info V.7.2 epidemiological software and exported to SPSS V.20 for further analysis. Data were presented by frequencies and percentages for most variables. We included predictors to the

Table 1 Sociodemographic characteristics of the study participants (n=402) in federal hospitals in Addis Ababa, Ethiopia, July–August 2021

Variables	Frequency	Percentage
Sex		
Female	245	60.9
Male	157	39.1
Age		
20–24 years	99	24.6
25–29 years	192	47.8
30–34 years	78	19.4
≥35 years	33	8.2
Marital status		
Single	250	62.2
Married	141	35.1
Others*	11	2.7
Educational status		
Diploma	13	3.2
BSc degree	371	92.3
MSc degree	18	4.5
Diploma or degree awarded from		
Public universities or colleges	321	79.9
Private universities or colleges	81	20.1

*Others include divorced, widowed and separated.
BSc, Bachelor of Science; MSc, Master of Science.

multivariable binary logistic regression model from the literature regardless of their bivariate p value to identify factors associated with medication administration errors. Statistically significant associations were declared on the basis of adjusted OR (AOR) with 95% CI and a p value less than 0.05. Model fitness was checked using Hosmer and Lemeshow model fitness test.

Patient and public involvement
There was no patient or public involvement in the study.

RESULTS
Sociodemographic characteristics of study participants
A total of 402 nurses participated in this study with a 95% response rate. Two hundred and forty-five (60.9%) of the respondents were female. The mean (±SD) age of the respondents was 27.8 (±4.36) years, and nearly half (192; 47.8%) of the respondents were aged between 25 and 29 years. Two hundred and fifty (62.2%) of the respondents were not married at the time of data collection. The vast majority (371; 92.3%) of the study participants were Bachelor of Science degree holders (table 1).

Work-related characteristics
The vast majority (370; 92%) of the respondents had less than 10 years of work experience. One hundred and

thirteen (28.1%) of the nurses worked in medical wards and 230 (57.2%) of the nurses worked in the current ward for at least 3 months. A quarter of the study participants (102; 25.1%) worked in alternative shifts, that is, day and night shifts. One hundred and sixty-two participants reported that the nurse-to-patient ratio in their ward was 1:10. Eighty-seven (21.6%) of the study participants reported that they took medication administration training and 220 (54.7%) reported that they have medication administration guidelines. Two hundred and forty-seven (61.4%) of the study participants reported that they faced interruptions while administering medication. Majority (292; 72.6%) of the study participants reported that they usually communicate with other nurses when faced with doubt during medication administration. Moreover, 66 (16.4%) of the nurses believed that reporting medication administration errors to a responsible body can minimise the frequency of committing medication administration errors (table 2).

Medication administration errors
From the total study participants, 241 (59.9%) (95% CI: 55.0% to 64.8%) of them committed one or more medication administration errors in the last 12 months prior to the survey; of these, 81 (20%) committed medication administration error three or more times during the specified period (figure 1). The most commonly reported medication errors were wrong time (56.8%), wrong documentation (33.3%), wrong advice (27.8%) and wrong dose (20.1%) (figure 2), and the most commonly reported reasons for committing one or more medication administration errors were work load (84.6%), lack of sufficient training (81.7%), interruptions during medication administration (68.9%), lack of experience (67.2%), illegible handwriting by prescribers (64.7%) and failure to respect the 10 rights of patients (61.4%) (table 3).
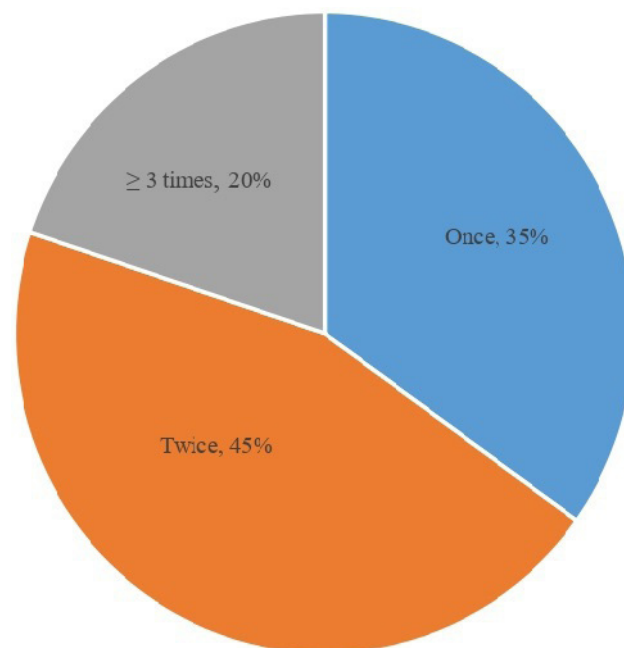
Factors associated with medication administration errors
Table 4 illustrates that medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia were significantly associated with work experience, on-the-job training, availability of medication administration guidelines, interruptions during medication administration and work shift. Nurses who had 10 years or below work experience had higher odds of committing medication administration errors compared with nurses who had long work experience (AOR: 6.48, 95% CI: 1.32 to 31.78). The odds of committing medication administration errors were 5.0 times higher among nurses who worked in the night shift compared with nurses who worked in the day shift (AOR: 5.0, 95% CI: 1.82 to 13.78). Medication administration errors in the federal hospitals in Addis Ababa were statistically associated with on-the-job training of nurses (AOR: 3.16, 95% CI: 1.67 to 6.00). Moreover, unavailability of medication administration guidelines in the ward explained the 2.07 higher odds of medication administration errors among nurses (AOR: 2.07, 95% CI: 1.06 to 4.06). Additionally, the odds

Table 2 Work-related characteristics of nurses in federal hospitals in Addis Ababa, Ethiopia, July–August 2021

Variables	Frequency	Per cent
Work experience		
<10 years	370	92.0
≥10 years	32	8.0
Work unit		
Medical ward	113	28.1
Surgical ward	87	21.6
Paediatrics ward	68	16.9
Emergency	56	13.9
Obstetrics and gynaecology	47	11.7
ICU	20	5.1
OPD	7	1.7
Others*	4	0.9
Duration of stay in the present unit		
≤3 months	230	57.2
4–5 months	143	35.6
≥6 months	29	7.2
Duty shift		
Day shift	182	45.3
Night shift†	118	29.4
Alternative shift	102	25.1
Nurse-to-patient ratio in the ward		
1–6	97	24.2
7–10	143	35.6
>10	162	40.2
Take training in medication administration		
Yes	87	21.6
No	315	78.4
Have guideline for medication administration		
Yes	220	54.7
No	182	45.3
Faced interruptions during medication administration		
Yes	247	61.4
No	155	38.6
Communicate with other nurses when faced with doubt		
Yes	292	72.6
No	110	27.4
Reporting errors is important		
Yes	66	16.4
No	336	83.6

*Others include oncology ward and multidrug-resistant tuberculosis ward.
†Night shift lasts for 15 hours.
ICU, intensive care unit; OPD, outpatient department.

Figure 1 Frequency of medication administration errors in the last 12 months prior to the survey in federal hospitals in Addis Ababa, Ethiopia, July–August 2021.

of medication administration errors were higher among nurses who faced interruptions during medication administration compared with nurses who did not face interruptions (AOR: 2.42, 95% CI: 1.30 to 4.49) (table 4).

DISCUSSION

This hospital-based cross-sectional study was carried out to assess medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia and found that 59.9% (95% CI 55.0% to 64.8%) of the nurses committed one or more medication administration errors in the last 12 months prior to the survey. The magnitude of medication administration errors reported in the current study is comparable with findings of studies in Felege-Hiwot Referral Hospital (56.4%)[9] and hospitals in Amhara regional state (57.7%).[22] Moreover, the prevalence of medication administration errors reported in this study is lower than findings of studies in two public hospitals in southern Ethiopia (71%),[23] Goba Referral Hospital (62.3%),[24] tertiary care hospitals in Addis Ababa (68.1%),[25] Iran Teaching Hospital (68.5%)[26] and in Pakistan (81.9%).[27] On the other hand, the result of this study is higher than findings of studies in Jimma University Specialized Hospital (51.8%),[17] Accra Tertiary Hospital (27.2%),[28] Ain Shames University Hospital in Egypt (37.7%),[29] two Dutch hospitals (13.7%)[30] and in Turkey (26.1%).[31] This high magnitude of medication administration errors could imply that the quality of nursing care in relation to medication administration did not appear to be up to standard. The safety of the patient during medication administration was poorly maintained. This increased magnitude of medication administration errors
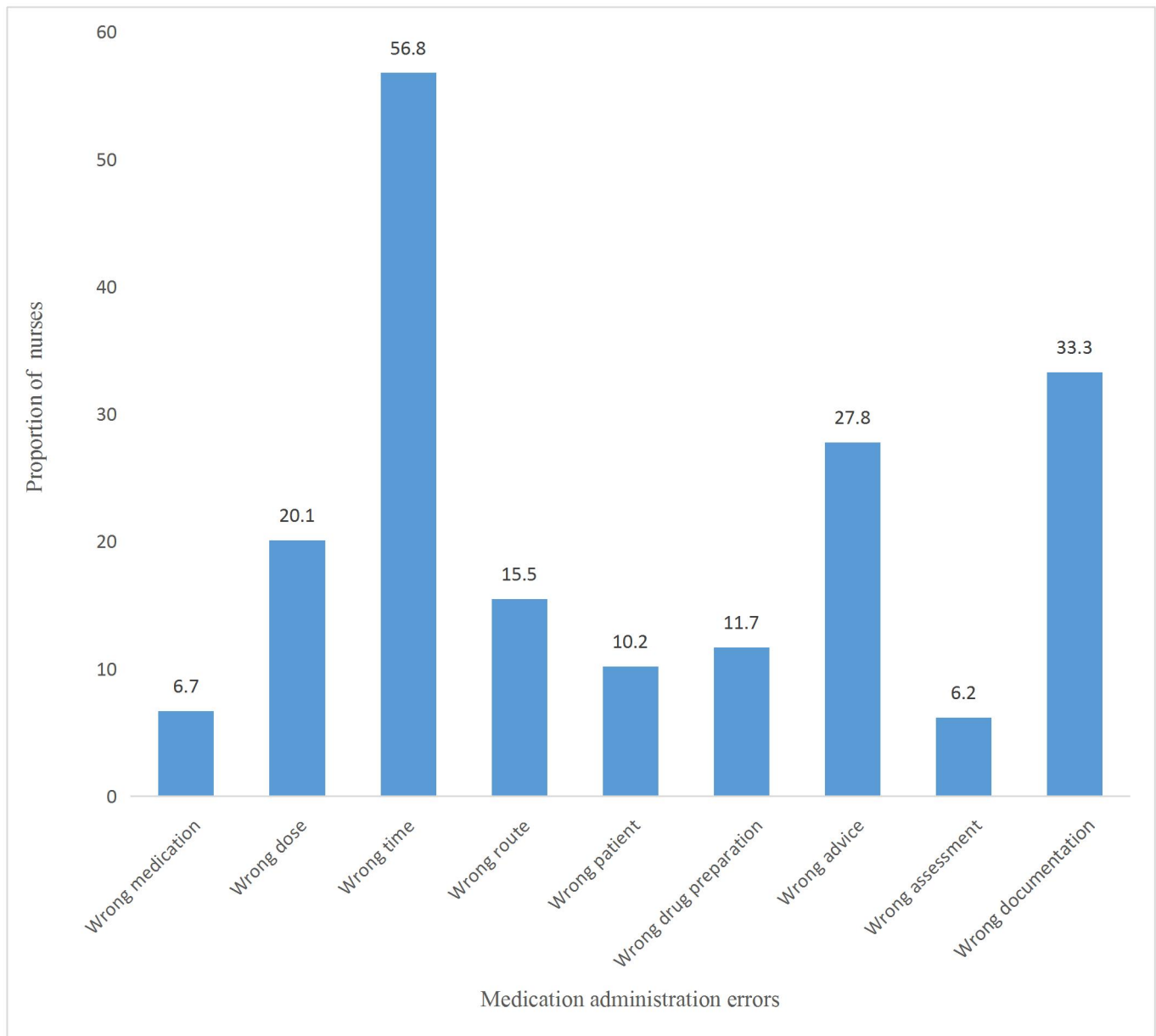
Figure 2 Types of medication administration errors the study participants committed in federal hospitals in Addis Ababa, Ethiopia, July–August 2021.

is likely to result in harming the patients and may erode public trust in nursing care.

The high prevalence of medication administration errors in the current study might be explained by professional factors (such as poor competency, experience, lack of training on parenteral medication administration, lack of communication skills), organisational factors (such as illumination system, high patient flow, work load, high nurse-to-patient ratio), work-related factors (such as work load, relation with other coworkers), personal factors (such as health condition of nurses, fatigue, lack of initiative on clarifying doubts regarding the medicine) and medication-related factors (such as medications that require mixing diluents and calculation has a higher risk of errors).[14–16]

The current study revealed that medication administration errors among nurses were significantly associated with service year. The odds of committing medication administration errors were high among nurses who had short work experience, which is in agreement with other studies.[9 14] Medication administration is one of the nursing practices and improved through experience. Nurses can improve their skill and gain greater knowledge on safe medication administration practice through experience. Moreover, experienced nurses are familiar with different medications and procedures.

It was found that medication administration errors were statistically associated with work shift. The odds of committing medication administration errors were higher among nurses who worked in the night shift compared

Table 3 Reported reasons for committing one or more medication administration errors among nurses (n=241) in federal hospitals in Addis Ababa, Ethiopia, July–August 2021

Reasons for committing medication administration errors	Frequency n (%)
Work load	204 (84.6)
Lack of sufficient training	197 (81.7)
Interruptions during medication administration	166 (68.9)
Lack of experience	162 (67.2)
Illegible handwriting by prescribers	156 (64.7)
Failure to respect the 10 rights of patients	148 (61.4)
Sound-alike drugs	123 (51.0)
Unclear verbal order	120 (49.8)
Wrong dispensing	116 (48.1)
Wrong prescription	107 (44.4)
Nurses write a prescription in place of physicians	47 (19.5)

with nurses who worked in the day shift. This finding is in line with findings of studies in Felege-Hiwot Referral Hospital, northwest Ethiopia and Ain Shams University Hospital, Egypt.[9 29 32 33] Long hours of night shift disrupt the body's circadian rhythms, or 24-hour internal 'clock' that controls sleep–wake cycles. This increases the risk of short sleep duration and sleep disturbances, which in turn increases risk of depression, fatigue and mood changes. Moreover, long night shift is linked to poorer working memory and slower mental processing speed. Due to this, long night shift increases the risk of workplace injury and committing medication administration errors.[34–37]

This study depicted that medication administration errors in the federal hospitals in Addis Ababa were statistically associated with on-the-job training. The odds of committing medication administration errors were high among nurses who did not take on-the-job training in medication administration. Implementing regular or scheduled training for all nurses in hospitals plays a role to improve and refresh their knowledge and skills. Training often has been referred to as teaching specific skills and behaviours. Training is the act of increasing the knowledge and skills of nurses for performing particular jobs; and when nurses learn new habits, refined skills and useful knowledge, they could improve their performance.[33 38–40]

Unavailability of medication administration guidelines in wards explained the higher odds of medication administration errors among nurses in the study area. This finding is in line with findings of other studies.[22 29 41] Having medication administration guidelines and providing care based on guidelines together with a consistent reporting system could prevent 75% of the occurrence of harm to hospitalised patients. The availability of guidelines for medication administration may improve the quality of nursing care and reduce medication administration errors.[8]

This hospital-based cross-sectional study found that medication administration errors were significantly associated with interruptions during medication administration. The odds of medication administration errors were higher among nurses who faced interruptions during medication administration compared with nurses who did not face interruptions, which is in agreement with findings of other studies.[42–44] Studies revealed that work interruptions during medication administration rounds are thought to be a prominent factor in medication errors that account for up to 43% of medication errors.[43 45] Nurses must remain attentive and focused when performing activities that require concentration to avoid distractions and errors. Reducing the occurrence of disruptions can improve the quality of services and helps both patients and nurses. An interruption is an unexpected disturbance that destroys the continuity of care, diverts attention and increases the time required to perform activities, reduces work efficiency, and increases negligence and human errors. This adversely affects the quality of care and patient safety.[46–48]

As limitations, the self-reported data may not be reliable since the study subjects may make the more socially acceptable answers rather than being truthful, and they may not be able to assess themselves accurately, which might result in reporting bias. The study might be also affected by recall bias since we asked nurses to recall medication administration errors happening in 12 months prior to the survey. The generalisability of results might be affected due to theses biases. Moreover, we did not inform the participants about the type of medication errors they committed since we used a self-administered questionnaire.

CONCLUSION

It was found that a high proportion of nurses in federal hospitals in Addis Ababa, Ethiopia committed one or more medication administration errors, and medication administration errors among nurses were explained by lack of work experience, night shift work, absence of on-the-job training, unavailability of medication administration guidelines and interruptions during medication administration. Developing appropriate medication guidelines, providing continuous on-the-job training, minimising distractions during medication administration and retaining experienced nurses would be helpful for minimising medication administration errors in the area.

Table 4 Factors associated with medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia, July–August 2021

Variables	Medication administration errors		COR (95% CI)	AOR (95% CI)
	Yes	No		
Age				
20–24 years	91	8	5.00 (2.00 to 12.49)	0.57 (0.10 to 3.30)
25–29 years	118	74	2.87 (1.22 to 6.73)	0.35 (0.06 to 1.95)
30–34 years	19	59	1.80 (0.62 to 5.35)	0.41 (0.08 to 2.09)
≥35 years	13	20	1.0	1.0
Work experience				
<10 years	229	140	4.8 (2.15 to 10.85)	6.48 (1.32 to 31.78)*
≥10 years	12	20	1.0	1.0
Duration of stay in the specific unit				
≤3 months	26	3	1.7 (0.66 to 4.34)	1.57 (0.55 to 4.54)
4–5 months	17	126	0.54 (0.24 to 1.22)	0.54 (0.20 to 1.48)
≥6 months	198	32	1.0	1.0
Work shift				
Day shift	67	115	1.0	1.0
Night shift	86	32	10.40 (4.17 to 26.1)	5.0 (1.82 to 13.78)**
Alternate shift	88	14	1.54 (0.9 to 2.66)	1.47 (0.78 to 2.76)
Take on-the-job training				
Yes	67	20	1.0	1.0
No	174	141	3.9 (2.35 to 6.57)	3.16 (1.67 to 6.00)***
Availability of guideline				
Yes	114	106	1.0	1.0
No	127	55	3.1 (1.83 to 5.32)	2.07 (1.06 to 4.06)*
Faced interruptions				
Yes	147	100	2.46 (1.49 to 4.05)	2.42 (1.3 to 4.49)**
No	94	61	1.0	1.0
Communicate with colleagues				
Yes	196	96	1.0	1.0
No	45	65	1.96 (0.93 to 4.12)	1.85 (0.72 to 4.77)
Reporting errors is important				
Yes	47	19	1.0	1.0
No	194	142	0.57 (0.27 to 1.67)	0.68 (0.29 to 1.57)

*Statistically significant at p<0.05, **significant at p<0.01, ***significant at p<0.001.
Hosmer and Lemeshow test=0.273.
AOR, adjusted OR; COR, crude OR.

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