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The Role of Pediatric Nursing Staff in the Prevention of Medication Errors

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Abstract: A descriptive study was conducted in a pediatric unit of a Brazilian hospital at São Paulo state. The purpose of this study were to classify the types of medication errors occurring in a pediatric unit, and to discuss the role of the nursing team in preventing these errors. The sample consisted of 23 medication errors that occurred during 20 days. Data was collected through direct and non-participant observation of medication preparation and administration. The most common errors detected were incorrect preparation technique (52.2%), incorrect time (34.8%) with higher frequency occurring during the morning shifts (50.0%), unauthorized drug (8.7%) and dose errors (4.3%). The pharmacological classes most involved in wrong technique were antimicrobials (66.7%), followed by analgesics (33.3%). The development of protocols for preparation and administration of medications can help the nursing professionals to provide medication safety, especially for pediatric patients, who usually receive fractionated doses.

Keywords: Medication errors, Pediatrics, Nursing

I. INTRODUCTION

Medication errors are considered a serious public health problem, causing the establishment of more efficient systems designed to address the issue. Medication errors acquired greater impact and special attention from public and healthcare professionals after the Institute of Medicine´s report, in 1999, *"To err is human"*[(1)]. In regards to pediatrics, the safety of drug therapy is hampered by the lack of clinical trials and accurate information about medication safety in patients who are not children. Thus, the information about new drugs on the market do not contain accurate information about the effectiveness, proper dose and medication safety for children[(2).]

More than 50% of drugs currently prescribed for pediatric clients in the United States (US) are not standardized or approved for use. This is most likely due to ethical limitations relating to research involving drug use in children in the past decades[(3)]. So often, the prescription and use of these drugs in pediatric units are based on extrapolations of rates and/or modifications of formulations that are used for adults, completely ignoring the anatomical and physiological differences between the two age groups, leading children to the risks of unproven efficacy and effects that are not evaluated[(4,5)].

Studies show that newborns and children are at further risk for harm from medication errors related to their body size parameters, and changing developmental systems that can affect drug absorption, distribution, metabolism, and excretion[(6-8)]. In Brazil, it is assumed that the rate of drugs that are used but not recommended for pediatric clients is also high, especially in hospital settings[(8)]. In this context, the European Commission has urged the pharmaceutical industry to develop medicines that are particularly suitable for children. The Commission believes that the absence of such formulations can lead to serious errors in dose calculations, resulting in overdose, ineffective therapy and occurrence of adverse reactions[(3)].

The purposes of this study were to classify the types of medication errors that occurred in the pediatric unit in São Paulo State, Brazil, and to discuss the role of the nursing team in preventing these errors.

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II. METHODS

A descriptive study was conducted in a pediatric setting of a hospital in the state of São Paulo, Brazil. It is a medium sized hospital, with a total of 95 beds: 28 for General Clinic, 26 for General Surgery, 16 for Obstetric Clinic, 15 beds for the Pediatric Clinic and 10 for mixed intensive care unit.

The study's population was composed of 213 doses of medications prepared and administered in the pediatric unit over a period of 20 days; and the sample included 23 medication errors. Data was collected in the second half of 2008 after the study had been approved by the Research Ethics Committee.

The nursing staff was invited to participate in the research personally and an orientation to the pediatric unit was provided by the research team before observations started. Every member of the nursing staff involved in preparing and administering the drugs were eligible for inclusion. These professionals were invited to participate and those who accepted to be observed gave written informed consent.

Data was collected through non-participant direct observation during the stages of medication preparation and administration because direct observation has been described in literature as one of the best methods to detect medication errors[(9)]. The observation team consisted of a nurse coordinator and two research assistants, both of them being fourth year undergraduate students. The presence of an observer was stablished in each shift in the pediatric unit (morning, afternoon and night shifts). The researchers had access to the original prescriptions before starting the direct observation and the research assistants made their own independent copies of the original medication orders.

The observer arrived on the pediatric unit in time to attend the change-of-shift report. Immediately before each drug administration round, the observer identified the professional who would be conducting the process and was asked to be accompanied during the round. The observer wrote down exactly what the nurse did, including details about the medication, and witnessed the administration of the medication to the child. Data recorded included details about medication preparation technique, drug product, dose, dose form, administration route, and administration time.

When discrepancies were detected between the information obtained from the prescription order and those observed during the preparation and administration by the nursing staff, the error was identified, described, categorized and reported to the professional. However, the errors that could cause harm to patients were intercepted by the observer to avoid the drugs reaching the children.

Thus, we used the definitions of medication errors proposed by previous studies[(10, 11)]:

- *Wrong preparation technique* - An inappropriate procedure or improper technique was used in the medication preparation (incorrect reconstitution - wrong solvent used; incorrect dilution - incorrect choice or volume of diluents);
- *Unauthorized drug* - Administration of a medication not ordered by the physicians responsible for the child;
- *Wrong dose* - Administration of a different dose from that prescribed (under dose or overdose);
- *Wrong route* - Administration of a dose in a different route than ordered. They included, for instance, oral administration of a medication ordered intravenously or administered via the wrong site, such as the right eye instead of the left eye;
- *Wrong time* - Dose prepared or given more than 60 minutes before or after the scheduled administration time;
- *Wrong patient* - Administration of a medication to a patient different to that ordered;
- *Omission error* - No administration of a dose ordered for the patient. It is not characterized as error when the patient refuses a dose or if there is a recognized contraindication.

The tools used for data collection were adapted from a previous Brazilian study[(10)], which were composed of two parts: one addressing issues related to drug prescription and another focusing on the medication preparation and administration. Data was stored in a Microsoft Office Excel program. Absolute frequencies were described as percentages.

III. RESULTS

A total of 213 doses prepared and administered were observed in the pediatric unit. From those, 23 (10.8%) medication errors were identified, which were: 12 (52.2%) wrong preparation technique; 8 (34.8%) wrong time, 2 (8.7 %) unauthorized drugs and 1 (4.3%) wrong dose. During the period of data collection, we did not identify wrong administration route and wrong patient (Table 1).

Table1. *Distribution of medication errors rates in the Pediatric unit. Pirassununga, 2008*

Type of Error	**Frequency**	
	n	**%**
Wrong preparation technique	12	52.2
Wrong time	8	34.8
Unauthorized drug	2	8.7
Wrong dose	1	4.3
Wrong route	0	0
Omission	0	0
Total	**23**	**100**

Below, Figure 1 presents example situations where an inappropriate procedure or improper technique was used during medication preparation and situations where a dose was administered at the wrong time.

Fig1. *Examples of medication errors in the Pediatric unit*

PRESCRIPTION	**WRONG PREPARATION TECHNIQUE**	**DESCRIPTION**
Metamizole sodium 1 ampoule dilute in 5ml of water for injection IV 6/6h	1 ampoule of metamizole sodium diluted in 10ml of water for injection IV	**Wrong technique**. 1 ampoule of metamizole sodium diluted in 10ml of water for injection instead of 5ml
Garamicin 30 mg IV 6/6h	1 ml (30mg) of garamicin diluted in 20ml of physiologic serum	**Wrong technique**. Over dissolution of garamicin without prescription
Salbutamol 2,5ml VO at 08:00h	Salbutamol 2,5ml VO done at 09:05h	**Wrong time**. Nurse forgot about medication administration time because she was helping her colleague at another unit.
1 ampoule (2 ml) of Lasix IV	1,5ml of Lasix administered IV	**Wrong dose**. Nurse said that the prescribed dose was too high for that particular child.

The pharmacological classes most involved in wrong technique were antimicrobials (gentamicin and amikacin) (66.7%), followed by analgesics (dipyrone) (33.3%). With regard to time of the day in which these errors occurred most, we identified that four (50%) occurred during the morning shift, two (25%) were administered during the afternoon shift and two (25%), during the night shift. From the total of 23 medication errors that occurred in the pediatric unit, two (8.7%) were related to the infusion of 500ml of physiologic serum which was not prescribed.

IV. DISCUSSION

Pediatric patients represent a higher risk group for medication errors because the majority of pharmaceutical preparations are presented in the adult dosage, and the dosage requirements vary substantially within this group due to age and the body-weight-function differences between them[12,13]. Literature review[14] estimated that the incidence of adverse reactions in children was 4.37% to 16.78% , similar to that found in this study (10.8%).

Although national studies[15,16] claim that the wrong time is the most common medication error in health care settings, this study identified a higher frequency of wrong preparation technique. This can be justified since those studies do not seem to consider wrong preparation technique as an adverse drug event.

A study involving the preparation and administration of drugs shows some factors that contribute to this type of error, including lack of knowledge about the use of drugs. In addition, the nursing staff are often unaware of the nature of the drug and of the appropriate volume of diluents to be used, and they have a lack of knowledge about the physical and chemical incompatibilities [17, 18].

The knowledge of the pharmacological profile could be an important strategy to be used in the prevention of medication errors in health institutions[15,18], and may contribute to the development of educational actions for specific types of drugs such as low therapeutic index.In this study, gentamicin and amikacin were the most involved in errors related to medication administration technique.They are two aminoglycoside antibiotics with low therapeutic index and they are also nephrotoxic and ototoxic[3]. In other countries these drugs were also associated with errors occurring in neonatal intensive care unit and pediatrics[14, 19].

The literature indicates that actions related to risk management can be effective in preventing medication errors in pediatrics[18]. Thus, the development of risk management programs focused on the proper use of medications can be started with the antibiotics gentamicin and amikacin. Moreover, the direct participation of pharmacists in clinical care and unit dose drug distribution systems can help the nursing staff, and prevent medication errors[20].

To administer a medication intravenously in the pediatric patient, nursing staff must be sure about the dilution, and this information should be written by the physicians for all prescription drugs. Also, the procedures related to drug dilution must be provided by all health care facilities to the nursing staff through guidelines for drug dilution in children[21]. Thus, it is one of the roles of pediatric nurses, along with physicians and pharmacists, to discuss the need for a thorough list of the prescription drugs required for safe medication practices, and develop protocols for drug dilution. Whilst always taking into account when prescribing and preparing the doses the particularities of each child, since some of them may have volume fluid restrictions.

The pediatric nurses also have the role of guiding their team of technical and nursing assistants on the need for appropriate use of diluents. Since their excess may lead to an overload of volume, while their absence or insufficiencies may cause adverse events ranging from phlebitis to renal failure.

The second most frequent type of error was the wrong administration time. Several studies have shown the administration of drugs at different scheduled administration times as the most frequent adverse drug event in the stage of medication administration [22, 23].

Doses that are delayed do not achieve the desired pharmacological effect, while drugs given in advance may lead to overdose and toxicity, leading to serious adverse events, and even patient death[24].

In research conducted in a pediatric outpatient clinic of a hospital in São Paulo State, they found that from a total of 83 prescriptions dispensed, only 2.5% had the time of administration specified[25,26]. This kind of problem may reflect in the actions of the nursing team, as it becomes their responsibility for the time administration scheduling. Again, this problem may be linked to the lack of protocols for medication administration in health care settings, or to the lack of knowledge of health care professionals about the consequences resulting from such acts. There is also the issue of an added workload for the nursing staff as there is often a disproportionate number of professionals available in the units for the number and severity of the health status of hospitalized patients.

Regarding the time of day that these errors occurred more frequently, the results showed that there was a predominance of errors occurring during the morning shift. This may be related to work overload of the nursing staff because the majority of care is provided at this time of day, such as bathing and curatives. In this hospital, the members of the pediatric nursing staff move to other units to help their colleagues with their duties and they often cover the lack of nursing staff on other wards.

In that way, the high incidence of errors related to the day shift could be due to the medication process at the pediatric unit, such as planning the medication scheduled times, so that there is a concentration of a large number of drugs in certain periods of the day, usually in the mornings.

Another factor that may contribute for the wrong administration time is the malfunctioning of the drug-dispensing system in the hospital pharmacy. This leads to delays in medication distribution and, consequently, in its administration(15).

According to research conducted in a private hospital in São Paulo, Brazil, the second most frequent cause of errors were the nursing team's time limitations due to distractions by other patients and/or by their colleagues and emergencies occurring at the unit.

The allocations of the nursing team with patients in the pediatric wards are usually the same as it is on adult wards. This problem may be associated with a lack of knowledge by the nursing team regarding the tools for classification of pediatric patients.

The use of a tool for classification of pediatric patients is recommended (27,28) for decision-making in the management process in pediatric units at all hospitals. There is evidence that it promotes the best allocation of resources and facilitates the improvement of quality of care.

The current nursing allocations, nursing working overtime, numbers of patients with more complex needs, early discharge from hospital, shorter hospital stays, new medications, and the use of equipment for drug-dispensing are factors that increase the incidence of adverse events among the teams that assist the patients[27, 28].

With regards to the administration of unauthorized drugs, there were two cases in which the nursing staff prepared and administered 500 ml of 0.9% saline solution in children.

These results are lower than those found in other studies[29]. However, this solution can also be used for electrolyte and sodium replacement to maintain extracellular volume, and when the rapid restoration of electrolytes is of utmost importance, as well as to stabilize circulation in surgical procedures and as a diluent for drugs to be administered intravenously.

Administering 0.9% sodium chloride to pediatric patients should only be done after careful considerations of the patient's individual therapeutic needs, as well as their age, weight, nutritional status, medical conditions, and their water, sodium and chloride levels so as to avoid adverse effects such as pulmonary edema. Furthermore, excessive administration of sodium chloride can also cause hypernatremia with consequent organ dehydration.

There were not many cases of dose errors found in this study. One dose error situation involved the administration of 1.5 ml of frusemide (Lasix) over 2.0 ml. Researchers have stated that dose errors are one of the most frequent problems related to medication administration errors, interfering with the quality of care provided to hospitalized patients[30,31].

In another investigation carried out in neonatal and pediatric intensive care units, and general pediatric settings at a hospital in Buenos Aires, Argentina, the authors found that the most prevalent errors were related to omission (47%) and wrong dose (30%)[30].

Although wrong dose was less frequent in this study, it is imperative to take a closer look at this type of error as children have specific variables which should be taken into account, such as age, weight, body surface area and absorption capacity, metabolism and excretion of drugs[32] . Attention should also be devoted to the fact that nursing staff need to know the safe dosage of medications for each child and for each age, as well as the expected action of drugs, possible side effects and signs of intoxication.

The quality of care offered to children may contribute to their recovery or to the deterioration of their condition, including hindering their growth and development. Ensuring a safe and satisfactory care for hospitalized children is the legal and ethical responsibility of nurses. Regarding medication administration for children, thorough procedures and details are required, as well as scientific knowledge and practical means to execute the procedure[5].

The nurse, through situations of errors in medication administration should speak with the nursing team as a whole, seeking resources to improve the knowledge of the team relating to medicines for children, preparation and administration of safe doses, and main routes for children in order to reduce the occurrence of errors[5].

The registration of complications related to medications, the conduct of medical and nursing staff, and the observations of children are very important to monitor any possible side effects and drug interactions. The nurse can also consult with the clinical pharmacist if need be. In this case, considerations of individual children, preparation and administration of drugs can be raised and resolved, so as to ensure correct knowledge about and safe administration of medicine.

In addition to preventing medication errors, the role of the nurse includes identifying and reporting any medication errors, and assessing their performance to work together within their team to provide safe and accurate administration of medication to children. The continuing education of nursing staff in relation to drug therapy in children is one of the strategies that nurses can use within their team. Thus, content and strength in children, risks in the administration of medications, incompatible drugs, safe preparation and administration, specificity of certain drugs, such as dilution, storage, knowledge of expected responses and adverse effects can and should be discussed in order to reduce the risk of medication errors[33].

V. CONCLUSION

In the present study 213 medications were prepared and administered in the pediatric unit. From those, 23 were classified as medication errors, and the wrong preparation technique was the most frequent error (52.2%).

With regards to the nursing staff, the practice of continuing education is needed so that all of the nursing staff can prepare and administer medications safely. The development of protocols for medication preparation and administration may help the nursing staff in this process, particularly in the pediatrics units where medications are usually fractionated and diluted doses.

Furthermore, knowledge of pharmacology by members of the health care team providing direct assistance to children is crucial in promoting medication safety. However, recommend further research studies be conducted involving pediatric patients and in philanthropic institutions, as this study sample was small and prevented the extrapolation of results.

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VII. REFERENCES

[1] Kohn LT. To err is human : building a safer health system / Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, editors.: Washington, D.C. : National Academy Press; 2000. p. xxi, 287 p. : ill. ; 24 cm.

[2] Cella M, Knibbe C, Danhof M, Della Pasqua O. What is the right dose for children? British Journal of Clinical Pharmacology. 2010;70(4):597-603.

[3] Brunton LL e. Goodman & Gilman's The pharmacological basis of therapeutics. 12th ed. / Laurence L. Brunton BAC, Björn C. Knollmann., editor. United States of America: McGraw-Hill Medical Publishing Division2011.

[4] Raju TN, Kecskes S Fau - Thornton JP, Thornton Jp Fau - Perry M, Perry M Fau - Feldman S, Feldman S. Medication errors in neonatal and paediatric intensive-care units. Lancet 1989;12(0140-6736 (Print)):374-6

[5] Harada MdJCS, Chanes DC, Kusahara DM, Pedreira MdLG. Safety in medication administration in pediatrics. Acta Paul Enferm. 2012;25(4):639-42.

[6] Raju TNK, Suresh G, Higgins RD. Patient Safety in the Context of Neonatal Intensive Care: Research and Educational Opportunities. Pediatr Res. 2011;70(1):109-15.

[7] Lan Y-H, Wang K-WK, Yu S, Chen IJ, Wu H-F, Tang F-I. Medication errors in pediatric nursing: Assessment of nurses' knowledge and analysis of the consequences of errors. Nurse Education Today. 2014;34(5):821-8.

[8] Belela ASC, Pedreira MdLG, Peterlini MAS. Medication errors in pediatrics. Rev Bras Enferm. 2011;64:563-9.

[9] Montesi G, Lechi A. Prevention of medication errors: detection and audit. British Journal of Clinical Pharmacology. 2009;67(6):651-5.

[10] Cassiani SHDB, Monzani AAS, Bauer De Camargo Silva AE, Trevisani Fakih F, Perufo Opitz S, Alux Teixeira TC. Identification and analysis of medication errors in six Brazilian hospital. Ciencia y Enfermería. 2010;16:85-95.

[11] Nguyen HT, Nguyen TD, van den Heuvel ER, Haaijer-Ruskamp FM, Taxis K. Medication Errors in Vietnamese Hospitals: Prevalence, Potential Outcome and Associated Factors. 18 September, 2015(1932-6203 (Electronic)).

[12] Rinke ML, Bundy DG, Velasquez CA, Rao S, Zerhouni Y, Lobner K, et al. Interventions to reduce pediatric medication errors: a systematic review. (1098-4275 (Electronic)).

[13] Nahata MC. Ensuring Safe and Effective Medication Use in Pediatric Patients. The Journal of Pediatric Pharmacology and Therapeutics : JPPT. 2014;19(1):4-9.

[14] Silva DCB, Araujo OR, Arduini RG, Alonso CFR, Shibata ARO, Troster EJ. Adverse drug events in a paediatric intensive care unit: a prospective cohort. BMJ 2013;3(2044-6055 (Electronic)).

[15] Reis AMM, Marques TC, Opitz SP, Silva AEBdC, Gimenes FRE, Teixeira TCA, et al. Errors in medicine administration - profile of medicines: knowing and preventing. Acta Paulista de Enfermagem. 2010;23:181-6.

[16] Gimenes FRE, Teixeira TCA, Silva AEBdC, Optiz SP, Mota MLS, Cassiani SHDB. Influence of the writing of the medical orders on the administration of medicationsd at the wrong schedule time. Acta Paulista de Enfermagem. 2009;22(4):380-4.

[17] Barker KN, Flynn EA, Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 health care facilities. Arch Intern Med. 2002;162(16):1897-903.

[18] Hughes RG, Edgerton EA. Reducing pediatric medication errors: children are especially at risk for medication errors. Am J Nurs. 2005;105(5):79-80, 2, 5 passim.

[19] Feleke Y, Girma B. Medication administration errors involving paediatric in-patients in a hospital in Ethiopia. Trop J Pharm Res. 2010;9(4):401-7.

[20] Valizadeh S, Rasekhi M, Hamishehkar H, Asadollahi M, Hamishehkar H. Medication errors in oral dosage form preparation for neonates: The importance of preparation technique. Journal of Research in Pharmacy Practice. 2015;4(3):147-52.

[21] ISMP. Some IV Medications Are Diluted Unnecessarily In Patient Care Areas, Creating Undue Risk. Institute for Safe Medication Practices; June 19, 2014.

[22] Stavroudis TA, Miller MR, Lehmann CU. Medication errors in neonates. Clin Perinatol. 2008;35(1):141-61, ix.

[23] Gonzales K. Medication administration errors and the pediatric population: a systematic search of the literature. J Pediatr Nurs. 2010;25(6):555-65.

[24] Niemann D, Bertsche A, Meyrath D, Koepf ED, Traiser C, Seebald K, et al. A prospective three-step intervention study to prevent medication errors in drug handling in paediatric care. J Clin Nurs. 2015;24(1-2):101-14.

[25] Sano PY, Masotti RR, Santos AACd, Cordeiro JA. Evaluation of the understanding level of pediatric prescription. J Pediatr. 2002;78(2):140-5.

[26] Belela AS, Peterlini MA, Pedreira ML. Medication errors reported in a pediatric intensive care unit for oncologic patients. Cancer Nurs. 2011;34(5):393-400.

[27] Cohen MR. Medication errors. ed., editor: Washington, DC: American Pharmacists Association; 2007.

[28] Dini AP, Fugulin FM, Verissimo Mde L, Guirardello Ede B. [Pediatric Patient Classification System: construction and validation of care categories]. Rev Esc Enferm USP. 2011;45(3):575-80.

[29] Martins TSdS, Silvino ZR, Silva LRd. Adverse events in pediatric pharmacotherapy: integrative literature review. Rev bras enferm. 2011;64(4):745-50.

[30] Otero P, Leyton A, Mariani G, Ceriani Cernadas JM. Medication errors in pediatric inpatients: prevalence and results of a prevention program. Pediatrics. 2008;122(3):e737-43.

[31] Murphy M, While A. Medication administration practices among children's nurses: a survey. Br J Nurs. 2012;21(15):928-33.

[32] Hockenberry MJ, Wilson D. Wong's essentials of pediatric nursing. 8th Edition. Elsevier; 2009. 1280 p.

[33] Bowden VR, Greenberg CS. Procedimentos de enfermagem pediátrica. 1ª ed. Rio de Janeiro (RJ): Guanabara Koogan; 2005.