Medication Errors in Ethiopia: Systematic Review and Meta-Analysis

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Abstract

**Background:** The caution of medication prescription and administration are the main physician and nursing services though there was no study to show medication error at the nation level in Ethiopia. Therefore, we estimated the national prevalence of medication errors.

**Methods:** A systematic review of studies searched in PubMed, Scopus, African Journal of Online, and Google Scholar was done. Newcastle-Ottawa quality assessment scale was used to assess the quality status of the included studies. We employed Galbraith plot and Egger’s regression test to assess publication bias. The national prevalence of medication errors was estimated using a random-effects model meta-analysis. Moreover, subgroup analysis and meta-regression analyses were done to explore the reason of statistical heterogeneity.

**Results:** A total of 14 studies with 5,552 administered medications and 5,661 prescription sheets were included. The overall prevalence of medication error in Ethiopia was 57.6% (95% CI: 46.2, 69.0). The pooled burden of medication administration and prescription error was 58.4% (95% CI: 51.4, 65.5) and 55.8% (95% CI: 27.0, 84.6), respectively. Omission error (38%), wrong dose (38.5%), and the wrong combination of drugs (28.7%) were highly reported types of prescription errors, whereas missed doses (57.0%), technical errors (47.0%), wrong time (35.0%), and wrong dose (30.0%) were frequently observed medication administration errors.

**Conclusions:** Medication errors were very common in Ethiopian hospitals whereby at least one out of two medications were wrongly prescribed and administered. Our review provided a shred of up-to-date evidence for clinicians, regional, and national healthcare policymakers to appraise and improve the quality of hospitals’ inpatient care.

**Trail registration:** The protocol is registered in the Prospero database with a registration number of CRD42019138125.

**Background**

To achieve the United Nations Sustainable Development Goals of prioritizing healthy lives and well-being for all [1], healthcare services are striving throughout the world to offer high quality care to their patients. Hence, with caution medication prescription and administration are the main responsibilities of physician and nurse in a clinical setting that helps for good prognosis of a diseased person [2]. Any medication prescription and administration error will lead to undesirable outcomes, including adverse drug reactions, drug-drug interactions, lack of drug efficacy, suboptimal patient adherence, poor quality of life, and death [3]. In 2016, medical errors are the third leading cause of death in hospitals [4], which may have significant health and economic consequences. Patient engagement, providing training and education for healthcare workers, evaluation of patients’ medication, medication reconciliation, writing medication information on discharge notes, and application of electronic tools (automated information systems) [5-8] are relevant interventions to prevent medication errors.
Medication administration and prescription errors are becoming common problem in the healthcare system. Out of 700 prescriptions of medical intensive care unit patients in India, 17.8% and 22.4% prescriptions found to have medication administration and prescription errors, respectively [9]. In Iran, a systematic review study revealed that 31.8% overall medication error, 44.8% prescription error, and 38.8% administration error [10]. Likewise, medication errors were reported with varieties of findings in Ethiopia. For instance, medication prescription error reported from the range of 32.3 % [11] to 95.2 % [12] and medication administration error was fall in the range between 46.1% [13] and 89.9% [14].

Medication error could be associated with numerous factors, such as poor coordination of care, cost-related barriers, multi-morbidity, increasing days of hospitalization, childhood and older age, lack of training, inadequate knowledge, inadequate perception of risks, overworked healthcare professionals, distractions, lack of standardized protocols, and insufficient resources. Medication packaging problem, poor nurse-physician communication, and problem in recruiting competent professional were also the suggested reasons [15].

In Ethiopia, there is no nationwide study that determines the national burden of medication administration and prescription errors. Thus, we aimed to estimate the national burden of medication administration and prescription errors in Ethiopia.

**Methods**

**Protocol and Reporting**

The protocol is registered in the Prospero database with a registration number of CRD42019138125. The reports of this systematic review and meta-analysis are reported with the standard flow of Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines [16].

**Literature Search**

The literature search was done using PubMed, Scopus, African Journal of Online databases, and Google Scholar. Additional unpublished research works were retrieved from Addis Ababa University, Ethiopia online research repository library. We further reviewed the reference lists of all included studies.

The search terms or phrases were medication error, prescribing error, dispensing error, administration error, documentation error, preparation error, medication mistake, drug error, drug administration error, drug mistake, prescribing mistake, administration mistake, preparation mistake, wrong medication, wrong drug, wrong dose, wrong route of administration, wrong calculation, and Ethiopia. Search strings were established by using "AND" and/ "OR" Boolean operators. For instance search string for Scopus was: (medication AND administration AND error[mesh AND terms] ) OR ( drug AND administration AND error ) OR ( medication AND prescribing AND errors ) OR ( drug AND prescribing AND errors ) OR ( drug AND preparation AND errors ) OR ( medication AND mistake ) OR ( drug AND mistake ) OR ( prescribing AND mistake ) OR ( administration AND mistake ) OR ( preparation AND mistake ) OR ( documentation
AND error) OR (wrong AND drug) OR (wrong AND route AND of AND administration) OR (wrong AND medication) OR (wrong AND dose) OR (wrong AND calculation) AND (Ethiopia) AND (LIMIT-TO (AFFILCOUNTRY, "Ethiopia")) AND (LIMIT-TO (SUBJAREA, "MEDI")] OR LIMIT-TO (SUBJAREA, "PHAR") OR LIMIT-TO (SUBJAREA, "IMMU")] AND (LIMIT-TO (LANGUAGE, "English")).

**Inclusion and exclusion criteria**

Studies were included if they have reported proportion of either overall medication error, administration error, or prescription error in Ethiopia and published in English.

Qualitative studies and studies without full-text were excluded.

**Measurement of variables**

1. Medication administration error: Occurrence of at least one of the following errors [12-14, 17-21]
2. Omission error: Failure to administer an ordered dose to a patient [14, 17, 18, 22]
3. Wrong time: Administration of medication without adhering a predefined time interval from its scheduled administration time (if there is greater than 30 minute or 1-hour difference between the ordered time and the time of medication is administered) [14, 17, 19, 20, 22]
4. Wrong dosage-form: Administration of a drug product to the patient in a different dosage form than ordered by the prescriber [14, 22]
5. Deteriorated drug error: Administration of a drug that has expired or for which the physical or chemical dosage-form integrity has been compromised [22]
6. Wrong dose: Administration a dose that is greater than or less than the amount ordered by the prescriber [17-20, 22]
7. Non-adherence: Inappropriate patient behavior regarding adherence to a prescribed medication regimen [22]
8. Wrong route: Includes order written for the wrong route and medication administered to a patient using a different route than ordered [17-20, 22]
9. Unauthorized drug error: When the prescriber did not authorize the administered medication [14, 17, 18]
10. Wrong patient: When a medication of one patient is wrongly given to another patient [17, 19, 20]
11. Documentation error: Medication that is administered to the patient but not documented in the medication administration record sheet or incorrectly documented [18, 19]
12. Wrong administration technique: Exclusion or incorrect performance of a procedure ordered by a prescriber immediately before administration of each dose of medication [14]
13. Wrong drug preparation: A drug product which formulated incorrectly or manipulated before administration [19]
14. Wrong drug: Medications administered to the patient that was not on the patient’s medication chart [19, 20]

15. Prescription error: the deviation of medication prescription from the standard practices. It includes the following errors [11, 23-25].

16. Wrong combination: Drug interactions and therapeutic duplications [23, 24]

17. Omission error: Medications ordered without specifying dose or type of dosage form or frequency or route [23-25]

18. Wrong frequency: Drugs prescribed with a frequency greater or less than what is recommended [23, 25]

19. Wrong dose: If the ordered dose is higher or lower than what is recommended [23, 25]

20. Wrong route: Medication was prescribed to be given in a route other than the recommended route [23, 25]

21. Wrong indication: The presence of inappropriate indications and contradictions which were not noted by the prescribing physician [23-25]

**Quality assessment**

The quality of included articles was evaluated by using the Newcastle-Ottawa quality assessment scale for a cross-sectional study. Two independent reviewers assessed the quality of included studies. Discrepancies between the two reviewers were resolved through discussion with the interference of the third reviewer.

**Data extraction**

Microsoft Excel 2010 worksheet (Microsoft Corporation, Redmond, WA, USA) was used for data extraction. The first author, year of publication, study patient unit or ward, study design, sample size (number of prescription and/or administration), data collection method, response rate, source of fund, and proportion with 95% confidence interval were extracted. The authors estimated proportion from available information using the recommended statistical formula.

**Data analysis**

Using Microsoft Excel, authors calculated the logarithm of proportion and standard error from the extracted observed data. Then, the stored data from Microsoft Excel 2010 worksheet were imported to STATA 14 statistical software for Windows for further analysis. Galbraith plot and Egger’s regression test were used to assess the presence of publication bias [26, 27]. I-square statistics was used to assess heterogeneity of studies. The pooled national medication error was estimated using a random-effects meta-analysis model [28]. Subgroup-analysis based on the types of medication error (administration versus prescribing error) was done. We also applied meta-regression analysis to see the effect of sample size and year of publication on statistical heterogeneity [29].
Results

**Search findings**

Based on our search, 93 studies were accessed in PubMed, 130 in Scopus, 317 in African Journals Online, 53 in Google Scholar, and 11 in Addis Ababa University Ethiopia's online research repository library. After rigorous screening and selection, 14 studies were included in the meta-analysis (Figure 1).

**Characteristics of studies**

All the included studies were conducted cross-sectionally and reported prescribing errors (n=4) \textsuperscript{[11, 23-25]}, both prescribing and administration errors (n=1) \textsuperscript{[30]}, and the medication administration errors (n=9) \textsuperscript{[12-14, 17-22]}. Medication administration errors were collected through a prospective approach using the observational checklist, whereas prescribing errors were collected through reviewing patents medical charts and prescription sheets. A total of 5,552 medications were found to be administered and 5,661 prescribed sheets were included. Details on the study characteristics are presented in Table 1. We found that none of the studies below the acceptable quality status (additional file).

**Meta-analysis**

**Medication errors**

The overall medication error in Ethiopia was found to be 57.6% (95% CI: 46.2, 69.0). The magnitude of medication administration and prescription error was 58.4% (95% CI: 51.4, 65.5) and 55.8% (95% CI: 27.0, 84.6), respectively (Figure 2).

**Types of prescription errors**

Different types of prescription errors were estimated using the overall prescribing error as a baseline. Illegible handwriting (99.4%) is the commonest problem of prescription error though it was reported only by one study. Omission error (38%), wrong dose (38.5%), and the wrong combination of drugs (28.7%) were also frequently reported types of prescription errors (Table 2).

**Types of administration errors**

Of the reported administration errors, 57.0% were missed doses, 47.0% were technical error, 35.0% were wrong time, and 30.0% were wrong dose (Table 3).

**Publication bias and meta-regression**

All the reported proportions from primary studies are plotted within the estimated confidence interval as shown in the Galbraith plot below (Figure 2). We also carried out Eggers' regression test and declared that there was no publication bias (p-value=0.998). The meta-regression analysis showed that neither sample size nor year of studies significantly contributed to between study heterogeneity.
**Discussion**

To achieve the WHO (World Health Organization) five years strategy to reduce medication-related errors by 50% throughout the world [31], subsequent (inter)national data generation is important. Hence, we assessed the national burden of medication errors in Ethiopia.

The overall medication error in Ethiopian hospitals was 57.6%. From medication administration and prescription perspectives, the estimated error was 58.4% and 55.8%, respectively. This finding was higher than a national survey study in Nigeria (47%) [32]. This discrepancy might be due to medication errors were recorded based on professionals report in case of a study in Nigeria, but data were collected through observation and assessing the prescribed sheets in all included studies of the current meta-analysis. Likewise, the result of this meta-analysis was higher than the report in Iranian hospitals (31.8%) [10] and United states or United Kingdom (2-14%) [33], which relatively well-established and equipped health systems are available in developed countries. They also implement a web-based error reporting surveillance system [34]. Strengthening the error reporting system is important to encourages safe medication administration and prescription practices, and improve the quality of clinical care services [35]. In Ethiopia, however, error reporting trend needs improvement given that only 57.4% medication administration errors were reported [36].

Furthermore, in Ethiopia, one study showed that only 30.4% of medical doctors adhered to the code of ethics [37] though 75.7% of medical doctors have good knowledge about code of ethics [38]. Non-adherence to professional ethics might lead to medication errors that cause harm to the patient, person who made the error, and/or healthcare system at large [39]. In addition, health professions who make errors may feel a variety of adverse emotions after medical errors. It is thought that the pervasive culture of perfectionism and individual blame in health disciplines plays a considerable role in these negative feelings [40]. This may further provoke them to make subsequent medication errors.

Healthcare providers should the standard guideline to minimize harms caused by errors [41]. However, the high proportions of medication prescription and administration errors in Ethiopian hospitals are most likely committed by physicians and nurses, respectively. In this meta-analysis, we showed that, illegible handwriting (99.4%), error of omission (38%), wrong dose (38.5%), and wrong combination of drugs (28.7%) were common prescription errors made by physicians. In addition, missed doses (57.0%), technical error (47%), wrong time (35.0%), and wrong dose (30.0%) were frequent medication administration errors most likely made by nurses. These might also be due to high work load, distraction, absence of medication preparation room, unavailability of medication administration guideline, lack of job site training, and inappropriate health worker to patient ratio [17, 18, 20].

Lack of motivation of health workers, unfavorable working environment, working at various health facilities simultaneously, low public awareness about medication errors, lack of integration of medico-legal issues course in to the country education system, weak system in reporting unethical conducts, absence of standardized monitoring tool, and weak collaboration among key stakeholders might have their own contribution to the high proportion of medication error in Ethiopia. Furthermore, WHO
recommended measures [42], like establishing well-standardized infrastructure (electronic networks, information technology-based reporting and communication systems for prospective use (computerized physician prescription systems), barcode medication administration, and medical-chart oriented error registration are still a big problem in Ethiopia. Nurse-physician communication is low as a single study showed in Ethiopia [43].

Quality improvement and patient safety intervention strategies for the prevention and management of medication errors are necessary for Ethiopia [44]. For instance, strong medico-legal rules, inter-and intra-professional communication, job aids system based reminders, computerization and automation, shift-to-shift handoffs [45], and wristband bar-code medication scanning could decrease medication errors [46], which are less likely to be implemented in Ethiopia.

Generally, medication errors are common in Ethiopia though there are great opportunities to reduce these events. Appointing qualified and capable inspectors, implementing advanced medication administration and prescription technologies, providing continues sensitizing training to clinician, developing culture of error reporting habit, and improving prescribers’ hand writing skill are some of practicable interventions in Ethiopia. Clinicians, researchers, and policy makers need to collaborate to minimize errors committed during medication prescription and administration phase.

Strength and limitations

No differences based on study country, study design, and no study with poor quality. Besides, we did subgroup analysis for further potential sources of variation. However, I-square showed the presence of statistical heterogeneity across studies though possible sources of heterogeneity resolved in the meta-analysis.

Conclusions

Medication errors were highly common in Ethiopian hospitals. In both medication administration and prescription errors, committed errors are very sensitive to further deteriorate and complicate the health of the patients. This finding has a policy implication to review the workforce of healthcare teams.

Abbreviations

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analysis

WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Not applicable
Consent to publish

Not applicable

Availability of data and materials

All data generated during this study are included in this manuscript.

Competing interests

The authors declare that they have no conflict of interest.

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Authors’ Contributions

AE developed the protocol and write the draft of the manuscript. AE and TDH did statistical analysis. AE and TDH contributed to draft the manuscript. GD, ZN, YB, and MB contributed to assess the quality of included studies. GMB, CAW, AW, and YA help to search literature. FW, HB, DK, and BM contribute on data extraction. AB, DA, and YW participated at the first revision phase of the manuscript. All the authors edit the manuscript and approve for submission.

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Tables
| First Author                  | Study setting (Health institution) | Ward/ Population | Error type | Prescription/administration frequency | Response rate with percentage | Source of fund |
|------------------------------|------------------------------------|------------------|------------|---------------------------------------|-------------------------------|----------------|
| Agalu A et al/2012 (Agalu et al., 2012) | Jimma university specialized hospital | ICU Administration | 1,200 | 100 | Jimma University |
| Agalu A et al/2011 (Agalu et al., 2011) | Jimma university specialized hospital | ICU Prescribing | 398 | 100 | Not reported |
| Baraki Z et al/2018 (Baraki et al., 2018) | Public Hospitals in Tigray Pediatrics patient Administration | 1,251 | 100 | Aksum University |
| Dedefo MG et al/2016 (Dedefo et al., 2016) | Nekemte Hospital Pediatrics patient Administration | 1,115 | 100 | Jimma University |
| Fekadu G et al/2019 (G. Fekadu et al., 2019) | Nekemte Hospital Pediatrics patient Prescribing | 1,596 | 100 | None |
| Fekadu T et al/2017 (T. Fekadu et al., 2017) | Ayder Hospital all patient Administration | 366 | 100 | None |
| Sada et al/2015 (Sada et al., 2015) | Tikur Anbesa Hospital Medical ICU Prescribing | 882 | 100 | Addis Ababa University |
| Feleke SA et al/2015 (S. A. Feleke et al., 2015) | Felege-Hiwot Referral Hospital Inpatient department Administration | 360 | 100 | University of Gondar |
| Zeleke A et al/2014 (Zeleke et al., 2014) | Dessie Referral Hospital Pediatrics ward Prescribing | 384 | 100 | Jimma University |
| Felekey, Girma | Jimma University Pediatrics inpatient Administration | 218 | | | |
| Study Reference | Hospital Type | Department | Administrative Level | Prescribing Activity | Details |
|-----------------|----------------|------------|----------------------|----------------------|---------|
| B/2010(Y. Feleke & Girma, 2010) | Specialized Hospital |  | | | 100 |
| Wondimien A/2018(Wondmieneh A, 2018) | Addis Ababa Tertiary care hospitals | Medical, surgical and emergency department | Administration | | 298 | 98.3 | Not reported |
| Alemu W et al/2017 (Alemu et al., 2017) | Two public hospitals in southern Ethiopia | All patients | Administration | | 130 | 92.2 | Jimma University |
| Fekadu H/2013 (H. Fekadu, 2013) | Tikur Anbesa & Zewuditu Memorial Hospital | Pediatrics ward | Prescribing | | 2,401 | 95.2 | Addis Ababa University |
| Fekadu H/2013 (H. Fekadu, 2013) | Tikur Anbesa & Zewudito Memorial Hospital | Pediatrics ward | Administration | | 200 | 100 | Addis Ababa University |
| Tsegaye D/2019 (Tsegaye D, 2019) | Public Hospitals in Amhara | All wards | Administration | | 414 | 98.1 | Amhara Health office |
### Table 2: Types of drug prescription errors with their reported proportion (p)

| Types of drug prescribing errors                                      | P (95% CI)          |
|-----------------------------------------------------------------------|---------------------|
| Omission ([G. Fekadu et al., 2019; Sada et al., 2015; Zeleke et al., 2014](#)) | 37.986 (15.195, 60.776) |
| Wrong dose ([Agalu et al., 2011; G. Fekadu et al., 2019; H. Fekadu, 2013; Sada et al., 2015; Zeleke et al., 2014](#)) | 38.482 (15.213, 61.750) |
| Wrong dosage-form ([Zeleke et al., 2014](#))                           | 7.170 (5.346, 8.994) |
| Wrong frequency ([Agalu et al., 2011; H. Fekadu, 2013; Sada et al., 2015; Zeleke et al., 2014](#)) | 8.042 (4.957, 11.127) |
| Inappropriate indication ([Agalu et al., 2011; T. Fekadu et al., 2017; Sada et al., 2015; Zeleke et al., 2014](#)) | 6.380 (1.982, 10.777) |
| Wrong combination of drugs ([Agalu et al., 2011; H. Fekadu, 2013; Sada et al., 2015](#)) | 28.707 (24.856, 32.559) |
| Wrong duration ([Agalu et al., 2011](#))                              | 3.400 (1.909, 4.891) |
| Wrong abbreviation ([Agalu et al., 2011; Sada et al., 2015](#))       | 7.821 (3.027, 18.669) |
| Wrong route of administration ([Agalu et al., 2011](#))                | 1.900 (0.817, 2.983) |
| Drugs with incorrect instruction ([G. Fekadu et al., 2019](#))         | 6.200 (5.045, 7.355) |
| Illegible handwriting ([H. Fekadu, 2013](#))                           | 99.400 (98.820, 99.98) |
| Types of drug administration errors                                                                 | P (95% CI)                       |
|------------------------------------------------------------------------------------------------------|----------------------------------|
| Wrong time (Agalu et al., 2012; Alemu et al., 2017; Baraki et al., 2018; Dedefo et al., 2016; H. Fekadu, 2013; S. A. Feleke et al., 2015; Y. Feleke & Girma, 2010; Wondmieneh A, 2018) | 34.992 (21.491, 48.493)          |
| Omission of drugs (Agalu et al., 2012; Baraki et al., 2018; Dedefo et al., 2016; H. Fekadu, 2013; S. A. Feleke et al., 2015; Y. Feleke & Girma, 2010)                        | 15.021 (5.827, 24.216)           |
| Missed doses (Agalu et al., 2012; T. Fekadu et al., 2017)                                            | 57.036 (18.912, 132.985)         |
| Wrong route (Agalu et al., 2012; Alemu et al., 2017; Dedefo et al., 2016; S. A. Feleke et al., 2015; Wondmieneh A, 2018)                               | 17.030 (8.084, 25.975)           |
| Wrong dose (Agalu et al., 2012; Alemu et al., 2017; Baraki et al., 2018; Dedefo et al., 2016; H. Fekadu, 2013; T. Fekadu et al., 2017; S. A. Feleke et al., 2015; Y. Feleke & Girma, 2010; Wondmieneh A, 2018) | 30.007 (8.970, 51.044 )          |
| Unauthorized drug (Agalu et al., 2012; Y. Feleke & Girma, 2010)                                      | 2.787 (2.097, 3.477)             |
| Wrong rate of infusion (Agalu et al., 2012)                                                          | 1.400 (0.945, 1.855)             |
| Wrong dose and rate (Agalu et al., 2012)                                                             | 3.900 (2.989, 4.811)             |
| Wrong drug (Alemu et al., 2017; Dedefo et al., 2016; Wondmieneh A, 2018)                             | 27.334 (11.961, 42.707)          |
| Wrong patient (Alemu et al., 2017; Wondmieneh A, 2018)                                              | 26.890 (8.840, 62.620)           |
| Wrong dosing schedule (Dedefo et al., 2016)                                                          | 1.800 (1.139, 2.461)             |
| Deteriorated drug (Dedefo et al., 2016)                                                              | 14.600 (13.202, 15.998)          |
| Wrong dosage form (Dedefo et al., 2016)                                                              | 1.200 (0.831, 1.569)             |
| Non-adherence (Dedefo et al., 2016)                                                                  | 4.500 (3.447, 5.553)             |
| Monitoring error (Dedefo et al., 2016)                                                                | 8.400 (7.151, 9.649)             |
| Technique error (S. A. Feleke et al., 2015; Y. Feleke & Girma, 2010)                                 | 46.995 (4.160, 98.150)           |
| Unauthorized error (S. A. Feleke et al., 2015)                                                       | 1.100 (0.671, 1.529)             |

**Figures**
Figure 1

PRISMA diagram of article searching process.
**Figure 2**

Forest plot presentation of a medication error, medication administration and prescribing error.
Figure 3

Galbraith plot with inverse standard error (1/se (b)) and standardized effect size (b/se (b)).

Supplementary Files

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