

Potential medication errors and their predictors among hospitalized pediatric patients at a tertiary hospital in Tanzania

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Abstract

Background

Medication errors (ME) are the most common preventable cause of undesired adverse events in clinical practice and represent a significant public health burden, particularly in pediatrics. Despite their considerable risk, data on the extent of medication errors in pediatric populations remain limited, especially in resource-limited African countries, including Tanzania. This study was done to assess the prevalence and predictors of potential medication errors (PME) among pediatric patients admitted to Muhimbili National Hospital (MNH) in Tanzania.

Methods

A hospital-based cross-sectional study was conducted from April to June 2024 at the Pediatric wards of Muhimbili National Hospital, Tanzania. A total of 365 participants were recruited consecutively during the study period. Data was collected using a structured questionnaire.

Results

The Prevalence of ME was found to be 72.1%. Duration errors 65.2% (238) and route errors 42.2% (154) were the most predominant ME. Commonly prescribed medications included vitamins/minerals (35.6%), bronchodilators (23.6%), and antibiotics (21.1%). Significant predictors of medication errors included shorter hospital stays (adjusted odds ratio [AOR]: 4.886, 95% CI: 2.702–8.835), absence of previous medication errors (AOR: 2.558, 95% CI: 1.393–4.697), and lack of medication error training for healthcare workers especially dispensers (AOR: 11.4, 95% CI: 4.945–26.348). Infrastructure factors, such as the absence of a dose reconciliation protocol, were also associated with increased odds of potential medication errors (AOR: 2.097, 95% CI: 0.793–4.912).

Conclusion

This study found a high prevalence of potential medication errors among pediatric patients. Significant predictors of medication errors identified include hospital stay of less than 5 days, lack of previous medication history, absence of medication error training for healthcare workers, and the absence of a dose reconciliation protocol.

Introduction

Medication errors (ME) can be defined as unintended failure in the drug treatment process that leads to or has the potential to cause harm to the patient (1). They include errors in the overall spectrum of drug delivery process involving prescribing, transcribing, dispensing, administering or monitoring regardless

of the occurrence of injury or potential injury. ME can result primarily from human errors or system defects within healthcare settings (1, 2).

ME are among the main contributors of preventable harms resulting from medical errors which collectively are estimated to be the third leading cause of death in the United States (US). According to the Institute of Medicine (2), on average every hospitalized patient is subjected to at least one medication error per day. Compared to adults, pediatric patients are at significantly higher risk of experiencing MEs primarily due to several factors such as the use of adult formulated medications and the need to change original dosages (3) therefore making medication errors (MEs) an important cause of morbidity and mortality in this patient population(4).

Despite advances in pediatric pharmacology, medication-related errors continue to be a serious concern, particularly in resource-limited settings such as sub-Saharan Africa (5). For example, a study conducted in Ethiopia reported a high prevalence of ME in pediatric hospital patients with an alarming rate of 89.9% (6). In Tanzania, there is still limited data on the prevalence and types of medication errors encountered in pediatric care, highlighting the need for further research to inform healthcare safety practices. A decade-old study in Dar es Salaam, Tanzania found that errors of omission and commission in prescription writing, accounted for 3.1% of all prescribed medicines. Another study conducted in 2018 in Kilimanjaro region identified errors by omission as the leading cause of prescription errors (7, 8).

Developing successful interventions and improving drug management procedures in pediatric healthcare settings requires an understanding of the factors causing these errors. Therefore, this study aimed at assessing the prevalence of potential medication errors (PME) and identify their predictors among pediatric patients admitted to Muhimbili National Hospital (MNH) in Tanzania.

Methods

Study Design and Setting

A hospital-based quantitative cross-sectional was conducted from April to June 2024 at the pediatric wards of Muhimbili National Hospital located in Dar es salaam, Tanzania. MNH is a national referral hospital, research center and university teaching hospital with 1,500 bed capacity and attending 2,000 outpatients per day.

Study Population

The study population comprised 365 hospitalized pediatric patients under the age of 18 years. Healthcare workers involved in the treatment of these patients were also included for evaluating PME predictors. The Inclusion criteria for the study were pediatric patients admitted for at least 24 hours and prescribed at least one medication. Assent was obtained from children aged 7–17 and consent was sought from parents/guardians of all participants.

A total of 51 healthcare workers involved in the management of the recruited pediatric patients were included for the assessment of predictors of potential medication errors. These comprised physicians (specialists, registrars, and intern doctors), nurses (registered nurses and intern nurses), and pharmaceutical personnel (pharmacists, pharmaceutical technicians, and pharmacy interns). Their characteristics, including qualification, work experience, workload, and training in medication error prevention, were collected in relation to patient care. Written informed consent was obtained from all healthcare workers prior to participation in the study

Sample size estimation

The sample size was determined using a single population proportion formula: $n = [(z_{\alpha/2})^2 p(1-p)] / d^2$ with the assumption that $Z = 1.96$, the proportion of PME $p = 69.5\%$ as reported in the study conducted in public hospitals of Gamo zone, Southern Ethiopia(9) and marginal error $d = 5\%$. The study population from the study sites was estimated to be 365 paediatric patients with a non-response rate of 10%. All healthcare workers serving the sampled paediatric patients during the data collection period were enrolled.

Ethical approval and consent to participate

Ethical approval for this study was granted by the Muhimbili University of Health and Allied Sciences Institutional Review Board (MUHAS-IRB) with Reference Number DA.282/298/01/C/2113. Permission to conduct the study was granted by Muhimbili National Hospital (MNH). The study was conducted in accordance with the Declaration of Helsinki for research involving human participants and complied with all relevant institutional and national ethical guidelines and regulations. Written informed consent was obtained from parents or legal guardians of all participating children, and assent was obtained from children aged 7–17 years prior to participation. Participation was voluntary, and all participants were informed about the study purpose, procedures, risks, and benefits before enrolment

Data Collection

Data were collected using a structured, pretested questionnaire and an observational checklist developed based on relevant literature and the study objectives. The tool consisted primarily of closed-ended questions with predefined response options, consistent with a quantitative survey approach.

The questionnaire captured data across five major domains:

1. Socio-demographic characteristics: including age, sex, weight, residence, and caregiver involvement in decision-making.
2. Healthcare provider characteristics: including qualification, years of experience, workload, and training in medication error prevention.

3. Clinical characteristics of the child: including diagnosis, severity of illness, prior medical conditions, previous admissions, and medication history.
4. Medication order data: including prescribed medications, dose, frequency, route of administration, duration, and completeness of prescription components.
5. Medication administration and error assessment: including direct observation of medication preparation and administration practices such as dose calculation accuracy, timing, route correctness, missed doses, administration of unprescribed drugs, and patient identification.

Data analysis

Data was analyzed by using IBM SPSS version 27. Descriptive statistics were performed for categorical variables, utilizing frequency and percentages. Continuous variables that followed a normal distribution were summarized using means and standard deviations, while non-normally distributed continuous data were represented by medians and interquartile ranges. Univariable logistic regression analysis was performed to assess associations, followed by multivariable regression for factors with $p < 0.2$.

Results

Social demographic characteristics.

A total number of 365 participants were enrolled in the study, of whom 54.5% were females. Among the participants, 47.7% were aged between 1–17 years. The most common diagnoses were sepsis (27.1%) and respiratory distress syndrome (21.6%).

Medication-Related Findings.

Vitamins/minerals (35.6%) and bronchodilators (23.6%) were the most prescribed medications among the hospitalized pediatric patients during the study period, Fig. 1. Furthermore, the majority of PME cases (78.3%) were observed in patients on more than 4 medications.

Prevalence and types of PMEs

The overall prevalence of PME among hospitalized pediatric patients at MNH was 72.1%. Among these, the most frequent PMEs observed were duration errors (65.2%) and route errors (42.2%) followed by frequency and dose errors, Fig. 2.

Predictors of PMEs

Univariable and multivariable analysis identified several predictors of PME as summarized in Table 1. In the univariable analysis, factors significantly associated with PME included age, hospital stays, previous medication history, number of medications, prescriber's experience, prescriber workload, prescriber

training on MEs, administrator’s training on ME, dispenser’s qualification, dispenser’s work experience, dispenser’s MEs training, dose reconciliation protocol and medication preparation room. After adjusting for confounders in the multivariable analysis, significant predictors included short hospital stays (< 5 days): AOR: 4.89 ($p < 0.001$), absence of previous medication history: AOR: 2.56 ($p = 0.002$) and lack of medication error training for healthcare dispensers: AOR: 11.40 ($p < 0.001$), Table 1.

Table 1
Predictors of PME

Variable	COR (95% C.I)	p-value	AOR (95% C.I)	p-value
Age				
0–28 days	1.434(0.864–2.378)	0.163	0.658(0.381–1.137)	0.134
29 days- 12months	0.931(0.473–1.830)	0.835	0.990(0.457–2.097)	0.978
1–17 years	Ref			
Hospital stays				
Less than 5 days	0.190(0.107–0.337)	< 0.001	4.886(2.702–8.835)	< 0.001
More than 5 days	Ref			
Previous medication history				
No	0.425(0.243–0.744)	0.003	2.558(1.393–4.697)	0.002
Yes	Ref			
Number of medications				
Less than 2	0.453(0.250–0.822)	0.009	1.906(0.986–3.681)	0.055
2–4	0.855(0.470–1.556)	0.608	0.926(0.484–1.773)	0.818
More than 4	Ref			
Prescriber's education				
Medical intern	0.731(0.434–1.230)	0.731		
Medical registrar	1.073(0.574–2.003)	0.826		
Registrar	Ref			
Prescriber's experience				
Less than a year	1.021(0.621–1.680)	0.934	1.332(0.749–2.369)	0.330
More than 3 years	2.933(1.267–6.790)	0.012	0.381(0.153–0.947)	0.038
1–3 years	Ref			
Prescriber's workload				
1–5	3.118(0.378–25.705)	0.291	0.534(0.052–5.435)	0.596
6–10	2.864(1.246–6.585)	0.013	0.330(0.133–0.818)	0.017
More than 10	Ref			
Prescriber's training on MEs				

Variable	COR (95% C.I)	p-value	AOR (95% C.I)	p-value
No	0.254(0.076–0.856)	0.027	0.873(0.165–4.625)	0.873
Yes	Ref			
Administrator's education				
Nursing officer	0.793(0.379–1.658)	0.538		
Assistant nursing officer	0.955(0.454–2.011)	0.904		
Intern nurse	Ref			
Administrator's training on ME				
No	0.306(0.134–0.700)	0.005	2.21690.710–6.913)	0.171
Yes	Ref			
Administrator's work experience				
Less than 3 years	0.771(0.319–1.868)	0.565		
More than 3 years	0.986(0.437–2.223)	0.973		
1–3 years	Ref			
Dispensers' qualification				
Intern pharmacist	0.694(0.423–1.138)	0.148	0.735(0.333–1.754)	0.912
Pharmaceutical technician	0.880(0.320–2.421)	0.805	0.928(0.297–2.897)	0.898
Pharmacist	Ref			
Dispenser's work experience				
Less than 3 years	0.161(0.021–1.248)	0.080	0.818(0.250–3.124)	0.467
More than 3 years	0.203(0.260–1.595)	0.129	0.495(0.450–2.409)	0.144
1–3 years	Ref			
Dispenser's MEs training				
No	0.073(0.033–0.164)	< 0.001	11.4(4.945–26.348)	< 0.001
Yes	Ref			
Dose reconciliation protocol				
No	3.127(1.288–7.594)	0.012	2.097(0.793–4.912)	0.05
Yes	Ref			
Medication preparation room				

Variable	COR (95% C.I)	p-value	AOR (95% C.I)	p-value
No	2.122(0.568–3.912)	0.02	0.135(0.122–0.983)	0.612
Yes	Ref			

Figure 2: **Types of PME (n = 365)**

Discussion

This study aimed to assess the prevalence of potential medication errors (PME) and identify their predictors among pediatric patients admitted to Muhimbili National Hospital (MNH) in Tanzania. The findings suggest a high prevalence of PMEs, at 72.1% among pediatric patients at MNH, consistent with global trends albeit with minor differences. Our findings are comparable to those from studies conducted in Jimma University Specialized Hospital (JUSH) pediatric ward in Ethiopia, (10), west Ethiopia (11), and South Africa (12), which reported prevalence rates of 89.9%, 75.1% and 78% respectively. The slight differences observed in these studies could be attributed to factors such as healthcare provider's workload, experience and qualification, availability of medication error-specific sessions of training, facilities infrastructure, medication reconciliation protocols, and computerized medication chart and dose calculation machines.

Our findings also identified duration errors as the most frequent type of PME encountered, followed by route errors. These findings are consistent with previous studies indicating that pediatric patients are particularly vulnerable to ME due to the complexity of dosing calculations and the need for individualized medication regimens. For instance, a study by Burns et al. reported an overall rate of 15.5 PME per 105 bed days, with prescribing and administration being the main contributors (13).

Key predictors such as lack of previous medication history underscore the need for focused interventions. The possible justification is that the absence of a well-coordinated electronic prescription system in the country, and lack of a medical error-monitoring system could all be cited as contributing factors to this error. Evidence suggests that computerized provider order entry with electronic medication alert systems reduces prescription errors (9).

Shorter hospital stays and the absence of previous medication history were linked to higher odds of ME. This observation suggests that shorter hospital stays may increase the risk of errors because of insufficient medication reconciliation during hospital stay which may be contributed by workload, hence insufficient time for patients monitoring. This finding contrasts with some studies that suggest longer hospital stays are associated with higher error rates due to increased medication exposure (14).

Greater prescriber experience was associated with lower odds of errors. This shows that more experienced prescribers are less prone to making errors and have greater ability to manage complex drug regimens. Less experienced prescribers, on the other hand, might not have the knowledge or abilities needed to avoid common medication management errors. These findings align with findings

from a study in Northern Ethiopia indicating that factors such as healthcare professionals' educational background and experience play crucial roles in mitigating ME (15).

Healthcare worker training emerged as a critical factor in reducing PMEs. Training programs, dose reconciliation protocols, and ensuring continuity of patient medication history are vital steps in addressing the high PME rates observed.

Conclusion

This study found a high prevalence of potential medication errors among pediatric patients. Significant predictors of medication errors identified include hospital stay of less than 5 days, lack of previous medication history, absence of medication error training for healthcare workers, and the absence of a dose reconciliation protocol. This study calls for further research in Tanzania to enhance medication error training among healthcare workers, developing standardized reconciliation protocols, as well as improving hospital infrastructure regarding medication prescription, dispensing and administration.

Abbreviations

ADE	Adverse Drug Event
ADRs	Adverse Drug Reaction
PME	Potential Medication Error
MNH	Muhimbili National Hospital
ICU	Intensive Care Unit
ME	Medication error(s)

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the Muhimbili University of Health and Allied Sciences (MUHAS), and permission to conduct the study was granted by Muhimbili National Hospital (MNH). The study was conducted in accordance with the Declaration of Helsinki for research involving human participants and complied with all relevant institutional and national ethical guidelines and regulations. Written informed consent was obtained from parents or legal guardians of all participating children, and assent was obtained from children aged 7–17 years prior to participation. Participation was voluntary, and all participants were informed about the study purpose, procedures, risks, and benefits before enrolment

Availability of data and material

The data sets used and analyzed during the current study are available upon reasonable request from the corresponding author.

Competing interest

The authors declare no conflicts of interest.

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This study was part of an academic qualification and did not receive any funds.

Author's contributions

JRT: Conceptualization and design of research, data collection, data analysis, interpretation of the results, and manuscript writing. HBI: Manuscript review and data interpretation, RC: Data collection, Manuscript review and data interpretation, MAM: Data collection, Manuscript review and data interpretation, GM: Manuscript review and data interpretation. GGN: Manuscript review and data interpretation. MAM: Manuscript review and data interpretation, RFM: Approved the research idea and research design, interpretation of the results, review of the manuscript, final approval of the manuscript. AIM: Approved the research idea and research design, interpretation of the results, review of the manuscript, final approval of the manuscript

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Figures

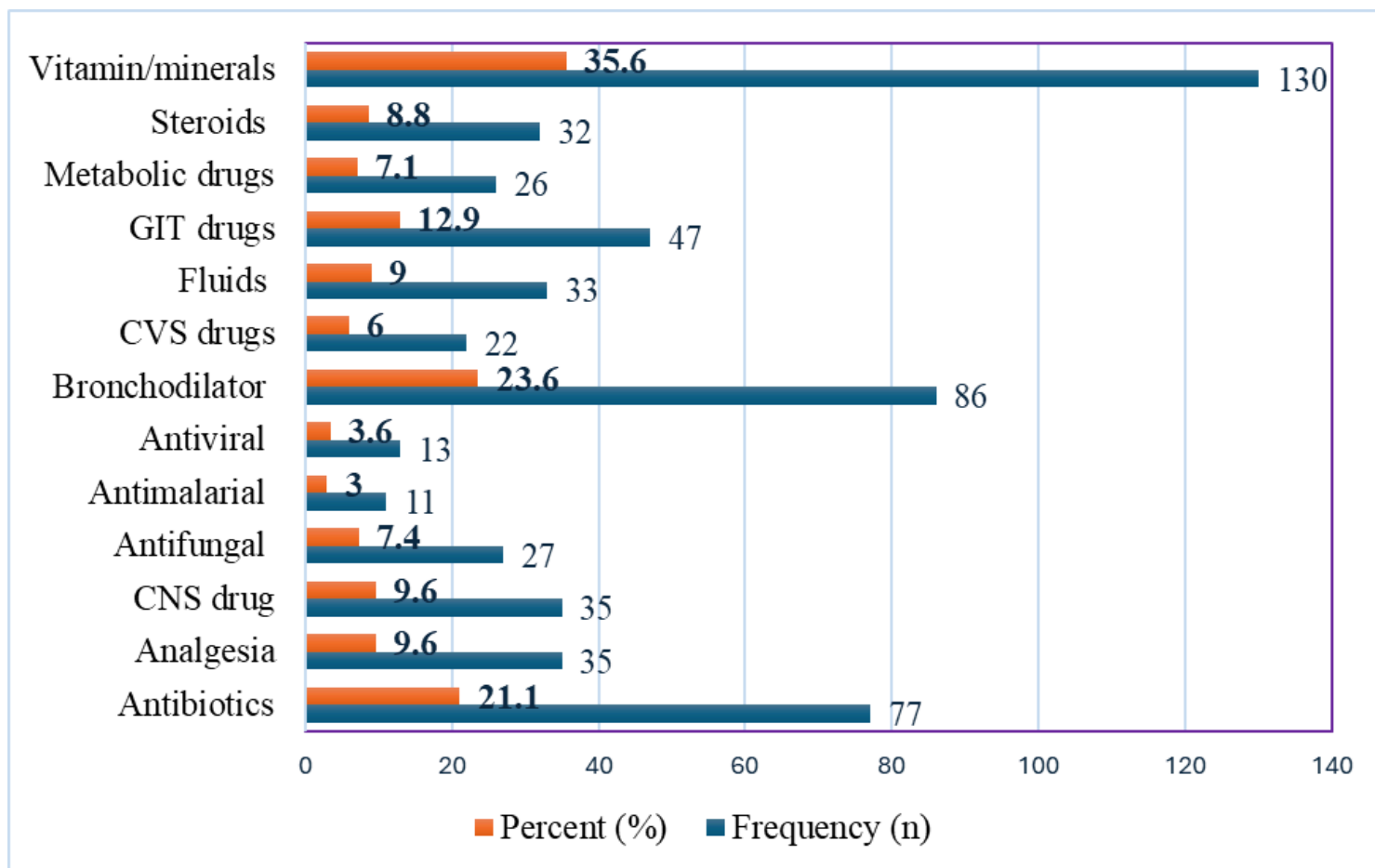


Figure 1

Classification of medications

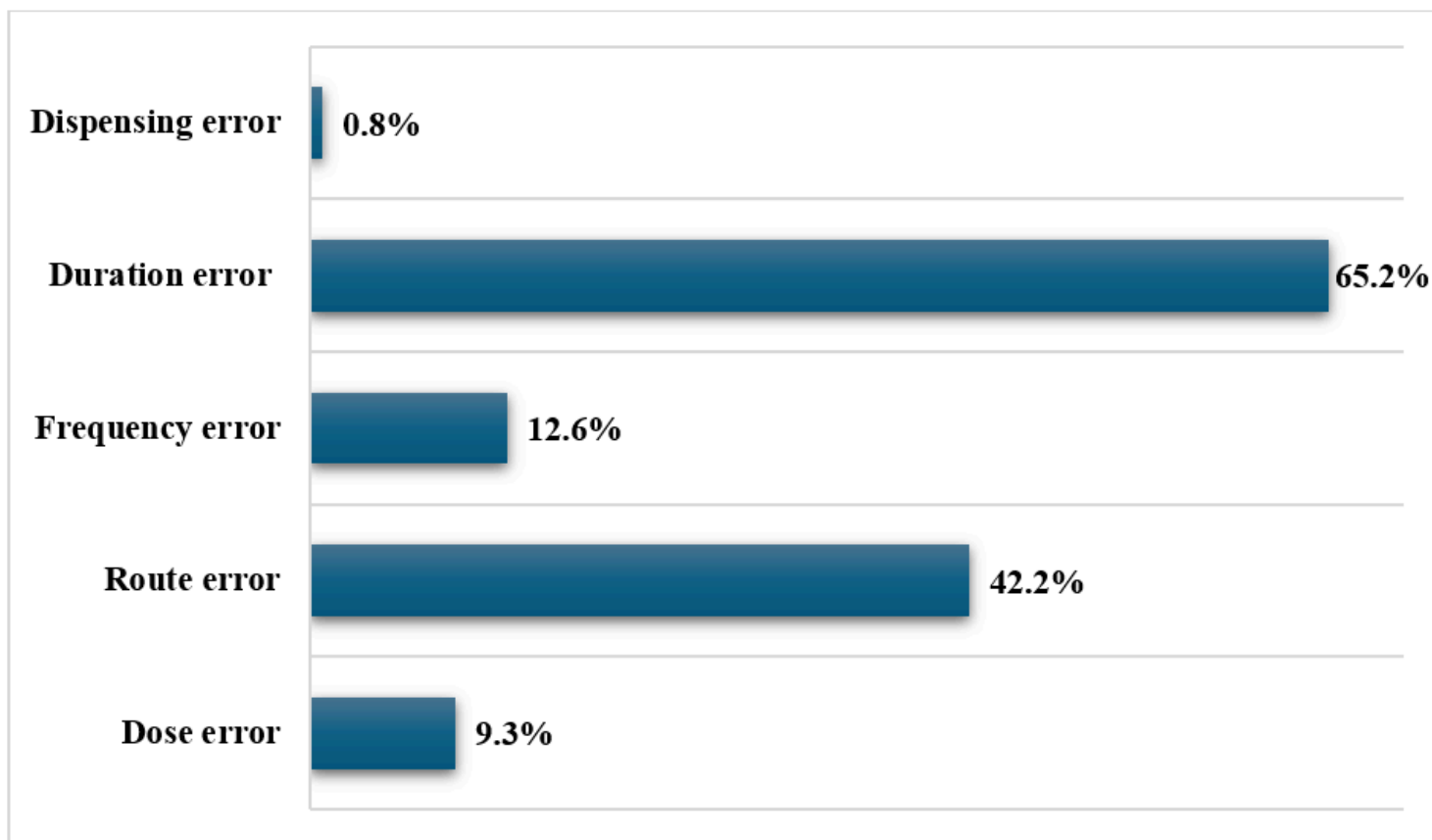


Figure 2

Types of PME (n=365)

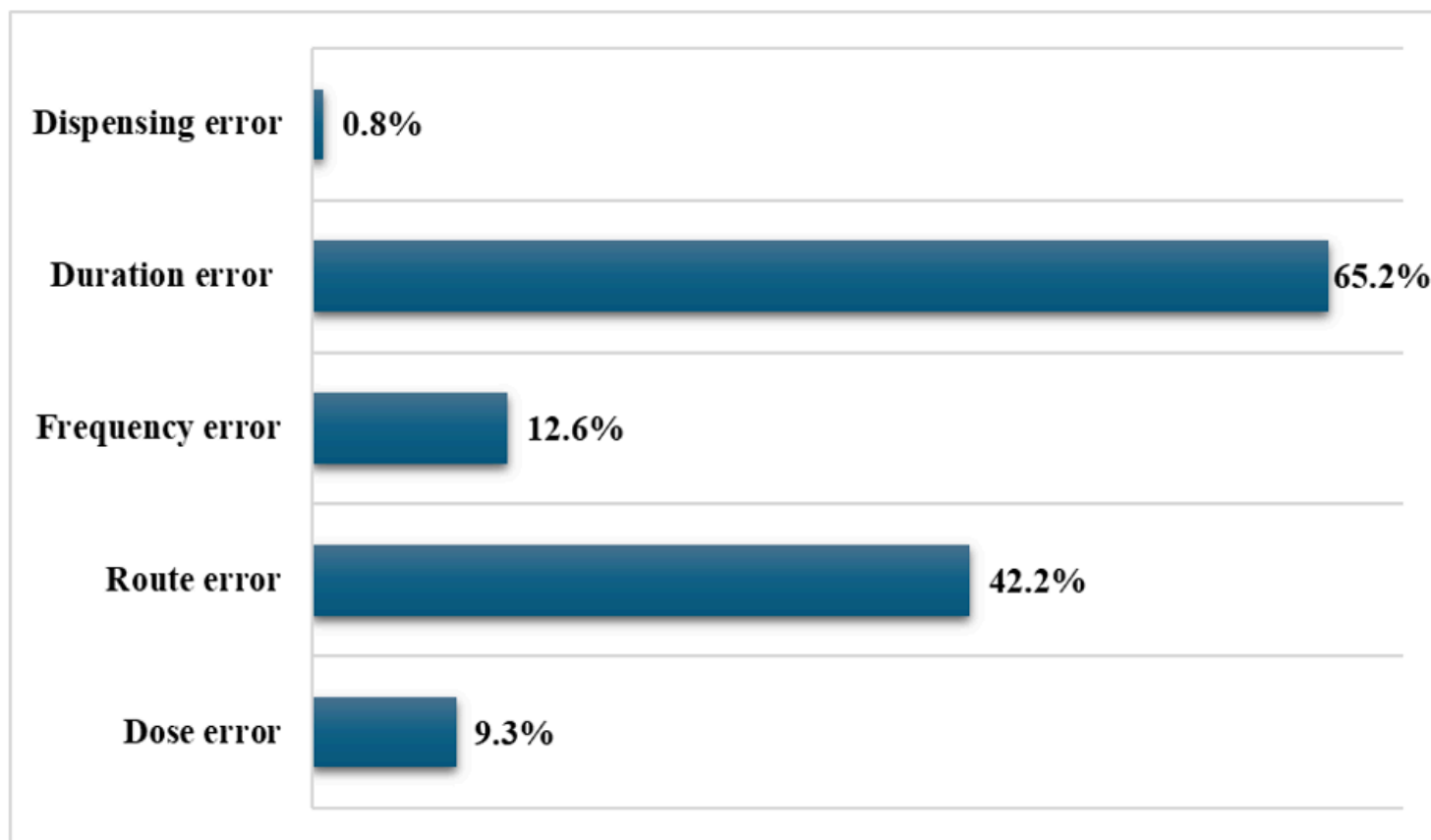


Figure 3

Figure 2: Types of PME (n=365)

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