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ORIGINAL RESEARCH

Medication Errors Among Hospitalized Adults in Medical Wards of Nekemte Specialized Hospital, West Ethiopia: A Prospective Observational Study

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Purpose: A high prevalence of medication errors in older adults are due to a combination of different factors such as polypharmacy, polymorbidity, enrolment in several disease-management programs, and fragmentation of care that causes medication errors in all age groups. This study aims to assess the incidence and determinants of medication errors among hospitalized adults in medical wards of Nekemte Specialized Hospital (NSH), West Ethiopia.

Patients and Methods: A prospective observational study design was conducted at Nekemte Specialized Hospital among hospitalized adults from October 30, 2018 to January 30, 2019. Data were collected by using checklist-guided observation and review of medication order sheets, medication administration records, and patient charts. To identify the independent predictors of medication errors, logistic regression analysis was used. Statistical significance was considered at a p-value <0.05.

Results: A total of 351 patients were included in the present study. The mean age of the patients was 40.67+15.78 years. A total of 813 medication errors were recorded. The most common stage for medication errors was physician ordering 263 (32.4%). In the multi-variable analysis, age ≥65 years (AOR: 2.54, 95%CI: 1.12–5.75, p=0.025), hospital stay ≥7 days (AOR: 2.16, 95%CI: 1.17–3.98, p=0.014), number of medication taken (AOR: 1.75, 95%CI: 1.13–2.73, p=0.013) and presence of comorbidity (AOR: 1.57, 95%CI: 1.01–2.46, p=0.049) had shown statistical significance in predicting medication errors.

Conclusion: Medication errors are common at Nekemte Specialized Hospital with an incidence of 48.3 per 100 orders, 231.6 per 100 admissions, and 433.4 per 1000 patient days. In particular, adults with older age, increased hospital stay, a greater number of medications, and presence of comorbidities were at greater risk for medication errors.

Keywords: medication error, incidence, determinants, adults, Ethiopia

Introduction

A medication error (ME) is any preventable event that has the potential to lead to inappropriate medication use or patient harm; it occurs during prescribing, transcribing, dispensing, administering, adherence, or monitoring a drug.[1,2]

The medication use process that comprises prescribing, preparing and administering medications is reliant on a variety of processes anticipated to confirm that patients receive the appropriate treatment. Their safety will be compromised if there is a problem in any phase of either the medication process or an organizational system and this increases the likelihood that a patient will not receive the correct medication.[3]

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Different studies revealed physician ordering is the most frequently observed stage of integrated medication delivery that is associated with errors, followed by nursing administration, transcription errors, and pharmacy dispensing errors.[4,5]

The most commonly reported errors include: inappropriate medication; incorrect dosage or frequency; wrong route; failure to recognize drug–drug interactions; lack of monitoring; missed/late dose errors with delayed drug administration; and inadequate communication.[6,7]

In many clinical settings, adverse drug events (ADEs) and MEs are common and can occur at any point in the process of medication use. About a third to half of ADEs are typically associated with MEs.[5] Medication errors cause 18.7–56% of all ADEs and a large number of ADRs with negative patient health outcomes and negative economic impact each year among hospitalized patients.[8,9] ADRs refer to any unexpected, unintended, undesired, or excessive response to a medicine.[1]

A high prevalence of MEs in older adults results from the accumulation of factors that contribute to MEs in all age groups; such as polypharmacy, polymorbidity, enrolment in several disease-management programs, and fragmentation of care (the lack of collaboration between health-care providers and/or health-care organizations); and specific geriatric aspects; these include age-related pharmacological changes, lack of specific evidence on the efficacy and safety of medications, underuse of comprehensive assessment, less availability of drug formulations, and inadequate harmonization of recommendations among geriatrics across Europe.[10] In Ethiopia there are limited studies done on medication errors, this study focuses on assessing medication errors among adults and elderly. Older people are prone for medication errors due to age-related or disease-related physiological and pathological changes that impact on pharmacokinetics and pharmacodynamics, such as impaired renal and hepatic function, altered body composition (eg less muscle mass) and altered homeostatic mechanisms.[11] This study aims to determine the incidence and determinants of medication errors among hospitalized adults in medical wards of Nekemte Specialized Hospital, West Ethiopia.

Patients and Methods
Study Design and Setting
A prospective observational study design was conducted at Nekemte Specialized Hospital (NSH) among hospitalized adults from October 30, 2018 to January 30, 2019.

The research was conducted at the NSH medical ward which is found in Nekemte town, Oromia Region, Western Ethiopia, 311 km away from the national capital city, Addis Ababa. NSH is one of the oldest public hospitals in the Oromia region delivering service since 1932. Data of hospital inception is not as important as estimated number of admissions. It provides services in different specialty areas such as surgery, gynecology and obstetrics, pediatrics, internal medicine, psychiatry, chronic disease clinic, and emergency and critical care.

Sample Size Determination and Sampling Technique
All adult patients admitted to medical wards during the three months of the data collection period and who fulfilled inclusion criteria were studied. A convenient sampling method was used.

Inclusion and Exclusion Criteria
All adult patients who are admitted to the medical wards of NSH during the study period and taking one or more medications for treatment or prophylaxis and stayed for at least 24 h in the ward. Patients with incomplete data who were transferred from other wards into medical wards and who were transferred from medical wards to other wards were excluded.

Data Collection Process and Data Quality Assurance
Data were collected prospectively from chart review by visiting the ward daily and reviewing discharge summary, procedure notes, physician orders, medication administration records, physician progress notes, pertinent laboratory reports, nursing/multidisciplinary progress notes and data about drug exposure was assessed for MEs. Interview of patients and/or parents/family was also made to identify MEs.

Medication errors were identified in accordance with the standard treatment guideline of Ethiopia[12] and a pharmacotherapy book[13] was used. In addition, actual occurrences of medication errors were originally reviewed by principal investigators, and severities were evaluated by a panel of four health professionals (two internists and two clinical pharmacists). The cause of medication errors were identified through observation during data collection and reviewing the patient's medical records.

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Data were collected by using a checklist which was adapted from the checklist prepared for California Health Care Foundation[14] for addressing MEs in hospitals, during hospitalization by visiting the wards daily and examining medical and nursing records. The severity of ME was reported by using the detailed scale published by the National Coordinating Council for Medication Error Reduction and Prevention (NCC MERP).[15]

Data Collection, Analysis and Interpretation

Data were collected by two pharmacists and two nurses. Before data collection, data collectors were trained by the principal investigator regarding how to go for data collection. Any unclear ideas and terms were explained well for the data collectors. The data collectors have received a written guide that detailed the procedure to be followed. Supervisors had strictly supervised data collectors during data collection. After the data collection process, the principal investigator checked the filled data collection checklist for completeness. Data were entered into a computer using EpiData version 3.1 and was exported to SPSS version 23.0 for analysis. Descriptive statistics were calculated for independent variables after data cleaning, coding and exploration. Frequencies, proportions, mean, and standard deviation were used to describe the study population. The significance and strength of associations were assessed by using an odds ratio with a 95% confidence interval, along with binary and multiple logistic regression. All factors with a p-value <0.25 in the bivariate logistic regression analysis were further entered into the multivariate model to control confounding effects. In multiple logistic regression, a p-value <0.05 was used as statistically significant. Rates of medication errors were reported per 100 orders, 100 admissions, and 1000 patient-days.[16]

Definitions of Terms
Wrong Time Error
Administration of medication outside a predefined time interval from its scheduled administration time (if there is greater than one hour difference between the ordered time and the time the medication is administered).[17,18]

Wrong Dose Error
Administration to the patient of a dose that is greater than or less than the amount ordered by the prescriber or administration of duplicate doses to the patient, ie, one

or more dosage units in addition to those that were ordered.[17]

Transcription Error
Errors associated with the order transcription and verification process. It includes a variety of omissions, inadvertent cancellations or duplications, and dose transcription errors such as reversing the doses between two drugs or charting a drug that is to be administered every eight hours as every six hours.[5]

Ethical Considerations
Ethical clearance was obtained from the Institutional Research Ethics Review Committee of Wollega University with approval number WU/IEC:90342/ST1-49. The patient's written informed consent was obtained after explaining the purpose and procedures of the study. This study was conducted in accordance with the Declaration of Helsinki. Subjects and their responses were kept confidential. For those patients in whom serious medication error detected on the spot intervention was done with appropriate management strategy by discussing with the health-care professionals.

Results
A total of 351 patients were included in the present study. Patients were followed for a total of 1876 patient-days during the three months of follow-up and a total of 1685 medication orders were given for the study participants. More than half of the patients (56.1%) were males. The mean age of the patients was 40.67+15.78 years. One hundred and sixty-four (46.7%) of the patients have stayed in the hospital for four to six days. Three out of five of the participants (60.4%) had at least one comorbidity. Out of the total study participants, the most commonly reported diseases were infectious disease, 168 (47.9%) followed by cardiovascular disorders, 85 (24.2%); neurologic disorders, 66 (18.8%); gastrointestinal disorders, 55 (15.7%); and endocrinologic disorders, 47 (13.4%) (Table 1).

Among a total of 1685 medication orders, the most ordered drugs for the patients during their hospital stay were antimicrobials (22.2%), followed by analgesics (15.4%), gastrointestinal drugs (12.7%) and cardiovascular drugs (12.2%) (Table 2).

During three months of follow-up, the study included 351 admissions and 1876 patient-days, during which 1685 medication orders were written. The incidence of

Table 1 Characteristics of the Patients Admitted in Nekemte Specialized Hospital (n=351)

Variables	Category	Frequency	Percent (%)
Sex	Female	154	43.9
	Male	197	56.1
Age	18–34	140	39.9
	35–64	178	50.7
	≥65	33	9.4
Hospital stay	1–3	105	29.9
	4–6	164	46.7
	≥7	82	23.4
Number of medications	≤4	158	45.0
	≤5	193	55.0
Presence of comorbidity	No	139	39.6
	Yes	212	60.4
Diagnosed diseases	Infectious disease	168	47.9
	Cardiovascular disorders	85	24.2
	Gastrointestinal disorders	55	15.7
	Respiratory disorders	42	12.0
	Renal disorders	32	9.1
	Dermatologic disorders	10	2.8
	Hematologic disorders	44	12.5
	Endocrinologic disorders	47	13.4
	Neurologic disorders	66	18.8
	Malnutrition	3	0.9
	Others	8	2.3

Table 2 Frequency of Drug Classes Utilized by Admitted Patients in Nekemte Specialized Hospital

Drug Classes	Frequency	Percent (%)
Antimicrobials	374	22.2
Analgesics	260	15.4
Electrolytes and fluids	197	11.7
Steroids	75	4.5
Cardiovascular drugs	205	12.2
Bronchodilators	45	2.7
Gastrointestinal drugs	214	12.7
Diuretics	127	7.5
Antihistamines	99	5.8
Anti-tuberculosis drugs	37	2.2
Others	52	3.1

intercepted before reaching the patient. From the errors that were reported 72 (27.4%) were intercepted during physician order, 35 (36.1%) were intercepted during transcription and 44 (38.3%) were intercepted during dispensing before reaching the patient.

The severity of medication errors was reported using the NCC MERP. Accordingly, 33 (4.0%) were classified as category A, 151 (18.6%) were classified as category B, 599 (73.7%) were classified as category C and 30 (3.7%) were classified as category D (Table 4).

The most common cause of MEs was lack of knowledge of appropriate dosing/dosing guidelines, 183 (22.5%) followed by lack of knowledge of indications for medication use, 160 (19.7%), lab values/clinical information not available/noted, 103 (12.7) and concomitant medication(s) not available/noted, 88 (10.8%) (Table 5).

Variables with p-value <0.25 in bivariable logistic regression analysis (age, hospital stay, number of medications taken, and presence of comorbidity) were entered into multiple logistic regression model to identify independent predictors of MEs. In the multivariable analysis, age ≥65 years (AOR: 2.54, 95%CI: 1.12–5.75, p=0.025), hospital stay ≥7 days (AOR: 2.16, 95%CI: 1.17–3.98, p=0.014), number of medications taken (AOR: 1.75, 95%CI: 1.13–2.73, p=0.013) and presence of comorbidity (AOR: 1.57, 95%CI: 1.01–2.46, p=0.049) had shown statistical significance in predicting medication errors (Table 6).

Discussion
The present study followed 351 patients who fulfilled inclusion criteria prospectively for three months. Among the study participants, a total of 813 medication errors were recorded,

medication errors per 100 orders was 48.3, per 100 admissions 231.6 and per 1000 patient-days 433.4.

Among the study participants, 178 (50.7%) encountered medication errors, and 131 (37.3%) patients had three or more medication errors. Overall, there were 813 medication errors from 1685 medication orders and 1876 patient-days. A total of 813 medication errors were recorded. Among the medication errors, 213 (26.2%) were wrong drug, 183 (22.5%) were wrong dose, 130 (16.0%) were monitoring error and 81 (10.0%) were wrong frequency. The most common stage for medication errors was physician ordering 263 (32.4%), followed by nurse administering 167 (20.5%) and patient monitoring 130 (16.0%) (Table 3). A total of 151 (18.6%) errors were

Table 3 Type of Medication Errors and Stage of Errors Among Hospitalized Adults in Nekemte Specialized Hospital (MEs=813)

Variables		Frequency	Percent (%)
Type of medication error	Wrong drug	213	26.2
	Wrong dose	183	22.5
	Wrong patient	57	7.0
	Wrong frequency	81	10.0
	Wrong route	45	5.5
	Wrong time	47	5.8
	Omission	12	1.5
	Compliance error	41	5.0
	Monitoring error	130	16.0
	Other MEs[a]	4	0.5
Stage of error	Physician ordering	263	32.4
	Transcribing	97	11.9
	Nurse administering	167	20.5
	Pharmacy dispensing	115	14.2
	Patient monitoring	130	16.0
	Other[b]	41	5.0

Notes: [a]Medication errors that do not fall into one of above categories; [b]Medication errors that happen due to patient non-compliance.

at least one ME had been reported in 50.7% of patients and 37.3% of patients had three or more errors. The high incidence of medication error in this study was due to the poor practice of clinical pharmacy service in the center. During the study we have observed that the clinical pharmacist do not regularly attend the rounds and although there are physicians with specialty, it was the general practitioners that mostly follow the patient and write prescriptions. We believe that these conditions might have increased the rate of medication errors.

This study revealed elderly patients were at increased risk of medication error. Patients aged ≥65 years experienced medication error three times more than those aged less than 65 years (AOR: 2.54, 95%CI: 1.12–5.75, p=0.025). This is in line with studies from Japan,[19] Britain,[20] USA,[21] Saudi Arabia,[22] Pakistan[23] and Jordan[24] in which older age was an independent predictor for medication error.

Hospital stay was an independent predictor of medication error in the present study. Patients who stayed seven days or beyond in hospital encountered medication errors more than two times than those who stayed for less than four days (AOR: 2.16, 95%CI: 1.17–3.98, p=0.014). This finding is consistent with the findings reported from Alem Ketema Enat Hospital of Ethiopia,[25] USA,[26] Egypt.[27,28] This is because as the patient hospital stay is prolonged, the patient was exposed to multiple drug-related therapies, which necessitates passing through all medication use process like prescription, dispensing, transcription, and administration that may increase the occurrences of MEs. It can be further justified that hospital stay is relatively longer in severe medical cases, which again results in very close follow-up, which might have increased the number of medications, which sounds scientific following polypharmacy being an independent predictor of MEs in the current study.

Polypharmacy was also significantly associated with MEs in the present study. Patients taking ≥5 drugs experienced nearly two times more medication errors than those who took ≤4 medications (AOR: 1.75, 95%CI: 1.13–2.73, p=0.013). This finding is in line with different studies reported across the globe, including Alem Ketema Enat Hospital of Ethiopia,[25] Pakistan,[23] Saudi Arabia,[22] Japan,[19] China,[29] Brazil,[30] USA[31] and Sweden[32] supporting the general fact that polypharmacy might result in adverse drug events.

The other factor with affects attributed to medication error was the presence of comorbid cases, in addition to the medical case resulting in admission. In the present

Table 4 Severity Categories of Medication Errors Among Hospitalized Adults in Nekemte Specialized Hospital (n=813)

Severity Categories of MEs	Frequency	Percent (%)
(A) Circumstances or events that have the capacity to cause error	33	4.0
(B) An error occurred but the error did not reach the patient	151	18.6
(C) An error occurred that reached the patient but did not cause patient harm	599	73.7
(D) An error occurred that reached the patient and required monitoring or intervention to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm	30	3.7

Table 5 Possible Causes of MEs Among Hospitalized Adults in Nekemte Specialized Hospital (MEs=813)

Possible Causes of MEs	Frequency	Percent (%)
Allergy information not available/noted	42	5.2
Concomitant medication(s) not available/noted	88	10.8
Concomitant condition(s) not available/noted	74	9.1
Lab values/clinical information not available/noted	103	12.7
Lack of knowledge of indications for medication use	160	19.7
Lack of knowledge of appropriate dosing/dosing guidelines	183	22.5
Lack of knowledge of appropriate routes for administration	45	5.5
Lack of knowledge of drug compatibility	15	1.9
Use of abbreviations in medication ordering	14	1.7
Incomplete medication order processed	19	2.3
Patient identification not checked	57	7.0
Illegible physician handwriting	13	1.6

Table 6 Odds Ratio of Factors Associated with ME Among Hospitalized Adults in Nekemte Specialized Hospital (n=351)

Variables		Medication Error		AOR (95%CI) p-value
		No (n=173)	Yes (n=178)	
Sex	Female	77	77	–
	Male	96	101	–
Age	18–34	82	58	1.00
	35–64	80	98	1.66 (1.05–2.64) p=0.031
	≥65	11	22	2.54 (1.12–5.75) p=0.025
Hospital stay	1–3	65	40	1.00
	4–6	75	89	1.74 (1.04–2.91) p=0.035
	≥7	33	49	2.16 (1.17–3.98) p=0.014
Number of medication taken	≤4	92	66	1.00
	≥5	81	112	1.75 (1.13–2.73) p=0.013
Presence of comorbidity	No	80	59	1.00
	Yes	93	119	1.57(1.01–2.46) p=0.049

Abbreviation: AOR, adjusted odds ratio.

study, patients with comorbidity experienced two times more medication errors than patients without comorbidity (AOR: 1.57, 95%CI: 1.01–2.46, p=0.049). This is consistent with the findings from studies conducted in Alem Ketema Enat Hospital of Ethiopia,[25] Pakistan,[23] USA[17] clearly showing that there was a statistically significant association between the number of disease conditions and MEs. This might be due to the presence of comorbidity means patients take more medication, which increases the chance of occurrence of the error.

The most common types of medication errors in the present study were the wrong drug followed by wrong dose, and monitoring error. This was in line with studies conducted in Pakistan,[23] where invalid indication was the leading medication error reported, and Alem Ketema Enat Hospital of Ethiopia[25] reporting unnecessary drug therapy as the commonest medication error. But this finding was not consistent with the study from Denmark,[33] which reported lack of drug form as the commonest medication error and the difference might be because of the fact that the study in Denmark included health-care professionals as the study subjects, which might have resulted in underreporting of professionals related errors like ordering and administering errors.

Our finding was also not in line with a finding from a study conducted at Jimma University Specialized Hospital of Ethiopia,[34] which reported wrong time followed by omission due to unavailability of the drug as the most common medication error in that study. This difference arose following the study at JUSH focusing on Medication administration only.

Medication errors occurred at different stages of patient care in the present study. Nearly one-third (32.4%) of the total medication errors were due to physicians ordering followed by nurses administering, pharmacists dispensing, and patient monitoring stages. Most of the medication errors committed were due to lack of knowledge of appropriate dosing guidelines and lack of knowledge of indications of medication use, unavailability of laboratory values or clinical information and unavailable medication or unrevealed medical conditions. This was consistent with the study conducted in Alem Ketema Enat Hospital of Ethiopia,[25] Brazil,[35] Uganda[36] in which physician ordering is the most common stage leading to medication error. To overcome these causes of medication errors the clinical pharmacy service has to be given effectively and prescribing physicians have to get training on the appropriate prescribing practice. Furthermore we recommend pharmacist-led medication reconciliation, pharmacist partnership, prescriber education, and computerized physician order entry (CPOE) as strategy to improve drug safety.

Limitations

The awareness of the study by the health-care professionals working in the study wards could have affected both the occurrence and detection of errors. This study did not assesse prescriber level factors like prescriber physician experience. Furthermore, as we were ethically obliged to take corrective action when we identified serious practice problems, the incidence of errors could have been reduced as the study progressed.

Conclusions

Medication error was prevalent and was detected in most of the patients with 48.3 errors per 100 orders and 433.4 errors per 1000 patient-days. Multivariable logistic regression analysis shows age, length of hospital stay, the number of medications the patient took, and comorbidity were independent predictors of medication errors. Hence, every error should be assessed to determine the contributing factors in the medication use process and design the appropriate strategies to prevent the occurrence of medication errors. In this way, the health-care providers and those who manage health systems can understand and learn from errors to improve patient safety.

Abbreviations

ADE, adverse drug event; ADR, adverse drug reaction; JUSH, Jimma University Specialized Hospital; ME, medication error; NCC MERP, National Coordinating Council For Medication Error Reduction And Prevention; NSH, Nekemte Specialized Hospital; USA, United States of America.

Data Sharing Statement

The datasets are available from the corresponding author and will be available upon request. The questionnaire used to ask information from the patients is available as Supplementary Material.

Author Contributions

All authors contributed to data analysis, drafting or revising the article, gave final approval of the version to be published, agreed to the submitted journal, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest for this work.

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