Saudi Pharmaceutical Journal 29 (2021) 1090–1095

Contents lists available at ScienceDirect

Saudi Pharmaceutical Journal

journal homepage: www.sciencedirect.com

Original article

Assessment and analysis of outpatient medication errors related to pediatric prescriptions

Amira B. Kassem [a], Haitham Saeed [b,*], Noha A. El Bassiouny [a], Marwa Kamal [c]

[a] Clinical Pharmacy and Pharmacy Practice Department, Faculty of Pharmacy, Damanhour University, Egypt
[b] Clinical Pharmacy Department, Faculty of Pharmacy, Beni-Suef University, Beni-Suef, Egypt
[c] Clinical Pharmacy Department, Faculty of Pharmacy, Fayoum University, Fayoum, Egypt

ARTICLE INFO

Article history:
Received 17 January 2021
Accepted 1 August 2021
Available online 4 August 2021

Keywords:
Medication error
Antibiotic misuse
Pediatric
Prescribed medication
Counseling

ABSTRACT

Background: Medication errors are the errors that impact the efficacy and safety of the therapy. The impact of medication errors is higher for certain subjects, such as pediatrics, who require more attention. Hence, the current study aimed to investigate the types and frequency of outpatient medication errors of pediatric subjects related to different prescription types.

Methods: A cross-sectional study was carried in several community pharmacies to record the medication errors found in outpatient pediatric prescriptions by gathering data from the outpatient prescriptions besides direct counseling with the subjects and their parents. Many medical resources (disease and drug-related) were used for checking the different aspects of medication errors. The data collection process included a preprepared sheet containing several items representing the medication errors in addition to a counseling session. Data were expressed as percentages and compared through the Chi-square test for results of handwritten and computerized prescriptions.

Results: 752 outpatient pediatric prescriptions were recruited in the study as they involve medication errors. Among the highest percentage of medication errors was the absence of essential data in the prescription, such as diagnosis, age, and weight. The duration of the therapy and contraindication for some of the prescribed medications were among the highest recorded errors. Among the critical errors were the drug interaction and drug duplication that directly affect the drug's efficacy and safety. There was a significant difference between computerized and handwritten prescriptions regarding the number of medication errors related to each type.

Conclusion: Medication errors related to outpatient pediatric prescriptions vary from one to another prescription with predominant errors that influence the therapy's safety or efficacy. The role of patient counseling and prescription checking is critical for improving patient therapy.

1. Introduction

National Coordinating Council of the United States for Medication Error Reporting and Prevention (NCC MERP) describes the medication error as, while the medication is under the hand of the health care providers, consumer, or patient, any preventable incident that could cause or trigger improper use of a drug or patient harm (NCCMERP, 2015). These incidents may be associated with clinical practice, health care equipment, techniques, and systems, including prescribing, order correspondence, labeling of products, nomenclature, compounding, distribution, dispensing, administration, education, monitoring, use, and packaging (Zarea et al., 2018, Zhou et al., 2018).

Medication errors, particularly in the pediatric population, are an important source of iatrogenic diseases (Berrier, 2016). This includes the need for increased monitoring, delayed hospital discharge, and Death. Outpatient prescription errors are one of the most common kinds of iatrogenic errors, and they can result in severe and often avoidable health problems. Pediatric subjects are particularly vulnerable because they are three times more likely than adults to have a potentially dangerous prescription error (George et al., 2016).

* Corresponding author.
E-mail address: Haitham.sd1@gmail.com (H. Saeed).

Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jsps.2021.08.009
1319-0164/

There are certain additional challenges to the use of medication in children in the outpatient setting. The off-label ones are widespread and unlicensed, increasing the risk of preventable harm associated with medication (Stingl et al., 2021). Compared to the adult population, a small error in the dose of medication given to children presents a greater risk of harm (Sutherland et al., 2019). Weight-related dose adjustment and other dosing calculations, which are less commonly found in adult prescribing, are also required for pediatric prescribing. Hence, the role of patient counseling and education is important for the detection of outpatient prescription errors such as drug interaction, drug allergy, and contraindication of certain medications. These medication errors could be defined through direct contact with the patient or parents in the outpatient setting due to a lack of archived medical records (Elgendy et al., 2020).

Providers of primary care may feel that they do not have time to examine doses correctly regarding the weight of a child, which is subject to change over time and, therefore, can write and dispense incorrect prescriptions. The liquid medication is also likely to be necessary for children, but reports suggest that more than 40 percent of caregivers make mistakes when making a dose of liquid medication (Brass et al., 2018). Hence, the intervention of community pharmacists to prevent outpatient medication errors is an essential part of rational drug therapy in the outpatient setting. This intervention should be done through patient counseling and deep revision of the outpatient prescription, also communication between community pharmacists and physicians is important to ensure the proper prescription.

Medication errors have been linked to a significant rise in overall healthcare costs in the U.S., and the drug-related cost and mortality costs are estimated to exceed $177.4 billion (Watanabe et al., 2018). Fatal errors result from dispensing either an incorrect medication or dose in most cases (Watanabe et al., 2018). Interestingly, studies in the U.K. also reveal that the incorrect selection of medications is responsible for several errors during data entry (Korb-Savoldelli et al., 2018). While some errors occur before the pharmacist receives the prescription, the pharmacy workload issues can increase error rates through dispensing without adequate counseling and education (Lester et al., 2020). Reduced staffing has been shown to have a detrimental effect on pharmacy professionals' ability to detect drug-drug interactions (Tawhari et al., 2021). Therefore, the current study aims to investigate the types and frequency of outpatient medication errors of pediatric subjects related to different prescription types.

2. Method

This is a cross-sectional study for all pediatric prescriptions received by several community pharmacies (1 July to 15 August 2020) located in Egypt's different areas. The samples for the current study were outpatient pediatric prescriptions that contain medication errors.

The study was carried in three different regions of Egypt. The prescriptions were collected from several community public pharmacies that receive a high number of pediatric prescriptions. The high flow pharmacies were determined for each region then each pharmacy was assigned a certain number, a randomization of the pharmacy's number was done, and 10 pharmacies were selected for each region.

2.1. Inclusion and exclusion criteria

The study's inclusion criteria were as follows; the prescriptions should be medication-related (not lab tests orders), the age of the subject should be <12 years, and each subject should only participate with a single prescription. All prescriptions were outpatient prescriptions (handwritten or computerized), prescriptions without medication errors were excluded. Besides, inpatient, adult, or self-prescription were excluded. Prescriptions were excluded in case of a lack of confident medical data (previous medical and medication history).

2.2. Data collection

Data collected from the included prescriptions to be examined and characterized to facilitate the conclusion. The first step was the classification and selection step in which all prescriptions were checked to ensure their inclusion criteria and to exclude the other prescription. After extraction of the pediatric prescription, the second step was to collect data from each prescription in a separate sheet that has been prepared before collecting the prescriptions. The data collection sheet was divided into 2 main parts; the first part contains the main items that should be available in each prescription (Age of the subject, weight, and diagnosis) to enable the healthcare professionals to determine the correct dose and dose regimen. In addition to the previous items, the manner of writing the prescription was also recorded (computerized or handwritten).

The second part of this section is extracting the data to the data collecting sheet that contains 12 items representing the different types of medications errors (Dose of the prescribed medication, active ingredient duplication, contraindication, drug administration, look-alike drug, route of administration, duration of treatment, presence of drug interaction, drug without indication, incorrect drug prescription, inappropriate dosage form, and absence of storage information). Each prescription may contain more than one type of medication errors. Several items could not be defined with outpatient counseling as these items depend mainly on the previous medical history and concomitant medications.

2.3. Counseling cession

Counseling with the subjects and their parents was included during data collection to indicate the past medical history if not mentioned in the prescription also allergies to the prescribed medications. It also indicates if the subject is receiving any other concurrent medication prescribed or used without prescription. At the start of the session, the investigator introduces himself and explains the aim of this section. The counseling session included asking the patient several questions starting from asking them to describe how they will use their medication. By collecting data related to drugs and diseases the investigator could determine the possible medication errors and start to educate the patient on the correct way to use their prescribed medications.

During this session, age, weight, gender, drug allergies, previous adverse effects of any medication, and laboratory data were recorded. Many pediatric medication errors could be discovered after detailed counseling with the patient and the parent such as contraindication of certain prescribed medication, drug-disease interaction, or drug-drug interaction between newly prescribed and concomitant medications. Besides, in some cases, the investigator continued the counseling session through phone calls or texting services to obtain missed data or to ensure the name of the concomitant medication.

Analysis of the gathered data for the determination of different medication errors included the utilization of some resources to indicate certain errors such as drug interactions, active ingredient duplications, therapy duration, and drug indication. The resources were online and hardcopies versions, such as Lexicomp, UpToDate, clinical key, BMJ, Micromedex, and several guidelines according to each case.

2.4. Statistical analysis

Medication errors were expressed as a percent. Chi squire test was used to compare different types of errors between handwritten and computerized prescriptions using the Statistical Package for the Social Sciences (IBM SPSS Statistics version 25).

3. Results

All prescription medication errors collected from pediatric prescriptions (n = 753) were expressed as percentages, as shown in Figs. 1 and 2, and Tables 1 and 2.

Most of the investigated prescriptions were handwritten (81.31%), while only less than a fifth were computerized prescriptions. The item that was mostly not included in most of the prescriptions was the subject's diagnosis (82.2). This type of error was significantly (P < 0.001) higher in hand-written prescriptions compared with computerized. Regarding the subjects' age and weight, more than half of the included prescriptions contained the two items by the following percentages 53.12% and 54.98% consequently. Also, the computerized prescriptions had significantly (P < 0.001) lower numbers of missed items.

The study results investigated only the prescription-related errors, and they were classified into 12 different types of errors. The most recorded medication error was the absence of specific storage information for pediatrics medications, and this type represented about 92.83% of all included prescriptions. This type of medication error was not significantly different from handwritten computerized prescriptions. Also, there were other three types of medication errors that have a high percentage compared to other errors, the highest of them was the duration of the therapy for each type of the prescribed medications followed by the presence of contraindication for the use of one or more of the drugs

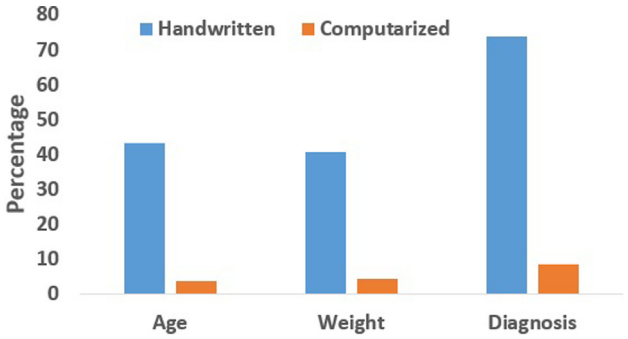

Fig. 2. Percentage of different medication errors related to outpatient pediatric prescriptions for both handwritten and computerized prescriptions.

because of drug or disease interactions, and the third error was the absence of accurate dose prescription, these errors have the following percentages 36.92%, 31.31%, and 29.13% consequently. Incorrect duration of drug therapy errors was mainly related to the antibiotics, which represent a large percentage of the prescribed drugs. Besides contraindications for using some of the prescribed drugs, drug interactions between the prescribed medication or between one or more of them with other concomitant drugs not included in the same prescription were recorded (23.05%).

There was a significant difference in the percent of error detect for computerized prescription compared with handwritten regarding inappropriate dosage form (P < 0.01), drug interaction (P < 0.001), duration of therapy (P < 0.001), look like drugs (P < 0.001), route of administration (P < 0.01), administration technique (P < 0.05), the dose of medication (P < 0.001), and active ingredient duplication (P < 0.001). While there was no significant

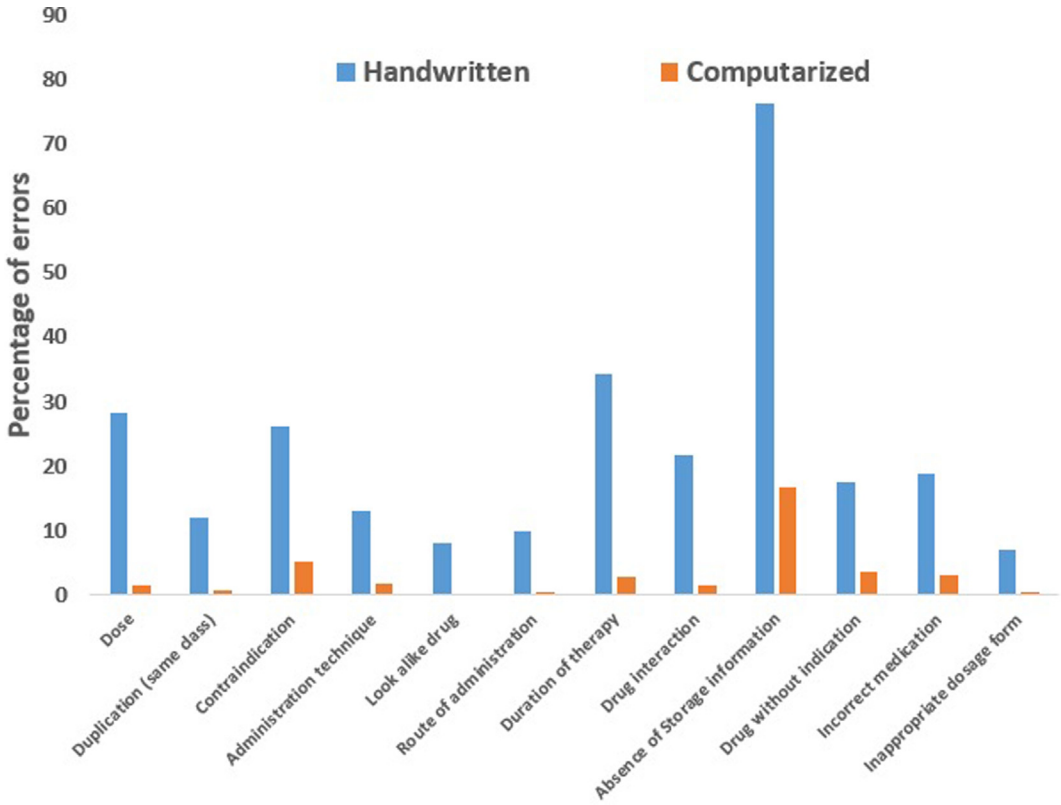

Fig. 1. Percentage of missed age, weight, and diagnosis in pediatric handwritten and computerized prescriptions.

Table 1
Percent of essential parameters that are missed in prescriptions.

Item	Hand-written		Computerized		P value
	N	%	N	%	
Age	325	43.16	28	3.72	<0.001
Weight	307	40.77	32	4.25	<0.001
Diagnosis	555	73.71	64	8.50	<0.001

Table 2
Types, number and percentage of medication errors included in the outpatient pediatric prescriptions.

	Hand-written		Computerized		P value
Type of error	N	%	N	%	
Dose	212	28.15	10	1.33	<0.001
Duplication (same class)	90	11.95	5	0.66	<0.001
Contraindication	197	26.16	39	5.18	0.325
Administration technique	97	12.88	12	1.59	0.028
Look alike drug	60	7.97	0	0.00	<0.001
Route of administration	75	9.96	4	0.53	<0.001
Duration of therapy	257	34.13	21	2.79	<0.001
Drug interaction	163	21.65	11	1.46	<0.001
Absence of Storage information	574	76.23	125	16.6	0.72
Drug without indication	131	17.40	26	3.45	0.462
Incorrect medication	142	18.86	23	3.05	0.082
Inappropriate dosage form	52	6.91	3	0.40	0.009

difference between the two types of prescription in contraindications, absence of storage information, drug without indication, and incorrect medication.

About 21.96% of the recorded errors were related to incorrect medication, which means that one or more of the prescribed drugs are not suitable for the subject's case. On the other hand, more than 20% of the prescription-related errors were because of prescribing unneeded drugs (medications without indications) that were in most cases expressed as prescribing more than one type of antibiotics or analgesics without a significant indication for adding these medications. Most of the included prescriptions prescribed the route of drug administration (85.51%); however, an inappropriate administration route was recorded as an error for 10.44% of the prescriptions. Among the low percent medication errors that had been recorded but with a high impact on the safety of the therapy was the duplicated medications (drugs that contain the same active ingredients). The lowest percent of medication errors were related to the inappropriately prescribed dosage form and look-alike drug (7.31% and 7.94% consequently).

There is a significant ($P < 0.01$) difference regarding the presence of drug interaction, active ingredient duplication between prescriptions contains more than 4 drugs compared with those that have lower numbers.

4. Discussion

This study confirms commonly occurring medication errors for pediatric subjects through recruiting and analyzing 753 outpatient pediatric prescription samples. The first part of these errors was classified as missed essential demographic data and medical status of pediatric subjects which includes all types of omission such as patient's weight (45.02 %), age (46.88%), patient diagnoses (82.20 %) from pediatrics prescriptions. Due to altered metabolism and drug excretion, also the need to adjust drug dosage to specific body weights, the pediatric population is at higher risk than adult patients. The missed diagnosis was the highly reported error for outpatient pediatric prescriptions in the first part (essential data) which was consistent was the finding of another study by Alsulaiman et al, which reflected a similar finding (Alsulaiman et al., 2017). While the incorrect dose was the second most common finding in the Alsulaiman study, the absence of storage information was the highest error in the current study. This difference is because this previous study did not consider this item as a medication error or it has been considered under the item "other".

These types of errors were highly significant ($P < 0.001$) with handwritten prescriptions compared with computerized, however, there was a few percent of computerized prescriptions that showed absent basic data. It was previously reported that the electronic prescription resulted in lower medication errors in the outpatient setting (Kenawy and Kett, 2019). However, there is a difference between the computerized prescription, some of them are just written with a computer while others are linked to medical databases for drug interaction and dose checking. The main advantage of using computerized prescriptions is the prevention of drug name confusion that could result in big health issues (Campmans et al., 2018). However, computerized prescriptions have several advantages over traditional handwritten prescriptions, but also several errors cannot be solved with this system. The computerized prescriptions failed to reduce the drug contraindications, incorrect drug prescription, and drugs without indications. Although it is difficult to compare medication error rates directly between different studies due to variations in definition and methodology (Assiri et al., 2018). It is well recognized that it is necessary to minimize the impact of medication errors, and this reduction should be strongly supported with patient and parents counselling (Bonetti et al., 2018). A combination of primary measures, such as pharmacists checking medication charts for the accuracy and suitability of therapy, and secondary measures, including disciplining the staff member responsible for an error, comprise the traditional approach to the prevention of medication errors. The counseling with the subject or his parents for the collection of medical history aid in the detection of more medication errors such as duplication of medications (12.62%) (prescribed and non-prescribed), presence of contraindications (31.31%) for the use of certain medications because of negative interaction with other disease or causing allergy to the subject. These findings were consistent with that of Bonetti et al study that demonstrates the significant impact of patient counseling on the detection and reduction of medication errors and hospital admission (Bonetti et al., 2018).

One of the important factors that result in outpatient medication errors is the boor coordination between the healthcare professionals (prescribing physician and community pharmacist), also, absence of tracking and documentation system (Khalil and Lee, 2018) of the patient medical history. Hence, medication review is a form of assessing patients' medicines evaluation to improve the clinical outcomes and decrease drug-related problems (Europe, 2016). A systematic review of 38 studies of primary care interventions aimed at reducing drug-related adverse events found that the most effective interventions included a drug review conducted by a pharmacist or other doctors or focused on multicomponent interventions that had a primary care professional medication review as a single component. And this finding was consistent with the results of the current study in which many medication errors were detected through reviewing the prescriptions. Studies have shown that medication reviews led by pharmacists have decreased hospital admissions (Lapointe-Shaw et al., 2020). Besides, the review of prescribed medication led to the discovery of 23.05% of medication errors presented as drug interactions between prescribed medications or one or more of the prescribed medications and other concomitant medications. Most of the detected medication errors were related to handwritten prescriptions.

The number of prescribed medications ranged from 2 to 7 drugs per prescription, but the majority of prescriptions ranged from 3 to 6 medications with an average of 4.08 drugs per prescription. An increased number of prescribed medications is associated with increased medication discrepancies at discharge, highlighting the need to treat polypharmacy as a multifaceted risk to patient health (Eriksen et al., 2020). This was clear from the finding that reflected a significant difference in medication errors between prescriptions that contain a large number of medications and those with low numbers. The rate of medication error with higher in prescriptions with numerous medications.

In general, the reliability of medication data on discharge summaries is poor (Tong et al., 2017, Tan et al., 2018). There have been tests on several medication reconciliation systems. These systems deal with new adjustments, deletions, and additions of medication after hospital Admissions. Hence, there is a big need to involve pharmacists and expand their role to include medication reconciliation which could enhance the entire process and decrease medication errors (Patel et al., 2019). The lack of medication records for outpatient cases ensures the need for patient counseling by community pharmacists.

A review of 10 randomized computerized interventions showed a decrease in a medication error in half of the studies. Computerized Provider Order Entry (CPOE) with decision support can be successful if aimed at a small number of potentially unsafe medicines and intended to minimize the alarming burden by focusing on clinically valid alerts (Prgomet et al., 2017). There is significant evidence supporting the use of CPOE to reduce the incidence of inpatient medication errors (Prgomet et al., 2017). And this finding is consistent with the current study-related finding in which the majority of prescriptions were not computerized which led to the problem of look-alike drugs (7.97%), and the absence of or unclear administration technique (12.88%). a recent review showed that the probability of error occurrence decreased by percent varied from a study to another (<1% to 33%) when a CPOE order was processed (Srinivasamurthy et al., 2021).

One of the most important latent factors was the selection of the incorrect drug and/or strength reported error based on the unclear or absent description in the outpatient prescription. Indeed, one in four reported U.S. medication errors is estimated to be a name confusion error. Naming and packaging similarity is a proven medication error risk factor for both community and hospital pharmacies (Goedecke et al., 2016). It is estimated that look-alike and sound-alike medicines can result in variable percent of medication errors ranged from 6.2 to 14.7% according to a previous study by Bryan et al (Bryan et al., 2021). Also, this type of error was detected in the current study and it was mainly related to the handwritten prescriptions in which some of the unclearly written drugs were similar in their appearance to other different drugs. A previous review showed that the wrong dose was the most common medication error reported by the trails (Korb-Savoldelli et al., 2018). The cardiovascular medications were the highest drug category that had been reported in medication errors (24.7%) detected during a previous study (Muroi et al., 2017). About 29.48% of the pediatric outpatient prescriptions showed incorrect medication doses, most of them were related to handwritten prescriptions (28.15%). Therefore, the education of health care providers is an important element to improve the safety of primary care through providing information about the correct medication use particularly for the inhaled medication that requires a specific technique for drug administration (Nicola et al., 2018, Saeed et al., 2019, Elgendy et al., 2020, Saeed et al., 2020). In this regard, about 14.49% of medication errors were related to the absence of administration techniques especially for inhalers (dry powder inhaler, and metered dose inhaler). This applies to the reduction of medication errors in which education is often part of multicomponent education interventions. The educational measures by a pharmacist are recommended to improve antibiotic prescription and reduce medication errors (Arimbawa and Adi 2019). There was some evidence from the review that, following appropriate education and preparation, patient self-administrated medication may be as effective or better than usual care (Saeed et al., 2020). Hence the role of patient and parents education and counseling is important for outpatients. Additional studies focusing on the role of electronic prescribing systems are needed to evaluate the impact on medication errors.

5. Strengths and limitations

The current study focused on outpatient pediatric prescription errors and the role of counseling in detecting medication errors. Besides, the current study indicated the difference in medication errors based on the type of prescription (Handwritten or computerized).

The current study did not recruit prescriptions that were dispensed at hospital outpatient pharmacies. Another limitation is very boor handwriting of some prescription which cause more difficulty in analyzing prescriptions and in few cases to lead to exclusion of the prescription.

6. Conclusion

Medication errors related to outpatient pediatric prescriptions vary from one to another prescription with predominant errors that influence the safety or efficacy of the therapy, such as drug interactions, contraindications, and absence of critical information. Hence, the role of reviewing prescriptions and patient or parents counseling is critical for detecting and prevention medication errors by the community pharmacist. Also, computerized writing of the prescription could aid in avoiding more medication errors because of the inability to correctly read the prescription. Further studies to investigate the impact of introducing an electronic prescribing system and to be compared with the traditional handwriting on medication errors frequency for the same prescribers are needed. Also, studies to assess the hospital outpatient prescription errors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Alsulaiman, K., Aljeraisy, M., Alharbi, S., Alsulaihim, I., Almolaiki, M., Alammari, M., 2017. Evaluation of prescribing medication errors in a pediatric outpatient pharmacy. Int. J. Med. Sci. Public Health 6, 1588–1593.

Arimbawa, P., Adi, I., 2019. Patient perceptions on the role of a pharmacist and the understanding of the rational use of medicines (RUM). Sustain. Sci. Manage. 14 (6), 137–144.

Assiri, G.A., Shebl, N.A., Mahmoud, M.A., Aloudah, N., Grant, E., Aljadhey, H., Sheikh, A., 2018. What is the epidemiology of medication errors, error-related adverse events and risk factors for errors in adults managed in community care contexts? A systematic review of the international literature. BMJ Open 8 (5), e019101. https://doi.org/10.1136/bmjopen-2017-01910110.1136/bmjopen-2017-019101.supp1.

Berrier, K., 2016. Medication errors in outpatient pediatrics. MCN Am. J. Matern. Child Nurs. 41 (5), 280–286. https://doi.org/10.1097/NMC.0000000000000261.

Bonetti, A.F., Bagatim, B.Q., Mendes, A.M., Rotta, I., Reis, R.C., Fávero, M.L., Fernandez-Llimós, F., Pontarolo, R., 2018. Impact of discharge medication counseling in the cardiology unit of a tertiary hospital in Brazil: A randomized controlled trial. Clinics 73. https://doi.org/10.6061/clinics10.6061/clinics/2018/e325.

Brass, E.P., Reynolds, K.M., Burnham, R.I., Green, J.L., 2018. Medication errors with pediatric liquid acetaminophen after standardization of concentration and packaging improvements. Acad. Pediatr. 18 (5), 563–568. https://doi.org/10.1016/j.acap.2018.03.001.

Bryan, R., Aronson, J.K., Williams, A., Jordan, S., 2021. The problem of look-alike, sound-alike name errors: Drivers and solutions. Br. J. Clin. Pharmacol. 87 (2), 386–394.

Campmans, Z., van Rhijn, A., Dull, R.M., Santen-Reestman, J., Taxis, K., Borgsteede, S. D., Pignataro, G., 2018. Preventing dispensing errors by alerting for drug confusions in the pharmacy information system—A survey of users. PLoS ONE 13 (5), e0197469.

Elgendy, M.O., Hassan, A.H., Saeed, H., Abdelrahim, M.E., Eldin, R.S., 2020. Asthmatic children and MDI verbal inhalation technique counseling. Pulm. Pharmacol. Ther. 61, 101900. https://doi.org/10.1016/j.pupt.2020.101900.

Eriksen, C.U., Kyriakidis, S., Christensen, L.D., Jacobsen, R., Laursen, J., Christensen, M.B., Frølich, A., 2020. Medication-related experiences of patients with polypharmacy: a systematic review of qualitative studies. BMJ Open 10, (9) e036158.

Europe, P.C.N.J.E.P., 2016. Medication review definition approved.

George, J.A., Park, P.S., Hunsberger, J., Shay, J.E., Lehmann, C.U., White, E.D., Lee, B.H., Yaster, M., 2016. An analysis of 34,218 pediatric outpatient controlled substance prescriptions. Anesth. Analg. 122 (3), 807–813. https://doi.org/10.1213/ANE.0000000000001081.

Goedecke, T., Ord, K., Newbould, V., Brosch, S., Arlett, P., 2016. Medication errors: new EU good practice guide on risk minimisation and error prevention. Drug Saf. 39 (6), 491–500.

Kenawy, A.S., Kett, V., 2019. The impact of electronic prescription on reducing medication errors in an Egyptian outpatient clinic. Int. J. Med. Inform. 127, 80–87. https://doi.org/10.1016/j.ijmedinf.2019.04.005.

Khalil, H., Lee, S., 2018. Medication safety challenges in primary care: Nurses' perspective. J. Clin. Nurs. 27 (9-10), 2072–2082.

Korb-Savoldelli, V., Boussadi, A., Durieux, P., Sabatier, B., 2018a. Prevalence of computerized physician order entry systems-related medication prescription errors: A systematic review. Int. J. Med. Inform. 111, 112–122. https://doi.org/10.1016/j.ijmedinf.2017.12.022.

Korb-Savoldelli, V., Boussadi, A., Durieux, P., Sabatier, B., 2018b. Prevalence of computerized physician order entry systems–related medication prescription errors: a systematic review. Int. J. Med. Informatics 111, 112–122.

Lapointe-Shaw, L., Bell, C.M., Austin, P.C., Abrahamyan, L., Ivers, N.M., Li, P., Pechlivanoglou, P., Redelmeier, D.A., Dolovich, L., 2020. Community pharmacy medication review, death and re-admission after hospital discharge: a propensity score-matched cohort study. BMJ Quality & Safety 29 (1), 41–51.

Lester, C.A., Tu, L., Ding, Y., Flynn, A.J., 2020. Detecting potential medication selection errors during outpatient pharmacy processing of electronic prescriptions with the RxNorm application programming interface: retrospective observational cohort study. JMIR Med. Inform. 8, (3). https://doi.org/10.2196/16073 e16073.

Muroi, M., Shen, J.J., Angosta, A., 2017. Association of medication errors with drug classifications, clinical units, and consequence of errors: Are they related? Appl. Nurs. Res. 33, 180–185.

NCCMERP, 2015. http://www.nccmerp.org/about-medication-errors. Retrieved 21 February 2021, 2021.

Nicola, M., Elberry, A., Sayed, O., Hussein, R., Saeed, H., Abdelrahim, M., 2018. The impact of adding a training device to familiar counselling on inhalation technique and pulmonary function of asthmatics. Adv. Therapy 35 (7), 1049–1058.

Patel, E., Pevnick, J.M., Kennelty, K.A., 2019. Pharmacists and medication reconciliation: a review of recent literature. Integrated Pharmacy Research & Practice 8, 39.

Prgomet, M., Li, L., Niazkhani, Z., Georgiou, A., Westbrook, J.I., 2017. Impact of commercial computerized provider order entry (CPOE) and clinical decision support systems (CDSSs) on medication errors, length of stay, and mortality in intensive care units: a systematic review and meta-analysis. J. Am. Med. Inform. Assoc. 24 (2), 413–422.

Saeed, H., Abdelrahim, M.EA., Rabea, H., Salem, H.F., 2020. Impact of advanced patient counseling using a training device and smartphone application on asthma control. Respiratory Care 65 (3), 326–332.

Saeed, H., Salem, H.F., Rabea, H., Abdelrahim, M.E.A., 2019. Effect of human error, inhalation flow, and inhalation volume on dose delivery from Ellipta® dry-powder inhaler. J. Pharm. Innovation 14 (3), 239–244.

Srinivasamurthy, S.K., Ashokkumar, R., Kodidela, S., Howard, S.C., Samer, C.F., Rao, U. S.C., 2021. Impact of computerised physician order entry (CPOE) on the incidence of chemotherapy-related medication errors: a systematic review. Eur. J. Clin. Pharmacol., 1–9

Stingl, J., Schulz, M., Schmid, M., Neubert, A., Sachs, B., 2021. "Analysis of the reporting of adverse drug reactions in children and adolescents in Germany in the time period from 2000 to 2019."

Sutherland, A., Phipps, D.L., Tomlin, S., Ashcroft, D.M., 2019. Mapping the prevalence and nature of drug related problems among hospitalised children in the United Kingdom: a systematic review. BMC Pediatrics 19 (1), 1–14.

Tan, Y., Elliott, R.A., Richardson, B., Tanner, F.E., Dorevitch, M.I., 2018. An audit of the accuracy of medication information in electronic medical discharge summaries linked to an electronic prescribing system. Health Information Manage. J. 47 (3), 125–131.

Tawhari, M.M., Tawhari, M.A., Noshily, M.A., Mathkur, M.H., Abutaleb, M.H., 2021. Hospital pharmacists interventions to drug-related problems at tertiary critical care pediatric settings in Jazan, Saudi Arabia. Hospital Pharmacy 0018578721990889.

Tong, E.Y., Roman, C.P., Mitra, B., Yip, G.S., Gibbs, H., Newnham, H.H., Smit, D.V., Galbraith, K., Dooley, M.J., 2017. Reducing medication errors in hospital discharge summaries: a randomised controlled trial. Med. J. Aust. 206 (1), 36–39.

Watanabe, J.H., McInnis, T., Hirsch, J.D., 2018. Cost of prescription drug-related morbidity and mortality. Ann. Pharmacother. 52 (9), 829–837. https://doi.org/10.1177/1060028018765159.

Zarea, K., Mohammadi, A., Beiranvand, S., Hassani, F., Baraz, S., 2018. Iranian nurses' medication errors: A survey of the types, the causes, and the related factors. Int. J. Africa Nursing Sci. 8, 112–116.

Zhou, S., Kang, H., Yao, B., Gong, Y., 2018. Analyzing medication error reports in clinical settings: an automated pipeline approach. AMIA Annual Symposium Proceedings, American Medical Informatics Association.