



Utilization of antibiotic drugs in the Pediatric department of a tertiary care hospital at southern Rajasthan

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Abstract

Introduction: Antibiotics rank among the highest prescribed drugs in pediatric practice in the management and prevention of infectious diseases. The misuse of antibiotics has been shown to worsen antimicrobial resistance, severe drug side effects, and rising healthcare costs. It is imperative that the consumption of antibiotics is monitored to ensure rational use of antibiotics in pediatric healthcare.

Methodology: In a tertiary care hospital in Udaipur, Rajasthan, prospective observational research was conducted in the pediatric department and pediatric intensive care unit. The participants of this study were pediatric inpatients who had received at least one antibiotic and were under twelve years of age. Descriptive statistics were used to examine the data, which were gathered using a standardized data collection form. WHO prescription indicators and the Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) system were used to measure drug usage.

Result: We examined 170 pediatric inpatient records in total. Many of the patients (44.11%) were between the ages of one month and five years, with men making up the majority (56.5%). At 11.20%, pneumonia was the most frequent diagnosis. Ceftriaxone was the most given antibiotic among cephalosporins (28.40%). The parenteral method was used to provide many of the antibiotics (88.88%). There were 1.55 antibiotics on average per prescription. Drug use study indicates that the ceftriaxone, ceftazidime, and meropenem had higher DDD values. 87.13% of prescriptions were generic, representing strong adherence to sensible prescribing guidelines.

Conclusion: The results of the investigation showed that the prescription of antibiotics in the pediatric department is rational in terms of the dosage and duration of the antibiotic. However, the high consumption of injectable and broad-spectrum antibiotics indicates the need for continuous monitoring and supporting antimicrobial stewardship programs for the optimization of antibiotic use and the prevention of resistance.

Keywords: Antibiotics, drug utilization, Pediatrics, ATC/DDD system, WHO prescribing indicators, antimicrobial stewardship, drug utilization study

Introduction

Antibiotics are about the most important therapeutic medications that are frequently used in modern medicine for the treatment and prevention of infectious diseases. Since antibiotics can stop the growth of germs or get rid of the bad ones, these medications are often used for empirical, definite, and preventative therapy. Antibiotics rank among the mostly prescribed drugs for children due to their high rate of incidence of infectious diseases that affects children, especially in the hospital setup (Mathew *et al.* ^[1]; Bandela *et al.* ^[3]).

Children are more susceptible to infectious diseases because of their immature immune system, high exposure rate to infectious agents, and the influences of various biological factors. As such, antimicrobial medications are often used by pediatric residents for the treatment of the infectious diseases that they contract in the hospital and community environments (Palikhe ^[5]; Baidya *et al.* ^[9]). Even though antibiotics have facilitated to control the morbidity and mortality rates associated with infectious diseases, the misuse of antibiotics has become an important public health problem worldwide.

The World Health Organization (WHO) has informed that the advancement, prescription, and administration of drugs are incorrect in more than half of the cases in the world. Among these, the use of antibiotics is significant. The

prescription of antibiotics for viral diseases, the selection of the wrong medicine, the wrong dose of the medicine, the prolongation of the period of antibiotic therapy, and the unnecessary use of broad-spectrum agents are the examples of irrational use of antibiotics in the management of pediatric patients (Satari *et al.* ^[6]; Cole *et al.* ^[7]). The above methods are not only not providing the benefits of the therapy, but they are also adding to the cost of the healthcare and the avoidable adverse reactions of the drugs in the children. The major risk to the health of the peoples in the world is the development of antimicrobial resistance (AMR), which is mainly due to the excessive and irrational use of the antibiotic agents. Several studies have reported that there is a significant association between the use of antibiotic agents and the emergence of resistance in the common bacterial diseases (Fahimzad *et al.* ^[8]; Girma *et al.* ^[2]). Antimicrobial resistance (AMR) is generally found in hospitals, especially in tertiary hospitals. This is because they make intensive use of broad-spectrum drugs, antibiotics, and procedures.

Drug use studies play a significant role in evaluating drug prescriptions, detecting irrational drug use, and encouraging rational drug use. To design effective antimicrobial stewardship programs that maximize the use of antibiotics, drug use studies play a significant role (Achal *et al.* ^[10]). Several studies have already evaluated the use of

antimicrobial agents in adults presenting to hospitals by standardized methods. However, there is a lack of data available in children, especially in developing countries (Feleke *et al.* [11]).

Pediatric patients pose challenges in the use of antibiotics due to differences in drug absorption, distribution, metabolism, and excretion when compared to adults. There is a lack of appropriate formulations of antibiotics in children, as well as a lack of clear pediatric dosing recommendations, leading to medication errors in the use of antibiotics (Satari *et al.* [6]; Palikhe [5]). Dissimilarities in diagnostic practices, prescriber practices, and patient compliance also lead to differences in antibiotic usage (Garedow *et al.* [4]).

Study from India, Nepal, Iran, Ethiopia, and Sierra Leone has shown that hospital pediatric wards in these countries had a significant rate of unscientific antibiotic usage (Mathew *et al.* [1]; Girma *et al.* [2]; Cole *et al.* [7]; Fahimzad *et al.* [8]). In the management of pediatric patients, this underscores the need for the monitoring of antibiotic usage and the adoption of proper antibiotic prescription practices.

In the design of measures that can help in the reduction of antibiotic resistance, irrational antibiotic usage, and the management of pediatric patients, there is a need for the understanding of the antibiotic prescription practices of the country. In the absence of data regarding antibiotic usage in the country, the evaluation of antibiotic usage in the pediatric wards of hospitals becomes even more imperative. The existing investigation aims to assess the pattern and rationality of antibiotic usage in the pediatric department of a tertiary care hospital.

Materials and Methods

Study Design

A prospective observational research was carried out to assess the appropriateness and pattern of antibiotic prescription in pediatric patients.

Study Site

The study was conducted in the pediatric intensive care unit (PICU) and pediatric department of Geetanjali Hospital, a tertiary care teaching hospital located in Udaipur, Rajasthan, India.

Study Duration

The study was conducted over a period of 6 months.

Study Population

Male and female pediatric inpatients aged ≤ 12 years who were administered antibiotic medication while in the hospital comprised the research population.

Study Criteria

Inclusion Criteria

- Patients aged ≤ 12 years
- All patients, regardless of gender, who were admitted to the pediatric ward or PICU and were prescribed at least one antibiotic
- Patients with written informed consent from their parents or legal guardians

Exclusion Criteria

- Patients aged above 12 years
- Patients whose parents or legal guardians did not consent to participate in the study

Sample Size Calculation

As prevalent reasons for antibiotic usage, bronchopneumonia, respiratory tract infections, and pyrexia were taken into account while calculating the sample size.

According to stated prevalence values:

- Bronchopneumonia (23.16%): 140 people in the sample.
- Infections of the respiratory tract (10.16%): sample size = 72.
- Pyrexia (16.16%): 107 samples.

To meet the study's goals, 140 patients were chosen, taking into account the largest computed sample size. The final sample size was raised to 154 patients in order to accommodate for a possible 10% dropout rate.

Data Collection

A pre-made, structured data collection form was used to gather the following information:

- Information about demographics
- Health history
- History of medication
- Information about prescription antibiotics

The hospital's pediatric inpatients' medical records provided pertinent information. Both Hindi and English versions of written informed consent forms were available.

Study Procedure

- Before the study initiated, approval was received from the Institutional Ethics Committee (IEC).
- Afterward parents or legal guardians gave their informed consent, eligible pediatric patients were enrolled.
- Standardized forms were used to gather data prospectively during the trial.
- Data was collected from the PICU and inpatient units.
- To evaluate patterns of antibiotic use, gathered data was collated, classified, and examined.

Statistical Analysis

After entering the gathered data into Ms Excel, descriptive statistics were used to describe the results.

Ethical Considerations

The study was conducted in accordance with ethical standards for human subjects in biomedical research. Ethical permission was given by Geetanjali University's Institutional Ethics Committee.

The reference number for ethical approval:

GU/HREC/EC/2023/2376

Results

1. Age-Wise Distribution

Table 1: Age-wise Distribution of the Study Population

Sr. No.	Age Groups	Number of Patients (n=170)	Percentage (%)
1.	Neonates	6	3.53
2.	1 Month – 5 years	75	44.11
3.	6 – 10 years	39	22.95
4.	11 – 12 years	50	29.41

Over the course of the investigation, 170 pediatric inpatient case records were examined. According to the age distribution, 75 (44.11%) of the patients were between the ages of 1 month and 5 years. Patients aged 11–12 years, including 50 (29.41%) cases, along with those over the age of 6–10 years, including 39 (22.95%) cases, came

next. With just 6 (3.53%) patients, neonates made up the least percentage. These outcomes show that many of the hospital admissions in the study group were amongst children under the age of five.

2. Gender wise Distribution of the Study Population

Table 2: Gender wise Distribution of the Study Population

Sr. No.	Gender	Number of Patients (n=170)	Percentage (%)
1.	Male	96	56.5
2.	Female	74	43.5

A gender-wise analysis revealed that the study population was predominately composed of male patients. There were 96 (56.5%) men and 74 (43.5%) women among the 170 patients. During the research period, male children had a

greater hospitalization rate than female children, as indicated by this distribution.

3. Disease Based Distribution of the Study Participants

Table 3: Disease Based Distribution of the Study Participants

Sr. No.	Diagnosis of Disease	Number of Patients (n=170)	Percentage (%)
1.	Pneumonia	19	11.20
2.	Urinary Tract Infection (UTI)	8	4.70
3.	Hepatitis	8	4.70
4.	Bronchopneumonia	6	3.53
5.	Acute Gastroenteritis	6	3.53
6.	Acute Febrile Illness	6	3.53
7.	Acute Hepatitis	5	2.94
8.	Allergy	4	2.35
9.	Bronchitis	4	2.35
10.	Coeliac Disease	4	2.35
11.	Worm Infection	4	2.35
12.	Surgical Anorectoplasty	4	2.35
13.	Bronchiolitis	5	2.94
14.	Other	87	51.18

Pneumonia was the greatest predominant diagnosis, found in 19 (11.20%) persons, according to the distribution of illnesses in the study population. Hepatitis and urinary tract infections were identified in 8 individuals (4.70%) each. Acute fever, acute gastroenteritis, and bronchopneumonia were found in 6 (3.53%) of the patients. There were 5 instances (2.94%) with both bronchiolitis and acute hepatitis. 4 (2.35%) patients each had additional problems such as pneumonia, celiac disease, worm infection,

allergies, and surgical anorectoplasty. A significant percentage of patients, 87 (51.18%), were classified under different diagnoses, indicating the variety of clinical disorders amongst children who were admitted to the hospital.

4. Distribution of Antibiotics Prescribed According to Class of Drug, Route of Administration (ROA), and Frequency

Table 4: Distribution of Antibiotics Prescribed According to Class of Drug, Route of Administration (ROA), and Frequency

Code	Antibiotic Classification	Generic Drug Name	Parenteral (n)	Oral (n)	Total (n)	Percentage (%)
1	Cephalosporin	Cefixime	0	7	7	2.65
		Cefuroxime	13	7	20	7.58
		Ceftriaxone	75	0	75	28.40
		Cefotaxime	23	0	23	8.71
		Ceftazidime	4	0	4	1.51
2	Macrolide	Azithromycin	19	5	24	9.10
		Clarithromycin	7	3	10	3.79
3	Carbapenem	Meropenem	2	0	2	0.76
4	Anthelmintic	Albendazole	0	4	4	1.51
5	Aminoglycoside	Amikacin	28	0	28	10.61
		Gentamicin	1	0	1	0.38
		Tobramycin	2	0	2	0.76
6	Fluoroquinolone	Ofloxacin	11	0	11	4.17
		Ciprofloxacin	3	0	3	1.14
7	Penicillin + β -lactamase inhibitor	Amoxicillin + Clavulanic acid	14	6	20	7.57
		Piperacillin + Tazobactam	17	0	17	6.44
8	Nitroimidazole	Metronidazole	2	0	2	0.76
9	Glycopeptide	Vancomycin	9	0	9	3.40
10	Sulphonamide	Cotrimoxazole	2	0	2	0.76

Investigation of antibiotic prescription trends revealed that cephalosporins were the most often prescribed type of antibiotics. Ceftriaxone was the most regularly prescribed drug amongst them, accounting for 75 (28.40%) prescriptions. Next were cefuroxime 20 (7.58%) and cefotaxime 23 (8.71%). Azithromycin was the most often prescribed macrolide, with 24 (9.10%) prescriptions. Amikacin was the maximum prescribed aminoglycoside,

making up 28 (10.61%) of the total. 20 (7.57%) and 17 (6.44%) of the patients received combination therapy with amoxicillin–clavulanic acid and piperacillin–tazobactam, respectively. Many antibiotics were administered parenterally, indicating that injectable medicine is preferred by hospitalized pediatric patients.

5. Drug utilization data of Antibiotics

Table 5: Drug utilization data of Antibiotics

Sr. No.	Drug Name	Average Dose	Days	Frequency	ATC Code	ATC Classification	DDD (g)
1	Cefuroxime	0.5	10	2	J01DC02	J01DD	0.5
2	Azithromycin	1	6	1	J01FA10	J01FA	0.5
3	Meropenem	2	7	2	J01BA01	J01DH	12
4	Albendazole	0.8	8	2	P02CA03	P02CA	0.64
5	Ceftriaxone	2	7	1	J01DD04	J01DD	4
6	Amikacin	0.25	10	1	J01GB06	J01G	0.25
7	Cefotaxime	2	7	2	J01DD01	J01DD	2
8	Amoxicillin + Clavulanic acid	0.25	7	3	J01CR02	J01CR	1.125
9	Piperacillin + Tazobactam	1.5	7	3	J01CR05	J01CR	2.25
10	Ofloxacin	0.2	10	1	J01MA01	J01MA	0.08
11	Ceftazidime	1.5	7	4	J01DD02	J01DD	4
12	Metronidazole	0.25	7	1	J01XD01	J01AB	0.375
13	Clarithromycin	0.25	10	2	J01FA09	J01FA	0.25
14	Vancomycin	0.25	10	2	J01DD08	J01X	2
15	Cefixime	0.1	10	2	J01DD08	J01DD	0.08
16	Gentamicin	0.04	8	3	D06AX07	J01G	0.028
17	Ciprofloxacin	0.5	10	2	J01MA02	J01MA	0.5
18	Co-trimoxazole	0.5	10	2	J01EE01	J01EE	4

Drug utilization study using the ATC/DDD classification exposed that most of the prescribed antibiotics were in the J01 category. Cephalosporins were often used, including cefuroxime (DDD: 0.5 g), ceftriaxone (DDD: 4 g), cefotaxime (DDD: 2 g), and ceftazidime (DDD: 4 g). Macrolides such as azithromycin (DDD: 0.5 g) and clarithromycin (DDD: 0.25 g) were also often prescribed. Meropenem's maximum DDD value (12 g) suggested its use

in severe infections. Ceftazidime was the most often prescribed drug, and it was taken one to four times daily for six to ten days. Meropenem, ceftriaxone, ceftazidime, and co-trimoxazole had greater DDD values than gentamicin and ofloxacin.

6. World Health Organization (WHO) Prescribing Indicators

Table 6: World Health Organization (WHO) Prescribing Indicators

Sr. No.	Details of prescription	Number (n/%)
1.	Total no. of drugs prescribed	640
2.	Total no. of Antibiotic drugs prescribed	264 (41.25%)
3.	Average number of antibiotics prescribed per prescription	1.55
4.	Number of antibiotics prescribed by Generic name	230 (87.13%)
5.	Number of antibiotics prescribed by Brand name	34 (12.87%)
6.	Number of antibiotics prescribed by Parenteral route	232 (88.88%)
7.	Number of antibiotics prescribed by Oral route	32 (12.12%)

A total of 640 medications were prescribed throughout the research period, of which 264 (41.25%) were antibiotics, according to evaluation based on WHO prescribing parameters. There were 1.55 antibiotics on average per prescription. Around 34 (12.87%) brand-name antibiotic prescriptions and 230 (87.13%) generic antibiotic prescriptions. While 232 (88.88%) prescriptions were written utilizing the parenteral route, only 32 (12.12%) antibiotics were administered orally. These results point to a preference for injectable formulations and comparatively high adherence to generic prescription guidelines.

Discussion

The current study used the ATC/DDD methodology and WHO prescription indicators to assess the pattern and appropriateness of antibiotic use among pediatric inpatients

in a tertiary care hospital. The outcomes suggestion a thorough understanding of existing prescription patterns and how they affect the prudent use of antibiotics. Many of the patients in the current research were amongst the ages of one month and five years, which indicates that early years of life are more prone to infections, Similar age distribution patterns have been reported by Mathew *et al.* [1] and Bandela *et al.* [3], where under-five children established the largest number of pediatric admissions. Comparable trends have also been documented in studies from Ethiopia and Nepal by Girma *et al.* [2] and Palikhe [5]. This increased susceptibility may be attributed to immature immune systems, incomplete vaccination coverage, and increased exposure to environmental pathogens. The current investigation revealed a preponderance of male patients. This finding is consistent with reports by Cole *et al.* [7] and

Baidya *et al.* [9], who also observed greater incidence of hospitalization among children who are male. Similar gender disparities have been documented by Wakjira *et al.* [4] and Fahimzad *et al.* [8]. This tendency may be influenced by biological predisposition, sociocultural influences, and diverse healthcare-seeking behaviors. The most frequent reasons for hospitalization and antibiotic treatment in the current investigation were respiratory tract infections, especially pneumonia. This observation agrees with findings reported by Feleke *et al.* [11], Girma *et al.* [2], and Achalu and Mensa [11]. Mathew *et al.* [1] and Bandela *et al.* [3] also reported respiratory infections as the leading cause of antibiotic prescription in pediatric patients. These results demonstrate that respiratory infections are an important cause of morbidity among children and the use of antibiotics.

Cephalosporins were the most used antibiotics, and ceftriaxone was the most used single drug, according to prescription trends, similar prescribing trends have been reported by Mathew *et al.* [1], Palikhe [5], and Fahimzad *et al.* [8]. 3rd generation cephalosporins are frequently used due to easy dosing, favorable pharmacokinetics, and broad-spectrum activity. Nevertheless, Girma *et al.* [2] and Achalu and Mensa *et al.* [10] have notified that unnecessary dependence on broad-spectrum antibiotics may lead to development of resistance.

In the present investigation, aminoglycosides like amikacin, and macrolides like azithromycin were commonly used. Comparable utilization patterns have been documented by Satari *et al.* [6], Bandela *et al.* [3], and Baidya *et al.* [9]. The management of mild to severe infections is replicated in the usage of β -lactam/ β -lactamase inhibitor combinations, such as piperacillin–tazobactam and amoxicillin–clavulanic acid, as reported by Girma *et al.* [2] and Wakjira *et al.* [4].

A higher percentage of parenteral antibiotic use was observed in the current investigation. Similar findings have been reported by Girma *et al.* [2] and Cole *et al.* [7]. Injectable therapy is often preferred for children in hospitals so that the therapeutic response is rapid. However, Baidya *et al.* [9] and Feleke *et al.* [11] have suggested the administration of oral therapy at an early stage so that complications, hospitalization, and costs are minimized.

Most given antibiotics fell into the J01 category, according to a drug usage analysis utilizing the ATC/DDD system, which is consistent with reports by Fahimzad *et al.* [8] and Girma *et al.* [2]. Meropenem's usage in severe and complex infections was indicated by its highest DDD value. Similar patterns of carbapenem utilization have been reported by Wakjira *et al.* [4] and Fahimzad *et al.* [8]. The frequent clinical use of ceftriaxone, ceftazidime, and co-trimoxazole is further indicated by elevated DDD values.

The typical length of antibiotic treatment was between 6 to 10 days, which is comparable to findings reported by Mathew *et al.* [1] and Baidya *et al.* [9]. A lot of antibiotics were administered one to three times per day, demonstrating a respectable level of adherence to recommended dosage regimens. Similar observations were reported by Bandela *et al.* [3] and Feleke *et al.* [11].

A substantial percentage of generic prescriptions was found afterward assessment operating WHO prescribing metrics, consistent with findings by Girma *et al.* [2] and Wakjira *et al.* [4]. The affordability and accessibility of the drug are further promoted by generic prescription, particularly in a resource-constrained environment. However, the high percentage of

antibiotic prescriptions indicates a high level of antimicrobial exposure.

The extensive use of injectable and broad-spectrum antibiotics indicates the need for antimicrobial stewardship programs despite the generally good use of antibiotics. The same issues have been emphasized by Palikhe [5], Fahimzad *et al.* [8], and Achalu and Mensa [11]. The optimization of antibiotic use and the control of antimicrobial resistance can be achieved by implementing institutional norms, regularly auditing antibiotic prescriptions, educating physicians, and implementing stewardship programs.

Conclusion

This study aims to provide a comprehensive evaluation of the prescription of antibiotics in pediatric inpatients of a tertiary hospital. The types of antibiotics commonly prescribed in this study were cephalosporins, particularly ceftriaxone, and the most common reason for antibiotic prescription was respiratory tract infections. The study concluded that many antibiotic prescriptions were following recommended durations of treatment and normal dosing regimens.

This study also found satisfactory compliance with WHO antibiotic prescription guidelines, as well as satisfactory use of generic prescriptions. The extensive use of parenteral and broad-spectrum antibiotics, however, underlined the importance of monitoring antibiotic use and optimizing its use. Optimization of antibiotic use can be achieved by strengthening antimicrobial stewardship programs, developing evidence-based treatment guidelines, and encouraging frequent audits of antibiotic prescriptions.

Periodic medication use evaluations in pediatric settings are considered important to prevent drug resistance, improve efficacy, and ensure that healthcare is delivered in a cost-effective manner. The findings of this study can be useful in future studies in formulating policies that promote rational antibiotic use in pediatric populations.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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