

## Evaluation the Use of Ceftriaxone Injection in the Emergency Departments of Pediatric Hospitals in Khartoum State, Sudan

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### Abstract

**Background:** Respiratory infections are the most common cause of pediatric hospitalization and among the main causes of mortality and morbidity. Injectable antibiotics are the main therapeutic option for the treatment of pediatric infections in hospitals, and ceftriaxone is considered one of the most prescribed in pediatric emergency units because of its high efficacy, high tolerability, and patient compliance. **Objectives:** This study was carried out to evaluate the uses of ceftriaxone in pediatric departments of pediatric hospitals in Khartoum state and to compare the findings with local and international guidelines. **Methodology:** This study was a cross-sectional hospital-based study conducted during winter 2016. Three different governmental pediatric hospitals were involved, Ahmed Qassim, Omdurman and Gafar Ibn Oaf pediatric hospitals. A total of 199 patients were included in the study. A consecutive probabilistic sampling technique was used. A structured data collection form was used containing demographic and clinical data. **Results:** The results showed that more than half of the patients came to Ahmad Qassim Paediatric Hospital (50.7%), most of the patients were between 2 and 12 years old (51.8%) and (60.3%) of the patients who received ceftriaxone were male. Most of the patients given ceftriaxone were diagnosed as febrile convulsions (28.64%) and respiratory tract infection (14.1%). (36.7%) of the physicians prescribed ceftriaxone according to international guidelines. Only (36.7%) of the patients received the correct doses, while the rest (63.3%) received subtherapeutic dose or overdose. various therapeutic outcomes were reported. **Conclusion:** This study concluded that most of the patients given ceftriaxone were diagnosed with febrile convulsions and respiratory tract infections, while most physicians prescribed ceftriaxone empirically without referral to any guidelines and most patients received overdose or sub-therapeutic doses. The study recommends that there must be a local guideline(s) adjusted according to local special requirements and comply with international guidelines. These simple and easy-to-use dosing guides to physicians at emergency departments of pediatric hospitals to alleviate the problems of dose calculations and to improve the therapeutic outcome(s) for the use of Ceftriaxone injection.

**Keywords:** Drug use evaluation, Ceftriaxone injection, Khartoum State, Emergency, Pediatrics hospitals

### Introduction

Data on emergency disease can provide a general overview of the out-of-hospital burden of acute lower respiratory infection (ALRI). Presentation rates to the emergency department

(ED) for ALRI were high (52.9%), but estimates were minimised by the limitations of emergency disease data sets, so it is highly recommended to improve these data sets. The most important causes of presentation to paediatric emergency departments were ALRI,

especially bronchiolitis and croup (**Moore et al., 2012**).

As most cases of Community-acquired pneumonia (CAP) are initially diagnosed and treated empirically in the emergency department, factors that influence emergency doctors' decisions to prescribe antibiotics should be addressed (**Almatar et al., 2014**).

Among children presenting to emergency departments with acute respiratory tract infection, the relative incidence and clinical impact of individual respiratory viruses remain unclear (**Gooskens et al., 2014**).

Respiratory tract infections are one of the most common diseases in paediatric clinics and generate an increase in antibiotic prescriptions (**Guzman Molina et al., 2014**).

Severe community-acquired pneumonia that requires admission to the intensive care unit is associated with high morbidity, mortality, and health care cost. The current practice guidelines, as well as the role of several scoring systems used to predict severity, prognosis, and site of care are reviewed. In addition, common complications and prevention strategies were discussed (**Sligl and Marrie, 2013**).

Community-acquired pneumonia is the main cause of mortality in children under 5 years of age. A diagnosis of pneumonia is made if a febrile child has a history of cough and difficult or rapid breathing and an up-normal respiratory rate; however, signs of airway obstruction should be checked. Severe pneumonia is diagnosed if with the above characteristics there is a lower retraction of the chest wall retraction is present; moreover, all infants under 2 months of age and children with moderate to severe malnutrition with pneumonia are classified as having severe pneumonia (**Dekate et al., 2011**).

Acute respiratory tract infections are the common cause of admission to the emergency department. Proper diagnosis and time to initiate treatment are highly reducing the morbidity and mortality rate due to lower

respiratory tract infection (LRTI) (**Tatar et al., 2013**).

The most common isolated pathogens were *Pseudomonas aeruginosa* and *Haemophilus influenzae*. C- Reactive Protein (CRP) and White Blood Cells (WBC) sputum are important markers for the diagnosis of LRTI in emergency departments, and the results of the microbiological analysis of respiratory samples were correlated with these markers (**Tatar et al., 2013**).

Respiratory viruses are very common in young children presenting to the hospital emergency department with ARTI and it is difficult to differentiate bacterial infections by signs and symptoms. Respiratory syncytial virus (RSV) and Human Rhinovirus (HRV) are the main causes of morbidity in the pediatric clinical setting (**Gooskens et al., 2014**).

Antibiotics are widely believed to be over-prescribed for pediatric respiratory infections, yet there is little data available on the effect of a sudden decrease in antibiotic availability on pediatric infectious diseases (**Crocker et al., 2007**).

Respiratory antibiotics appear to be available in the community more than the amount required to control pneumonia. A 28% decrease in antibiotic availability did not result in a significant increase in respiratory disease (**Crocker et al., 2007**).

Antibiotics utilization patterns were unclear for patients who presented to USA emergency departments with ARTI, and the rate of using antibiotics was decreased in many outpatient clinics (**Donnelly et al., 2014**).

Based on the derived Centor Score (<3), 80% of patients were prescribed antibiotics inappropriately and antibiotics, especially broad spectrum, were prescribed only by judgment. On the other hand, throat soaps were commonly performed in emergency departments, but did not improve diagnosis or guide antibiotic prescription (**Kanji et al., 2016**).

Periodic surveillance of drug resistance and epidemiological analysis of patient data will have a great influence on the management of antimicrobial resistance (**Ibrahim et al., 2012**).

The 2005 American Thoracic Society/Infectious Diseases Society of America (ATS/IDSA) guidelines for hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP) and health care-associated pneumonia (HCAP) stress the importance of initiating rapid appropriate empiric antibiotic therapy (**Erwin et al., 2015**).

Acute respiratory tract infections (ARTI) are the main reasons for prescribing antibiotics to pediatric patients. The French Drug Agency published guidelines to control the use of antibiotics for ARTI in 2005 (**Angoulvant et al., 2012**).

Non-severe typical pneumonia is treated at home with oral amoxicillin for 3-5 days, while a typical pneumonia is treated with azithromycin. The patient should be hospitalized if age <2 months, treatment failure with oral antibiotics, severe/very severe or recurrent pneumonia, shock, hypoxemia, severe malnutrition, and compromised immune state. Severe pneumonia is treated with injectable ampicillin. Very severe pneumonia is treated with injectable ampicillin plus gentamicin. If it improves after 48 h, oral amoxicillin and gentamicin are continued for 10 days. If not, respiratory support is enhanced, antibiotics are changed to intravenous Ceftriaxone and Amikacin and further work is planned (**Dekate et al., 2011**).

A total of 53,055 children with ARTI were diagnosed and the proportion of ARTI patients given antibiotic prescriptions decreased from 32.1% during the first year to 21% in year 4. Amoxicillin-Clavulanic acid and amoxicillin represented 50% and 34% of antibiotic prescriptions for ARTI, respectively. French antibiotic guidelines led to significant decreases in antibiotic prescription for ARTI in our pediatric emergency department (**Angoulvant et al., 2012**).

The use of antibiotics in febrile infants and toddlers in emergency departments can be highly minimized by rapid confirmation of influenza virus type A infection (**Sharma et al., 2002**).

The average antibacterial prescription rate in Beijing general hospitals was 71.2%, of which single use was 80.0%. Among acute upper respiratory tract infections, the antibacterial prescription rate for acute tonsillitis was highest 85.1%, followed by acute laryngitis and bronchitis 81.69%, acute pharyngitis 81.4%, acute sinusitis 77.0%, acute nasopharyngitis 74.3%, and common cold 67.6%. In visitors who used antibacterial drugs, the average percentage of injection use was 50.6%. The top antibacterial drugs on the list of varieties were second-generation cephalosporins (28.4%), followed by third-generation cephalosporins (21.7%), fluoroquinolones (21.0%) and macrolides (17.6%). This huge study which was conducted in Beijing in 1,5979 patient records concludes that the antibacterial prescription rate for acute upper respiratory tract infections in general hospitals in Beijing is high, with the predominance of second-generation cephalosporins, third-generation cephalosporins, fluoroquinolones and macrolides, respectively (**Wu et al., 2014**).

Two guidelines are currently available to guide Japanese clinicians caring for ventilator-associated pneumonia (VAP) patients: the 2005 American Thoracic Society/Infectious Diseases Society of America (ATS/IDSA) guidelines or the 2008 Japanese Respiratory Society (JRS) guidelines. The treatment of 62 patients (73 %) was appropriate based on in vitro sensitivity testing. Using ATS/IDSA criteria, 16 patients (19 %) received guideline-compliant therapy, and 69 patients (81 %) received non-compliant treatment. Using JRS criteria, 24 patients (28 %) received guideline-compliant therapy, and 61 patients (72 %) received non-compliant treatment. The mortality at 28 days of all causes was 24 %. Compared to patients who received non-compliant therapy, there were no differences in 28-day mortality rates for patients who received regimens compliant with the ATS / IDSA guidelines or regimens compliant with the JRS guidelines. The study revealed poor

compliance with the guideline-recommended antibiotic therapy for VAP in Japanese Intensive Care Units (ICUs) and showed that compliance with the current VAP guidelines was neither associated with increased rates of appropriate antibiotic treatment nor with improved 28-day mortality (**Sakaguchi et al., 2013**).

Ceftriaxone is one of the most common empirical antibiotics prescribed in emergency rooms in Thailand and there are frequent reports of inappropriate use. A cross-sectional study on 278 pediatric patients for whom Ceftriaxone was prescribed was included in the analysis; of these ceftriaxone uses, 162 (58.3%) cases were considered appropriate. Clinical suspicion of infection was associated with the appropriateness of the use of Ceftriaxone for empirical treatment in emergency rooms (**Phuphuakrat et al., 2013**).

Antibiotic resistance was found to be very high in Vietnam, with amoxicillin/clavulanic acid being the most active agent and Ceftriaxone highly active against *H. influenza* (**Van et al., 2016**).

Implementation of a Clinical Practice Guideline (CPG) for the treatment of refractory acute otitis media (AOM) with Ceftriaxone did not improve indications for its use (**Gauthier et al., 2009**).

For the study conducted in 289 patients and based on published guidelines, Ceftriaxone use was justified in 48 patients (16.6%), questionable in 49 patients (17%), and not justified in 192 patients (66.4%), so we can conclude that According to published guidelines, Ceftriaxone use in pediatrics was not justified in the majority of cases (**Jain and Sullivan, 2002**).

Community-acquired bacterial pneumonia (CABP) can be considered a major infection among children, even with the use of pneumococcal vaccination. Ceftaroline fosamil is a broad-spectrum cephalosporin antibiotic with activity against many bacteria, including *Streptococcus pneumonia* and *Staphylococcus aureus*. Ceftaroline fosamil had similar efficacy to Ceftriaxone, with high clinical cure rates. The

results of this study suggest that ceftaroline fosamil may be an important treatment option for pediatric patients hospitalized with CABP (**Cannavino et al., 2016**).

The resistance to antibiotics in Vietnam was high, with amoxicillin/clavulanic acid being the most active agent. Ceftriaxone was highly active against *H. influenza* while Ofloxacin appeared highly active against *S. pneumonia* (**Van et al., 2016**).

Of the 9377 emergency department visits included in the study; 21 of 33 emergency departments (63.6%) had a Clinical Practice Guideline (CPG). For neonates  $\leq 28$  days, the CPG recommendations did not vary and were not associated with differences in tests, hospitalization, or costs. Among infants 29 to 56 days, the CPG recommendations for Cerebrospinal fluids (CSF) testing and Ceftriaxone use varied. Ceftriaxone use at ED discharge varied significantly according to the CPG recommendations. Costs were higher for admitted and discharged babies 29 to 56 days old in hospitals with CPG (**Aronson et al., 2015**).

### **Significance of the study**

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Ceftriaxone is one of the most used drugs for pediatrics in emergency departments, observations revealed inappropriate use that can lead to resistance development, increased patient cost, and negative economic impact. Few enough data was available to assess the use of ceftriaxone in emergency departments of pediatric hospitals in Khartoum state. An urgent need was required to state the current state and evaluate its utilization in emergency departments.

### **Aim of the study**

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This study was established to evaluate the use of ceftriaxone at three different emergency departments of Khartoum state pediatric hospitals. The study was set out to answer the clinical practice question; How do Sudanese Physicians prescribe Ceftriaxone for pediatrics at ED? Thus, it examines the hypothesis which stated that 'Sudanese

Physicians were rationally prescribe Ceftriaxone for pediatrics at ED'.

### Operational definitions

**1.Ceftriaxone Injection:** A parenteral (administered by injection) third-generation cephalosporin antibiotic used to treat bacterial infections. Any recorded instance of ceftriaxone injection administered to a patient in the emergency department of a pediatric hospital in Khartoum State, Sudan, during the study period. This includes information on dosage, frequency, and route of administration.

**2.Emergency Departments:** Healthcare facilities providing immediate medical care for acute illnesses or injuries. Specifically defined emergency departments within pediatric hospitals in Khartoum State, Sudan, participating in the study. This may include criteria such as bed capacity, staffing levels, and availability of diagnostic equipment.

**3.Pediatric Hospitals:** Healthcare facilities specializing in the care of children. Hospitals in Khartoum State, Sudan, designated as pediatric hospitals, providing comprehensive medical care for children, including emergency services. This may involve criteria such as the proportion of pediatric patients, availability of pediatric specialists, and specialized equipment for children.

**4.Khartoum State, Sudan:** A Capital state in Sudan with a specific geographical boundary. Clearly defined geographical boundaries of Khartoum State, Sudan, as per official administrative maps. This ensures consistent inclusion or exclusion of healthcare facilities based on their location.

**5.Use Evaluation:** An assessment of how a medication (ceftriaxone) is used in clinical practice. In this study, it likely involves: Gathering information on ceftriaxone prescriptions, including patient demographics, diagnoses, dosages, and treatment outcomes. Analyzing the collected data to identify patterns of ceftriaxone use, such as indications for use, appropriateness of prescribing, and potential adverse events. Comparing the observed

patterns of ceftriaxone use with established guidelines or best practices to identify areas for improvement.

### Methodology

#### Study design and study area

This cross-sectional study was conducted at three different government pediatric hospitals, Ahmed Qassim pediatric hospital, Omdurman pediatric hospital and Gafar Ibn Oaf pediatric hospital. All hospitals located in the state of Khartoum (Sudan).

Data were collected using a structured data collection form. The data collection form was pre-tested in 20 patients and the necessary modifications were made.

#### Study Time Framework

The study was started on 25 December 2015 and ended on 20 January 2016. Data were collected from each hospital at a fixed duration, every day during the study duration, and any patient who came to the emergency departments at a predetermined period (8.30 am to 4.30 pm) and met the inclusion criteria was included in the study. Data were collected by qualified well-trained nurses in all three hospitals.

#### Population Criteria and Sampling

##### Inclusion Criteria

Both sexes, aged from birth to less than 18 years, presented to the emergency units of Ahmed Qassim pediatric hospital, Omdurman pediatric hospital and Gafar Ibn Oaf pediatric hospital between December 2015 and January 20, 2016 at (8.30 am - 4.30 pm) and received Ceftriaxone injection.

##### Exclusion criteria

Patients were treated at hospital sites other than emergency units. Who attended the emergency but did not receive ceftriaxone.

#### Sample size determination

As we do not know the exact population number of the selected hospital pediatric patient. A Consecutive probabilistic sampling procedure was conducted based-on the pre-determined time framework of the study. All patients who attended Ahmed Qassim Pediatric Hospital, Omdurman Pediatric Hospital, and Gafar Ibn Oaf pediatrics hospital at (8.30 am- 4.30 pm)

between December 2015 and January 2016, were recorded and added to the study sample.

The duration of the study was 21 days, and the number of patients included in the study was 199 patients, 101 at Ahmed Qassim hospital, 72 patients at Omdurman pediatric hospital and 26 patients at Gafar Ibn Oaf pediatric hospital.

### Data Collection Methods

The data collection form consists of two main parts, demographic data and clinical and outcome data. Demographic data contains hospital name, child age, sex, weight, and body mass index. These data were collected from co-patients and admission sheet.

The ages of the children were classified according to the WHO classification into four groups (less than a month, from 1 month to 2 years, 2 to 12 years and 12 -18 years). Child sex, male or female.

Clinical data were collected from the doctors and the admission form. It contains diagnoses, outcomes, outcome measures, awareness of guidelines, source of guidelines, rationale for prescribing Ceftriaxone, and dose range. Diagnoses were classified into respiratory tract infection, GIT infection or typhoid, UTI, febrile convulsions, meningitis, anemia, and others.

The outcome was classified into improved and discharged, improved and admitted to long-stay wards, not improved and admitted to long-stay wards, not improved and admitted to ICU and worsened admitted to ICU.

Outcome measures either clinical examinations only or clinical examination plus laboratory investigations.

Awareness of the international, local, or hospital guidelines of guidelines. The source of guidelines was from the boss, colleagues, read about the guideline or told by the boss and read about the guideline. The rationale for prescribing Ceftriaxone was an open question for the prescriber.

The dose range was calculated using the formula (dose mg / patient weight) to determine the dose per kilogram weight, and then classified into within range, below range, or above range since the correct dose range of ceftriaxone is (50-75 mg/kg).

### Ethical Considerations

Before starting the study, ethical clearance was obtained from the Ministry of Health, Khartoum State, General Directorate of Therapeutic Medicine (MH\ Kh. S\ GDTM\44\1-2015) for each hospital, while informed consent of the patients was obtained from their co-patients (always parents) before data collection.

### Statistical analysis of data

Each case was numbered, and its data was coded and entered to the SPSS software program (version 16) for the analysis of the results.

Descriptive statistics were performed, and each demographic data were analysed by measuring frequency and distribution percentage for each data. Simple bars were used for description of frequency distribution of certain data, whilst where there were certain useful relationships between different data were performed, for example, between hospitals and outcome/decision.

### Results

#### Demographic Data

Most of the paediatric patients were male (60.6%) aged between 2 years and 12 years (51.8%) and came to Ahmad Qassim Pediatric Hospital (50.7%) as shown in Table 1.

#### Clinical data

#### Pediatrics Medical Conditions

Most of the patients given Ceftriaxone were diagnosed as febrile convulsions (28.64%) then other indications (26.63%) followed by respiratory tract infection (14.04%), anemia (12.06%), meningitis (9.05%), UTI (5.53%) and the minor percentage was GI & Typhoid (4.02%) as shown in Figure 1.

#### Methods of diagnosing

Most of the patients were diagnosed by clinical examinations and laboratory investigations (98.5%) and the rest (1.5%) were

diagnosed by clinical examinations only, as shown in Figure 2.

### Guidelines Awareness

Most doctors prescribed ceftriaxone according to international guidelines (36.7%), where doctors follow hospital guidelines in (28.1%) of cases, local guidelines in (10.6%) and no guidelines in (24.6%) of cases, as shown in Figure 3.

### Source of guideline

(26.1%) of doctors prescribed Ceftriaxone based on guidelines were told about the guideline by no one while (37.2%) of doctors prescribed ceftriaxone told by their bosses, (18.6%) from their colleagues, (17.1%) read about the guideline, and a minor percentage (1%) told by their boss and colleagues and read about the guideline as shown in Figure 3.

### Dose range

Only (36.7%) of the patients were given doses within the correct dose range, while (34.7%) of the patients were given doses below the range and (28.6%) of the patients were given doses above the range as shown in figure 4.

The use of Ceftriaxone injection showed various therapeutic outcomes that vary from improved/discharge to get worsening/admitted to the ICU at different emergency department of Khartoum state's pediatrics hospitals, Table 5.

**Table1.** Population characteristics of patients targeted by the study on the uses and outcome of ceftriaxone in emergency departments of pediatric hospitals in the state of Khartoum (N = 199).

| Patterns              | Frequency | %    |
|-----------------------|-----------|------|
| <b>1. Hospital</b>    |           |      |
| Ahmed Qassim          | 101       | 50.7 |
| Omdurman              | 72        | 36.2 |
| Gafar Ibn Oaf         | 26        | 13.1 |
| <b>2. Sex</b>         |           |      |
| Male                  | 120       | 60.3 |
| Female                | 79        | 39.7 |
| <b>3. Age</b>         |           |      |
| >Month                | 4         | 2.0  |
| 1month-2 years        | 78        | 39.2 |
| 3-12 years            | 103       | 51.8 |
| 13-18 years           | 14        | 7.0  |
| <b>4. Weight</b>      |           |      |
| Newborn (>3)          | 5         | 2.5  |
| Infant (4-19)         | 79        | 39.7 |
| Toddler (10.1-14)     | 35        | 17.6 |
| Preschooler (14.1-18) | 35        | 17.6 |
| Schooler (<20)        | 45        | 22.6 |

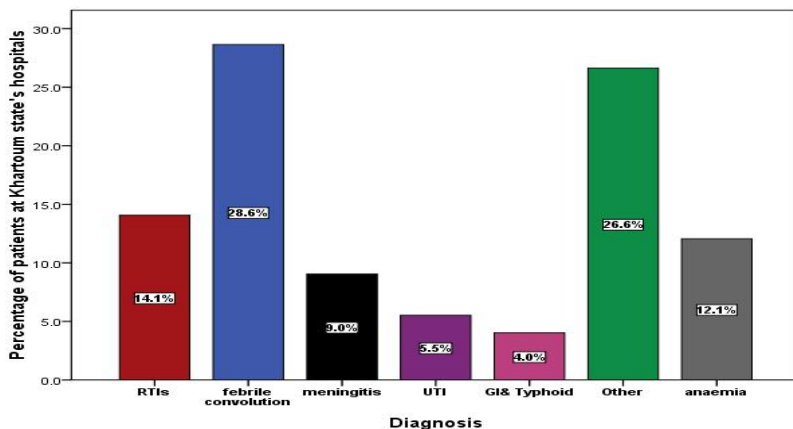


Fig. 1: The percentage of pediatric patients diagnosed and received Ceftriaxone in emergency departments of Khartoum state pediatric hospitals, n= 199.

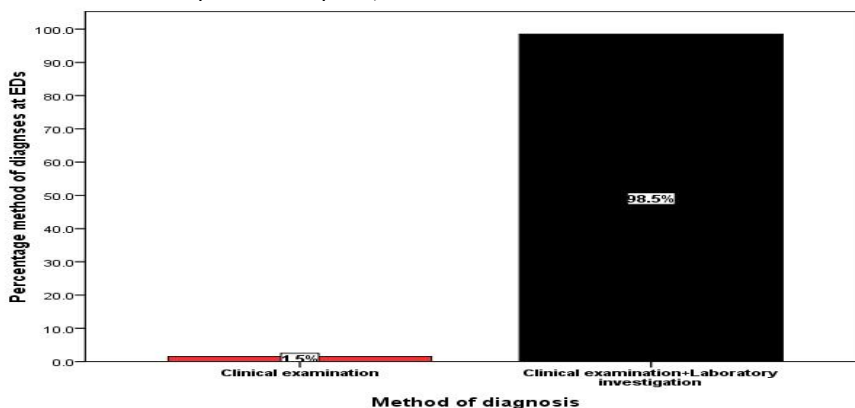


Fig. 2: The percentage of distribution of the diagnostic method among patients who received ceftriaxone in emergency departments of pediatric hospitals of the state of Khartoum.

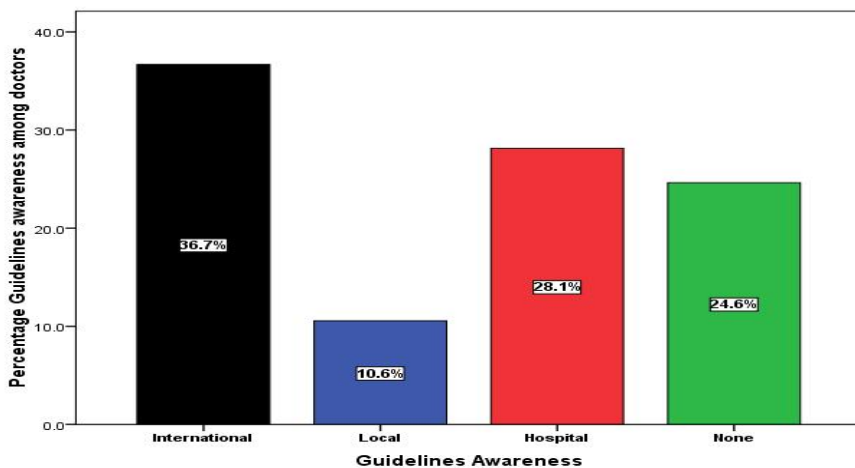
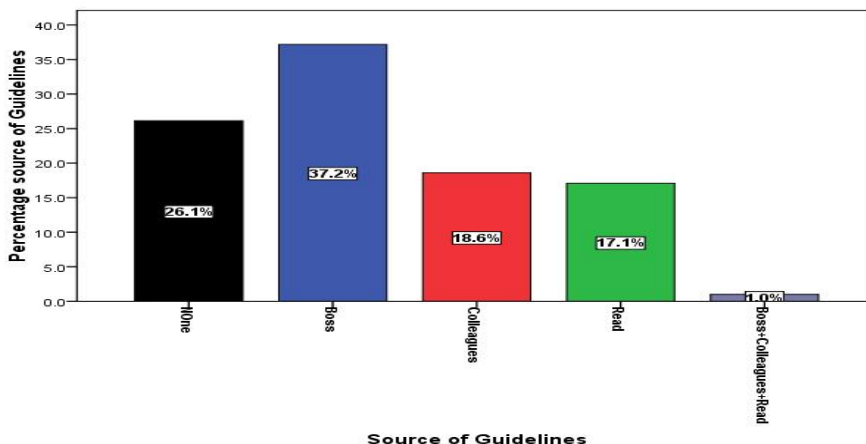
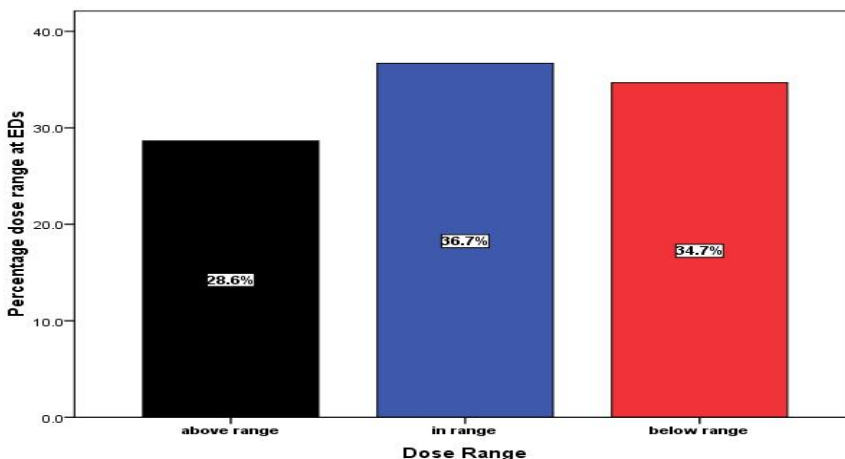


Fig. 2: The percentage of awareness of the guidelines among doctors prescribed Ceftriaxone in emergency departments in pediatric hospitals in Khartoum states.





**Fig. 3:** The percentage distribution of the source of the guideline among the doctors prescribed ceftriaxone according to the guidelines in the emergency departments of the pediatric hospitals in Khartoum state.



**Fig. 4:** The percentage frequency of the ceftriaxone dose range in pediatric hospitals of Khartoum states. The correct dose range of ceftriaxone is (50-75 mg/ Kg).

**Table 5:** The therapeutic outcome of the use of Ceftriaxone injection at different emergency department of Khartoum state’s pediatric hospitals. Data presented as Frequency(percentage).

| Outcome/Decision                 | Jaafar Pediatric Hospital | Ibnoaf Pediatric Hospital | Omdurman Pediatric Hospital | Ahmed Gassim Pediatric Hospital |
|----------------------------------|---------------------------|---------------------------|-----------------------------|---------------------------------|
| Improved and discharged          | 0(0.0)                    |                           | 1(1.4)                      | 20(19.8)                        |
| Not improved admitted to ward    | 20(76.9)                  |                           | 18(25.0)                    | 20(19.8)                        |
| Improved and admitted to ward    | 6(23.1)                   |                           | 45(62.5)                    | 55(54.5)                        |
| Not improved and admitted to ICU | 0(0.0)                    |                           | 8(11.1)                     | 2(2.0)                          |
| Worsen and admitted to ICU       | 0(0.0)                    |                           | 0(0.0)                      | 4(4.0)                          |
| Total                            | 26(100)                   |                           | 72(100)                     | 101(100)                        |

**Discussion**

Ceftriaxone is widely used in paediatric emergency departments, while there was not enough data available on its use. This research

was carried out in the Ahmad Qassim paediatric hospital, the the Omdurman paediatric hospital, the Gaafar Ibn Oaf paediatric hospital to evaluate Ceftriaxone Ceftriaxone prescription pattern in these hospitals.

Most of the patients were male and their migration was children (2-12 years) and infants (1month-2 years) because the use of Ceftriaxone is questionable for the age group below 1 month and the patient over 12 years are less likely to have infections because their immune system becomes more effective by this age. This finding is compatible with (Gooskens et al., 2014) who found that one-third of patients were below 3 years old, this finding also agrees with (Guzman Molina et al., 2014) who found that children under the age of 2 years were the most represented age group.

The most common indication for Ceftriaxone was febrile convulsions and this could be decreased according to (Sharma et al., 2002) who found that antibiotic use in febrile infants and toddlers in emergency departments can be greatly minimised by rapid confirmation of influenza virus type A infection. The second most common indication was respiratory tract infections, which agrees with (Guzman Molina et al., 2014) who found that respiratory tract infections are one of the most common diseases in paediatric clinics and generate an increased number of antibiotic prescriptions and (Dekate et al., 2011) study in which community-acquired pneumonia was the main cause of mortality in children under 5 years of age; it is also consistent with the findings of (Tatar et al., 2013) who reported that acute respiratory tract infections were the common cause of admission to the emergency department. The third common indication was anemia for which there is no clear justification and requires further research to know the exact reasons for prescribing Ceftriaxone to anaemic patients.

Most doctors prescribed Ceftriaxone based on international guidelines, then hospital guidelines and local guidelines, while quarter of them follow no guidelines. By reviewing the data from the Federal Ministry of Health and the Sudan Medical Council, we assured that there are no national guidelines to control the use of ceftriaxone in paediatric hospitals and by asking the medical directories of the three hospitals, we ensured that there are no local or hospital guidelines. These results were too far away from what (Aronson et al., 2015) found that more than half (21 of 33) EDs had clinical

practice guidelines; this difference is due to the huge difference in infrastructure and health care facilities in the US where the study was conducted. These results were quite different from (Jain and Sullivan, 2002) who found that the use of ceftriaxone was justified only sixteen and six tenths percent, questionable seventeen percent and not justified in sixty-six and four percent. Also results are closer to (Guzman Molina et al., 2014) who found that antibiotic prescriptions followed current guidelines, except for cases diagnosed with AOM.

Most of the doctors prescribed Ceftriaxone had been directed by their bosses, and the least percentage of them read the guideline. This reflects the fact that junior doctors rely more on the opinions of their bosses than on reading the guidelines.

Given that the correct dose range of Ceftriaxone is (50-75 mg/ Kg) the majority of the patients received doses below or above the therapeutic range, while only thirty-six and seven tenths percent received doses within the correct dose range. This is a very serious indicator that doctors do not pay enough attention to dose calculation and we noticed that there are no dosing guides available in emergency departments.

All patients were given ceftriaxone once per day, which is the recommended frequency of administration, this result contradicts (Sileshi et al., 2016) who found that, almost hundred percent of patients were given ceftriaxone twice per day. All patients received ceftriaxon I.V in normal dextrose 1/5 saline, except one patient who received Ceftriaxone in ringer lactate, which is contraindicated and leads to fatal side effects (precipitation).

The use of Ceftriaxone injection showed various therapeutic outcomes at different emergency department, this may be due to the variation in the type of infection and the absence of local guideline. These findings agree with (Ayele et al., 2018) who evaluate prospectively the Ceftriaxone use in medical and emergency wards of an Ethiopian referral hospital, and reported inappropriate and unjustified ceftriaxone high utilization rate of

use of ceftriaxone as empirical indication for respiratory tract and other infections.

### Conclusions

The study concluded that the majority of the patients were male aged between 2-12 years, were diagnosed as febrile convulsions and respiratory tract infections and the majority were diagnosed only by clinical examination.

Most doctors prescribed Ceftriaxone according to international guidelines and knew the guidelines from their bosses.

The majority of patients received a subtherapeutic dose or a dose overdose and only about a third of the patients received correct doses.

The study recommends that there must be local guidelines adjusted according to local special requirements and comply with international guidelines, as (Gauthier et al., 2009) found that physicians were twice as likely to use ceftriaxone adequately after the implementation of the guideline. Continuous education programmes for junior doctors about the importance of following guidelines in managing paediatric diseases and to make the guidelines closer to the hands of doctors (distributed regularly as hard copies, sending soft copies to their emails when shifting or sticking in emergency clinics. Distributing simple and easy-to-use dosing guides to physicians at emergency departments of paediatric hospitals to alleviate the problems of dose calculations. More studies on this topic were highly recommended by covering hospitals outside of Khartoum and with longer duration.

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