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Original article

Medication dosing errors and associated factors in hospitalized pediatric patients from the South Area of the West Bank - Palestine

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ABSTRACT

Background: Medication dosing errors are a significant global concern and can cause serious medical consequences for patients. Pediatric patients are at increased risk of dosing errors due to differences in medication pharmacodynamics and pharmacokinetics.
Objectives: The aims of this study were to find the rate of medication dosing errors in hospitalized pediatric patients and possible associated factors.
Method: The study was an observational cohort study including pediatric inpatients less than 16 years from three governmental hospitals from the West Bank/Palestine during one month in 2014, and sample size was 400 pediatric inpatients from these three hospitals. Pediatric patients' medical records were reviewed. Patients' weight, age, medical conditions, all prescribed medications, their doses and frequency were documented. Then the doses of medications were evaluated.
Result: Among 400 patients, the medications prescribed were 949 medications, 213 of them (22.4%) were out of the recommended range, and 160 patients (40.0%) were prescribed one or more potentially inappropriate doses. The most common cause of hospital admission was sepsis which presented 14.3% of cases, followed by fever (13.5%) and meningitis (10.0%). The most commonly used medications were ampicillin in 194 cases (20.4%), ceftriaxone in 182 cases (19.2%), and cefotaxime in 144 cases (12.0%). No significant association was found between potentially inappropriate doses and gender or hospital (chi-square test p-value > 0.05).The results showed that patients with lower body weight, who had a higher number of medications and stayed in hospital for a longer time, were more likely to have inappropriate doses.
Conclusion: Potential medication dosing errors were high among pediatric hospitalized patients in Palestine. Younger patients, patients with lower body weight, who were prescribed higher number of medications and stayed in hospital for a longer time were more likely to have inappropriate doses, so these populations require special care. Many children were hospitalized for infectious causes and antibiotics were widely used. Strategies to reduce pediatric medication dosing errors are recommended.

1. Introduction

Medication errors are a significant global concern and can cause serious medical consequences for patients. Pediatric patients are at increased risk for medication errors due to a complex medication use process (Fortescue et al., 2003). Medicines can cure infectious diseases, prevent problems from chronic diseases, and ease pain. However, medicines can also cause harmful reactions if not used correctly or if they are prescribed in a wrong way (Al-Dahwailie, 2011). Infants and children constitute a large proportion of the population in the developing countries. They are especially vulnerable to contract illnesses and to the harmful effects of drugs due to differences in pharmacodynamics and pharmacokinetics (Shankar et al., 2006).

Despite all clinical strategies to avoid mistakes like training doctors and pharmacists to ensure that they have a full oversight in administering, dispending, standardizing and identifying medications effectively, medication errors are still an important problem in all hospitalized populations (Kaushal et al., 2001) and may

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result in adverse drug events and contribute in mortality and morbidity of hospitalized patients (Classen et al., 1997).

The unique nature of children and pediatrics makes them at higher risk of experiencing medication errors than adults because they have an immature physiology as well as developmental limitations that affect their ability to communicate and self-administer medications (Kaushal et al., 2004). Another important factor is that the great majority of medications are developed in concentrations appropriate for adults, and pediatric indications and dosage guidelines are often not included with a medication, so it needs many calculations based on many factors (Lim et al., 2013).

In pediatrics medicine, drug doses are usually calculated individually based on the patient's age, weight and clinical condition. Therefore, there are increased opportunities for, and a relatively high risk of, dosing errors in this setting. Studies have shown that dosing errors are the most common type of medication errors among pediatrics (Lesar et al., 1997; Miller et al., 2007; Al-Jeraisy et al., 2011).

Pediatric patients are special population who need a special care. It is important to evaluate the appropriateness of doses according to patients' weight to avoid therapeutic failure or increase in side effects. To the best of our knowledge, this will be the first study in this field in Palestine, so we hope it can help in providing recommendations and education to decrease dosing errors.

The aims of this study were to assess the rate of medication dosing errors in hospitalized children and find any possible association between some factors (e.g. age, weight, number of medications and duration of hospital stay) and dosing errors.

2. Methodology

2.1. Overview of design

This study was an observational cohort study, and the data were collected during one month (August 2014) for all pediatric inpatients in three governmental hospitals: Bait Jala Governmental Hospital in Bethlehem, Alia Governmental Hospital in Hebron and Palestinian Medical Complex in Ramallah. The West Bank of Palestine includes 12 governmental hospitals, so these three hospitals were randomly selected from them.

2.2. Study subjects and selection criteria

The medical records of all pediatric patients who were admitted to the pediatric units in the selected hospitals and prescribed at least one medication during the study period were reviewed until the required sample was collected.

2.3. Sample size

The minimum sample size for this study was calculated to be 400 patients from three hospitals according to Raosoft sample size calculator.

2.4. Data collection

The study protocol was authorized by the Institutional Review Boards (IRB) of An Najah National University (IRB approval number (253-7-14)) and the Ministry of Health before initiation of this study. Data collection form was prepared after literature review of previous studies. All information was collected from the governmental electronic health records of the governmental hospital (AviCenna HIS program). Pediatric patients' medical records were reviewed. Patients' weight, age, medical conditions, length of hospital stay, all prescribed medications, their doses and frequency were documented. Then the doses of medications were evaluated using Drug Information Handbook (2014).

2.5. Statistical methods

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS version 16.0). Descriptive statistics were carried out for all variables. Mean ± standard deviation was computed for continuous data. Frequencies (percentages) were calculated for categorical variables. Categorical variables were compared using Chi-square. When categorical and continuous variables were compared, independent student t test or Mann-Whitney test according to the normality was used. Kolmogorov Smirnov test was used for

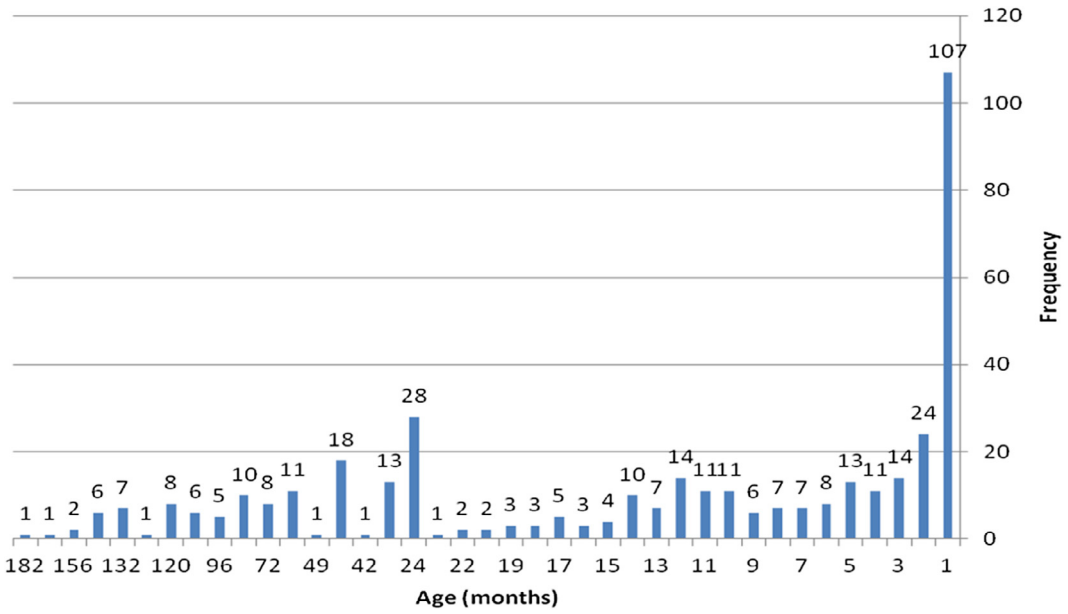

Figure 1. Age distribution of the patients.

normality. A p-value of less than 0.05 was considered to be statistically significant for all analyses.

3. Results

3.1. Socio-demographic characteristics of patients

During the study period, a total of 400 patients' files were reviewed in three governmental hospitals: 222 (55.5%) patients from Hebron hospital, 80 (20.0%) from Beit Jala hospital and 98 (24.5%) from Ramallah hospital.

The sample included 242(60.5%) males and 158 (39.5%) females. The age of patients ranged from 1 to 182 months (around 15 years) Fig. 1. The weight was measured and documented for all patients, and the mean weight was 11.3 ± 10.2 kg (range: 2–63 kg). A high percentage 25% of patients remained in hospital for 2 days. Hospital stay ranged from 1 to 20 days.

3.2. Reasons of hospital admission and the most commonly prescribed medications

There were 76 different causes of hospital admission in the study according to the suspected diagnosis documented by the physicians. The most common cause was sepsis which presented 14.3% of cases, followed by fever (13.5%), meningitis (10.0%), gastroenteritis (6.0%) and upper respiratory tract infections (6.0%).

During the study, 60 different medications with a total of 949 were prescribed. The most commonly used medications were ampicillin in 194 cases (20.4%), ceftriaxone in 182 cases (19.2%), and cefotaxime in 114 cases (12.0%). The top 15 prescribed medications are shown in Table 1.

In the 400 cases, there were seven different routes of administration where 702 out of 949 medications (74.0%) were intravenous (IV), followed by oral route for 159 (16.8%) medications.

3.3. Appropriateness of the doses prescribed and associated factors

The doses of the medications prescribed for 400 patients were reviewed, and 949 medications were prescribed; in 213 of them (22.4%) the doses were higher or lower the recommended range of doses based on children's weight, and the doses of the rest (736) medications were correctly prescribed (77.6%).

Among the 400 patients, 160 (40.0%) were prescribed one or more inappropriate doses.

No significant association was found between inappropriate doses and gender or hospital (chi-square test p-value > 0.05).

Table 1
The top 15 prescribed medications for children during their hospital stay.

No.	Medication	Frequency	Percentage from total number of medications (%)
1	Ampicillin	194	20.4
2	Ceftriaxone	182	19.2
3	Cefotaxime	114	12.0
4	Paracetamol	72	7.6
5	Salbutamol	53	5.6
6	Gentamicin	42	4.4
7	Dexamethazone	38	4.0
8	Hydrocortisone	29	3.1
9	Ranitidine	21	2.2
10	Furosemide	19	2.0
11	Acyclovir	15	1.6
12	Azithromycin	13	1.37
13	Vancomycin	12	1.26
14	Ibuprofen	10	1.05
15	Metronidazole	10	1.05

Table 2
Association between inappropriate doses and some variables.

Variable	Appropriate dose median (Q1–Q3)	Inappropriate dose median (Q1–Q3)	p-value
Age (month)	11 (2–36)	6 (1–24)	0.012
Weight (kg)	9 (4.8–14.5)	7 (4–12.42)	0.001
Number of medications	2 (1–3)	3 (2–3)	0.0001
Length of hospital stay (day)	3 (2–5)	3.5 (2–6)	0.033

Mann-Whitney test.

Age, weight, number of medications and duration of hospital stay significantly associated with inappropriate doses, younger patients, and patients with lower body weight, who were prescribed higher number of medications and stayed in hospital for a longer time were more likely to have inappropriate doses (Table 2).

4. Discussion

Dosing error was the most common type of prescribing errors in several studies (Lesar, 2002; Al-Jeraisy et al., 2011; Alsulami et al., 2013; Fernández-Llamazares et al., 2013). To the best of our knowledge, this study was the first from Palestine in which 22.4% of the medications were prescribed in potentially inappropriate doses. Nearly the same percentage of dose errors (22.1%) was found in a study to identify medication errors in a general pediatric ward and pediatric intensive care unit in Saudi Arabia (Al-Jeraisy et al., 2011).The incidence rate of dose errors in a systematic review of the literature related to medication errors in Middle Eastern countries was from 0.15% to 34.8% of prescriptions (Alsulami et al., 2013). So the rate found in this study is in this range and is considered high.

According to this study, the most commonly used medications were ampicillin in 20.4% cases, ceftriaxone in 19.2% cases, and cefotaxime in 12.0% cases. It can be noticed that antibiotics were highly prescribed for pediatric patients. This is similar to other studies related to pediatric inpatients (Rauniar et al., 2003; Akter et al., 2004; Fernández-Llamazares et al., 2013). Compared to other countries, gentamicin, ampicillin, crystalline penicillin and cefotaxime were most commonly prescribed in a study in eastern Nepal (Rauniar et al., 2003). While in a teaching hospital in Bangladesh, the most commonly-prescribed antibiotics were ampicillin, gentamicin, amoxicillin, cloxacillin and ceftriaxone (Palikhe, 2004). Intravenous route (IV) has been reported as the most common route of medication errors in children admitted in hospitals (Al-Jeraisy et al., 2011). This may be because it is the most common route of drug administration in the critical care setting. This is obviously seen in this study where IV route represented 73.97% of routes of administrations which is relatively a high percentage. If a wrong IV dose is given, the effect will be fast, so special care that includes reviewing parenteral medications by double check from nurses and pharmacists is recommended before administering IV doses for children.

Sepsis (14.3%), fever (13.5%), meningitis (10.0%) and gastoenteropathy (6.0%) were common conditions, necessitating admission for pediatric patients. In a study from Nepal, infective diseases (42.0%), respiratory conditions (18.2%), perinatal disorders (14.9%) and nutritional deficiencies (9.9%) predominated (Rauniar et al., 2003). On the other hand in a study in Karachi, Pakistan, the presenting complaints were fever in 18%, cough in 9%, both fever and cough in 21%, vomiting in 20% and diarrhea in 41% of encounter (Nizami et al., 1997). However, the Pakistani study was carried out among outpatients while this study was among pediatric inpatients.

The number of drugs prescribed was less than the number of drugs prescribed in other studies (Shankar et al., 2006).This is a good trend as there is an increased risk of drug interactions and errors of prescribing with polypharmacy.

The study found that younger patients, patients with lower body weight, and those who were prescribed a higher number of medications and stayed in hospital for a longer time were more likely to have inappropriate doses; these findings can be useful to identify high risk groups so special attention can be made.

One of the features that we found during the research that all patients' information and files were computerized and this is a good thing in reducing medication dosing errors. The weight of each patient was measured and this is a good finding because pediatric doses should be calculated according to the weight.

The study has several limitations. It included 3 governmental hospitals in three different cities, so the results may not be representative to other hospitals in which children receive care in other cities. The study period was short (one month), and maybe longer periods are needed to represent the current situation in a more comprehensive picture. An important limitation is that the doses were compared to the recommended doses in one drug information reference only, and it is important to know that different references might give different recommendations sometimes. However, this data can be baseline data for further studies.

In order to minimize errors, computerized physician order entry with clinical decision support systems and drug-dosing applications might be considered. So we recommend using dose checking software programs to provide alerts for potentially incorrect doses. A clinical pharmacist service is another possible useful intervention.

Also we recommend improving communication among clinicians during transitioning and handoffs,like when the patient is in transition from one clinician to another or from one setting to another. So clarity is required whenever one communicates with another clinician, and especially when handing off a patient to the next shift or to another clinician. It is advised to review the child weight when new medications might be added.

Finally, it is important to remember that these are potential dosing errors and not actual errors; it is recommended to study the clinical effect of these over or under doses in future studies.

5. Conclusion

Potential medication dosing errors were common in pediatric inpatient settings in this study, and further efforts are needed to reduce them. Associated factors included younger age, lower body weight, higher number of medications and longer hospital stay. It is recommended to review doses for children by clinical pharmacists or having a computerized order system with alerts when doses are not within the recommended range. It is also recommended to give special attention to high risk groups.

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