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A PRESCRIBING PATTERN OF ANTIBIOTICS IN PEDIATRIC POPULATION OF A TERTIARY CARE TEACHING HOSPITAL- A PROSPECTIVE, OBSERVATIONAL STUDY

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ABSTRACT:

Background: Antibiotics are indispensable in pediatric healthcare, especially considering children's heightened vulnerability to bacterial infections, which can pose life-threatening risks. The judicious use of antibiotics is paramount to combatting infections effectively while mitigating the emergence of resistance.

Methodology: A prospective observational study, conducted at Parul Sevashram Hospital in Vadodara, Gujarat, focused on assessing the prescribing patterns of antibiotics in pediatric patients. Over ten months, 155 patients aged between 1 month to less than 17 years were included, with data collected on demographic details, clinical diagnoses, and antibiotic prescriptions. The analysis of prescription patterns was benchmarked against the World Health Organization's core indicators, revealing significant insights.

Results: The study highlighted a predominance of male participants (65.16%) and a notable highest age group of children aged 2 to 11 years. The most commonly prescribed antibiotic was Amoxycillin & Potassium Clavulanate (26.07%) and the most prevalent infection type was digestive system infections (26.35%). The average number of medications per prescription was high at 10.87. Furthermore, the study identified a concerning trend of parenteral antibiotic administration exceeding recommended levels. Despite the majority of antibiotics being prescribed (100%) from the National List of Essential Medicines, the adherence to 65.16% prescribing generic medications fell short of the WHO's recommended threshold. The prevalence of pathogenic organisms E. Coli (38.10%), emphasised the necessity for targeted treatment strategies.

Conclusion: The pattern of antibiotic prescriptions was inconsistent as a result of polypharmacy, high parenteral use and non-adherence to the generic drug. Prophylactic antibiotic use, particularly in the reproductive system, raised concerns regarding potential overuse and misuse. Continued education and awareness initiatives among healthcare providers are essential to combat antibiotic resistance effectively and align prescribing practices with global guidelines.

KEYWORDS: Antibiotics, pediatric, Antibiotic resistance, Prescribing Pattern, WHO core indicator, Infection

INTRODUCTION:

Antibiotics are a class of medications used to combat bacterial infections in the body. Antibiotics play a crucial role in promoting positive health outcomes and reducing the risk of complications that may arise from bacterial infections. Antibiotics are a cornerstone in modern pediatric care, playing a critical role in combating bacterial infections that can be life-threatening to children. Due to their developing immune systems, children are more susceptible to infections; hence, the use of antibiotics can be a lifesaver. However, antibiotics must be prescribed judiciously to prevent resistance. Adequate understanding and monitoring of antibiotic prescribing patterns are essential to ensure these medications are used appropriately, maximizing benefits while minimizing harm[1,2]. It is estimated that the consumption of antibiotics in humans has increased by 65% between 2000 and 2015. By 2030, antibiotic consumption is estimated to increase worldwide by 200% if nothing changes[3]. Using antibiotics inappropriately and overusing them can result in antibiotic resistance, making once easily treatable infections more difficult to manage[4]. When bacteria become resistant to antibiotics, infections become more difficult to treat and can lead to prolonged illness, increased healthcare expenses, and even death. It is estimated that antibiotic-resistant infections cause at least 700,000 deaths worldwide each year, with projections indicating that this number could rise to 10 million by 2050 if no action is taken[5]. One of the significant factors influencing the prescribing trends of antibiotics in the pediatric population is the physician's knowledge and attitudes. These include clinical factors, such as the severity of the infection, the type of pathogen, and the presence of comorbidities. Physicians who have a better understanding of the risks associated with antibiotic overuse are more likely to prescribe antibiotics only when necessary. Physicians who have a better understanding of the risks associated with antibiotic overuse are more likely to prescribe antibiotics only when necessary[6].

In today's healthcare landscape, the appropriate and effective use of medications is vital to promoting patient safety and well-being. The World Health Organization (WHO) has developed a set of core prescribing indicators to help healthcare professionals evaluate prescribing patterns and identify areas for improvement.

The World Health Organization's (WHO) core prescription indicators are a widely utilized gauge for measuring and assessing the rational use of prescribed drugs in healthcare settings[4,7,8]. They assist in identifying opportunities for rise in the field of healthcare, such as multiple medications incorrect antibiotic usage, overuse of injecting medication, inability to prescribe by expert guidance standards, and improper self-medication.

This analysis will improve prescription standards, identify issues with patient understanding of consultation guidelines, and reduce cost burden. This indicator helps in evaluating the adherence to essential medicines guidelines and promoting cost-effective prescribing practices[8].

The field of pediatric medicine is continuously evolving, and ongoing research is focused on developing new antibiotics and improving their effectiveness and safety in children. Researchers are working to identify new targets for antibiotics, investigate alternative treatment strategies, and

develop vaccines to prevent bacterial infections in the first place[9].

MATERIAL AND METHODS

Study setting and design

The study was a prospective observational study carried out at Parul Sevashram Hospital in Vadodara, Gujarat. Over a period of 10 months and 155 patients were included aged between 1 month to less than 17 years as per the USFDA guidelines, who were receiving one or more antibiotics.

Ethical Approval

The study commenced after receiving ethical approval from the Institutional Ethics Committee of Parul University (Reference: PUIECHR/PIMSR/00/081734/6413). Before subjects participated in the study, consent forms were obtained in both Gujarati and Hindi.

Data Collection

The collected data for assessing prescription patterns included demographic information, clinical diagnoses, and antibiotic prescriptions. This data was compared against the WHO core prescribing indicators.

Statistical Analysis

The collected data were evaluated by using various statistical analysis methods, including mean, standard deviation, Paired T-Test, Chi-square Method and One Way ANOVA. The analysis was performed using statistical software such as MS Excel and GraphPad Prism, and the results will be presented in percentages, tables, and graphs.

RESULTS

A total of 155 subjects participants were recruited in the study, out of which 101 were male (65.16%) and 54 were female (34.84%).

The patient population is divided into age categories according to US FDA guidelines. Children aged 2 to 11 years were the highest in number, accounting for 60.65% of all subjects with a mean age of 5.53±2.78. Followed by the patients between the ages of 28 days to 1 year accounted for 27.10%. A lesser fraction of patients, 12.26%, were aged 12 to 16 years.

Among the 155 patients studied, the highest medical involvement was in the digestive system, affecting 26.35% of patients, while the lowest was in the respiratory and reproductive systems, at 18.56% and 15.57% respectively.

The majority, 49.68%, had conditions not classified as bacterial or viral infections. Bacterial infections were present in 30.32%, and viral infections in 20.00%.

From 21 culture sensitivity tests, E. Coli was the most prevalent organism at 38.10%, and the least prevalent were Staphylococcus Haemoluticus and Stenotrophomonas matophilia, each at 4.76%. These results underscore the importance of targeted strategies, especially against E. Coli (TABLE 1).

Table 1: Distribution according to different systems, type of infection and pathogenic organism

Distribution of different systems affected in pediatrics		
System Involved	**No. of patients**	**Percentage**
Skeletal system	2	1.20%
Nervous System	15	8.98%
Digestive System	44	26.35%
Respiratory system	31	18.56%
Reproductive system	26	15.57%
Urinary System	22	13.17%

Circulatory system	14	8.38%
Lymphatic system	4	2.40%
Immune System	4	2.40%
Integumentary System	3	1.80%
Endocrine System	2	1.20%
Total	167	100.00%
Distribution of patients according to type of infection		
Type of Infection	**No. of Patient**	**Percentage**
Bacterial	47	30.32%
Viral	31	20.00%
Not Applicable	77	49.68%
Total	155	100.00%
Distribution of identify the infections by pathogenic organisms in Pediatric population		
Organisms	**No. of patients**	**Percentage**
Staphylococcus Haemoluticus	1	4.76%
Burkholderia Cepacia	2	9.52%
Enterococcus Faecium	2	9.52%
E. Coli	8	38.10%
Pseudomonas Aerusinosa	3	14.29%
Salmonella ser. Typhi	4	19.05%
Stenotrophomonas matophilia	1	4.76%
Total	21	100.00%

A total of 1685 drugs were prescribed with the average number of medications per prescription was 10.87. A total of 25.04% of antibiotics were prescribed, with an average of 2.72 antibiotics per prescription.

The prevalence of parenteral treatment was high, as 60.42% of antibiotics were administered by intravenous, which is higher than the WHO recommended rang of 13.4 to 24.1%. In our study, only 65.16 % of antibiotics were prescribed by generic name, which is below the WHO's recommended value of 100%.

Additionally, all antibiotics were prescribed from the National List of essential Medicines (NLEM), showing adherence to the recommended practice of using only essential pharmaceuticals in prescriptions (TABLE 2).

Table 2: WHO core prescribing indicators to evaluate the prescribed antibiotics

Parameter	Total number of drugs prescribed per prescription	Percentage	Standard value (%)
Average number of drugs per prescription	1685	10.87%	< 2
Percentage of antibiotics prescribed	422	25.04%	20-26.8
Percentage of antibiotics with an injectable	255	60.42%	13.4-24.1
Percentage of antibiotics with generic name	275	65.16%	100
Percentage of antibiotics prescribed from NLEM	422	100%	100

A total of 422 antibiotics were prescribed, Amoxicillin and Potassium Clavulanate had the highest prescription rate at 26.07%, while Azithromycin had the lowest at 3.32%.

Therapeutic use dominated at 69.43%, compared to prophylactic use at 30.57%. Intravenous administration was the most common at 60.43%, and topical application was the least at 9.72%.

The data also indicated a higher prevalence of patients prescribed more than three antibiotics, suggesting complex or multi-drug resistant infections (TABLE 3).

Table 3: Patterns of Antibiotic Prescription in Pediatric Patient Management

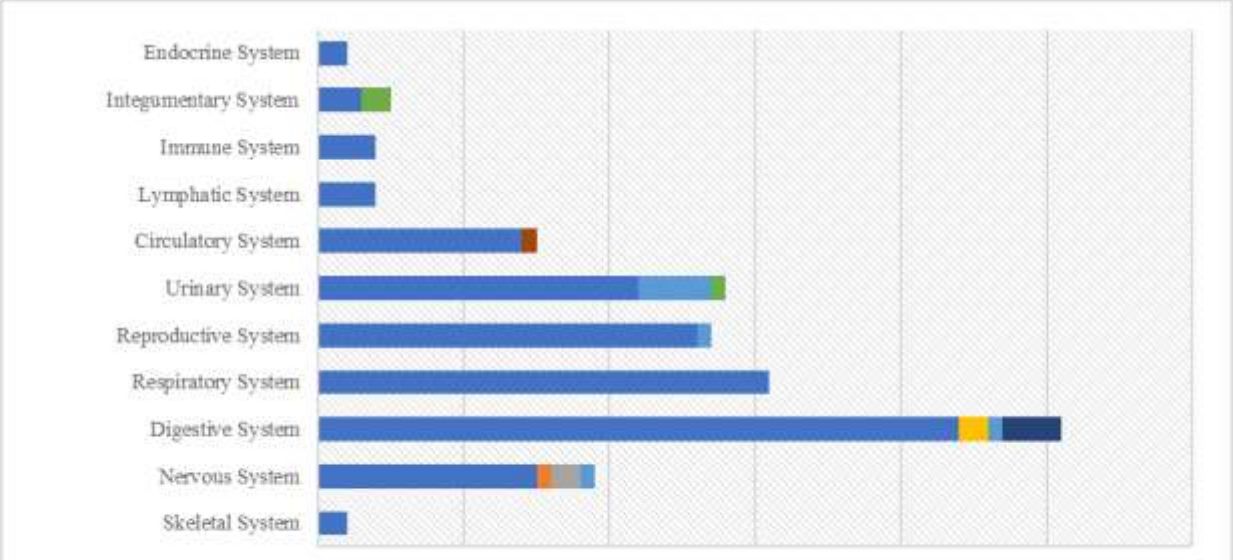
Distribution according to number of antibiotics prescribed		
Prescribed Antibiotics	**No. of Antibiotics**	**Percentage**
Ceftriaxone	71	16.82%
Amikacin	60	14.22%
Vancomycin	9	2.13%
Meropenem	15	3.55%
Azithromycin	14	3.32%
Amoxycillin & Potassium Clavulanate	110	26.07%
Linezolid	7	1.66%
Cefixime	34	8.06%
Metronidazole	23	5.45%
Neosporin Ointment	40	9.48%
Cefalexin	3	0.71%
Cefotaxime	15	3.55%
Piperacillin & Tazobactam	2	0.47%
Ceftazidime	2	0.47%
Faropenem	2	0.47%
Nitrofuratoin	2	0.47%
Moxifloxacin	2	0.47%
Rifaximin	1	0.24%
Cefoparazone + Sulbactam	3	0.71%
Cefuroxime	2	0.47%
Cefoparazone	1	0.24%
Levofloxacin	2	0.47%
Fluconazole	2	0.47%
Total	422	100.00%
Distribution of antibiotics according to indication		
Indication of Antibiotics	**No. of Antibiotics**	**Percentage**
Infection	293	69.43%
Prophylaxis	129	30.57%
Total	422	100.00%
Distribution of antibiotics prescribed according to route of administration		
Route of Administration	**No. of Antibiotics**	**Percentage**
Intravenous	255	60.43%
Oral	126	29.86%
Topical	41	9.72%
Total	422	100.00%
Number of antibiotics prescribed per study population		
No. of Antibiotics	**No. of patients**	**Percentage**
One Antibiotics	39	25.16%
Two Antibiotics	36	23.23%
Three Antibiotics	34	21.94%
More than Three Antibiotics	46	29.68%
Total	155	100.00%

Comparative analysis among different organisms, the Digestive System stands out as the most affected, with the highest patient count (44) and the most organisms (7), suggesting that infections or

disorders occur more frequently in this system (FIGURE 1).

E. Coli has the highest number of patients and is associated with the use of 19 antibiotics, indicating a broad range of treatment options. Interestingly, Burkholderia Cepacia is associated with 13 antibiotics, even though there are only two patients, suggesting potential antibiotic resistance or complex treatment regimens, with p-values of 0.0058 and 0.0053, respectively (FIGURE 2).

Notably, the Reproductive System shows a higher prophylaxis rate than infection treatment, potentially indicating misuse of antibiotics, A statistically significant difference is indicated by a p-value of less than 0.0001 (FIGURE 3).



	Skeletal System	Nervous System	Digestive System	Respiratory System	Reproductive System	Urinary System	Circulatory System	Lymphatic System	Immune System	Integumentary System	Endocrine System
No. of patient	2	15	44	31	26	22	14	4	4	3	2
Staphylococcus Haemoluticus	0	1	0	0	0	0	0	0	0	0	0
Burkholderia Cepacia	0	2	0	0	0	0	0	0	0	0	0
Enterococcus Faecium	0	0	2	0	0	0	0	0	0	0	0
E. Coli	0	1	1	0	1	5	0	0	0	0	0
Pseudomonas Aerusinosa	0	0	0	0	0	1	0	0	0	2	0
Salmonella ser. Typhi	0	0	4	0	0	0	0	0	0	0	0
Stenotrophomonas matophilia	0	0	0	0	0	0	1	0	0	0	0

Figure 1: Comparison of system affected Vs number of patient affected by different organisms

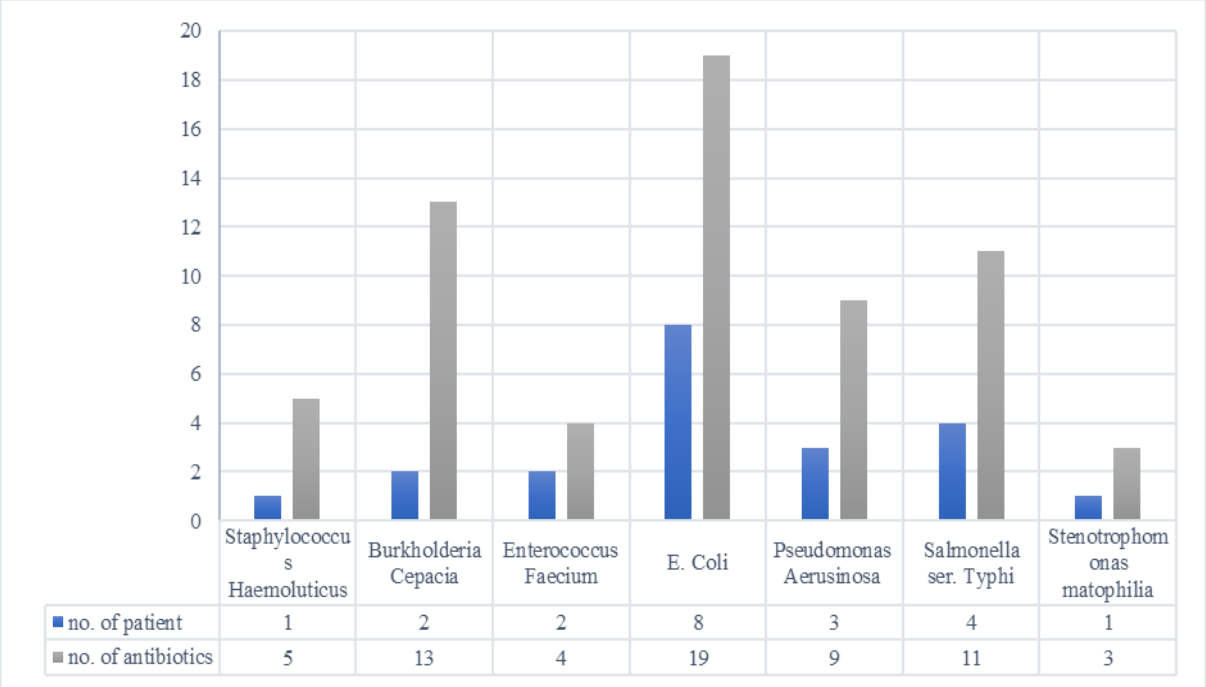


Figure 2: Prescription of antibiotics in comparison with number of patient affected by different organism

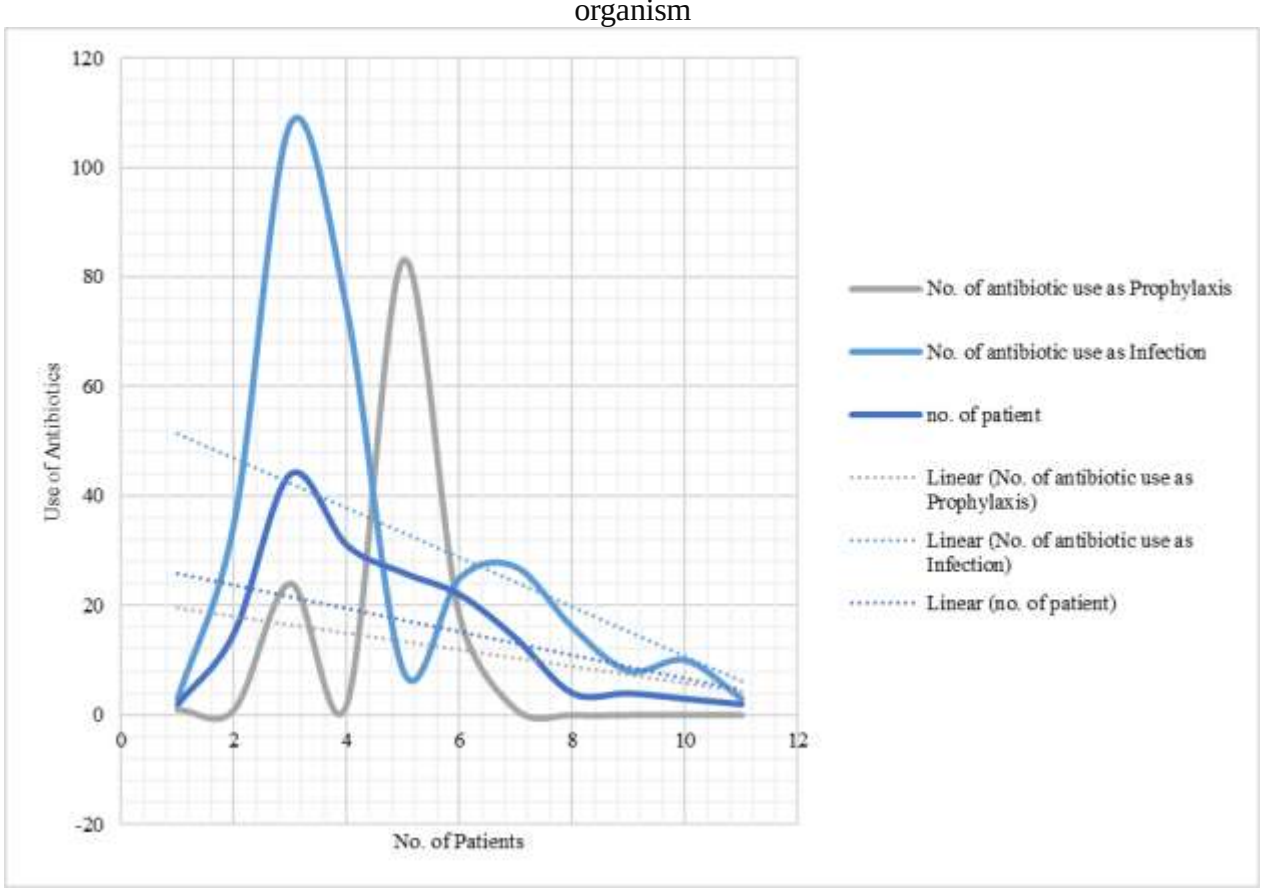


Figure 3: Comparison of system affected Vs used of antibiotics for the prescribed drugs.

Comparative analysis of different body systems, the Digestive System is the most affected, with the highest patient count
(44) and the most antibiotics administered (132). Intravenous antibiotics were predominantly used in this system (82). In contrast, the Endocrine System is less affected, with only 2 patients and 3 antibiotics prescribed. The data revealed significant differences in antibiotic prescription rates and

administration routes across systems, with p-values of 0.0144 and 0.0012, respectively. Additionally, the Respiratory system has the highest incidence of both bacterial (15) and viral (16) infections, likely due to direct exposure to airborne pathogens. In contrast, the Skeletal and Endocrine systems had the least infections, possibly due to less direct interaction with external infectious agents.

DISCUSSION:

The prescribing patterns for antibiotics, an area of pediatric medicine that cares for the health of newborns, children, and adolescents, show a general reliance on these drugs to treat a wide range of infections, from the common strep throat to potentially life-threatening illnesses like meningitis[10,11]. A growing concern about the development of antibiotic resistance, which can result in more complex and expensive medical challenges, highlights the need for judicious use of these drugs[5].

This study aimed to assess prescribing patterns using WHO core prescribing indicators and the economic evaluation of antibiotics in the pediatric population in tertiary care hospital. This discussion is based on the data obtained from 155 patients in the study, which were included in the study for data analysis.

In our study, we observed a predominant male representation (65.16%) within the 155 pediatric participants, with the majority falling into the 2 to 11 years age group (60.65%), followed by infants aged 28 days to 1 year (27.10%), and adolescents 12 to 16 years (12.26%), as categorized by the US FDA. A similar study conducted by Raju et al. (2022)[11] Assessed that male is more than females and the Children's age group (1 year -11 years) is more seen (43.84%). In our study of 155 patients, the digestive system was most affected (26.35%), followed by the respiratory (18.56%) and reproductive systems (15.57%), with Amoxicillin and Potassium Clavulanate being the most prescribed antibiotics (26.07%); Similar Study is conducted by Jangra et al. (2019)[12] which show that that the amoxicillin Clavulanate (27.21%) Followed by other antibiotics are prescribed. notably, E. Coli emerged as the predominant organism (38.10%), underscoring the imperative for targeted antibiotic stewardship and prevention measures. Several factors contribute to the prevalence of E. Coli in pediatrics as a cause of urinary tract infections (UTIs). Because it is a common pathogen found in the gastrointestinal tract and contaminates the periurethral area, E. Coli is most commonly isolated from pediatric UTIs[13]. Similarly, found out in this study R.K.C. Bharath et al. (2020)[14] and Biradar et al. (2019)[15] show that E. coli was the most isolated organism followed by others such as Staphylococcus aureus and Klebsiella.

Our study's analysis of 155 pediatric patients revealed that a significant portion (49.68%) did not fall into the bacterial or viral infection categories, while bacterial (30.32%) and viral (20.00%) infections were also prevalent; the majority of antibiotics (60.43%) were administered intravenously, reflecting their critical role in severe cases. Similar results were obtained by Biradar et al. (2019)[15]. The study also revealed a substantial number of patients (46) receiving more than three antibiotics, hinting at the complexity of cases encountered, including those with multi-drug resistant infection and the frequent prescription of Amoxicillin and Potassium Clavulanate 68 (TID) and Ceftriaxone 66 (BD) suggests a strategic approach to dosing based on the nature of infections and antibiotic pharmacokinetics. Contrast results were obtained by Biradar et al. (2019)[15] found that amikacin 48 (BD) and Metronidazole 30 (TDS) are frequently prescribed. In our study involving 422 antibiotic prescriptions, 69.43% were utilized for treating active infections, highlighting a predominant therapeutic approach over prophylactic use, which accounted for 30.57%, indicating a strategic prioritization of immediate treatment over prevention in pediatric care.

The core prescription indicators established by the World Health Organization (WHO) serve as a commonly used gauge for evaluating the judicious prescription of medications within healthcare

environments[7,8]. Following the WHO Core prescribing indicator, it is essential to keep the average number of medications per patient encounter below 2. This practice helps minimize the risks associated with polypharmacy, such as increased drug interactions, higher costs, reduced patient compliance, and the emergence of drug resistance. In our study, the average number of medications per prescription was 10.87 indicating a presence of polypharmacy. In polypharmacy, more drugs are prescribed than are clinically necessary or indicated by medical professionals. Compared to our research, the studies by Raju et al. (2022)[11] and Mathew et al. (2021)[4] reported average medication counts per prescription of 4.53 and 6.12, respectively. In our study, 25.04% of antibiotics were prescribed, and the average number of antibiotics per prescription was 2.72. This aligns with the recommended balance between effective treatment and minimizing unnecessary antibiotic use to prevent adverse effects and resistance development. In the study, parenteral antibiotic treatment was widely used, with 60.42% of antibiotics administered by injection, ranging from 13.4 to 24.1%. Overuse of injectables can lead to the development of complications, blood-borne diseases, and increased costs. However, several reasons behind the increased prescription of injectables in pediatrics, such as limited oral formulations, poor compliance with oral therapy, and emergent action in severe conditions[4]. Compared to our research, the studies by Raju et al. (2022)[11] found a higher rate of injectable antibiotics (91.01%). In our study, only 65.16 % of antibiotics were prescribed by generic name, which is below the WHO's recommended value of 100%. The practice of prescribing generic medications is effective not only in streamlining the process, but also in helping to reduce the probability of errors in dispensing, improving collaboration and openness between healthcare providers and patients, and generally being less costly than branded medications. A complete list of antibiotics (100%) was obtained from the National List of Essential Medicines (NLEM), which demonstrated compliance with the guideline not to prescribe anything other than essential drugs. Its proven clinical efficacy and cost-effectiveness make the WHO recommend utilizing the Essential Drugs List (EDL) for rational antibiotic prescribing[4,11].

CONCLUSION

In this study, we analyse the use of antibiotics in pediatric patients based on their age, gender, body system, and type of antibiotic prescribed, focusing primarily on WHO core indicators and pharmacoeconomic factors. A majority of the participants in the study were males, and the largest age group was children aged 2 to 11. A significant number of patients had conditions related to the digestive, respiratory, and reproductive systems. Amoxicillin and Potassium Clavulanate were the most commonly prescribed antibiotics.

E. Coli was found to be the most prevalent pathogenic organism. The study highlight the average number of drugs per prescription was high indicating a polypharmacy and the prevalence of parenteral antibiotic treatment. As a result, the hospital uses generic names, but does not meet the WHO's recommended range of antibiotics, and all antibiotics fulfil with essential medicine guidelines. It is advised that healthcare providers use prophylactic antibiotics with caution, especially in the reproductive system, where they have been used more frequently than actual infections. This raises concerns about potential overuse and misuse. Analyse the need for prophylactic antibiotics on a case-by-case basis to prevent unnecessary use, which can lead to the development of antibiotic resistance. The findings highlighted the need for antimicrobial stewardship measures, infection prevention measures, and health policies that promote the use of cost-effective medications to ensure equitable access and sustainable pediatric care. It is advised to persistently educate and raise awareness among healthcare providers regarding antibiotic resistance and to prescribe rationally, adhering to WHO guidelines.

CONFLICT OF INTEREST:

The authors have no conflicts of interest regarding this investigation**.**

AUTHOR CONTRIBUTIONS:

All authors contributed to proposal development, write-up, data collection, data analysis, manuscript writing, editing and endorsed the final version of the manuscript.

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