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Incidence of medication administration errors in Ethiopia: A systematic review and meta-analysis of observational studies

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ABSTRACT

Introduction: In Ethiopia, the overall incidence of medication administration errors (MAEs) has been variously estimated within the range of 16% to 99%; a wide range and difficult to conclude. Thus, this study aimed to assess the pooled incidence of MAEs in Ethiopia.

Materials and Methods: A systematic literature search in the databases of Pub-Med, Cochrane, and Google Scholar were performed. The quality of study was assessed using criteria adopted from similar studies. Heterogeneity test and evidence of publication bias were assessed. Sensitivity test and trim and fill analysis was also performed. Pooled incidence of MAE was calculated using random effects model.

Results: A total of nine studies, including a total of 46,426 medication administrations interventions, were included in this systematic review and meta-analysis. The frequently reported MAEs were wrong dose, wrong time, and wrong route. The reported error was ranged from 0.1% for wrong medication to 95.8% for omitted drug error. Overall the pooled incidence of MAE was found to be 37.9% (95% CI, 34%-41.9%). It has no evidence of significant heterogeneity (I^2=0%, P<0.820) and publication bias from the visual inspection of funnel plot and Egger's test (P=0.481).

Conclusion: The incidence of MAE was high. Wrong dose, wrong time, and wrong route were the frequently reported errors. Omission error was the most incident errors. Authors suggested to give more attentions to the rights of medication administration guide, particularly to prevent omission error.

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Introduction

Patient safety incident (PSIs) is defined as 'any unintended or unexpected incident, which could have or did lead to harm for one or more patients receiving health care (1).

Medication errors are any PSIs in the process of prescribing, preparing, dispensing, administering, monitoring or providing advice on medicines (2-4).

Error is defined as failure to execute action as intended. Medication error is any preventable event that harm user while it is in the control of the health care professional or consumer (5).

Such events may be related to professionals, health care products, procedures, and systems including: prescribing, order communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, and monitoring (5).

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Though medication errors can occur in any phase of the medication use process, medication administration errors (MAEs)is one of the most common (6-10), expensive, un reversed and adversely affect the life of user.MAE is an error during medication administration process such as preparation, administration, and documentation (11-13). For the safety of medication administration, scientists and expertise in the field developed standard or rights of guideline including other different interventions like use of technologies (14-17); yet, MAEs remain a serious safety issues. That is why in 2017, World Health Organization (WHO) in the third global patient safety challenge aimed at improving medication safety. Studies also revealed that the incidence of MAEs is high with the estimate ranged from 28% to 99% (16,18-20). Medication administration is influenced by number of factors such as: type of medications, policies and procedures (4,18-22), age of participant, work experience and working time/shift (13,18-20,22). Error in medication administration cause a number of adverse effect on the life of patient's morbidity, mortality and length of hospital stay (4,8, 22-24). It also associated with distrust and dissatisfaction of patients with the health care systems. Moreover, MAEs can lead health care workers (HCWs) to develop stress and moral issues that reduce the quality of health care (25). Despite evidence of MAEs' and its adverse effect, in developing countries like Ethiopia, it is difficult to have a conclusive evidence on the burden of MAEs(26).This is not because of a low incidence of MAEs rather it is a result of inefficient documentation or reporting and insufficient research (26,27). Thus, the purpose of this study was to assess the incidence of MAEs in Ethiopia.

Materials and Methods

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)(28) guideline (Fig1).

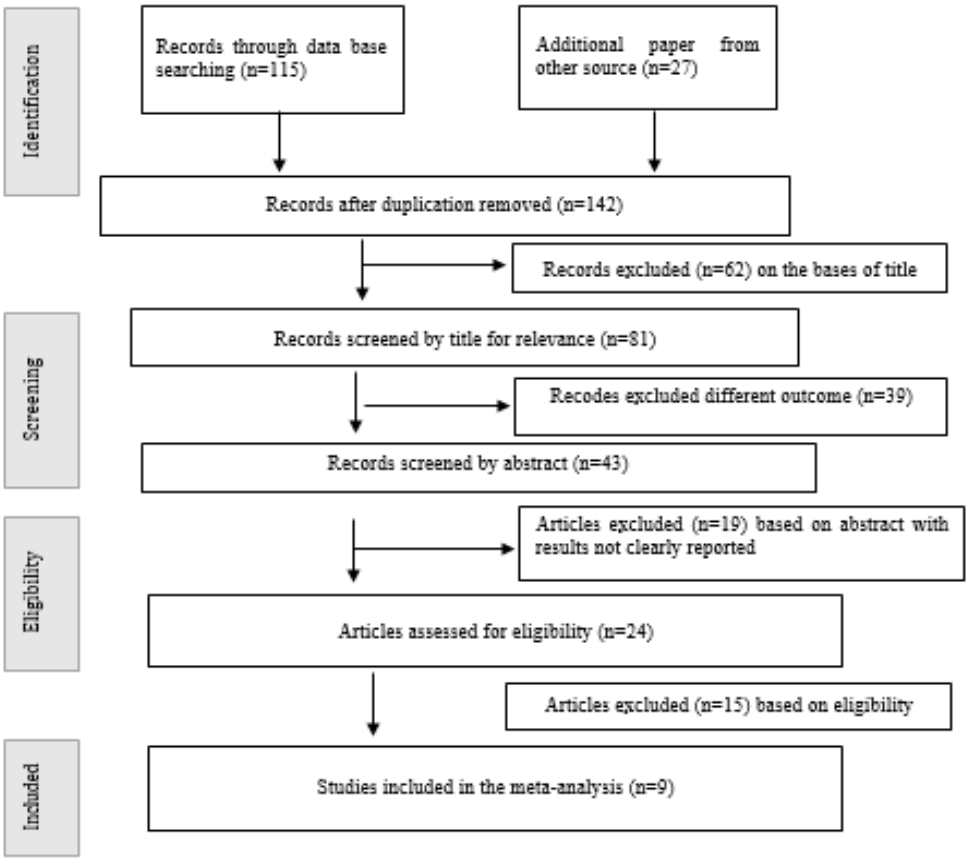

Figure 1: Flow diagram of the included studies.

Search strategies

We searched databases: PubMed, Cochrane, and Google Scholar. PubMed electronic database was searched until December, 9, 2018 using the search term: Search # 1: ((medication error [MeSH Terms]) OR (medication error) OR (medication mistake [MeSH Terms]) OR (medication mistake) OR (drug error [MeSH Terms]) OR (drug error) OR (drug mistake [MeSH Terms]) OR (drug mistake) OR (adverse drug event [MeSH Terms]) OR (adverse drug event) OR (near miss [MeSH Terms]) OR (near miss) OR (administration error [MeSH Terms]) OR (administration error) OR (medication administration error [MeSH Terms]) OR (medication administration error) OR (drug administration mistake [MeSH Terms]) OR (drug administration mistake) OR (drug administration [MeSH Terms]) OR (drug administration) OR (preparation error [MeSH Terms]) OR (preparation error) OR (omission error [MeSH Terms]) OR (omission error) OR (patient error [MeSH Terms]) OR (patient error) OR (dose error [MeSH Terms]) OR (dose error) OR (time error [MeSH Terms]) OR (time error) OR (route error [MeSH Terms]) OR (route error) OR (documentation error [MeSH Terms]) OR (documentation error)). Search # 2: ((reasons [MeSH Terms]) OR reasons) OR associated factors [MeSH Terms]) OR associated factors) OR determinants factors [MeSH Terms]) OR determinants factors)). Search # 3: ((nurse [MeSH Terms]) OR (nurse) OR (pharmacist [MeSH Terms]) OR (pharmacist) OR (physicians [MeSH Terms]) OR (physicians) OR (health care workers [MeSH Terms]) OR (health care workers) OR (patient [MeSH Terms]) OR (patient) OR (pediatrics [MeSH Terms]) OR (pediatrics)). Search # 4: Ethiopia and search # 5: Search # 1 AND Search # 2 AND search # 3 AND Search # 4. No restriction on year of publication.

The reference lists of included studies were manually searched. Likewise, a Cochrane review database was searched using similar search terms tailored to it. Google Scholar was also searched for gray literature and published paper in un indexed journals. For the required information not clear/ not avail, authors were contacted via email.

Definition of the variables

Medication administration error was defined when there is one or combination of any medication administration error (omission, patient, dose, medication, time, route, documentation, Unauthorized, rate, Wear/change glove, Wash/rub-hand before the procedure and administration techniques during the medication administration process. Omitted drug error: when there is failure to administer a prescribed medication, patient error: when a medication of one patient is wrongly given to another patient, dose error: when prescribed quantity is not administered, medication error: when another medication is administered to the patient other than the prescribed, time error: when there is a difference of greater or less than 30 min between the ordered time and administered time, route error: When medication is administration in difference route other than the ordered actual route, documentation error: when medication that is administered to the patient is not documented in medication administration record sheet(16,18-20,29-31).

Eligibility criteria

In this meta-analysis, we included: (i)MAEs among carried out in Ethiopia (ii) observational quantitative study with prospective or retrospective designs,(iii), for studies that reported about adverse drug events, we included only for preventable injuries,(v) for studies that reported MAEs using both data collection methods i. e observational and self-administered questionnaire, we included the observational.

Exclusion criteria

Articles that do not meet the eligibility criteria such as review, studies that used self-reported, assess knowledge and attitude of ADRs, ADEs and MAE, errors in over the counter medication, non-adherence to medication or self-harm (intentional toxicity) were excluded. Qualitative study design that did not estimate the prevalence of MAEs and studies that assessed association factors without the report of MAEs magnitude were also excluded. Moreover, studies that focus on case reports, and conference abstracts that did not

provide enough information were excluded. Finally, studies that relayed on specific drug therapy (e.g. drug dosage adjustment), type/number of drug (e. g. single drugs), drug classes (e.g. Antiretroviral), disease condition (e.g. human immunodeficiency virus/acquired immunodeficiency syndrome, diabetes mellitus) were excluded.

Quality assessment

Two review authors' were independently assessed the quality of included studies using the criteria adopted from previous studies. This tool included thirteen items such as: objectives of the study, definition of what constitutes MAEs, error categories specified, definition of each error categories, clearly defined denominator, description of data collection method, description of setting, sampling and calculation of sample size, description of reliability measures, measures to ensure results as valid, description of the limitations of study, description of any assumptions made and description of Ethical Committee Approval (1-13). A score of "1" was given if the study met the criteria and "0" if not met. To determine the quality of each studies, the overall sum of each item score was considered and defined as "good" for score ≥10, "average" for score ranged from 7-10 and "poor" for score <7. This quality appraisal score was assessed by two investigators (BBB and AWT) and disagreements were solved by discussion.

Data extraction

A standardized and pre-piloted checklist was used to extract the required information. Data were extracted on study characteristics and outcomes by two independent reviewers (BBB and AWT) and stored in a Microsoft Excel Spread Sheet. The extracted data include details of: author's name, year of publication, study area, study design (retrospective or prospective), data collection method (observational and chart review), time frame, study subject (HCWs, patient chart), outcomes (number/incidence of overall/each errors and total intervention).

Data synthesis and statistical analysis

The extracted data were entered into a Microsoft Excel Database and then imported into STATA 14 that we installed packages for Meta-analyses online. In this study, MAEs was defined as the number of errors relative to the total opportunity for error. The total opportunity for error is the sum of the doses given plus the number of doses missed (omission errors) that is (the percentage rate of MAEs was determined by dividing the number of actual MAEs that occurred by the total number of MAEs multiplied by 100). If the authors did not specify the denominator used was the total opportunity for error but evaluated the rate of omission errors, then the denominator was considered to be the total opportunity for error. The included studies used different types of MAEs, therefore, to summarize each errors, we used the reported incidence of errors using text and table. For the analysis of overall pooled incidence, meta-analyses was performed. The estimated pooled incidence and weighted mean differences of MAE was calculated using random-effects model at 95% confidence interval(32). Test for Heterogeneity between the studies was performed using Cochran's Q statistic and the I^2 statistics (33). I^2 values greater than 50% were considered as indicative of substantial heterogeneity. Evidence of publication bias was assessed using visual inspection of the symmetry in funnel plot and egger test (34,35). Sensitivity analysis was also conducted to examine influential study (36).

Results

The literature search resulted in 142 recorded papers. Of this record, 62 were excluded just by reading their titles. Of the remaining 81 studies, 39 were excluded on the bases of outcome assessment. Moreover, 19 studies were excluded after reading the abstract because of unclearly reported outcome variable. Finally, 15studies were excluded based one eligibility criteria and the remained 9 studies were included in the systematic review and meta-analysis (Fig 1).

Study characteristics

A total of nine studies, including a total of 46426 medications administrations interventions, were included in this systematic review and meta-analysis. These

studies were carried out in the year between 2010 and 2018. All studies used institution based cross-sectional study design. The included studies were carried out in Amhara (n=1), Oromia (n=4)(16,18,29,37), Tigray (n=2)(19,20) and Addis Ababa (n=2) (31,38). Majority of the studies (n=4) were carried out in pediatrics and adult ward (16,18,19,31); while three studies carried out in pediatrics(20,29,37), the remaining two studies carried out in intensive care unit (n=1), and emergency room (n=1) (Table 1) (38).

Table: 1: Characteristics of the included studies

Author Year	Study area	Working unite	Study design	Methods of data collection	Time frame	Assessment tool	Sample size	Cases
Feleke, 2010	Oromia	Pediatrics ward	Prospective observational	Direct observational	February 18 to March 2, 2009)	Observational checklist	218	196
Agalu, 2012	Oromia	ICU, specialized Teaching hospital	Prospective Cross sectional	Direct observational	February 7 to March 24, 2011.	Observational checklist	1200	622
Feleke, 2015	Amhara	Inpatient Departments of Pediatric and Adult units	Prospective, observation-based, cross-sectional study	Questionnaire-based Interviews, observations	March 24–April 7, 2014.	Questionnaire & observational checklist	360	356
Alemu, 2017	Oromia	Medical, Surgical , Pediatrics, Oby-gyne, OPD, OR and Others	Prospective Cross sectional	Self-administered and observational Checklist	March 1–30, 2014	Questionnaire And observational checklist	139	138
Wondmieneh, 2018	Addis Ababa	Medical, Surgical , Pediatrics, Oby-gyne, Emergency OPD, ICU, Oncology	Prospective Cross sectional	Observational	February to March 2018.	Questionnaire And observational checklist	225	216
Baraki, 2018	Tigray	Pediatric ward	Prospective	Observational	Sep, 2016 6 to August, 2017	Questionnaire And observational checklist	1251	784
Fekadu, 2017	Tigray	Inpatient Departments of Pediatric and Adult units	Cross sectional	Observational	---	Observational checklist	366	169
Negash, 2013	Addis Ababa	Emergency	Cross sectional	Observational		Observational checklist	41552	15467
Dedefo,2016	Oromia	Pediatrics	Cross sectional	Observational		Observational checklist	1115	179

Note: Icu: Intensive Care Unit, Maes**:** Medication Administration Errors, Opd: Out Patient Department, Or: Operation Room

Quality assessment of included studies

The quality score of the included studies varied between 9 and 12.Overall, all of the included studies have good quality (Fig 2).

Type and incidence of medication administration errors. The most frequently reported errors were wrong dose (n=8), wrong time (n=6), and wrong route (n=6)(16,18-20,29,31,38,39). For one study, we included the overall MAE (38). The incidence was ranged from 0.1% for wrong drug/medication to 95.8% for drug omitted error (19,39). The incidence of each error was ranged from25.5% (29) to 58.5% (16) for wrong time error, 4.2% (19) to 53.7%(20)for wrong dose errors,0.3(20) to 40% (16) for wrong route error, 0.4%(20)to 30%(16)for wrong patient error, 0.1%(20) to 33.1%(16) for wrong drug/medication error and 1.4%(20) to 95.8% for omissions error (Table 2) (19).

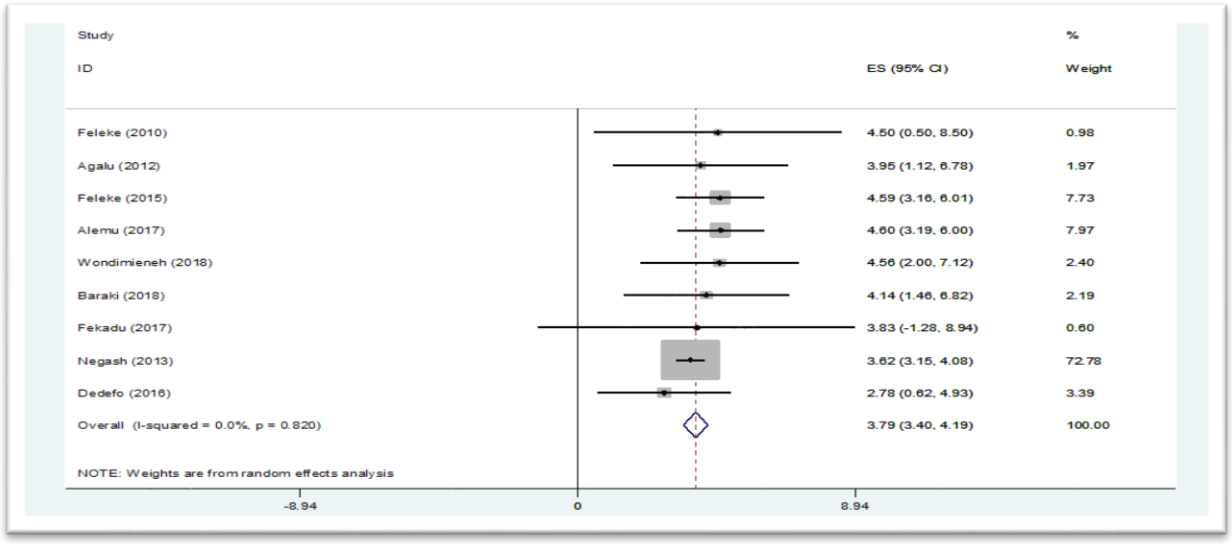

Figure 2: Forest plot presenting the pooled incidence of MAE using random effect models with 95% CI.

Table: 2Typeand incidence of medication administration errors in percent

Type and incidence of MAEs	Authors, year and percentage of MAEs							
	Fekadu, 2010	Agalu, 2012	Feleke, 2015	Alemu, 2017	Wondmieneh, 2018	Baraki, 2018	Fekadu, 2017	Negash, 2013
Wrong route	-	9.1	8.2	40	14.2	0.3	-	1.9
Wrong time	25.2	30.3	53.6	58.5	34.7	34.6	-	
Wrong patient	-	-	-	30	15.1	0.4	-	-
Wrong Dose	23.4	4.4	23.1	33.8	23.1	53.7	4.2	1.92
Wrong drug	-	-	8.3	33.1	16.4	0.1	-	5.4
Medication is omitted	19.3	47.3	-	-	-	1.4	95.8	23.2
Wrong rate	-	1.4	-	-	-	-	-	-
Wear/change glove	-	-	-	-	41.4	-	-	-
Wash/rub-hand before the procedure	-	-	-	-	76	-	-	-
Distraction	-	-	-	-	26.2	-	-	-
Documentation	-	-	87.5	85.4	52	-	-	-
Unauthorized	2.8	2.7	1.1	-	-	0.2	-	-
Wrong administration techniques	18.8	-	73.1	-	-	-	-	-
Wrong duration	-	0.9	-	-	-	-	-	50.25
No of dose	-	-	-	-	-	-	-	15.4
Form	-	-	-	-	-	-	-	1.92

Pooled incidence of medication administration errors

The overall pooled incidence of MAE was found to be 37.9% (95%CI,34%-41.9%) using random effect model (I^2=0%, P<0.820) (Figure 2). It has no evidence of significant heterogeneity test result (I^2=0%, P<0.820) and publication bias from the visual inspection of the funnel plot and the Egger's test (P =0.481).

Discussion

To our knowledge, this is the first systematic review and meta-analysis about the incidence of MAEs in Ethiopia. Overall, the pooled incidence of MAEs was found to be 37.9% (95% CI, 34%-41.9%) using random effect model. This result is similar with a systematic review and meta-analysis in Iran [44.5% (27-50.6%) (40)]. On the contrary, this result is higher than the previous systematic review and meta-analysis carried out in developed countries [19.6% (8.6%-28.3%)](41) and within the interval of study in South East Asia (15.2%-88%)(42), Middle East (9.4%-80%)(43)and East Africa [56.4% (39.5%-87.5%)]; yet, overall lower than review in Africa (44). The difference might

be due to variation in definitions and types/number of MAEs studied(45). For example the cut-off point for time error is ±30 minutes for some of studies and ±60% for the other to define/consider as error (41).This affects the overall magnitude of MAE.

This is supported by a systematic literature review of studies that confirmed the variation in prevalence of MAEs because of the inconsistency definition of MAEs (45, 46). The other possible reason for the difference may be due to variation in the study settings (20,39,46).

The assessment method may also contribute for the variation that is whether the assessment method is observational, self-reported and patient chart review. For example a previous study in Ethiopia revealed the prevalence of MAE was 71%using self-reported method as compared to 97% for observational method (16). Study from Korea also supports this (47). This may suggest the need of both methods to understand the difference between perceived and actual experience of MAE. Though the proportion of the errors were varied based on the standard or right used as: a reference (14,15), definitions and phases of medication administration process in this study (45); wrong route, wrong time, wrong patient (11-13), wrong dose, wrong drug, omitted error, wrong rate, documentation errors were the reported errors (16,18-20,29,31,38,39). Of this, the most frequently reported errors were wrong dose (n=8),wrong time (n=6), and wrong route (n=6) respectively (16,18-20,29,31,38,39). These result is supported with studies carried out in US where doses was the most common error reported (48). A systematic review and meta-analysis from Southeast Asia also showed time error, omission error and wrong dose were the most frequent reported errors (42).

Regarding the incidence of errors drug omitted error and documentation error were the highest reported errors respectively. This may be due to the working environment/system reasons as supported by previous evidence that showed the associations of MAE with systems including: prescribing, order communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use (5,11,40,49-51). The other possible reason may be due to the work load of HCWs, they could have enough time to cover all patient with in the required time and to record their activities. Work load is an important factor to have enough time to cover the allot work properly and document the activities.

Strengths and limitations of the study

The strength of this meta-analysis is the inclusions of all studies without restriction to study time and published studies in reputable peer reviewed journal to include all the available studies. However, this study had some important limitations. First, lack of similar studies in Ethiopia limit the discussions.

Second, although we used reference lists and Google Scholar to include all the available studies, there may be possibility of having some overlooked articles. Third, the limited numbers of included studies minimize the representativeness for Ethiopia. Despite these, this systematic review and meta-analysis revealed the recently available evidence that help to narrow the scant evidence in Ethiopia.

Conclusion

The incidence of MAE was high in Ethiopia. The most frequently reported type of MAEs were wrong dose, wrong time, and wrong route errors. Drug omitted error and documentation error were the most reported prevalent of MAEs. Authors suggested to give more attentions on the rights of medication administration to reduce MAEs, particularly drug omitted and documentation errors.

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