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Patterns of Broad-Spectrum Antibiotic Use in Paediatric Inpatients and Stewardship Opportunities

Akila E[1], Sesathri[2], Kavitha[3], Uppalapadu Sudarsana[4]

[1]Assistant Professor, Department of Pharmacology, Government Medical College, Thiruvallur
[2]Professor, Bhaarath Medical College and Hospital, Chennai
[3]HOD & Professor, Sri Ramachandra Medical College & Research Institute, Chennai
[4]Assistant Professor, Department of Physiology, Rajalakshmi Medical College and Hospital, Chennai

Corresponding Author: Dr. Uppalapadu Sudarsana

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ABSTRACT

Background: Infectious diseases are a major cause of paediatric morbidity and mortality, and hospitalised children are frequently exposed to antimicrobials. Understanding local prescribing patterns is essential to guide antimicrobial stewardship and curb emerging resistance.
Objectives: To describe the pattern of antimicrobial utilisation among paediatric inpatients aged 1–12 years, including demographic and clinical profile, spectrum of diagnoses, classes and routes of antimicrobials used, and the extent of microbiological testing supporting therapy.
Methods: This descriptive observational study was conducted using case records of paediatric inpatients aged 1–12 years who received at least one systemic antimicrobial during their hospital stay. A total of 213 case sheets were screened; 23 were excluded, and 190 were included. Data on demographics, diagnoses, antimicrobial agents (class, number, route and duration), microbiological investigations and length of stay were extracted using a structured proforma and analysed descriptively.
Results: The mean age of the children was 5.9 ± 3.1 years; 55.8% were male. The most frequent diagnoses were enteric fever (15.8%), bronchitis (15.8%), acute gastroenteritis (15.3%) and pneumonia (12.6%), with infectious diseases comprising the majority of admissions. All 190 children received antimicrobials, accounting for 300 prescriptions (mean 1.7 ± 0.8 agents per patient): 43.2% received one antimicrobial, 40.0% received two and 16.8% received three or more. Cephalosporins were the most commonly prescribed class (33.0%), followed by penicillins (18.0%), aminoglycosides (18.0%), fluoroquinolones (13.0%) and antiamoebics (12.0%). Parenteral-only therapy was used in 46.3% of patients, oral-only in 17.9% and both routes in 35.8%. Microbiological cultures were sent in 58.9% of cases, with 41.9% positivity among those tested.
Conclusion: Paediatric inpatients showed high exposure to antimicrobials with predominant use of broad-spectrum cephalosporins and frequent combination therapy. These findings highlight the need to strengthen paediatric antimicrobial stewardship, promote guideline-based prescribing and enhance culture-guided, targeted therapy.

Keywords: Antimicrobial utilization; Paediatric inpatients; Antibiotic prescribing; Drug utilisation study; Cephalosporins; Antimicrobial stewardship

INTRODUCTION

Infectious diseases remain one of the leading causes of childhood morbidity and mortality worldwide, particularly in low- and middle-income countries (LMICs). Acute respiratory infections and diarrhoeal diseases together account for a substantial proportion of deaths in children under five years of age. Despite the availability of effective, inexpensive treatments, preventable infections still contribute significantly to hospital admissions and mortality in many regions, including India. Factors such as high population density, variable access to clean water and sanitation, and wide disparities in healthcare access between urban and rural areas all play an important role in sustaining this burden. [1-6]

Antimicrobial agents have dramatically reduced the impact of many childhood infections, but their benefits are now threatened by the rapid emergence and spread of antimicrobial resistance (AMR). The World Health Organization (WHO) recognises AMR as one of the top global public health threats and warns that common infections may again become difficult or impossible to treat if current trends continue. National and international reports consistently document rising resistance among common bacterial pathogens such as Escherichia coli, Klebsiella species and Staphylococcus aureus in both adult and paediatric populations. This is of particular concern in countries like India, where the overall infectious disease burden is high and antibiotic consumption is substantial. [7,8]

Children are especially vulnerable in this context. They are more prone to infections because of immature immunity, close contact in households, schools and childcare settings, and environmental exposures, especially in resource-limited communities. At the same time, they are heavily exposed to antimicrobials in both inpatient and outpatient settings. Observational studies from paediatric wards in India and other LMICs have reported that a large proportion of hospitalised children receive at least one antibiotic, often for suspected rather than confirmed bacterial infections. In many series, beta-lactam antibiotics—particularly third-generation cephalosporins—dominate prescriptions, followed by penicillins and aminoglycosides. Reviews of paediatric prescribing patterns consistently highlight extensive use of broad-spectrum agents, frequent combination therapy and prolonged courses, all of which increase selection pressure for resistant organisms and raise the risk of adverse drug reactions. [9,10]

In response to the AMR crisis, the WHO's Global Action Plan on Antimicrobial Resistance emphasises optimising the use of antimicrobial medicines as a key strategic objective. To support this, the WHO introduced the AWaRe classification, which groups antibiotics into Access, Watch and Reserve categories based on spectrum, resistance potential and recommended use.[11,12] Access agents are intended to serve as first-line treatments for common infections; Watch agents, which include most third-generation cephalosporins and fluoroquinolones, should be used more judiciously; and Reserve agents are last-resort drugs for multi-drug resistant infections. Paediatric antimicrobial stewardship efforts increasingly use the AWaRe framework to monitor prescribing and set targets, including the recommendation that at least 60% of national antibiotic consumption should come from the Access group. [13,14]

Evidence from hospital-based studies, however, suggests that in many settings Watch antibiotics make up a substantial, sometimes predominant, share of inpatient antibiotic use, particularly in tertiary-care and intensive-care units managing complex or severely ill patients. This pattern is often mirrored in paediatric services, where broad-spectrum therapy is commonly initiated empirically in the absence of rapid diagnostic support or definitive microbiological confirmation. Contributing factors include the high baseline burden of infectious disease, concerns about missing serious bacterial infections, limited and delayed culture results, easy over-the-counter access

to antibiotics in the community and variable adherence to standard treatment guidelines. While broad-spectrum empirical therapy can be life-saving, its unnecessary or prolonged use contributes directly to AMR, increases healthcare costs and exposes children to avoidable toxicity. [15,16]

In this context, there is a clear need for local, hospital-specific data on antimicrobial utilisation in paediatric inpatients. Patterns of infection, prescribing behaviour and resistance can vary significantly between institutions and regions, even within the same country, so stewardship strategies need to be informed by local evidence rather than relying solely on national or international averages. Existing Indian and international studies provide useful insights but do not fully capture the diversity of practice in different hospitals and geographic areas. [17,18]

The present study was therefore undertaken to describe the pattern of antimicrobial utilisation among paediatric inpatients aged 1–12 years in a teaching hospital setting. By analysing case sheets of children who received at least one antimicrobial during their hospital stay, the study aims to: (i) characterise the demographic and clinical profile of these patients; (ii) describe the spectrum of diagnoses associated with antimicrobial use; (iii) quantify the utilisation of different antimicrobial classes, routes and combinations; and (iv) examine the extent of microbiological testing supporting therapy. Situating these findings within the wider literature on paediatric antibiotic prescribing can help identify areas of good practice and highlight opportunities to strengthen antimicrobial stewardship in similar settings.

MATERIALS & METHODS

Study design and setting

This hospital-based descriptive observational study was conducted in the Medical Records Department of Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Madhuranthagam. The institute is a teaching hospital that caters to both urban and rural populations in and around Madhuranthagam and functions as a referral centre for a wide range of paediatric illnesses. The study focused on analysing existing inpatient case records to assess antimicrobial utilisation patterns among paediatric inpatients. Case sheets of children admitted to the paediatric ward were retrieved from the Medical Records Department and systematically reviewed. The design was cross-sectional and descriptive, with no intervention in patient management and no change in routine clinical practice.

Study population and sample size

The study population comprised paediatric inpatients aged 1–12 years who were admitted to the paediatric ward and received at least one systemic antimicrobial agent during their hospital stay. A total of 213 consecutive paediatric case sheets were initially retrieved from the Medical Records Department for the defined study period. After applying the eligibility criteria, 23 case sheets were excluded due to either incomplete documentation or non-fulfilment of inclusion criteria. The final sample consisted of 190 paediatric inpatients. A formal sample size calculation was not performed; instead, a census of all eligible cases within the specified period was undertaken to reflect real-world prescribing practices at the institution.

Inclusion and exclusion criteria

Children were included in the study if they were between 1 and 12 years of age, admitted as inpatients under the paediatrics department, and had received at least one systemic antimicrobial agent such as an antibacterial, antiamoebic or antimalarial drug during the admission. Only case sheets with legible and complete documentation of diagnosis and treatment details were considered. Case records were excluded if the admission was purely for surgical, trauma or non-infectious elective procedures without any antimicrobial therapy, or if the child's antimicrobial regimen had been initiated exclusively at another hospital with

inadequate records of the drugs used. Case sheets with major missing data on diagnosis or drug therapy, or those pertaining to children younger than 1 year or older than 12 years, were also excluded to maintain uniformity in analysis.

Data collection procedure

Data collection was carried out retrospectively from the Medical Records Department. After obtaining approval, the case sheets of eligible paediatric inpatients were retrieved and reviewed using a predesigned data collection proforma. For each child, demographic information such as age, sex and place of residence (urban or rural) was recorded. Clinical details included the mode of admission (emergency or elective), provisional and final diagnoses as documented by the treating paediatrician, and the dates of admission and discharge. Antimicrobial therapy details were transcribed from the treatment charts and medication orders, including the name of each antimicrobial agent, its pharmacological class, dose, frequency, route of administration (oral or parenteral) and duration of use. Any changes in antimicrobial regimen during hospitalization, such as the addition of new agents, switching from parenteral to oral therapy or de-escalation of therapy, were noted when mentioned in the records. Relevant laboratory and microbiological data, including blood counts, biochemical tests and culture and sensitivity reports (blood, urine or other specimens), were extracted where available. The length of hospital stay was calculated by counting the number of days from admission to discharge. Data extraction was performed by trained investigators under faculty supervision to ensure accuracy and consistency, and completed forms were checked for completeness before entry into the database.

Variables and operational definitions

Age was recorded in completed years and subsequently classified into four groups for analysis: 1–3, 4–6, 7–9 and 10–12 years. Sex was recorded as male or female. Place of residence was categorised as urban or rural based on the address documented in the case sheet. The type of admission was classified as emergency when the child was admitted through casualty or emergency services, and elective/routine when the admission occurred via the outpatient department or planned referral. The primary clinical diagnosis at discharge was used as the main diagnostic category when more than one diagnosis was present, and included conditions such as enteric fever, bronchitis, acute gastroenteritis, pneumonia, viral fever, urinary tract infection, sepsis, cellulitis, nephrotic syndrome, appendicitis and malaria.

An antimicrobial agent was defined as any systemic antibacterial, antiamoebic or antimalarial drug administered during the hospital stay. Topical antimicrobial preparations (eye drops, ear drops, creams, ointments) were excluded from analysis. Antimicrobials were grouped into pharmacological classes: cephalosporins, penicillins, aminoglycosides, fluoroquinolones, macrolides, antiamoebics and antimalarials. For each patient, the number of different antimicrobials received during admission was counted and categorised as 1, 2 or ≥3. The route of administration was categorised as parenteral only (exclusive intravenous or intramuscular use), oral only, or both, where the child received parenteral therapy initially and was later switched to oral therapy or had mixed use during the stay. Length of hospital stay was defined as the total number of days from the date of admission to the date of discharge, inclusive.

Outcome measures

The primary outcome of interest was the pattern of antimicrobial utilisation among paediatric inpatients at Karpaga Vinayaga Institute of Medical Sciences and Research Centre. This was described by calculating the proportion of total prescriptions accounted for by each antimicrobial class, the distribution of monotherapy versus

combination therapy (two or more antimicrobials), and the pattern of routes of administration. Secondary outcomes included the distribution of clinical diagnoses among children receiving antimicrobials, descriptive associations between common diagnoses and classes of antimicrobials used, and the frequency and positivity rate of microbiological culture tests.

STATISTICAL ANALYSIS

Data from the completed proformas were entered into Microsoft Excel and analysed using standard statistical software (such as SPSS or an equivalent package). Continuous variables, including age and length of hospital stay, were summarised as mean ± standard deviation and, where appropriate, median with interquartile range. Categorical variables such as sex, age group, place of residence, type of admission, diagnostic categories, antimicrobial classes, number of antimicrobials per patient and route of administration were expressed as frequencies and percentages. The study was primarily descriptive in nature, and the main emphasis was on summarising patterns rather than testing specific hypotheses. Where exploratory comparisons were carried out—for example, comparing antimicrobial use across diagnostic groups—Chi-square test or Fisher's exact test was considered, with a p-value < 0.05 regarded as statistically significant, and these results were interpreted with caution.

Ethical considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Madhuranthagam. As the study involved retrospective review of medical records without direct contact with patients or alteration of clinical care, individual informed consent was waived by the Ethics Committee. Patient confidentiality was strictly maintained throughout the study. Case sheets were handled only within the Medical Records Department, and all extracted data were anonymised before analysis. No personal identifiers were entered into the database, and findings are presented in aggregate form so that individual patients cannot be identified.

RESULT

Study population

During the study period, a total of 213 paediatric inpatient case sheets were screened. After exclusion of 23 case sheets that did not meet the eligibility criteria, 190 case sheets were included in the final analysis. The age of the children ranged from 1 to 12 years, with a mean age of 5.9 ± 3.1 years and a median age of 5.5 years (IQR 3–8 years). Overall, 106 (55.8%) of the 190 children were males and 84 (44.2%) were females, indicating a modest male preponderance (Table 1). The largest proportion of admissions occurred in the 1–3-year age group (60 children, 31.6%), followed by 4–6 years (55, 28.9%), 7–9 years (45, 23.7%), and 10–12 years (30, 15.8%). A higher proportion of children were from rural areas (114, 60.0%) compared to urban areas (76, 40.0%), and 82 (43.2%) admissions were via the emergency department, reflecting the acute nature of presentations (Table 1). The age distribution is also depicted graphically in Figure 1.

Table 1. Demographic and background characteristics of paediatric inpatients (N = 190, approximate values)

Variable	Category	n	%
Sex	Male	106	55.8
	Female	84	44.2
Age group (years)	1–3	60	31.6
	4–6	55	28.9
	7–9	45	23.7
	10–12	30	15.8
Age (continuous)	Mean ± SD (years)	–	5.9 ± 3.1
	Median (IQR)	–	5.5 (3–8)
Place of residence	Urban	76	40.0
	Rural	114	60.0
Type of admission	Emergency	82	43.2
	Elective / routine	108	56.8

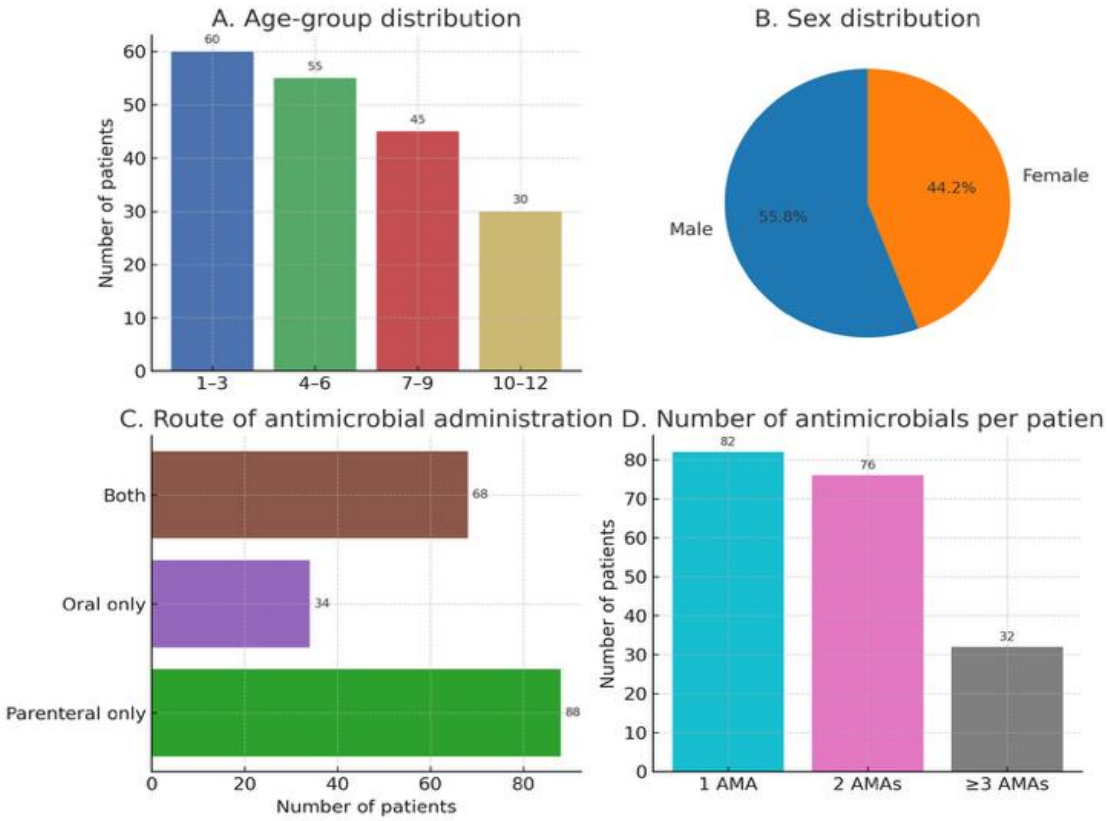

Figure 1. Multi-panel summary of demographic and treatment characteristics of paediatric inpatients (N = 190).

(A) Age-group distribution showing that children aged 1–3 years formed the largest group, followed by 4–6, 7–9 and 10–12 years.

(B) Sex distribution with a modest predominance of males over females.

(C) Route of antimicrobial administration, indicating frequent use of parenteral therapy alone or in combination with oral therapy.

(D) Number of antimicrobials per patient, demonstrating that most children received one or two agents, while a smaller proportion received three or more.

Pattern of clinical diagnoses

The spectrum of clinical diagnoses among paediatric inpatients is shown in Table 2. The most frequent diagnoses were enteric fever and bronchitis, each accounting for 30 (15.8%) cases. Acute gastroenteritis (AGE) was diagnosed in 29 (15.3%) children, while pneumonia was seen in 24 (12.6%) children. Viral fever and bronchial asthma each contributed 19 (10.0%) cases. Less frequent but clinically important diagnoses included urinary tract infection (UTI) in 12 (6.3%) patients, sepsis in 9 (4.7%), cellulitis in 7 (3.7%), and nephrotic syndrome in 5 (2.6%) patients. Appendicitis and malaria were the least common diagnoses, with 3 (1.6%) cases each (Table 2). Overall, infectious diseases (enteric fever, bronchitis, AGE, pneumonia, viral fever, UTI, sepsis, cellulitis, malaria) constituted the majority of admissions, underlining the high burden of infection-related morbidity in this paediatric inpatient setting.

Table 2. Distribution of clinical diagnoses among paediatric inpatients (N = 190)

Diagnosis	n	%
Enteric fever	30	15.8
Bronchitis	30	15.8
Acute gastroenteritis (AGE)	29	15.3
Pneumonia	24	12.6
Viral fever	19	10.0
Bronchial asthma	19	10.0
Urinary tract infection (UTI)	12	6.3
Sepsis	9	4.7
Cellulitis	7	3.7
Nephrotic syndrome	5	2.6
Appendicitis	3	1.6
Malaria	3	1.6
Total	190	100.0

Utilization pattern of antimicrobial agents

All 190 children included in the analysis received at least one antimicrobial agent. In total, 300 antimicrobial prescriptions were recorded, corresponding to an average of 1.7 ± 0.8 antimicrobials per patient. Eighty-two (43.2%) children received a single antimicrobial, 76 (40.0%) received two, and 32 (16.8%) were treated with three or moreantimicrobial agents during their hospital stay (Table 4). The class-wise distribution of antimicrobial prescriptions is presented in Table 3 and Figure 2. Cephalosporins were the most frequently prescribed class, accounting for 99 prescriptions (33.0%). Within this group, third-generation cephalosporins such as ceftriaxone and cefotaxime were predominantly used, particularly in cases of pneumonia, sepsis, severe UTI and enteric fever. Approximately 80% of cephalosporin use was via the parenteral route, reflecting the severity of illness and the need for rapid drug action. Penicillins and aminoglycosides were the next most frequently used classes, each contributing 54 prescriptions (18.0%). Penicillins (e.g. amoxicillin, amoxiclav, ampicillin) were more commonly used in bronchitis, mild pneumoniaand upper respiratory tract infections, with a higher proportion of oral use (60%). Aminoglycosides (primarily amikacin and gentamicin) were almost exclusively administered parenterally (95%), particularly in sepsis, severe AGEand complicated UTI. Fluoroquinolones (39 prescriptions, 13.0%) and antiamoebic agents (36 prescriptions, 12.0%) also formed a substantial proportion of antimicrobial use. Fluoroquinolones, mostly ciprofloxacin and ofloxacin, were used for enteric fever and UTI, with both oral and parenteral formulations. Antiamoebics such as metronidazole and tinidazole were employed in AGE with suspected protozoal etiology and various abdominal infections. Macrolides (15 prescriptions, 5.0%) were used mainly for atypical pneumonia and bronchitis, predominantly in oral form. Antimalarial agents constituted only 3 prescriptions (1.0%), reflecting the low number of malaria cases (Table 3, Figure 2).

Table 3. Detailed class-wise distribution of antimicrobial agents used (Total prescriptions = 300, approximate values)

Antimicrobial class	Example agents*	Prescriptions, n	% of total	Parenteral use within class (%)	Oral use within class (%)	Common indications (in this study)
Cephalosporins	Ceftriaxone, Cefotaxime, Cefixime	99	33.0	80	20	Pneumonia, sepsis, enteric fever, severe UTI
Penicillins	Amoxicillin, Ampicillin, Amoxiclav	54	18.0	40	60	Bronchitis, mild pneumonia, ENT infections
Aminoglycosides	Amikacin, Gentamicin	54	18.0	95	5	Sepsis, severe AGE, complicated UTI
Fluoroquinolones	Ciprofloxacin, Ofloxacin, Levofloxacin	39	13.0	30	70	Enteric fever, UTI, suspected gram-negative infections
Antiamoebics	Metronidazole, Tinidazole	36	12.0	50	50	AGE with suspected protozoal cause, abdominal infections
Macrolides	Azithromycin, Erythromycin	15	5.0	20	80	Atypical pneumonia, bronchitis
Antimalarials	Artesunate, Artemether–lumefantrine	3	1.0	70	30	Confirmed/suspected malaria
Total	–	300	100.0	–	–	–

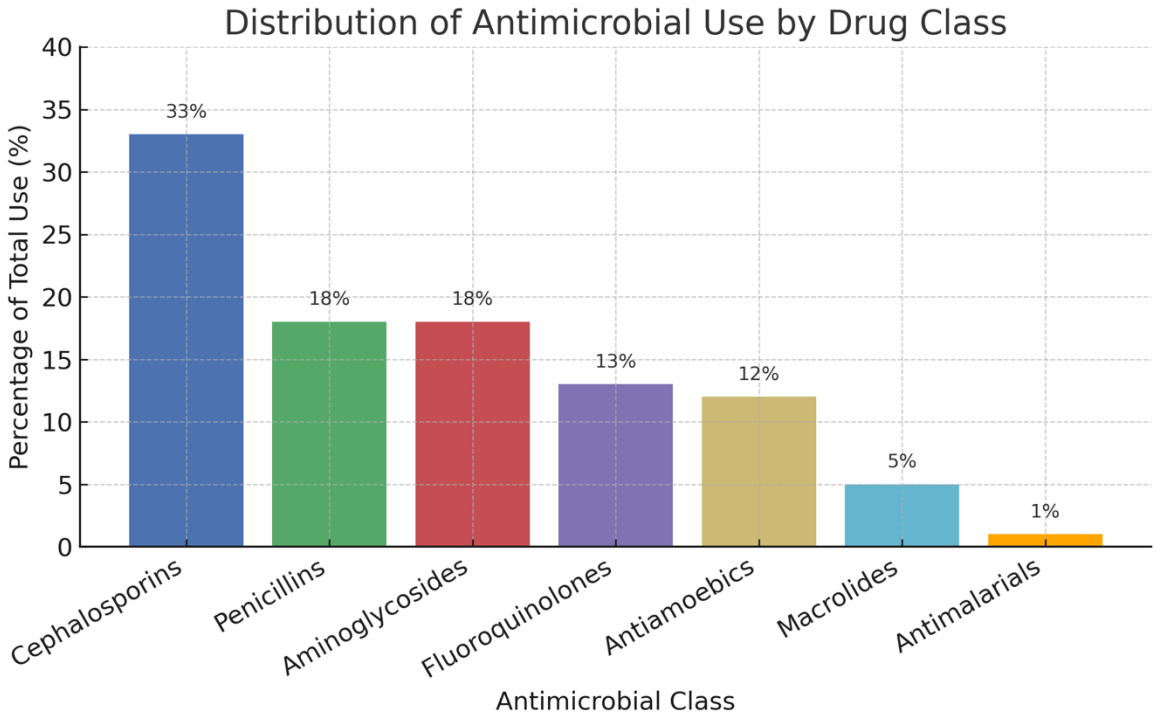

Figure 2. Distribution of antimicrobial use by drug class (Total prescriptions = 300)

Cephalosporins constituted one-third of total antimicrobial prescriptions, followed by penicillins and aminoglycosides (18% each). Fluoroquinolones and antiamoebic agents were also commonly used, whereas macrolides and antimalarials contributed a smaller share.

Additional treatment characteristics

Additional treatment-related characteristics are summarized in Table 4. The mean length of hospital stay was 6.2 ± 2.8 days, with most children remaining hospitalized for 4–8 days. Regarding route of administration, parenteral-only therapy was used in 88 (46.3%) patients, oral-only therapy in 34 (17.9%), and a combination of parenteral followed by oral therapy in 68 (35.8%). This pattern suggests initial stabilization with intravenous agents followed by step-down to oral therapy in clinically improving cases (Table 4). Microbiological cultures (including blood, urine or other relevant samples) were sent for 112 (58.9%) of the 190 children. Among these, 47 (41.9%) yielded a positive culture and 65 (58.0%) were negative. Overall, approximately 24.7% of the total cohort had a documented microbiological diagnosis guiding antimicrobial therapy (Table 4).

Table 4. Treatment characteristics of paediatric inpatients (N = 190, approximate values)

Variable	Category	n	% (of N = 190)
Number of antimicrobials per patient	1	82	43.2
	2	76	40.0
	≥3	32	16.8
Route of administration	Parenteral only	88	46.3
	Oral only	34	17.9
	Both parenteral and oral	68	35.8
Length of hospital stay	Mean ± SD (days)	–	6.2 ± 2.8
Culture sent	Yes	112	58.9
	No	78	41.1
Culture result (among 112 tested)	Positive	47	41.9*
	Negative	65	58.0*

*Percentages for culture result are calculated with denominator = 112 (patients for whom culture was sent).

DISCUSSION

This study provides a detailed snapshot of antimicrobial utilization among paediatric inpatients in a tertiary-care setting and, when placed beside published Indian and international data, highlights both reassuring patterns and areas of concern for antimicrobial stewardship. Our cohort comprised 190 inpatients aged 1–12 years, all of whom received at least one antimicrobial agent by design. Infectious diseases—particularly enteric fever, bronchitis, acute gastroenteritis, pneumonia and viral fever—dominated the diagnostic spectrum, which is consistent with reports from other Indian paediatric wards where acute respiratory and gastrointestinal infections remain leading causes of hospitalisation. [19,20]

Because our inclusion criteria required at least one antimicrobial, 100% of our cohort received antibiotics, with a mean of 1.7 ± 0.8 agents per patient and 56.8% receiving two or more agents. This intensity of exposure is higher than that reported by Jeeyani et al., who observed antibiotic use in 40.4% of all paediatric inpatients and a mean of 1.13 antibiotics per treated child, with 90% receiving monotherapy. It is more comparable to Bandela et al., who reported frequent combination therapy in a 600-patient paediatric inpatient cohort, with many children receiving two or more antibiotics and extended durations of therapy. [21,22]

Our data therefore likely represent a sicker subset of inpatients—those for whom clinicians judged antimicrobial therapy necessary—rather than the full ward population. Even so, the relatively high proportion of children on multiple agents (especially those receiving three or more) is in line with concerns raised by several paediatric prescribing studies that highlight polypharmacy and combination therapy as major drivers of resistance and adverse effects. This underscores the importance of robust criteria for initiating combination therapy and mechanisms for de-escalation as clinical status and microbiology data evolve. [23,24]

In our cohort, cephalosporins constituted 33% of all antimicrobial prescriptions, followed by penicillins and aminoglycosides (18% each), fluoroquinolones (13%), antiamoebics (12%), macrolides (5%) and antimalarials (1%). This pattern is broadly consistent with the dominance of β-lactams in paediatric practice but sits between two distinct Indian patterns reported previously. [25,26]

Jeeyani et al. classified 440 antibiotic prescriptions among paediatric inpatients and found a striking 68.4% share for cephalosporins, with penicillins (20.2%) and aminoglycosides (4.3%) used much less frequently and only minimal use of fluoroquinolones and macrolides. In contrast, Bandela et al. reported penicillins as the largest class (41%), followed by cephalosporins (29%) and aminoglycosides (22%) in their Warangal cohort. Peter et al. also described cephalosporins (especially cefotaxime and ceftriaxone) as the most common antibiotics in a South Indian paediatric inpatient study.[27]

Our distribution, with cephalosporins as the leading class but with a more substantial contribution from aminoglycosides and fluoroquinolones, therefore reflects a "middle" pattern: heavy but not extreme cephalosporin reliance, paired with more liberal use of second-line or broad-spectrum agents than some earlier reports. This mix may reflect local microbiology, empirical preferences for combination regimens in sepsis and complicated infections, and the inclusion of diagnoses such as enteric fever and complicated UTI, where fluoroquinolones and aminoglycosides are frequently considered.[28]

From a stewardship perspective, this class profile is significant when viewed through the WHO AWaRe lens. Many of the agents we used most—third-generation cephalosporins and fluoroquinolones—belong to the Watch group, which WHO recommends should be used more sparingly than Access drugs such as narrow-spectrum penicillins and certain first-line agents. Recent Indian surveillance (NAC-NET) has

shown that in many tertiary hospitals, consumption of Watch antibiotics exceeds that of Access antibiotics, with Watch making up 52–73% of total antibiotic use. Our class distribution, dominated by cephalosporins and supplemented by fluoroquinolones, is consistent with this national trend and reinforces concerns that paediatric inpatient care in India is increasingly Watch-heavy.[29]

Nearly half of our patients received parenteral-only therapy, and over one-third had a parenteral-to-oral step-down, mirroring patterns described by Bandela et al., where injectable antibiotics comprised more than 80% of dosage forms. This is unsurprising in a hospital setting managing moderately to severely ill children; however, it also highlights an opportunity to standardise criteria for early switch to oral therapy once clinical stability is achieved, thereby reducing line-related complications, nursing workload and costs.

Microbiological cultures were obtained in roughly 59% of our patients, with about 42% of those being positive. This culture rate is higher than some Indian reports, where samples were collected in less than 10–15% of paediatric inpatients on antibiotics, but still leaves a substantial portion of therapy empiric. Jeeyani et al. sent cultures in all children with suspected bacterial infection and emphasised culture-guided treatment as a key factor enabling relatively low antibiotic use in predominantly viral admissions. Our intermediate position suggests that improving timely access to culture and sensitivity results, and embedding them into de-escalation protocols, could further rationalise therapy. [29,30]

Large, multi-centre Indian data now document high overall antibiotic exposure and a worrisome tilt toward broad-spectrum Watch and even Reserve agents in tertiary-care settings, especially among high-acuity patients. Globally, AWaRe-based analyses in paediatric inpatients have shown that in many hospitals the proportion of Access antibiotics falls short of the WHO target of at least 60% of total use, with Watch agents accounting for a substantial and sometimes increasing share. Against this backdrop, our findings—that a third of prescriptions are cephalosporins and a further quarter involve aminoglycosides and fluoroquinolones—are not unexpected but do signal the need for deliberate stewardship action.[31]

Taken together with prior Indian studies, three consistent themes emerge:

1. **High antibiotic exposure in paediatric inpatients –** Whether 40–80% of all admissions (as in Jeeyani et al. and others) or 100% of a treatment-focused cohort like ours, most hospitalised children are exposed to at least one antibiotic.
2. **Broad-spectrum dominance –** Third-generation cephalosporins are repeatedly the most prescribed class, often justified by enteric fever, pneumonia and sepsis, but also influenced by habit and perceived safety.
3. **Variable but generally limited use of diagnostics to guide therapy –** Culture practices and documentation of susceptibility patterns vary widely, constraining the ability to de-escalate and tailor therapy.

Our study aligns closely with this national picture. Where it adds value is in its granular breakdown of routes, combinations and indications, and in linking these directly to stewardship opportunities: restricting cephalosporins and fluoroquinolones to clearly defined indications; favouring Access-group penicillins where appropriate; systematising parenteral-to-oral switch; and increasing culture-guided de-escalation. [32,33]

Strengths, limitations and future directions

A strength of our work is its focus on a clearly defined inpatient cohort with detailed prescription-level data, allowing a nuanced view of how and why particular classes are used. Its limitations include the single-centre design and the fact that only children receiving antimicrobials were included,

preventing us from estimating the true proportion of all admissions exposed to antibiotics (as many comparator studies do). We also did not formally classify drugs by AWaRe category or evaluate appropriateness against local guidelines, which would be valuable next steps. Future work should integrate AWaRe-based monitoring, compare pre- and post-stewardship-intervention periods and, ideally, link prescribing patterns to resistance trends and clinical outcomes. Nonetheless, when examined against the existing literature, this study reinforces a consistent message: paediatric inpatient care in India is heavily antibiotic-dependent, often broad-spectrum, and ripe for structured, data-driven stewardship interventions that safeguard both current patients and the effectiveness of these drugs for future generations.

CONCLUSION

In summary, this study demonstrates a high burden of infectious diseases among paediatric inpatients and a corresponding high level of antimicrobial use, with cephalosporins, penicillins and aminoglycosides being the most frequently prescribed classes. While these patterns are broadly consistent with current clinical practice for moderate to severe infections, they also highlight clear opportunities for optimising antimicrobial therapy through strengthened stewardship, increased diagnostic support and greater adherence to evidence-based guidelines. Rationalisation of antimicrobial use in children is essential not only for improving individual patient outcomes but also for mitigating the growing threat of antimicrobial resistance at the community and hospital level.

Declaration by Authors

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REFERENCES

1. Jehan I, Harris H, Salat S, et al. Neonatal mortality, risk factors and causes: a prospective population-based cohort study in urban Pakistan. Bull World Health Organ. 2009;87(2):130-8.
2. Moro ML, Marchi M, Gagliotti C, Di Mario S, Resi D; ProBA Regional Group. Why do paediatricians prescribe antibiotics? Results of an Italian regional project. BMC Pediatr. 2009;9(1):69.
3. Costelloe C, Metcalfe C, Lovering A, Mant D, Hay AD. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis. BMJ. 2010;340:c2096.
4. Bradley JS, Byington CL, Shah SS, et al. The management of community-acquired pneumonia in infants and children older than 3 months of age: clinical practice guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. Clin Infect Dis. 2011;53(7):e25-76.
5. Laxminarayan R, Duse A, Wattal C, et al. Antibiotic resistance—the need for global solutions. Lancet Infect Dis. 2013;13(12): 1057-98.
6. Kronman MP, Zhou C, Mangione-Smith R. Bacterial prevalence and antimicrobial prescribing trends for acute respiratory tract infections. Pediatrics. 2014;134(4):e956-65.
7. World Health Organization. Antimicrobial resistance: global report on surveillance. Geneva: World Health Organization; 2014.
8. World Health Organization. Global action plan on antimicrobial resistance. Geneva: World Health Organization; 2015.
9. Ventola CL. The antibiotic resistance crisis: part 1: causes and threats. P T. 2015; 40(4):277-83.
10. Ding L, Sun Q, Sun W, et al. Antibiotic use in rural China: a cross-sectional survey of knowledge, attitudes and self-reported practices among caregivers in Shandong province. BMC Infect Dis. 2015;15(1):576.
11. Laxminarayan R, Matsoso P, Pant S, et al. Access to effective antimicrobials: a worldwide challenge. Lancet. 2016; 387(10014):168-75.
12. Versporten A, Bielicki J, Drapier N, Sharland M, Goossens H; ARPEC Project Group. The worldwide Antibiotic Resistance and Prescribing in European Children (ARPEC) point prevalence survey: developing hospital-quality indicators of

antibiotic prescribing for children. J Antimicrob Chemother. 2016;71(4):1106-17.
13. Government of Pakistan. National Action Plan for Antimicrobial Resistance (AMR). Islamabad: Ministry of National Health Services, Regulations & Coordination; 2017. Available from: https://www.nih.org.pk/wp-content/uploads/2018/08/AMR-National-Action-Plan-Pakistan.pdf. Accessed 16 Oct 2023.
14. World Health Organization. WHO guidelines on use of medically important antimicrobials in food-producing animals. Geneva: World Health Organization; 2017. Available from: https://www.who.int/publications/i/item/9789241550130. Accessed 25 Oct 2023.
15. World Health Organization. Global priority list of antibiotic-resistant bacteria to guide research, discovery, and development of new antibiotics. Geneva: World Health Organization; 2017. Available from: https://www.who.int/news/item/27-02-2017-who-publishes-list-of-bacteria-for-which-new-antibiotics-are-urgently-needed. Accessed 15 Nov 2023.
16. Sharland M, Pulcini C, Harbarth S, et al. Classifying antibiotics in the WHO essential medicines list for optimal use—be AWaRe. Lancet Infect Dis. 2018;18(1):18-20.
17. World Health Organization. WHO report on surveillance of antibiotic consumption: 2016–2018 early implementation. Geneva: World Health Organization; 2018. Available from: https://www.who.int/publications/i/item/9789241514880. Accessed 18 May 2023.
18. Labi AK, Obeng-Nkrumah N, Sunkwa-Mills G, et al. Antibiotic prescribing in paediatric inpatients in Ghana: a multi-centre point prevalence survey. BMC Pediatr. 2018;18(1):391.
19. National Institute of Population Studies (NIPS) [Pakistan], ICF. Pakistan Demographic and Health Survey 2017–18. Islamabad: NIPS and ICF; 2019. Available from: https://dhsprogram.com/publications/publication-fr354-dhs-final-reports.cfm. Accessed 13 May 2023.
20. World Health Organization. AWaRe classification. Geneva: World Health Organization; 2019. Available from: https://www.who.int/news/item/01-10-2019-who-releases-the-2019-aware-classification-antibiotics. Accessed 13 May 2023.
21. Jeeyani HN, Parikh RH, Sivanandan S, Muliya HJ, Badiyani SN, Patel MB. Study of antimicrobial use in paediatric inpatients in a tertiary care hospital in Ahmedabad, India. Int J Contemp Pediatr [Internet]. 2020 Dec. 23 [cited 2025 Dec. 2];8(1):35-40. Available from: https://www.ijpediatrics.com/index.php/ijcp/article/view/3940
22. Bandela, Avanthi & Rathod, Sonika & Mullukuntla, Mounika & Guduru, Vijay & Puchchakayala, Goverdhan. (2019). An Assessment of Antibiotic Drugs Utilization Pattern in Paediatric Population. Indian Journal of Pharmacy Practice. 12. 250-255. 10.5530/ijopp.12.4.53.
23. Miao R, Wan C, Wang Z, et al. Inappropriate antibiotic prescriptions among pediatric inpatients in different type hospitals. Medicine (Baltimore). 2020;99(2):e18714.
24. Smith CM, Williams H, Jhass A, et al. Antibiotic prescribing in UK care homes 2016–2017: retrospective cohort study of linked data. BMC Health Serv Res. 2020;20(1):555.
25. Bilal H, Khan MN, Rehman T, Hameed MF, Yang X. Antibiotic resistance in Pakistan: a systematic review of past decade. BMC Infect Dis. 2021;21(1):244.
26. World Health Organization. WHO model list of essential medicines for children: 8th list, 2021. Geneva: World Health Organization; 2021. Available from: https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2021.03. Accessed 15 Nov 2023.
27. Fabre V, Cosgrove SE, Secaira C, et al. antimicrobial stewardship in Latin America: past, present, and future. Antimicrob Steward Healthc Epidemiol. 2022;2(1): e68.
28. World Health Organization. Antimicrobial resistance: global report on surveillance. [Updated 2023.] Geneva: World Health Organization; 2023.
29. WHO Collaborating Centre for Drug Statistics Methodology. Guidelines for ATC classification and DDD assignment 2024. Oslo: WHO Collaborating Centre for Drug Statistics Methodology; 2023. Available from: https://atcddd.fhi.no/filearchive/publications/1_2024_guidelines__final_web.pdf.
30. Ardillon A, Ramblière L, Kermorvant-Duchemin E, et al. Inappropriate antibiotic

prescribing and its determinants among outpatient children in three low- and middle-income countries: a multicentric community-based cohort study. PLoS Med. 2023;20(6): e1004211.
31. World Health Organization. WHO model lists of essential medicines. Geneva: World Health Organization; 2023. Available from: https://www.who.int/groups/expert-committee-on-selection-and-use-of-essential-medicines/essential-medicines-lists. Accessed 13 May 2023.
32. Institute for Health Metrics and Evaluation (IHME). Antimicrobial resistance (AMR). Seattle (WA): IHME; 2024. Available from: https://www.healthdata.org/research-analysis/health-risks-issues/antimicrobial-resistance-amr. Accessed 10 Jun 2023.
33. Islam MW, Shahjahan M, Azad AK, Hossain MJ. Factors contributing to antibiotic misuse among parents of school-going children in Dhaka City, Bangladesh. Sci Rep. 2024;14(1):2318.

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