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Wrong time medication administration errors: Frequency and their causes at Adult University Teaching Hospitals in Zambia

Martin Kampamba[1] *, Tilolele Mwanza[1], Kennedy Saini[2,1], Hanzooma Hatwiko[1], Luke Biete[3] and Christabel Nangandu Hikaambo[1]

[1]Department of Pharmacy, School of Health Sciences, University of Zambia, Lusaka, Zambia.
[2]Department of Pharmacology, Faculty of Medicine, Lusaka Apex Medical University, Lusaka, Zambia.
[3]Deparment of Pharmacy, Ndola Teaching Hospital, Ndola, Zambia.

Wrong-time medication administration errors (WTMAEs) can have serious consequences for medication safety. The study was a cross-sectional study that employed a prospective observation technique and was conducted from 4th June to 20th July 2018 at Adult University Teaching Hospital (AUTH) in the Internal Medicine and Surgery departments. A total of 1749 doses were observed being administered to 325 inpatients and the frequency of WTMAEs was 47.8% (n= 836). Further analysis of WTMAEs was performed of which early and late time medication administration errors accounted for 47.2% (n= 826) and 4.9% (n=86), respectively. In the multivariable regression model, medications administered every 6 h (QID) [AOR=5.02, 95% CI (2.66, 9.46)] were associated with a higher likelihood of being involved in WTMAE. The most common causes of early and late time medication administration errors as reported by nurses were work overload (88.9%) and change in patients' condition (86.1%), respectively. Wrong time medication administration errors were common in the Adult Hospital at AUTH in the two departments studied. Unless effective interventions such as continuous nursing education and the recommended patient to nursing ratio are put in place, WTMAEs will continue to persist and this will in turn, continue compromising patient safety.

Key words: Wrong time medication administration errors, frequency, late medication administration errors, early medication administration errors.

INTRODUCTION

Medication administration errors (MAE) in hospital settings can result in adverse effects, morbidity, increased hospital stay and even mortality (Feleke et al., 2015; Härkänen et al., 2019). MAE is defined as "any difference between what the patient received or was supposed to receive and what the prescriber intended in the original order (Zed et al., 2008; Keers et al., 2018). MAEs have been reported to be the most common types of

medication errors in the medication use process (Krähenbühl-Melcher et al., 2007; Alduais et al., 2014) and there is increasing interest to further study the types of MAEs such as wrong time errors, omission, unordered drug, wrong generic drug, wrong dosage, wrong formulation, wrong route, wrong administration techniques and deteriorated drug (Taufiq, 2015).

Wrong-time medication administration errors (WTMAEs) are a serious medication safety problem and can cause severe injuries resulting in increased hospital stay or even death (Taufiq, 2015). Wrong-time medication administration error can be defined as administering the medication at least 60 min early or late (van den Bemt et al., 2009; Wigiyantoro and Darmawan, 2018). WTMAEs have been reported to be the most prevalent types of administration errors in France (Berdot et al., 2012), the United Kingdom (UK) (Keers et al., 2013), and Ethiopia (Wondmieneh et al., 2020) including certain Asian countries. For example, one study in Pakistan revealed a WTMAEs prevalence of 17% and some identified common causes of these were late receiving of medication from pharmacy, nurses being busy, misplaced medication and forgetting to record the medication administered on time (Taufiq, 2015).

There are certain medications whose administration is required within a specific narrow window to achieve the desired therapeutic goals and to circumvent adverse events (Yang and Nelson, 2016). Therefore, administering medications that are considered a time-critical schedule for 30 min early or late might cause harm or may have huge negative effect on the intended therapeutic outcome (Medved, 2016). The problem of medication errors has been well documented especially in developed countries. Some of the countries have put in place mechanisms, such as care standards and computerised information management systems to improve quality patient care including the reduction of medication errors (Tshiamo et al., 2015).

In Zambia, not much is known about the frequency prevalence and causes of WTMAEs. Therefore, the purpose of this study was to assess the frequency and factors associated with wrong time medication administration errors at the Adult University Teaching Hospitals and generate information that would help in reducing the stated errors.

MATERIALS AND METHODS

Study design and description of study settings

The study was a cross-sectional study conducted from 4th June to 20th July, 2018 at Adult University Teaching Hospital (AUTH) in the Internal Medicine and Surgery departments.

Study design

This was a descriptive study in which data was collected manually from the drug charts after nurses were observed administering medications to inpatients and the pretested questionnaire was administered to nurses to solicit causes of administration errors. The head of nurses in both Internal Medicine and Surgery departments were informed about the objective of the study as well as the nurses that were observed. A single observer who was a clinical pharmacist and was trained to collect data took the responsibility of observing nurses administering medications to inpatients and recorded the time the drugs were administered on the checklist after reviewing the drug charts.

Sample size determination and sampling technique

Cochran formula (N = Z^2 P (100-P)/e^2) was used to calculate sample size based on the following parameters: 30.3% prevalence of WTMAEs (Agalu et al., 2012), ±5% precision level, a 95% confidence level. The target sample size was 325 of patients' prescription medication charts to be reviewed. The sample size was divided between the two departments by the use of probability proportional to size (PPS). Hence, 150 in surgery and 175 treatment prescription drug charts in internal medicine were screened for WTMAEs. The 36 nurses observed administering medications were selected by convenience sampling as the body of knowledge has shown that most drugs are administered by a single nurse (Carabrase et al., 2001).

Data collection

Firstly, nurses were directly observed as they administered medications and later prescription drug charts for all inpatients in the study were prospectively screened for WTMAEs. The basic data in the study was the number of actual errors divided by the total number of opportunities for WTMAEs. What was observed and recorded in the medication charts was written down during data collection including some details about the medication. Observations were carried out on 6 consecutive days per ward excluding Sunday. Medications that were given 60 min earlier or later were considered as WTMAEs. A semi-structured questionnaire was also adopted from Taufiq (2015) which was pretested and modified slightly to meet the objectives of our study and was later administered to the 36 nurses who took part in administering the medications during morning, afternoon and evening shifts. It contained closed and open-ended questions and was used to solicit information on the causes of WTMAEs.

Data analysis

The data was entered in the excel sheet after scrutinizing for its completeness, missing values, and coding of questionnaires and was later imported into Stata version 13.0 for analysis. Adjusted odd ratios at 95% confidence intervals were used to determine the relationship between the independent and the dependent variables. Independent variables with p-value < 0.2 in the unadjusted logistic regression were included into the adjusted logistic regression model and variables with P-value < 0.05 in the final model were considered as associated factors of WTMAEs. The categorical variables were summarized using frequencies and percentages. The mean and standard deviation was used to describe categorical variables. The data was presented using tables and graphs.

Ethics

Permission to conduct this study at the Adult University Hospital

Table 1. Sociodemographic characteristics of nurses, n=36.

Variable	Frequency	%	Mean ± SD
Female	28	77.8	
Male	8	22.2	
Age in years			
18-24	11	30.6	
25-29	21	58.3	26 ± 3
>30	4	11.1	
Working experience in years			
<10	28	77.8	
>10	8	22.2	
Nurse to patient ratio			
>20	36	100	

was obtained from the institution's management and the study was approved by UNZA Health Sciences Research Ethics Committee (Protocol ID: 20171226147). Nurses in Internal Medicine and Surgery departments were informed verbally and in writing about the purpose of the observational study, but not about the prescription drug chart reviews and the informed consent was obtained from the nurses for the observation of administration of medicine.

RESULTS

Socio-demographic characteristics of the nurses

A total of 36 nurses were interviewed and observed administering 1749 doses of medicines to 325 inpatients. The majority 28 (77.8%) of the respondents were female with the mean age of 26 years (SD: ±3), with 28 (77.8%) respondents having had the working experience of less than 10 years while all the 36 (100%) had nurse to patient ratio of greater than 20 as shown in Table 1.

Frequency of wrong time medication administration errors

Out of 1749 doses prescribed over a period of 4 weeks to 325 inpatients, 913 (52.2%) doses were administered on time while 836 (47.8%) were WTMAEs as shown in Figure 1.
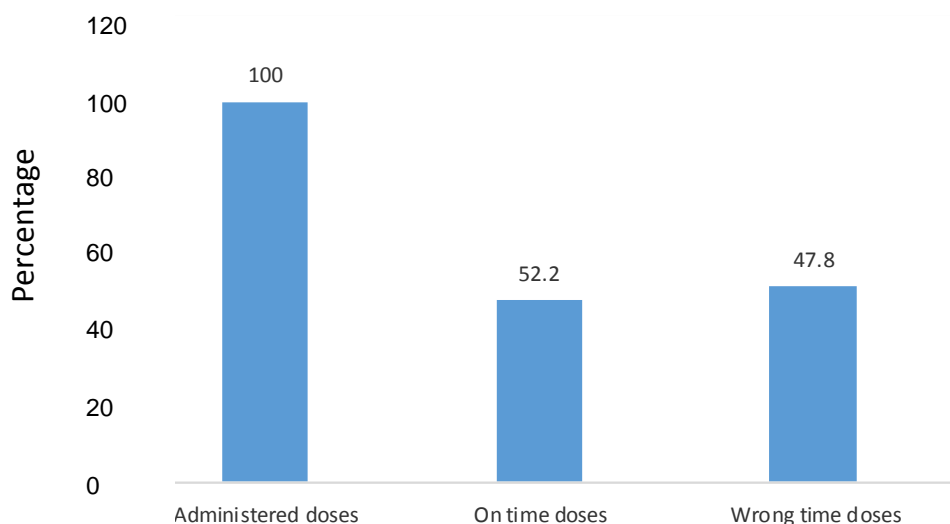
Distribution of wrong time medication administration errors

As shown in Table 2, further analysis of WTMAEs (n=836) was performed of which early and late time

medication administration errors accounted for 47.2% (n= 826) and 4.9% (n=86), respectively. When WTMAEs were distributed according to frequency of administration, the highest number 344 (39%) of WTMAEs was observed among those medications that are given TDS. Regarding work shift, the majority 721 (88.7%) of WTMAEs had occurred during the morning shift compared to afternoon 71 (18.4%) and night 44 (8%) shifts. The highest number 550 (58.3%) of WTMAEs were observed in Internal Medicine than in Surgery Department 286 (35.4%). The WTMAEs were also distributed according to class of medications and the study revealed that antimicrobial drugs were involved in the most 272 (44.2%) of WTMAEs.

Factors associated with wrong time medication administration error

Based on the unadjusted logistic regression analysis, the factors found to be significantly associated with WTMAEs were frequency of drug administration, work shift and departments. After entering the variables in the multivariable regression analysis, the frequency of drug administration and work shift were significantly associated with WTMAEs. In the adjusted logistic regression model, medications that were administered QID) [AOR=5.02, 95% CI (2.66, 9.46)] were associated with a higher likelihood of being involved in WTMAE. Medications that were administered OD [AOR=0.05, 95% CI (0.29, 0.88)], administered TDS [AOR=0.05, 95% CI (0.30, 0.86)], those administered during afternoon shift [AOR=0.02, 95% CI (0.01, 0.03)] and during night shift [AOR=0.01, 95% CI (0.00, 0.01)] were associated with a lower likelihood of WTMAEs. The department and class of drugs were not associated with WTMAE as shown in

Figure 1. Frequency of wrong time medication administration errors (n=1749).

Table 2. Distribution wrong time medication administration errors, n=836.

Variable	Category	On time	Wrong time
Frequency	OD	131 (37.0)	223 (63.0)
	BD	184 (51.1)	176 (48.9)
	TDS	526 (60.5)	344 (39.5)
	QID	72 (43.6)	93 (56.4)
Shifts	Morning	92 (11.3)	721 (88.7)
	Afternoon	316 (81.7)	71 (18.4)
	Night	505 (92)	44 (8)
Department	Internal medicine	392 (41.61)	550 (58.3)
	Surgery	521 (64.6)	286 (35.4)
Class of drugs	Antimicrobial	343 (55.8)	272 (44.2)
	Cardiovascular drugs	174 (42)	240 (58)
	Analgesia drugs	288 (58.9)	201 (41.1)
	Others	108 (46.8)	123 (53.2)

OD: Once daily, BD: Twice daily, TDS: Three times a day, QID: Four times a day, Others: Drugs acting in the central nervous system, Endocrine drugs, Drugs acting in the GIT.

Table 3.

Cause of late medication administration errors

According to the nurses' response, the main causes of late medication administration errors were work overload (88.9%) followed by unavailability of drugs at the pharmacy (86.1%) while the lowest was the nurse inexperience (13.9%) as shown in Figure 2.
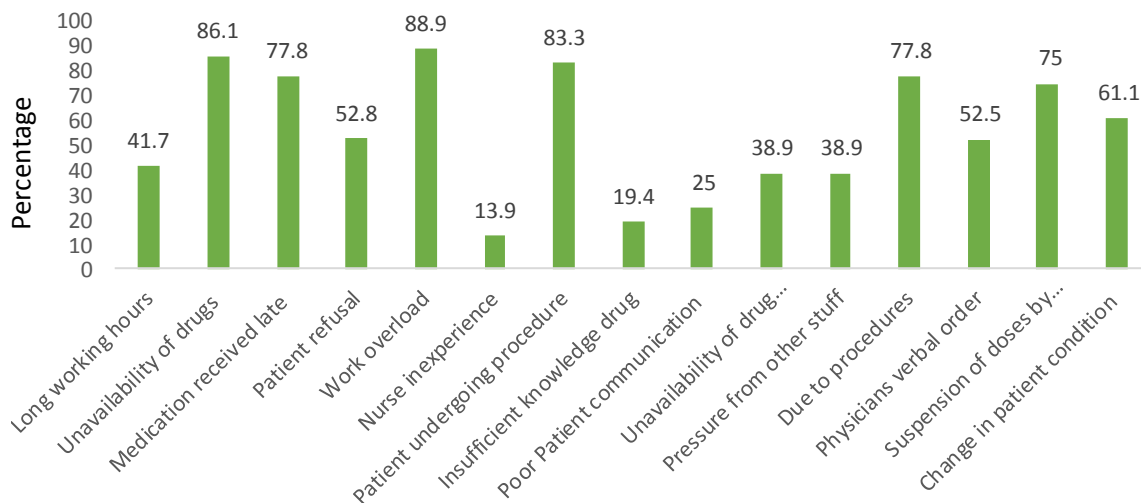
Causes of early medication administration errors

As shown in Figure 3, the main cause of early WTMAEs was the change in patients' condition (86.1%) followed by

Table 3. Unadjusted and adjusted analysis of factors associated with the WTMAEs.

Variable	Category	Unadjusted			Adjusted		
		UOR	95% CI	P-value	AOR	95% CI	P-value
Frequency	BD	Ref			Ref		
	OD	1.78	1.32, 2.40	0.001*	0.50	0.29, 0.88	0.016*
	TDS	0.68	0.53, 0.88	0.003*	0.50	0.30, 0.86	0.013*
	QID	1.35	0.93, 1.96	0.112	5.02	2.66, 9.46	0.001*
Shift	Morning	Ref			Ref		
	Afternoon	0.03	0.02, 0.04	0.001*	0.02	0.01, 0.03	0.001*
	Night	0.01	0.01, 0.02	0.001*	0.01	0.00, 0.01	0.001*
Department	I.M	Ref			Ref		
	S	0.39	0.32, 0.47	0.001*	0.79	0.55, 1.14	0.203
Class of Drugs	AMD	Ref			Ref		
	CVD	1.73	1.35, 2.24	0.001*	1.00	0.59, 1.69	1.000
	AD	0.88	0.69, 1.12	0.298	1.04	0.70, 1.54	0.862
	Others	1.43	1.06, 1.95	0.019*	1.16	0.66, 2.02	0.609

CI: Confidence Interval, IM: Internal Medicine, S: Surgery AMD: Antimicrobial drugs, CVD: Cardiovascular Drugs, AD: Analgesic drugs, Others: Drugs acting in the central nervous system, Endocrine drugs, Drugs acting in the GIT. UOR: unadjusted odd ratio, AOR: adjusted odd ratio. *P value < 0.05.
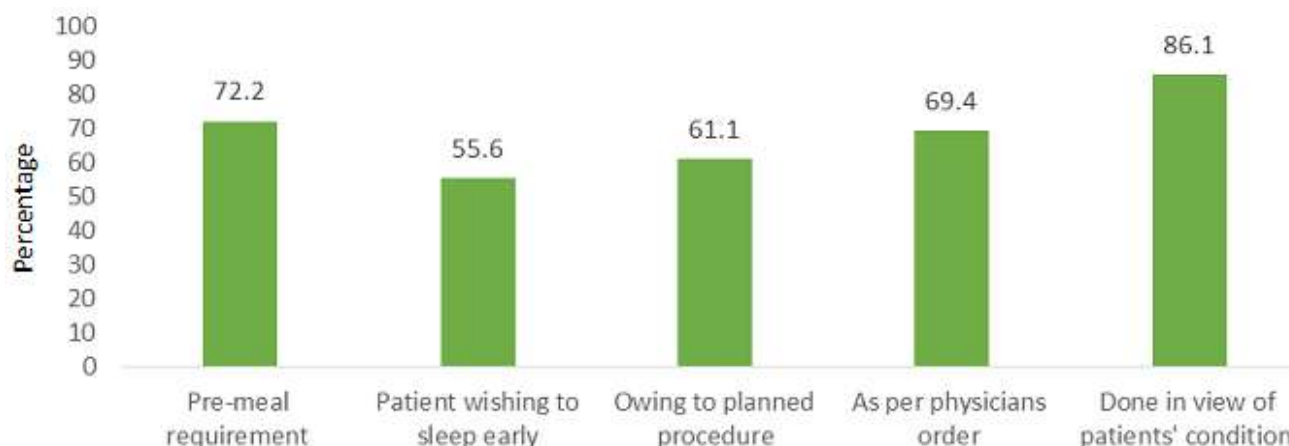

Figure 2. Causes for late medication administration errors.

medication administered early as pre-meal requirement (72.2%) while the lowest reason was patient wishing to sleep early (55.6%).

DISCUSSION

The body of knowledge has established that 10% of patients are harmed by healthcare, the primary cause of which seem to be associated with adverse effects of medication (de Vries et al., 2008; Cottney, 2015; Rostami et al., 2019). Many studies have reported that these preventable drug adverse effects are caused by medication errors, the administration medication errors being the most common (Elliott et al., 2018; Rostami et al., 2019). In this study, it was found that the frequency of WTMAEs was 47.8% of which early and late time medication administration errors accounted for 47.2 and

Figure 3. Causes of early medication administration errors.

4.9%, respectively. The frequency of drug administration and work shift were significantly associated with WTMAEs at p-value of $< = 0.05$ and most causes of early and late medication administration errors as reported by respondent were change in patients' condition and work overload, respectively.

The study revealed that the frequency of WTMAEs was 47.8% lower than studies done in Ethiopia which found 53.6% (Feleke et al., 2015), 51% in Kenya (Simiyu et al., 2018) and 54.1 and 51.7% in the USA's medical and surgical wards, respectively. Much higher rates of WTMAEs were reported in Switzerland (78.4%) and Ethiopia (58.5%) (Alemu et al., 2017). The difference between the finding of the current study and those of others cited here could be partly explained by the difference in methodology and study settings.

The frequency of WTMAEs identified in this study is higher than 43% reported in South Africa, 40.2% in the USA (Kim et al., 2018), 30.9% in Saudi Arabia (Blignaut et al., 2017; Aboshaiqah, 2014), 27.5% in Pakistan (Raja et al., 2019) and 20.8% in France (Berdot et al., 2012). Moreover, the rate of WTMAEs for this study is extremely higher than the 14.2% which was reported in China (Tsang et al., 2014), 17% in Pakistan (Taufiq, 2015) and 25.2% reported in Malaysia (Chua et al., 2009). This could be due to the differences in methods used to calculate medication administration error rate and nurse to patient ratio which is usually high in developing countries like in the Zambian set up. Irrespective of the reasons, medication errors of this magnitude are likely to result in harming the patient and erode public confidence in medical care.

The study also showed that the frequency of WTMAEs in internal medicine was higher (58.3%) than that observed in the department of surgery (35.4%). This is contrary to a study done by Taufiq (2015) which reported

that WTMAEs were more prevalent in the surgical unit (83%) compared to the medical unit (81%). The difference in the results could be that in our study, more doses were observed being administered to inpatients in internal medicine than in Surgery department. The current study also revealed that 58% of cardiovascular drugs were involved in WTMAEs followed by antimicrobial drugs (44.2%). This is in support of the previous studies which found the similar results (Patel et al., 2016, 2018).

This study also revealed that the medications that are given QID are significantly likely to be involved in WTMAEs. The contributing factor to this could be the schedule for dug administration that has been put in place in respective wards at AUTHs that is 06, 12, 18 and 22 h. Therefore, all the last doses of the drugs that are given QID were most likely to be given 2 h earlier. This may highlight the need to pay close attention to drugs that are administered QID. The current study also revealed that afternoon shift and night shift were associated with a lower likelihood of WTMAE when compared to their related morning shift. The current study finding is similar to a study in Nigeria and Pakistan which revealed that morning shift nurses were prone to medication errors than those working in other shifts (Ayorinde and Alabi, 2019; Raja et al., 2019). However, this finding is incomparable to previous studies where medication administrations errors were perceived to occur more with night shift (Souzani et al., 2007; Abdar et al., 2014; Taufiq, 2015). The reason for this difference could be that the majority of the doses in our study were administered during the morning shift and this might have led to increased workload as it is linked to the causes of medication administration errors (Mahmood et al., 2011; Gorgich et al., 2016; Ayorinde and Alabi, 2019). The working areas of nurses (departments) and class of drugs

were not associated with WTMAEs. In one study, working area was found to be associated with WTMAEs and this could be attributed to different study settings (Raja et al., 2019).

In order to make a successful intervention and decrease WTMAEs, probable causes of WTMAEs need to be identified (Kim et al., 2018). Therefore, further analysis of WTMAEs was done and found that early and late time medication administration errors accounted for 90.6 and 9.4%, respectively. When nurses were asked to state the causes of early or late WTMAEs, late WTMAEs were mostly attributed to work overload (88.9%) and this is consistent with the nurses to patient ratio reported in this study which was 1 nurse to greater than 20 patients. Other studies done in France (Berdot et al., 2012), Ethiopia (Feleke et al., 2015) and Rwanda (Nkurunziza et al., 2019) also highlighted work overload as the main cause of administration errors. Tauifiq (2015) reported that medications received late from pharmacy and work overload were the main reason for the cause of late WTMAEs. In this study, it was found that change in patients' condition (86.1%) followed by medication administered early as pre-meal requirement (72.2%) were the main causes of early WTMAEs. This is supported by the study that was conducted in Pakistan that revealed that medication administered early as pre-meal requirement was one of the causes of early WTMAEs (Taufiq, 2015).

Study limitations

Nurses were not observed during Sundays, and therefore the applicability of the results on those days is unknown. It is also possible that the Hawthorne effect increased on observed nurses as they were aware that they were being observed to identify problems in the medication use process. However, most studies have adopted observation method as a gold standard for data collection in these types of studies.

Conclusion

Wrong time medication administration errors were common in the Adult UTH in the two departments studied. The overall frequency of wrong time medication administration errors was 52.1% of which early and late time medication administration errors accounted for 90.6 and 9.4%, respectively. The work overload and medication administered early as pre-meal requirement were reported as the cause of late and early wrong time medication administration errors. Unless effective interventions such as continuous nursing education and recommended patient to nursing ratio are put in place, WTMAEs will continue to persist and this may in turn

continue compromising patient safety.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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