Research Article

Detection and Prevention of Medication Errors in the Operating Rooms of a Pediatric Surgery Department in Egypt

Mai Gamal Fawaz[1]*, Nagwa Ali Sabri[1], Ayman Ahmed Albaghdady[2], Fady Adib Abdel Malek[3]
[1]Department of Clinical Pharmacy, Faculty of Pharmacy, Ain Shams University, Cairo, Egypt.
[2]Department of Pediatric Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt.
[3]Department of Anesthesiology, Faculty of Medicine, Ain Shams University, Cairo, Egypt.
***Corresponding author's E-mail:** mai_fawaz87@yahoo.com

Received: 29-11-2016; **Revised:** 15-01-2017; **Accepted:** 29-01-2017.

ABSTRACT

Medication errors are widespread in the health care system and stated to be the seventh most common cause of death overall. The role of clinical pharmacist in controlling medication use in the operating rooms in Egypt is not clearly defined. The objective of this study was to investigate the role of clinical pharmacist in the detection, reporting and prevention of medication errors in a pediatric surgery department in Cairo, Egypt. In this pre-post study, medication errors were detected in two groups of patients. Direct observation and chart review methods were used for detection of the errors. The type, category, stage of medication errors, in addition to who committed and who detected the error were determined for each error detected in both pre- and post-intervention groups. Five drug classes were studied that included: anti-microbials, anesthetics, analgesics, gastrointestinal agents and miscellaneous drugs. The intervention included educating physicians and anesthesiologists about detection, reporting and prevention of medication errors, and involvement of a clinical pharmacist in the surgery department. A total of 312 medication errors were detected in the pre-intervention group out of 936 medication orders for 110 patients, and 224 medication errors were detected in the post-intervention group out of 693 medication orders for 112 patients (P= 0.67). The intervention resulted in a significant reduction in low-dose errors (P=0.005) and high-dose errors (P=0.001). Other types of medication errors were reduced at different rates. Additionally, there was a significant reduction in number of prescribing errors post-intervention (P<0.05). Category C medication errors were significantly reduced post-intervention (P<0.05). Clinical pharmacist has an essential role in reducing medication errors in the preoperative setting. Implementation of clinical pharmacy department in surgery departments in Egypt is necessary to enhance patient safety during surgery.

Keywords: Medication errors, clinical pharmacist, operating rooms.

INTRODUCTION

A medication error is any error in the medication use process, whether it resulted in adverse outcomes or not. Medication errors are widespread in health care system and stated to be the seventh most common cause of death overall.[1] A medication error could occur at any stage of the medication use process (prescribing, transcription, dispensing, or administration of a medication) which can lead to failure of administering the correct drug or the designated appropriate drug dosage to the patient.[2]

Medication errors are common in anesthesia practice and the peri-operative environment.[3,4,5] Serious incidents occurred usually during middle of the anesthesia (42%), often during induction (26%) and at the beginning of the procedure (17%), and less at the end of the procedure (9%).[6] Many errors induce little or no harm, but some have disastrous complications for patients and occasionally for practitioners.[3,7,8]

Pediatrics are exposed to a higher risk for medication errors compared to adults, due to wide variation in body mass, where doses are to be calculated individually according to patient age, weight or body surface area, and clinical condition.[9]

In a systematic review of 32 studies about medication errors in pediatric patients, it was observed that wrong dosing was the most common type of error. Other types of medication errors were wrong drug, wrong route of administration, wrong transcription, wrong date, incorrect frequency of administration, errors of omission, wrong patient, drugs given to patients with known allergies, drug interaction, intravenous incompatibility, and wrong rate of intravenous drug administration. Antibiotics and sedatives were the most commonly reported drug classes associated with errors, and the intravenous route was found to be the most common route associated with medication errors in children.[10]

Various measures can be implemented to help reduce medication errors in pediatrics. Pediatric antibiotic dosing standardization policy was found to significantly reduce the incidence of dosing errors in antibiotics prescribed for pediatric patients in a tertiary care hospital.[11] The use of a checklist can reduce prescription and administration errors of medications and intravenous sloutions.[12] The use of computerized physician order entry has also shown to be effective in reducing the risk of prescribing medication errors.[13,14] Educational interventions to physicians and other healthcare team members can decrease medication errors.[15] In addition, reporting medication errors is an essential measure to prevent medication error events in a healthcare system and can serve as an important tool for enhancing patient safety.[16] Another largely discussed method of reducing medication administration errors is the bar-coded medication administration.[17]

This study was conducted to assess the impact of the presence of a clinical pharmacist in the operating room and the effect of pharmacist's educational intervention to the healthcare staff on the detection and prevention of medication errors in the operating rooms of a pediatric surgery department in Egypt. To our knowledge, this is the first study to investigate intra-operative medication errors in pediatric patients in Egypt.

MATERIALS AND METHODS

Study Design and Setting

This was a pre-post study, conducted on 222 pediatric patients admitted to the pediatric surgery department in a teaching Children's hospital, Ain Shams University, Cairo, Egypt, in the period from April 2014 till October 2015.

Patients and Data Collection

All pediatric patients undergoing surgical operations and/or receiving general anesthesia were included in the study. The pre-intervention group included 110 patients and the post-intervention group included 112 patients. Medication errors were detected pre-, intra-, and post-operatively. All surgeries were attended by the researcher to observe and detect medication errors intra-operatively. For each patient enrolled in the study, the following data were recorded: patient's name, patient's hospital ID number, patient's age, patient's weight, patient's sex, parent or caregiver's phone number, procedure name, site of the procedure, date of hospital entry, date of surgery, date of discharge, date and number of follow-up visits, length of hospital stay, all medications received pre-, intra-, and post-operatively, and post-operative complications including: nausea, vomiting, fever, persistent pain, diarrhea, and death. A follow-up sheet was used to record possible post-operative complications. Follow-up was performed through phone calls to the parent or caregiver of the patients, observing inpatients in the ward and the intensive care unit (ICU), and attending the follow-up visits. Medication errors were detected through direct observation[9,18-22], and review of medication orders.[9,20,22-25] Medication errors reports were used by the researcher for the post-intervention group medication errors to report detected medication errors.[9,20,26] Detected medication errors for drugs used pre- and/or post-operatively were reviewed by a pediatric surgeon, and detected medication errors for drugs used during anesthesia were reviewed by an anesthesiologist.

Ethical Committee Approval

The protocol was approved by the ethical committee of the faculty of Pharmacy, Ain Shams University.

Classification of Medication Errors

Detected medication errors were classified according to: type of the detected error (wrong dose (deviation of ≥ 10% of the recommended dose in pediatric references), wrong drug concentration, wrong route of administration, wrong dosing interval, duration of treatment was not mentioned, wrong drug for patient's age, dose administered but not recorded by nurse in the patient's ticket), who committed the error (surgery resident, anesthesia resident, nurse), category of medication error according to the National Coordinating Council for Medication Error Reporting and Prevention(NCCMERP)(A: circumstances or events that have the capacity to cause error, B: an error occurred but the error did not reach the patient, C: an error occurred that reached the patient but did not cause patient harm, D: an error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm, E: an error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention, F: an error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization, G: an error occurred that may have contributed to or resulted in permanent patient harm, H: an error occurred that required intervention necessary to sustain life, I: an error occurred that may have contributed to or resulted in the patient's death)[27], who detected the error (researcher, physician, nurse), and stage of the medication error (prescribing, transcribing, administration).

Intervention

An educational session was held to the physicians (pediatric surgery and anesthesia residents) about medication errors detection and prevention. The session covered the following items:

Definition of medication errors, medication use process, difference between medication errors and adverse drug events, barriers to reporting medication errors, categories of medication errors according to the NCC MERP[27], types of medication errors, USP medication errors reporting program, prevention strategies according to the Anesthesia patient safety foundation's new paradigm for enhancing medication safety in the operating room; denoted as STPC (standardization-technology-pharmacy/premixed/prefilled-culture)[28],and the role of clinical pharmacist in the operating room.

Statistical Methods

Standard computer program SPSS for Windows, release 13.0 (SPSS Inc, USA) was used for data entry and analysis. All numeric variables were expressed as mean ± standard deviation (SD). Chi-square (χ^2) test was used to compare frequency of qualitative variables among the different groups. Spearman's correlation test was used for correlating non-parametric variables. For all tests a probability (p) less than 0.05 was considered significant.

RESULTS

A total of 312 medication errors were detected in the pre-intervention group out of 936 medication orders administered to 110 patients, and 224 medication errors were detected in the post-intervention group out of 693 medication orders administered to 112 patients. Demographic characteristics of patients in both groups are illustrated in (Table 1).

According to the type of medication errors detected, there was a significant difference between both groups regarding the low dose errors (p=0.005). The intervention also resulted in a significant reduction in the high dose errors (p=0.001). Although the wrong drug concentration errors significantly increased in the post-intervention group (p=0.03), they were all category B errors, so these errors in the post-intervention group were corrected before reaching the patient. The most common type of error in the pre-intervention group was the high dose errors, while for the post-intervention group; it was the low dose errors (Figure 1).

In the pre-intervention group, 184 of the errors detected were committed by surgery residents, that decreased to 112 errors in the post-intervention group, with a significant difference between the two groups (P=0.04). There was no significant difference between the two groups regarding the number of errors committed by the anesthesia residents and nurses with p-values of 0.15 and 0.3, respectively.

Regarding the category of medication errors according to the NCC MERP, the difference between the two groups in category B medication errors was highly significant (p=0.00006). In addition, there was a significant difference between the two groups in category C medication errors (p=0.005), where 269 of the detected errors in the pre-intervention group were category C errors, that has dropped to 172 category C errors in the post-intervention group. No errors were detected in categories: E, F, G, H, and I, for both groups (Table 2).

The researcher has detected 309 out of 312 errors committed in the pre-intervention group, and 223 out of 224 errors committed in the post-intervention group, where the difference between the two groups was non-significant (p=0.44). Three errors were detected by the residents in the pre-intervention group, while only one error was detected by them in the post-intervention group (p=0.44). No errors were detected by the nurses in both groups.

In this study, all detected medication errors occurred in one of three stages of the medication use process; prescribing, transcribing, or administration. Most of the errors detected occurred during the prescribing process in both groups with a significant difference between both groups (p=0.04) (Table 3).

Due to the large number of drugs administered by the patients, pre-, intra-, and post-operatively, we decided to group drugs into therapeutic classes, which included: anti-microbials, analgesics, gastrointestinal agents, anesthetics, and miscellaneous class that included any other drugs used. In all therapeutic classes, there was no significant difference between the two groups regarding the number of errors detected within the therapeutic class. The most common class of errors in both pre-intervention and intervention groups was the anesthetics followed by the antimicrobials as demonstrated in (Figure 2).

CORRELATION

For the pre-intervention group, there was a significant positive correlation between the number of medication errors and the length of hospital stay (r=0.000), and a non-significant positive correlation between the number of medication errors and the number of follow-up visits (r=0.153).

For the post intervention group, there was a significant positive correlation between the number of medication errors and the length of hospital stay (r=0.018), and a significant positive correlation between the number of medication errors and the number of follow-up visits (r=0.001).

For all patients, there was a significant positive correlation between the number of medication error and the length of hospital stay (r=0.000), and similarly a significant positive correlation between the number of medication errors and the number of follow-up visits (r=0.000).

DISCUSSION

This study demonstrated a reduction in medication errors in a pediatric surgery department in a teaching Children's hospital in Egypt as a result of physicians' education about detection, reporting and prevention of medication errors, and providing clinical pharmacy services on the department by a research clinical pharmacist. Similarly, Davey et al., presented a prescribing tutorial to physicians in a pediatric unit at a district general hospital in the United Kingdom. They found that prescription errors have reduced by 46% due to the introduction of the tutorial.[29] Another study about the influence of a multifaceted educational intervention on the error rates in medication preparation and administration in a tertiary neonatal ICU found that the rate of medication errors declined significantly, from 49% to 31%.[30]

Our data showed that there was a reduction in the total number of medication errors after the intervention. For all errors detected, a high dose error represented the chief group of errors, followed by low dose errors, unrecorded doses, wrong dosing interval, unmentioned duration of treatment, wrong drug concentration, and the least two groups of errors were wrong route of administration, and wrong drug for age group.

Table 1: Demographic Characteristics of Patients in the Pre- and Post-Intervention Groups

	Pre-Intervention		Post-Intervention		P-Value
Number of Patients	110		112		
Mean Age in Months (Range)	41.11 (1.33-192)		43.72 (0.1-156)		0.532
Mean Weight in Kg (Range)	13.86 (2.2-40)		14.89 (2.5-50)		0.230
Gender	No. of Males	No. of Females	No. of Males	No. of Females	0.946
	80	30	81	31	

Table 2: Comparing the Categories of Medication Errors Detected in the Pre- and Post-Intervention Groups

Category of Error	Pre-Intervention	Post-Intervention	P-Value
A	39	35	0.3
B	3	17	0.00006
C	269	172	0.005
D	1	0	0.58

Table 3: Comparing the Stage of Medication Errors Detected in the Pre- and Post-Intervention Groups

Stage of Error	Pre-Intervention	Post-Intervention	P-Value
Prescribing	184	112	0.04
Transcribing	39	35	0.3
Administration	89	77	0.15

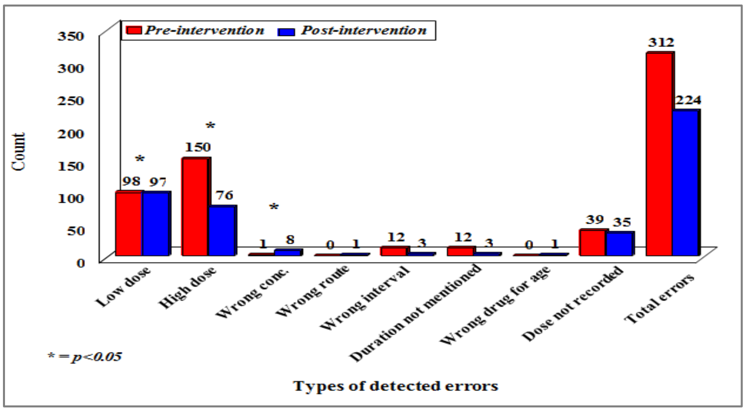

Figure 1: Comparing the Types of Medication Errors Detected in the Pre- and Post-Intervention Groups

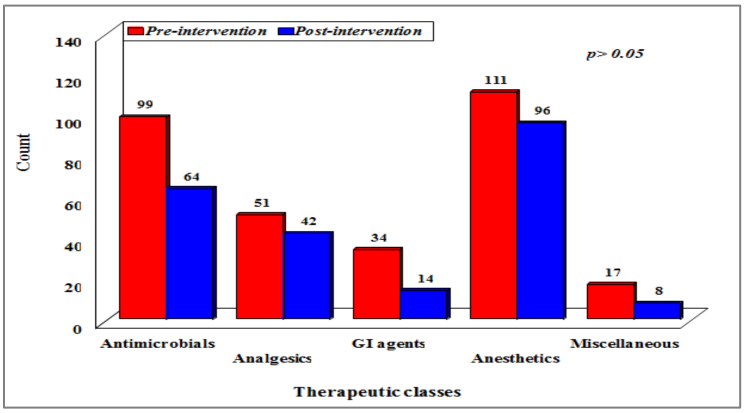

Figure 2: Comparing the Total Number of Errors Detected in Different Drug Classes in the Pre- and Post-Intervention Groups

In coincidence, Kaushal et al in their study to analyze the major types of medication errors in all pediatric wards including surgical wards at two teaching hospitals reported that most medication errors were dosing errors (28%), followed by errors in route of administration, medication administration records transcription and documentation, date, and frequency of administration in pediatric inpatient settings.[31] Similarly, Engum and Breckler in their study to evaluate medication errors in the pediatric surgical service provided at a Children's tertiary hospital reported that an incorrect dose of medications was the dominant type of error detected.[32] In a systematic review of thirty two studies about medication errors in pediatrics, dosing errors were found to be the most common type of error.[10]

In the current study, Anesthetics were the class of drugs most involved in medication errors, followed by antimicrobials, analgesics, gastrointestinal agents, and the least involved was the miscellaneous class. In a study considering pediatric medication errors in the post-anesthetic care unit (PACU) reported to the MEDMARX database over a period of six years, researchers reported that half of the errors were involving morphine, acetaminophen, meperidine, or fentanyl.[33]Contrarily, Engum and Breckler stated that antibiotics were the most involved class in medication errors.[32] in another study; the drug classes associated most frequently with errors were anti-infectives, electrolytes and fluids, and analgesics and sedatives.[31]

Most of the medication errors detected in this study were category C (82.2%) where the errors reached the patient but caused no harm, followed by categories A (13.8%) and B (0.18%) errors where errors never made it to the patient, and only one category D (0.18%) error was detected in the pre-intervention group where the error reached the patient and required monitoring to confirm that it resulted in no harm. In Engum and Breckler's study, most of the incorrect orders were categories A and B, and (5%) only reached the patient and caused temporary harm (category E).[32] In a research examining seven years of PACU medication errors from the MEDMARX database, category C represented (67.8%) of the submitted medication error reports in the pediatric population.[4]

In this study, (55.2%) of the medication errors occurred during prescribing, (30.9%) during administration, and (13.8%) during transcribing stage. Similarly, a study investigating medication errors in a pediatric ICU found that administration and prescription errors had the highest share of medication errors detected.[34]

For all medication errors detected in the study, the errors were chiefly detected by the researcher pharmacist (99.2%). (0.74%) of the errors was detected by the residents, while no errors were detected by the nurses. Surgery residents committed (55.2%) of the total medication errors detected. (30.9%) of the errors were committed by the anesthesia residents and (13.8%) were committed by the nurses.

Our method for detection of the medication errors was mainly the direct observation method. Direct observation is the only method available for detecting errors of administration.[20] Many studies have used the direct observation method for detection of medication errors.[9,18,19,21,22,25,30,32,34] In addition; review of medication charts was used to detect medication errors that might be missed during observation. Some studies have used the chart review method for detection of medication errors.[9,12,15,22-25] Incident reporting was used in some studies to detect medication errors where the person who witnessed, committed or discovered an error spontaneously reports the error through filling in an incident report.[7-9,26] In this study, incident reports were used by the researcher in the post-intervention group to report the detected medication errors.

Our study has several limitations. The comparison of our data with other studies was challenging due to the lack of studies investigating intra-operative medication errors in the pediatric population, in addition to differences in the healthcare systems, definitions of medication errors and methodology used. We studied errors in the surgery department in one teaching Children's hospital in Egypt, so our findings may not be applicable to other hospitals, but we think they may be applicable to other departments in the hospital. Even with an integrative methodology to data collection, we probably failed to detect some errors, because only the researcher was observing drug administration, reviewing charts and collecting all data required for the study. Errors may be more reliably detected by including a number of trained observers in the study. Finally, the occurrence and detection of medication errors could be affected by the Hawthorne effect as the observation process was undisguised.

CONCLUSION

Clinical pharmacist involvement in the medication use process in surgery departments is critical to help reduce medication errors in the peri-operative setting, and ensure compliance and adherence to the standards related to the medication use process. Implementation of clinical pharmacy department in surgery departments in Egypt is necessary to enhance patient safety during surgery through reviewing medication requests from surgery or anesthesiology staff before the drug is dispensed, detecting and preventing medication errors not identified by the physician, recommending the appropriate management of adverse drug reactions that occur in the operating room, and monitoring drug therapy that help assess improved patient outcome.[35]

REFERENCES

1. Moyen E., Camiré E., Stelfox H.T., Clinical review: Medication errors in critical care. Critical Care 12, 2008, 208-208, DOI: 10.1186/cc6813, PMID: 18373883.

2. Merry, A.F., Anderson, B.J., Medication errors--new approaches to prevention. Paediatr Anaesth 21, 2011, 743-

753, DOI: 10.1111/j.1460-9592.2011. 03589.x, PMID: 21518115.

3. Webster C.S., Merry A.F., Larsson L., McGrath K.A., Weller J., The frequency and nature of drug administration error during anaesthesia. Anaesth Intensive Care 29, 2001, 494-500, PMID: 11669430.

4. Hicks R.W., Becker S.C., An overview of intravenous-related medication administration errors as reported to MEDMARX, a national medication error-reporting program. J Infus Nurs 29, 2006, 20-27, PMID: 16428997.

5. Hicks R.W., Becker S.C., Windle P.E., Krenzischek D.A., Medication errors in the PACU. J Perianesth Nurs 22, 2007, 413-419, DOI: 10.1016/j.jopan.2007.08.002, PMID: 18039513.

6. Cooper J.B., Newbower R.S., Long C.D., McPeek B., Preventable anesthesia mishaps: a study of human factors. 1978. Qual Saf Health Care 11, 2002, 277-282, DOI: 10.1136/qhc.11.3.277, PMID: 12486995.

7. Thomas A.N., Panchagnula U., Medication-related patient safety incidents in critical care: a review of reports to the UK National Patient Safety Agency. Anaesthesia 63, 2008, 726-733, DOI: 10.1111/j.1365-2044.2008. 05485.x, PMID: 18582258.

8. MacLennan A.I., Smith A.F., An analysis of critical incidents relevant to pediatric anesthesia reported to the UK National Reporting and Learning System, 2006-2008. Paediatr Anaesth 21, 2011, 841-847, DOI: 10.1111/j.1460-9592.2010. 03421.x, PMID: 21054660.

9. Wong I.C., Ghaleb M.A., Franklin B.D., Barber N., Incidence and nature of dosing errors in paediatric medications. Drug Safety 27, 2004, 661-670, DOI: 10.2165/00002018-200427090-00004, PMID: 15230647.

10. Ghaleb M.A., Barber N., Franklin B.D., Yeung V.W., Khaki Z.F., Wong I.C., Systematic review of medication errors in pediatric patients. Annals of Pharmacotherapy 40, 2006, 1766-1776, DOI: 10.1345/aph.1G717, PMID: 16985096.

11. Aseeri M.A., The Impact of a Pediatric Antibiotic Standard Dosing Table on Dosing Errors. The Journal of Pediatric Pharmacology and Therapeutics: JPPT 18, 2013, 220-226, DOI: 10.5863/1551-6776-18.3.220, PMID: 24052785.

12. Otero P., Leyton A., Mariani G., Cernadas J.M.C., Medication errors in pediatric inpatients: prevalence and results of a prevention program. Pediatrics 122, 2008, e737-e743, DOI: 10.1542/peds.2008-0014, PMID: 18762510.

13. van Rosse F., Maat B., Rademaker C.M.A., van Vught A.J., Egberts A.C.G., Bollen C.W., The Effect of Computerized Physician Order Entry on Medication Prescription Errors and Clinical Outcome in Pediatric and Intensive Care: A Systematic Review. Pediatrics 123, 2009, 1184-1190, DOI: 10.1542/peds.2008-1494, PMID: 19336379.

14. Potts A.L., Barr F.E., Gregory D.F., Wright L., Patel N.R., Computerized Physician Order Entry and Medication Errors in a Pediatric Critical Care Unit. Pediatrics 113, 2004, 59-63, DOI: PMID: 14702449.

15. Alagha H.Z., Badary O.A., Ibrahim H.M., Sabri N.A., Reducing prescribing errors in the paediatric intensive care unit: an experience from Egypt. Acta Paediatrica 100, 2011, e169-e174, DOI: 10.1111/j.1651-2227.2011. 02270.x, PMID: 21418100.

16. Sarvadikar A., Prescott G., Williams D., Attitudes to reporting medication error among differing healthcare professionals. Eur J Clin Pharmacol 66, 2010, 843-853, DOI: 10.1007/s00228-010-0838-x, PMID: 20532494.

17. Perry A., Englebright J., Improving Safety with Barcode-Enabled Medication Administration. Patient Safety and Quality Healthcare (May/June), 2007, 26-30. Available from: < http://www.psqh.com/mayjun07/improvingsafety.html>.

18. Kopp B.J., Erstad B.L., Allen M.E., Theodorou A.A., Priestley G., Medication errors and adverse drug events in an intensive care unit: direct observation approach for detection. Crit Care Med 34, 2006, 415-425, DOI: 10.1097/01.CCM.0000198106. 54306.D7, PMID: 16424723.

19. DeYoung J.L., Vanderkooi M.E., Barletta J.F., Effect of bar-code-assisted medication administration on medication error rates in an adult medical intensive care unit. Am J Health Syst Pharm 66, 2009, 1110-1115, DOI: 10.2146/ajhp080355, PMID: 19498127.

20. Montesi G., Lechi A., Prevention of medication errors: detection and audit. Br J Clin Pharmacol 67, 2009, 651-655, DOI: 10.1111/j.1365-2125.2009. 03422.x, PMID: 19594533.

21. Sulaiman Z.H., Detection and Evaluation of Medication errors at Jordan University Hospital [Dissertation]. University of Petra (Jordan), 2014, Ann Arbor 128,

22. Raban M.Z., Walter S.R., Douglas H.E., Strumpman D., Mackenzie J., Westbrook J.I., Measuring the relationship between interruptions, multitasking and prescribing errors in an emergency department: a study protocol. BMJ Open 5, 2015, e009076, DOI: 10.1136/bmjopen-2015-009076, PMID: 26463224.

23. Kaushal R., Using chart review to screen for medication errors and adverse drug events. Am J Health Syst Pharm 59, 2002, 2323-2325, PMID: 12489372.

24. Grasso B.C., Genest R., Jordan C.W., Bates D.W., Use of Chart and Record Reviews to Detect Medication Errors in a State Psychiatric Hospital. Psychiatric Services 54, 2003, 677-681, DOI: 10.1176/appi.ps.54.5.677, PMID: 12719497.

25. Lisby M., Nielsen L.P., Mainz J., Errors in the medication process: frequency, type, and potential clinical consequences. International Journal for Quality in Health Care 17, 2005, 15-22, DOI: 10.1093/intqhc/mzi015, PMID: 15668306.

26. Capucho H.C., Arnas E.R., Cassiani S.H., [Patient safety: a comparison between handwritten and computerized voluntary incident reporting]. Rev Gaucha Enferm 34, 2013, 164-172, DOI: 10.1590/S1983-14472013000100021, PMID: 23781738.

27. NCC MERP index for categorizing medication errors, 2001. Avilable from: <http://www.nccmerp.org/categorizing-medication-errors-index-color>.

28. Vanderveen T., Successful implementation of the new paradigm for medication safety: standardization, technology, pharmacy, and culture (STPC). APSF Newsletter, 2010, 26-28. Available from: <http://www.apsf.org/newsletters/html/2010/summer/03_STPC.htm>

29. Davey A.L., Britland A., and Naylor R. J, "Decreasing paediatric prescribing errors in a district general hospital. Quality & safety in health care 17 (2), 2008, 146-149, DOI: 10.1136/qshc.2006.021212, PMID: 18385410.

30. Chedoe I, Molendijk H, Hospes W, Van den Heuvel ER, Taxis K. The effect of a multifaceted educational intervention on medication preparation and administration errors in neonatal intensive care. Archives of Disease in Childhood-Fetal and Neonatal Edition. 97 (6), 2012, F449-55, DOI: 10.1136/fetalneonatal-2011-300989, PMID: 22491014

31. Kaushal R., Bates D.W., Landrigan C., McKenna K. J., Clapp M. D., Federico F., Goldmann D. A, Medication errors and adverse drug events in pediatric inpatients. JAMA 285 (16), 2001, 2114-2120, DOI: 10.1001/jama.285.16.2114, PMID: 11311101.

32. Engum S.A., Breckler F.D., An evaluation of medication errors—the pediatric surgical service experience. Journal of Pediatric Surgery 43, 2008, 348-352, DOI: 10.1016/j.jpedsurg.2007.10.042, PMID: 18280288.

33. Payne CH, Smith CR, Newkirk LE, Hicks RW. 2.2 Pediatric Medication Errors in the Postanesthesia Care Unit: Analysis of MEDMARX Data. AORN journal. Apr 30;85(4), 2007, 731-40, DOI: 10.1016/S0001-2092(07)60147-1, PMID: 17418130.

34. Haghbin S, Shahsavari S, Vazin A. Medication errors in Pediatric Intensive Care Unit: incidence, types and outcome. Trends in Pharmaceutical Sciences. Jun 1;2(2), 2016, DOI: http://dx.doi.org/10.1111%2Ftips.v2i2.68.

35. Donnelly A., Golembiewski J., ASHP guidelines on surgery and anesthesiology pharmaceutical services. American Journal of Health-System Pharmacy 56, 1999, 887-895, PMID: 10344614.

Source of Support: Nil, **Conflict of Interest:** None.