Journal of Caring Sciences 2020; 9 (1): 1-8
doi:10.34172/jcs.2020.001
http:// journals.tbzmed.ac.ir/ JCS

Review Article

The Magnitude of Medication Administration Errors among Nurses in Ethiopia: a Systematic Review and Meta-analysis

Berhanu Boru Bifftu[1*], Bezenaw Yimer Mekonnen[1]

[1]Department of Community Health Nursing, School of Nursing, University of Gondar College of Medicine and Health Science, Gondar, Ethiopia

ARTICLE INFO

Article History:
Received: 13 Mar. 2019
Accepted: 28 Jul. 2019
ePublished: 1 Mar. 2020

Keywords: Error, Ethiopia, Nurses, Medication administration

*Corresponding Author:
MSc in Integrated Clinical and Community Mental Health,
Email:
berhanuboru@gmail.com

ABSTRACT

Introduction: Nurses are the final safety check in the process of medication administration process to prevent errors that adversely affect life; yet death of comprehensive evidences in Ethiopia. The present study aimed to assess the pooled magnitude of MAEs (Medication Administration Errors) in Ethiopia.

Methods: Systematic literature search in the databases of Pub-Med, Cochrane, and Google Scholar for gray literature were performed until December 3, 2018. The quality of study was assessed using criteria adopted from similar studies. Heterogeneity test and evidence of publication bias were assessed. Moreover, sensitivity analysis was also performed. Pooled prevalence of MAE was calculated using the random effects model.

Results: A total of 2142 medication administrations were from observational and 681from self-reported studies were included in this systematic review and meta-analysis. The most prevalent and frequently reported type of MAEs was documentation error (52% to 87.5%) and time error (25.5% to 58.5%) respectively. Overall, the pooled magnitude of MAE was found to be 39.3% (95% CI, 29.1%-49.5%).It has no evidence of significant heterogeneity (I^2 = 0%, P = 0.57) and publication bias Egger's test (P = 0.40).

Conclusion: Overall, more than one in four observed/perceived medication administrations had errors. Documentation error is the most prevalent type of error. Nurses are suggested to strengthen their focus on the rights of medication administration guide particularly, documentation of their activities need special attention.

Citation: Boru Bifftu B, Yimer Mekonnen B. The magnitude of medication administration errors among nurses in Ethiopia: a systematic review and meta-analysis. J Caring Sci 2020; 9 (1): 1-8. doi:10.34172/jcs.2020.001

Introduction

Patient safety incidents (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 error during 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 professionals or consumers.[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, monitoring, and use.[5] Though medication errors can occur in any phase of the medication use process, medication administration error (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]

Globally, different interventions are implemented including both process changes and use of technologies, yet MAEs remain a serious safety issue. For example, in USA 67%,[14,15] in India 68.5%, in South-East Asia15-88%[16] and in Ethiopia it reached up to 89.9%.[17-20]

In nursing, the medication administration process is a daily task account for around 40% of their working time[11,21] and nurses are the final safety check.[22] Due to this and professional, legal and ethical responsibility; nurses have a central role in the cause, identification and correction of errors.[13,23-25] For the safety of medication administration; scientists, and expertise in the field developed standard or rights.[20,22,26,27] Nurses can decrease MAEs with the application of these rights; although, a number of factors such as: type of medications, policies and procedures,[4,17-19,28,29] age of participant, work experience and working time/shift[13,17-19,29] associated with MAEs. The impact of MAEs is huge on the life of patient: morbidity, mortality and length of hospital stay.[4,8,29-31] MAEs can also lead nurses to develop error associated moral and ethical issues that reduce their quality of health.[32] These adverse effect and its high prevalence is evidenced as studies from Western revealed; however, this is difficult to have a general concept in developing countries[33,34] like Ethiopia. This is not because of a low incidence of MAEs rather a result of (i) inefficient documentation or reporting of errors, (ii) insufficient research with inconsistent report[17-20] and (iii) lack of comprehensive systematic review and meta-analysis. The present study, address these reasons and showed the current available evidences for policy and decision maker and other researchers; therefore, this study aimed to assess the pooled magnitude of MAE among nurses 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)[35] guideline.

We searched databases including: Pub-Med, Cochrane and Google Scholar. PubMed electronic database was searched until December, 3, 2018 using the search terms: ((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)) AND ((reasons [MeSH Terms]) OR (reasons) OR (associated factors [MeSH Terms]) OR (associated factors) OR determinants factors[MeSH Terms]) OR (determinants factors)) AND nurses AND Ethiopia. There was no restriction on year of publication. The reference lists of included studies were manually searched. Likewise, Cochrane review database was searched using similar search terms tailored to it. Google Scholar was also searched for gray literature and published paper in unindexed journals. For the required information not clearly written, authors were contacted via email. All the included studies were written in English.

For the purpose of this study, MAEs were defined when there is one or combination of any MAEs (omission, patient, dose, drug/medication, time, route, documentation, unauthorized, rate, not wear/change glove, not wash/rub-hand before the procedure and administration techniques) or deviation from the prescriber's medication order as written on the patient's chart, manufacturers' preparation/administration instructions, or relevant institutional policies during the medication administration process. Omitted drug error: 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, unauthorized drug error: medication administered was not authorized by the prescriber, technique error: the nurse performs less than 50% among the procedure put at the technique competency checklist for medication administration, route error: when medication is administrated in different 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.[17-20,36,37]

This review targets all nurses in Ethiopia. Studies, in which participants were drawn from overall health care professionals, were excluded; unless the studies were separately documented for nurses.

This review included studies that investigated the prevalence of MAEs irrespective of the intent, data collection tools and/or definition. For those studies that reported MAEs using both data collection methods i.e.

Observational and self-administered questionnaire, we included the observational part because of its reliability as compared to self-administered. Studies that reported about adverse drug events (unpreventable errors) and studies that relayed on specific drug therapy (e.g. drug dosage adjustment), type/number of drug (e. g. single drugs), and drug classes (e.g. co-trimoxazole, Antiretroviral), disease condition (e.g. human immunodeficiency virus/acquired immunodeficiency syndrome, diabetes mellitus) were excluded.

Observational studies (cross-sectional and cohort/longitudinal) were included in this systematic review and meta-analysis. Studies that focused on review, case reports, and conference abstracts that did not provide enough information were excluded.

This review systematic review and meta-analysis included studies that carried out in Ethiopia from 2010 to 2018. Two review authors' were independently assessed the quality of included studies using the criteria adopted from previous similar studies.[16,38,39] This tool included thirteen items such as: 1) objectives of the study, 2) definition of what constitutes MAEs, 3) error categories specified, 4) definition of each error categories, 5) clearly defined denominator, 6) description of data collection method, 7) description of setting, 8) sampling and calculation of sample size, 9) description of reliability measures, 10) measures to ensure results as valid, 11) description of the limitations of study, 12) description of any assumptions made and 13) description of Ethical Committee Approval.

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" if the overall score ≥10, "average" for score ranged from 7-9 and "poor" for score<7. This quality appraisal score was assessed by two investigators (BBB and BYM) and disagreements were solved by discussion.

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 BYM) 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, chart review and self-reported), assessment tool, definition of MAEs, time frame, sample size and outcomes (number/prevalence of overall/each MAE's type).

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 were 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, 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 different types of MAEs, we used the reported incidence of MAEs using text and table. For the analysis of overall pooled magnitude, meta-analyses was performed. The estimated pooled prevalence and weighted mean differences of MAE was calculated using random-effects model at 95% confidence interval.[40] Test for Heterogeneity between the studies was performed using Cochran's Q statistic and the I2 statistics.[41] I2 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[42] and egger test.[43] Sensitivity analysis was also conducted to examine influential study.[44]

Results

The literature search resulted in 102 recorded papers. Of this record, 41 studies were excluded just by reading their titles. Of the remaining 61 studies, 29 were excluded on the bases of the outcome assessment. Moreover, 14 studies were excluded after reading the abstract because of unclearly reported outcome variable. Finally, 11studies were excluded based on the eligibility criteria and the remaining 7 studies were included in the systematic review and meta-analysis (Figure 1).

A total of seven studies [(five observational, including a total of 2142 medication administration interventions) and (two self-reported, including 681 participants)] were included in this systematic review and meta-analysis.

These studies were carried out in the year between 2010 and 2018. All studies were institution based cross-sectional study.

The included studies were carried out in Amhara (n=3), Oromia (n=3) and one study was in Addis Ababa. Majority of the studies (n=5) used pediatrics and adult patient while the remaining (n=2) studies from pediatrics and Intensive Care Unit (ICU) patients. For the assessment of MAEs, direct observation was the most ommonly used method for detecting MAEs (n=6).[17-20, 36,37]

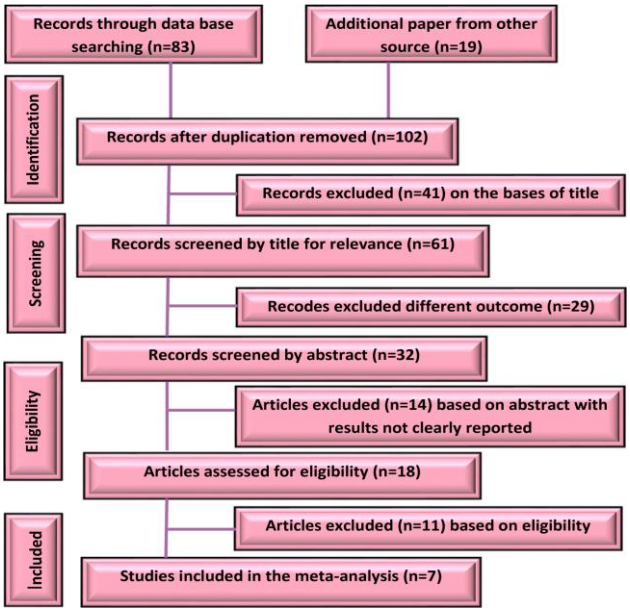

Figure 1. Flowchart of the study

Two studies used self-administered questionnaire[24,45] and other two studies used the combination of both methods (observational and self-administered questionnaire) (Table 1).[20,37]

Type and magnitude of MAEs

Regarding the types of MAEs, though the proportion of MAEs is varied for each type of error based on the number of rights used as a reference[26,27] definitions[46] and phases of medication administration process;[11-13] in this study, around thirteen different types of MAEs were identified such as: wrong route, wrong time, wrong patient, wrong dose, wrong drug, error of omission, wrong rate, documentation errors, duration error, technical error, unauthorized and without hand washing/change glove.[17-20,24,36,37] In each included study, five[18] up to eight[37] different types of MAEs were identified; though, one study reported only the overall result.[45] The most frequently reported type of MAEs were wrong time and wrong dose errors (n=6.7).[17-20,24,37] The next most common type of administration error was wrong route (n=5.7).[17,19,20,24,47] The magnitude of MAEs was ranged from 0.9%[47] for wrong duration to 87.5%[17] for documentation error. Documentation error is the most prevalent type of MAEs as revealed by three studies 87.5%,[17] 85.4%[20] and 71.6%[24] For each type of MAEs, the magnitude ranged from 25.5%[18] to 58.5%[17] for wrong time error, 4.4%[47] to 68.4%[20] for wrong dose errors, 8.2%[17] to 40%[20] for wrong route error, 15.1%[37] to 63.5%[20] for wrong patient error, 8.3%[18] to 63.5%[24] for wrong drug/medication error and 19.3%[37] to 47.3%[47] for omissions error (Table 2).

Quality assessment of the included studies: The quality of the included studies varied between 4 and 12. Of which, two studies have good quality, four studies have average and one study has poor quality (Table 3).

Table 1. Characteristics of the included studies

Author Year	Study area	Working unit	Study Design	Methods of data collection	Time frame	Assessment tool	Definition of MAEs (Yes/No)	Sample Size	Cases
Feleke et al., 2010	Oromia	Pediatrics ward	Prospective observational	Direct observational	February 18 to March 2,2009	Observational checklist	Yes	218	196
Agalu et al., 2012	Oromia	ICU, Specialized teaching hospital	Prospective Cross sectional	Direct observational	February 7 to March 24, 2011.	Observational checklist	Yes	1200	622
Feleke et al., 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	Yes	360	356
Alemu et al., 2017	Oromia	Medical, Surgical , Pediatrics, Oby-gyne, OPD€, OR£ and Others	Prospective Cross sectional	Self-administered and observational checklist	March1–30, 2014	Questionnaire and observational checklist	Yes	139	138
Wondmieneh et al., 2018	Addis Ababa	Medical, Surgical , Pediatrics, Oby-gyne, Emergency OPD, ICU, Oncology	Prospective Cross sectional	Observational	February to March 2018.	Questionnaire and observational checklist	Yes	225	216
Jember et al., 2018	Amhara	Internal medicine, Surgical ward, Emergency room, Psychiatry, ICU, Pediatric ward	Quantitative cross sectional	Self-administered questionnaire	March 6 to May10, 2015	Questionnaire	Self developed	397	198
Bifftu et al., 2018	Amhara	Inpatient departments of Pediatric and Adult units	Quantitative cross sectional	Self-administered questionnaire	May, 1 to 30, 2015	Questionnaire	Self-developed	282	203

€Out Patient Department, £Operation Room

Table 2. Type and magnitude of medication administration errors in percent

Type of MAEs	Authors, year and percentage of MAEs						
	Fekadu et al., 2010	Agalu et al., 2012	Feleke et al., 2015	Alemu et al., 2017	Wondmiene et al., 2018	Jember et al., 2018	Bifftu et al., 2018
Wrong route	-	9.1	8.2	40	14.2	-	39
Wrong time	25.2	30.3	53.6	58.5	34.7	-	52.1
Wrong patient	-	-	-	30	15.1	-	63.5
Wrong dose	23.4	4.4	23.1	33.8	23.1	-	68.4
Wrong drug	-	-	8.3	33.1	16.4	-	63.5
Omission error	19.3	47.3	-	-	-	-	28
Wrong rate	-	1.4	-	-	-	-	-
Wear/change glove	-	-	-	-	41.4	-	-
Not Wash/rub-hand	-	-	-	-	76	-	-
Documentation	-	-	87.5	85.4	52	-	71.6
Unauthorized	2.8	2.7	1.1	-	-	-	-
Administration techniques error	18.8	-	73.1	-	-	-	-
Wrong duration	-	0.9	-	-	-	-	-

Table 3. Quality of included studies in the analysis of MAEs

Criteria for quality assessment	Authors, year						
	Fekadu et al., 2010	Agalu et al., 2012	Feleke et al., 2015	Alemu et al., 2017	Wondmieneh et al., 2018	Jember et al., 2018	Bifftu et al., 2018
Aims/objectives clearly stated	Yes	Yes	Yes	Yes	Yes	No	Yes
Definition of MAEs	Yes	Yes	Yes	Yes	Yes	No	Yes
Error categories specified	Yes	No	Yes	No	Yes	No	Yes
Error categories defined	Yes	Yes	Yes	Yes	Yes	No	Yes
Clearly defined denominator	Yes	Yes	Yes	Yes	Yes	No	Yes
Data collection method described clearly	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Setting in which study conducted described	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sampling and calculation of sample size described	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reliability measures	No	No	Yes	Yes	No	No	No
Measures in place to ensure that results are valid	No	No	Yes	Yes	No	No	No
Limitations of study listed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mention of any assumptions made	No	N o	No	No	No	No	No
Ethical committee approved	No	Yes	Yes	Yes	Yes	No	Yes
Total score	9	9	12	11	10	4	10

Pooled magnitude of MAEs

The overall pooled magnitude of MAE was found to be 39.3% (95% CI, 29.1%-49.5%) using random effect model (I^2 = 0%, P = 0.576) (Figure 2).

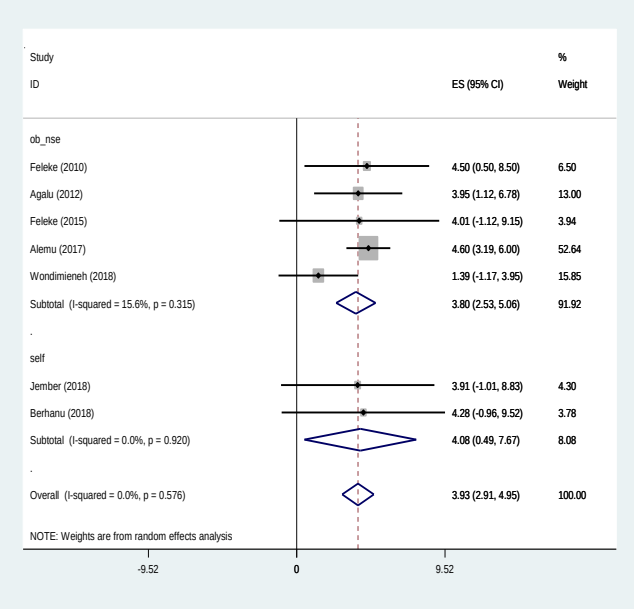

Figure 2. Forest plot presenting the pooled prevalence of MAE using random effect models with 95% CI

It has no evidence of significant heterogeneity test result (I^2 = 0%, P =0.576) and publication bias from the visual inspection of the funnel plot and the Egger's test (P =0.406).

Discussion

To our knowledge, this is the first systematic review and meta-analysis about the magnitude and nature of MAEs among nurses in Ethiopia. Overall the pooled magnitude of MAE was found to be 39.3% (95% CI, 29.1%-49.5%).

This result is consistent with study carried out in Iran [44.5% (27%-50.6%)].[48] This result is higher than the previous systematic review and meta-analysis carried out in developed countries [19.6%],[49] South East Asia [51.6%],[16] Middle East [44.7%][38] and lower than the review in East Africa [56.4%%)].[39] The difference might be due to variation in definitions and types/number of MAEs studied.[46] For example, the cut-off point for time error, is ±30 minutes for some of the studies and ±60 minutes for the other to define/consider as error.[49] 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.[46,50] The other possible reasons for the difference may be due to variation in the study settings,[19,47,50] the assessment method (observational, self-reported and patient chart review) also contributed for the variation. This is supported by previous study in Ethiopia that revealed the prevalence of MAE was 71% for self-reported method as compared to 97% for observational method.[20] Study from Korea also supports this.[51] This may suggest the need of both methods to understand the difference between perceived and experienced prevalence of MAE.

Regarding the types of MAEs; though the proportion of MAEs for each type of errors is varied based on the standard or right used as a reference,[26,27] definitions[46] and phases of medication administration process,[11-13] in this study around thirteen different types of MAEs were identified such as: wrong route, wrong time, wrong patient, wrong dose, wrong drug, omitted error, wrong rate, documentation errors, duration error, technical error, unauthorized, and without hand washing/change glove.[17-20,24,36,37] Of these, the most frequently reported MAEs were wrong time and wrong dose[17-20,24,37] and the third commonly reported MAE was wrong route.[17,19,20,24,47] The magnitude of reported MAEs was ranged from 0.9%[47] for wrong duration to 87.5%[17] for documentation error.[17] For each MAEs, the magnitude ranged from 25.5%[18] to 58.5%[17] for wrong time error, 4.4%[47] to 68.4%[20] for wrong dose errors, 8.2%[17] to 40%[20] for wrong route error, 15.1%[37] to 63.5%[20] for wrong patient error, 8.3%[18] to 63.5%[24] for wrong drug/medication error and 19.3%[37] to 47.3%[47] for omissions error. These result is supported with studies carried out in US where doses was the most common type of error reported.[21] A systematic review and meta-analysis from Southeast Asia also showed time error, omission error and wrong dose were the most frequent reported errors.[16] Regarding the magnitude of the errors, documentation error was the most prevalent type of MAE (87.5%). This showed the value nurses' had for documentation. Documentation is a written evidence of interactions between and among health professionals, clients, their families, and health care organizations.[52]

Nursing documents is a source of communication that reveals the treatment and quality of care given. This makes it essential for nurses to bier in mind the saying 'if it was not documented, it was not done'.[53] That is why in Ethiopia, the Federal Ministry of Health Operational Standard for Nursing Care outlines that every nursing care provided must be clearly and correctly documented.[54]

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. Lack of similar studies in Ethiopia limits the discussions. Although we used Pub-Med, Cochrane, Google Scholar and reference lists, there may be the possibility of having some overlooked.

Despite these, this systematic review and meta-analysis revealed the recently available evidence that may help to narrow the scant evidence of research in Ethiopia.

Conclusion

Overall, the magnitude of MAE was high in Ethiopia. Wrong route, wrong time, wrong patient, wrong dose, Wrong drug, omission error, wrong rate, and documentation errors were the reported type of MAEs. Of these, the most prevalent and most frequently reported type of MAEs was documentation error and wrong time error respectively. Authors suggested nurses to give more attentions on the rights of medication administration particularly, to strengthen their documentation behaviors.

Acknowledgments

Authors' gratitude goes to University of Gondar for office arrangement and motivational support to conduct this protocol.

Ethical issues

None to be declared.

Conflict of interest

The authors declare no conflict of interest in this study.

Research Highlights

What is the current knowledge?

Nurses are the final safety check during the medication administration process with inconsistent reported prevalence MAEs and dearth of comprehensive evidences.

What is new here?

The present study showed high overall pooled prevalence of MARs. Moreover, it identifies the type of error frequently observed with its respective magnitude that may help as an indication for area of intervention during the planning of preventive strategies. In addition, the present study suggested areas that need to be strengthen or need special attention during medication administration process.

Authors' contributions

BBB designed the review protocol in collaboration with BYM. BBB developed the search strategy and drafted the protocol. BBB and BYM were searches and conduct data selection and extraction. Both authors involved in data analysis and interpretation of results. Both authors have read and approved the final manuscript.

References

1. NHS England and NHS Improvement. Improving medication error incident reporting and learning [Internet] [cited 2014, March 03]. UK: NHS England and NHS Improvement. Available from: https://www.england. nhs.uk/2014/03/improving-medication-error-incident-reporting-and-learning/
2. Keers RN, Williams SD, Vattakatuchery JJ, Brown P, Miller J, Prescott L, et al. Medication safety at the interface: evaluating risks associated with discharge prescriptions from mental health hospitals. J Clin Pharm Ther 2015; 40 (6): 645-54. doi: 10.1111/jcpt.12328
3. World Health Organization. The third WHO global patient safety challenge: Medication Without Harm [Internet] [cited 2017, Sep. 05]. Available from: http://wwwwhoint /patientsafety /medica tion-safety/en/
4. Mulatsih S, Dwiprahasto I, Sutaryo. Implementation of medication safety practice in childhood Acute Lymphoblastic Leukemia treatment. Asian Pac J Cancer Prev 2018; 19 (5): 1251-7. doi: 10.22034 /APJCP.2018. 19.5.1251
5. National Coordinating Council for Medication Error Reporting and Prevention. Defining the problem and developing solutions [Internet][2015 Sep. 12]. Available from: http://www nc cmerporg. org on 12/09/2015.
6. Vadera S, Griffith SD, Rosenbaum BP, Chan AY, Thompson NR, Kshettry VR, et al. National Incidence of medication error in surgical patients before and after accreditation council for graduate medical education duty-hour reform. J Surg Educ 2015; 72 (6): 1209-16. doi: 10.1016/j.jsurg.2015.05.0 13.
7. Pham JC, Story JL, Hicks RW, Shore AD, Morlock LL, Cheung DS, et al. National study on the frequency, types, causes, and consequences of voluntarily reported emergency department medication errors. J Emerg Med 2011; 40 (5): 485-92. doi: 10.1016/j.jemermed.2008.02.059
8. Hedlund N, Beer I, Hoppe-Tichy T, Trbovich P. Systematic evidence review of rates and burden of harm of intravenous admixture drug preparation errors in healthcare settings. BMJ Open 2017; 7 (12) :e015912. doi: 10.1136/bmjopen-2017-015912
9. Ameer A, Dhillon S, Peters MJ, Ghaleb M. Systematic literature review of hospital medication administration errors in children. Integr Pharm Res Pract 2015; 4: 153-65. doi: 10.2147/IPRP.S54998
10. Gonzales K. Safe medication administration [dissertation]. United States: University of Iowa; 2011.
11. Haroun F. Teaching medication administration to nursing students – a scoping review with a decolonialnlens [master's thesis]. South Africa: Stellenbosch University; 2018.
12. Huynh N, Snyder R, José M. Vidal, Sharif O, Bo Cai, et al. Assessment of the nurse medication administration workflow process. J Healthc Eng 2016, 2016; 6823185. doi: 10.1155/2016/6823185
13. Shawahna R, Masri D, Al-Gharabeh R, Deek R, Al-Thayba L, Halaweh M. Medication administration errors from a nursing viewpoint: a formal consensus of definition and scenarios using a Delphi technique. J Clin Nurs 2016; 25 (3-4): 412-23. doi: 10.1111/jocn.13062
14. Policy Research Unit in Economic Evaluation of Health & Care Interventions. Prevalence and economic burden of medication errors in the NHS in England [Internet][Cited 2018, Feb. 22]. Available from: http://wwweepruo rguk/wp-content/uploads/2018/02/ medicationerror -report-revised-final2-22022018pdf
15. Epstein RH, Dexter F, Gratch DM, Perino M, Magrann J. Controlled substance reconciliation accuracy improvement using near real-time drug transaction capture from automated dispensing cabinets. Anesth Analg 2016; 122 (6): 1841-55. doi: 10.1213/ANE.0000 000000001289

16. Salmasi S KT, Hong YH, Ming LC, Wong TW: Medication errors in the Southeast Asian countries: a systematic review. PLoS One 2015, 10 (9) :e0136545. doi: 10.1371/journal.pone.0136545
17. Feleke SA, Mulatu MA, Yesmaw YS. Medication administration error: magnitude and associated factors among nurses in Ethiopia. BMC Nurs 2015; 14: 53. doi: 10.1186/s12912-015-0099-1.
18. Fekadu T, Teweldemedhin M, Esrael E, Asgedom SW. Prevalence of intravenous medication administration errors: a cross-sectional study. Integr Pharm Res Pract 2017; 6: 47-51. doi: 10.2147/IPR P.S125085.
19. Baraki Z, Abay M, Tsegay L, Gerensea H, Kebede A, Teklay H. Medication administration error and contributing factors among pediatric inpatient in public hospitals of Tigray, northern Ethiopia. BMC Pediatr 2018; 18 (1): 321. doi: 10.1186/s 12887-018-1294-5.
20. Alemua W, Belachew T, Yimam I. Medication administration errors and contributing factors: A cross sectional study in two public hospitals in Southern Ethiopia. Int J Afr Nurs Sci 2017; 7; 68-74. doi. 10.1016/j.ijans.2017.09.001.
21. Armitage G, Knapman H. Adverse events in drug administration: a literature review. J Nurs Manag 2003; 11 (2); 130-40. doi: 10.1046/j.1365-2834.2003.00359.x
22. World Health Organization. Medication errors: Technical series on safer primary care. ISBN 978-92-4-151164-3.
23. Sears K, O'Brien-Pallas L, Stevens B, Murphy GT. The relationship between nursing experience and education and the occurrence of reported pediatric medication administration errors. J Pediatr Nurs 2016; 31 (4): 283-90. doi: 10.1016/j.pedn.2016.01.003.
24. Bifftu BB, Dachew BA, Tiruneh BT, Beshah DT. Medication administration error reporting and associated factors among nurses working at the University of Gondar referral hospital, Northwest Ethiopia, 2015. BMC Nursing 2016; 15: 43. doi: 10.1186/s12912-016-0165-3
25. Westbrook JI, Rob MI, Woods A, Parry D. Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. BMJ Qual Saf 2011; 20 (12): 1027-34. doi: 10.1136/bmjqs-2011-000089
26. Jones JH, Treiber L. When the 5 rights go wrong medication errors from the nursing perspective. J Nurs Care Qual 2010; 25 (3): 240-7. doi:10.1097/NCQ.0b 013e3181d5b948
27. Elliott M, Yisi L. The nine rights of medication administration: an overview. British Journal of Nursing 2010; 9 (5): 1-7.
28. Kelly J, Wright D, Wood J. Medicine administration errors in patients with dysphagia in secondary care: a multi-centre observational study. J Adv Nurs 2011; 67 (12): 2615-27. doi: 10.1111/j .1365-2648.2011.05700.x
29. Blignaut AJ, Coetzee SK, Klopper HC, Ellis SM. Medication administration errors and related deviations from safe practice: an observational study. J Clin Nurs 2017; 26 (21-22): 3610-23. doi: 10.1111 /jocn.13732
30. Patel N, Desai M, Shah S, Patel P, Gandhi A. A study of medication errors in a tertiary care hospital. Perspect Clin Res 2016; 7 (4): 168-73. doi: 10.4103/2229-3485.192039
31. Institute of medicine (US) committee on quality of health care in America, Kohn LT, Corrigan JM, Donaldson MS. To err is human: building a safer health system. 1st ed. Washington (DC): National Academies Press (US); 2000.
32. Bonney W. Medical errors: moral and ethical considerations. Journal of Hospital Administration 2014; 3 (2): 1-9. doi: 10.5430/jha.v3n2p80
33. Joolaee S, Hajibabaee F, Peyrovi H, Haghani H, Bahrani N. The relationship between incidence and report of medication errors and working conditions. Int Nurs Rev 2011; 58 (1): 37-44. doi: 10.1111/j. 1466-7657.2010 .00872.x
34. Mrayyan M, Shishani K, Al-Faouri I. Rate, cause and reporting of medication errors in Jordan: nurses' perspectives. J Nurs Manag 2007; 15 (6): 659–70. doi: 10. 1111/j.1365-2834.2007.00724.x
35. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 2015; 4 (1): 1-9. doi: 10.1186/2046-4053-4-1
36. Feleke Y, Girma B. Medication administration errors involving paediatric in-patients in a hospital in Ethiopia. Trop J Pharm Res; 9 (4): 401-7.
37. Wondmieneh A. Assessments of magnitude and contributing factors of medication administration error among nurses in tertiary hospitals, Addis Ababa, Ethiopia 2018 [master's thesis]. Ethiopia: Addis Ababa University College of Health Sciences, School of Nursing and Midwifery; 2018.
38. Alsulami Z, Conroy S, Choonara I. Medication errors in the middle East countries: a systematic review of the literature. Eur J Clin Pharmacol 2013; 69 (4): 995-1008. doi: 10.1007 /s00228-012-1435-y
39. Alemayehu B, Tariq M. Andrew J, Jo-anne E. Adverse drug events and medication errors in african hospitals: a systematic review. Drugs Real World Outcomes 2018; 5: 1–24. doi:101007/s40801-017-0125-6
40. Berkey CS HD, Mosteller F, Colditz GA. A random-effects regression model for meta-analysis. Stat Med 1995; 14 (4): 395-411. doi: 10.1002/sim.4780140406
41. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002; 21 (11): 1539-58. doi: 10.1002/sim.1186
42. Liu JL. The role of the funnel plot in detecting publication and related biases in meta-analysis. Evid Based Dent 2011; 12 (4): 121-2. doi: 10.1038/sj.ebd.6400831
43. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997; 315 (7109): 629-34. doi: 10.1136/bmj.315.7109.629
44. Duval S, Tweedie R. Trim and fill: a simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics 2000; 56 (2): 455-63. doi: 10.1111/j.0006-341x.2000. 00455 .x
45. Jember A, Hailu M, Messele A, Demeke T, Hassen M. Proportion of medication error reporting and associated factors among nurses: a cross sectional study. BMC Nurs 2018; 17: 9. doi:101186/s12912-018-0280-4.
46. Lisby M, Nielsen LP, Brock B, Mainz J. How should medication errors be defined? Development and test of a definition. Scand J Public Health 2012; 40 (2): 203-10. doi: 10.1177/1403494811435489
47. Agalu A, Ayele Y, Bedada W, Woldie M. Medication administration errors in an intensive care unit in Ethiopia. Int Arch Med 2012; 5 (15): 1-7. doi: 10.1186/1755-7682-5-15
48. Mansouri A, Ahmadvand A, Hadjibabaie M, Kargar M,

Javadi M, Gholami K. Types and severity of medication errors in Iran; a review of the current literature. Daru 2013; 21 (1): 49. doi: 10.1186/2008-22 31-21-49
49. Keers RN, Williams SD, Cooke J, Ashcroft DM. Prevalence and nature of medication administration errors in health care settings: a systematic review of direct observational evidence. Ann Pharmacother 2013; 47 (2): 237-56. doi: 10.1345/aph.1R147
50. Berdot S, Gillaizeau F, Caruba T, Prognon P, Durieux P, Sabatier B. Drug administration errors in hospital inpatients: a systematic review. PLoS One 2013; 8 (6): 68856. doi: 10.1371 /journal.pone .006 8856
51. You MA, Choe MH, Park GO, Kim SH, Son YJ. Perceptions regarding medication administration errors among hospital staff nurses of South Korea. Int J Qual Health Care 2015; 27 (4): 276-83. doi: 10.1093 /intqhc /mzv036
52. White L. Documentation & the nursing process: a review. 1st ed. United States: Cengage Learning; 2002.
53. Krishna R, Khyati GV. Nursing errors in documentation: a review. Ruas-Uas JMC 2017; 3 (2): 1-5.
54. Takele M. Improving the implementation status of nursing and midwifery care standard practice at medical, surgical and gynecology wards in dilchora hospital [master's thesis]. Ethiopia: Addis Ababa University College of Health Sciences, School of Nursing and Midwifery; 2018.