

ANTIBIOTIC PRESCRIBING PATTERNS AND TREATMENT OUTCOMES IN PEDIATRIC PNEUMONIA: EVIDENCE FOR ANTIMICROBIAL STEWARDSHIP FROM TERTIARY CARE HOSPITALS IN PESHAWAR, PAKISTAN

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Abstract

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Background: Rational antibiotic selection is central to the safe and effective management of pediatric pneumonia, particularly against a backdrop of rising antimicrobial resistance (AMR) in South Asia.

Objective: To characterize antibiotic prescribing patterns for pediatric pneumonia in tertiary care hospitals in Peshawar, Pakistan, and to evaluate whether treatment outcome differed by antibiotic agent, as a marker of guideline-concordant, stewardship-consistent prescribing.

Methods: A cross-sectional, retrospective chart-review study of 180 hospitalized paediatric pneumonia patients (2 months–

12 years) was conducted at participating tertiary care hospitals using non-probability convenience sampling. Primary antibiotic therapy and treatment outcome (recovered, improved, ICU transfer, death) were extracted from structured medical records. The association between antibiotic agent and outcome was tested using chi-square analysis, one-way ANOVA, and linear regression in SPSS. **Results:** Five antibiotic regimens accounted for the entire cohort: Ampicillin + Gentamicin (21.7%), Azithromycin (21.1%), Amoxicillin (20.6%), Cefotaxime (20.6%), and Ceftriaxone (16.1%). Favourable outcome (recovery or clinical improvement) ranged from 67.6% with Amoxicillin to 89.5% with Azithromycin and 89.2% with Cefotaxime, with Ampicillin + Gentamicin (84.6%) and Ceftriaxone (79.3%) intermediate. Despite this numeric spread, neither one-way ANOVA ($F = 2.241, p = 0.067$), chi-square association ($\chi^2 = 18.105, df = 12, p = 0.113$), nor linear regression ($B = 0.073, \beta = 0.107, p = 0.153; R^2 = 0.011$) demonstrated a statistically significant relationship between antibiotic choice and treatment outcome. Overall, 62.2% of patients recovered and 20.0% improved, while 10.6% required ICU transfer and 7.2% died. **Conclusion:** Antibiotic prescribing at the participating hospitals followed established first- and second-line regimens for pediatric pneumonia, and no antibiotic agent was associated with significantly worse outcomes - evidence consistent with broadly guideline-concordant, stewardship-appropriate practice. Continued adherence to evidence-based antibiotic protocols, rather than empirical escalation to broader-spectrum agents, should be reinforced to sustain favourable outcomes while limiting resistance pressure.

Keywords: *pediatric pneumonia; antibiotic therapy; antimicrobial stewardship; treatment outcome; prescribing patterns; tertiary care; Pakistan*

Introduction

Antibiotic therapy is the mainstay of treatment for bacterial pediatric pneumonia, yet the choice of agent must balance clinical efficacy, severity of presentation, local resistance patterns, and the imperative of antimicrobial stewardship.[1] Comparative studies of commonly used agents — such as amoxicillin and ceftriaxone — have shown that clinical

response can vary by agent and by clinical context, underscoring the need for evidence-based, guideline-aligned prescribing.[1]

Antimicrobial resistance (AMR) has emerged as one of the most pressing global health threats, with recent global burden estimates attributing millions of deaths to bacterial AMR and projecting continued escalation without effective containment measures.[2,3] Pakistan's National Action Plan on AMR identifies gaps in antibiotic stewardship, surveillance, and translation of policy into clinical practice as ongoing challenges,[4,5] making setting-specific evidence on real-world prescribing patterns and their clinical consequences particularly valuable.

This study characterizes antibiotic prescribing patterns for pediatric pneumonia at tertiary care hospitals in Peshawar, Pakistan, and evaluates whether treatment outcome varied by antibiotic agent — a comparison that serves as an indirect but clinically meaningful marker of whether current prescribing practice is achieving comparable, guideline-consistent results across the antibiotic options in use.

2. Materials and Methods

2.1 Study Design and Setting

A descriptive, cross-sectional observational study was conducted using retrospective review of hospital medical records at participating tertiary care hospitals in Peshawar, Pakistan.

2.2 Study Population and Sampling

Pediatric patients aged 2 months to 12 years with a confirmed clinical diagnosis of pneumonia, admitted to a participating hospital and receiving antibiotic therapy, with complete treatment and outcome records, were eligible. Using non-probability convenience sampling, 180 patients met all eligibility criteria and constituted the final analytic sample.

2.3 Variables and Measurement

The primary antibiotic prescribed for each patient was recorded in one of five categories: Amoxicillin, Ampicillin + Gentamicin, Azithromycin, Cefotaxime, or Ceftriaxone. Treatment outcome was recorded in four categories: recovered, improved, ICU transfer, or death. For summary purposes, recovery and improvement were combined into a "favorable outcome" category, and ICU transfer and death into a composite "adverse outcome" category.

2.4 Statistical Analysis

Data were analyzed in IBM SPSS Statistics. The association between primary antibiotic and treatment outcome was tested using the chi-square test of independence, one-way ANOVA on numerically coded outcome, and simple linear regression. A two-tailed p-value < 0.05 was considered statistically significant.

2.5 Ethical Considerations

The study was conducted following ethical clearance from the respective hospital administration and institutional ethical review committee. No personally identifying information was collected.

3. Results

Antibiotic prescribing across the 180-patient cohort was distributed across five regimens without marked dominance of any single agent: Ampicillin + Gentamicin (39 patients, 21.7%), Azithromycin (38, 21.1%), Amoxicillin (37, 20.6%), Cefotaxime (37, 20.6%), and Ceftriaxone (29, 16.1%) (Table 1, Figure 1a).

Table 1. Distribution of primary antibiotic therapy and treatment outcome (n = 180).

Variable	Category	n	%
Primary antibiotic	Ampicillin + Gentamicin	39	21.7
	Azithromycin	38	21.1
	Amoxicillin	37	20.6
	Cefotaxime	37	20.6
	Ceftriaxone	29	16.1
Treatment outcome	Recovered	112	62.2
	Improved	36	20.0
	ICU transfer	19	10.6
	Death	13	7.2

3.1 Treatment Outcome by Antibiotic Agent

Recovery was the most frequent outcome in every antibiotic group, and favorable outcome (recovered + improved) ranged from 67.6% with Amoxicillin to 89.5% with Azithromycin (Table 2, Figure 1b). One-way ANOVA showed no statistically significant difference in treatment outcome across antibiotic groups ($F(4,175) = 2.241, p = 0.067$).

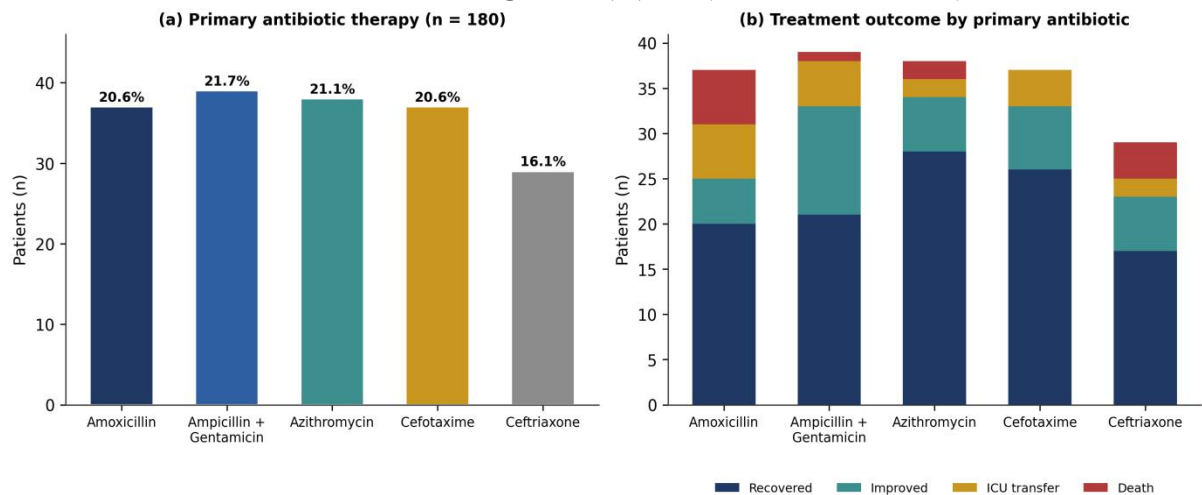


Figure 1. (a) Distribution of primary antibiotic therapy and (b) treatment outcome by primary antibiotic (n = 180).

Table 2. Treatment outcome and favorable-outcome rate by primary antibiotic therapy.

Primary antibiotic	Recovered	Improved	ICU transfer	Death	Total	% favorable
Amoxicillin	20	5	6	6	37	67.6
Ampicillin + Gentamicin	21	12	5	1	39	84.6
Azithromycin	28	6	2	2	38	89.5
Cefotaxime	26	7	4	0	37	89.2
Ceftriaxone	17	6	2	4	29	79.3
Total	112	36	19	13	180	82.2

$\chi^2 = 18.105$, $df = 12$, $p = 0.113$ (association); one-way ANOVA $F(4,175) = 2.241$, $p = 0.067$.

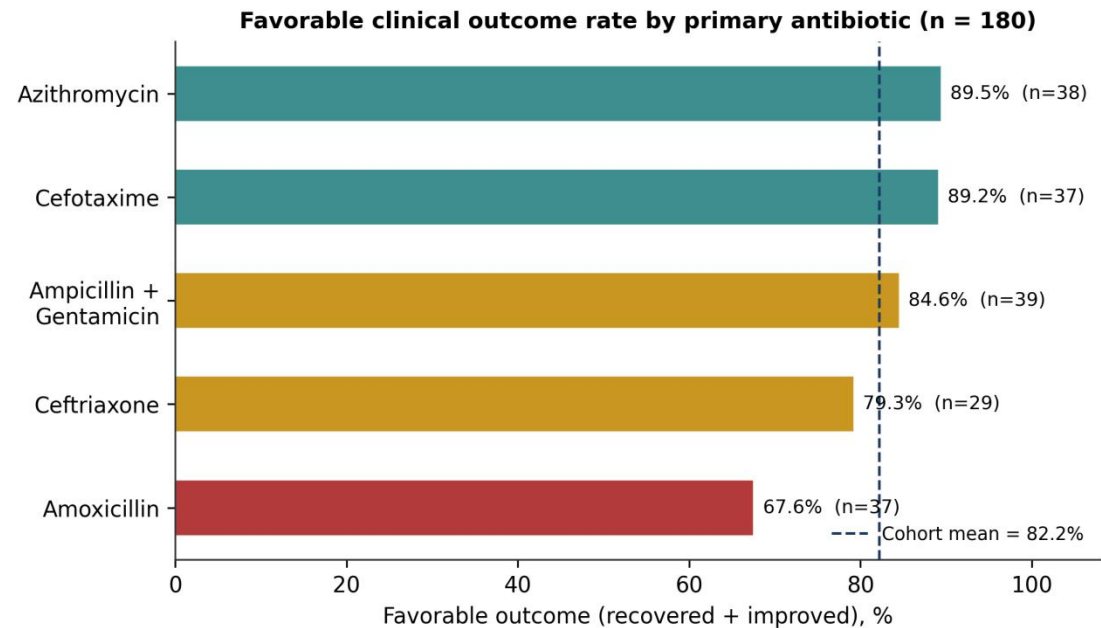


Figure 2. Favorable clinical outcome (recovered + improved) rate by primary antibiotic, ranked lowest to highest (n = 180). Dashed line marks the cohort-wide favorable-outcome rate (82.2%).

3.2 Regression Analysis

Simple linear regression using primary antibiotic (coded 1–5) as predictor of numerically coded treatment outcome found no statistically significant relationship ($B = 0.073$, $SE = 0.051$, $\beta = 0.107$, $t = 1.434$, $p = 0.153$), with the model explaining only 1.1% of outcome variance ($R^2 = 0.011$; $F(1,178) = 2.055$, $p = 0.153$) (Table 3).

Table 3. Linear regression of treatment outcome on primary antibiotic therapy.

Model	B	SE	β	t	p
(Constant)	3.160	0.163	—	19.339	<0.001
Primary antibiotic	0.073	0.051	0.107	1.434	0.153

$R^2 = 0.011$; $F(1,178) = 2.055$, $p = 0.153$.

4. Discussion

This study found that antibiotic selection for pediatric pneumonia at the participating tertiary care hospitals was distributed relatively evenly across five agents commonly recommended for bacterial pneumonia in children, and that treatment outcome did not differ significantly by antibiotic choice on any of three complementary statistical tests. The great majority of patients — 82.2% overall — achieved a favorable outcome (recovery or clinical improvement) regardless of which antibiotic they received.

These findings are consistent with earlier comparative work showing broadly similar clinical efficacy between first-line agents such as amoxicillin and ceftriaxone in pediatric pneumonia,[1] and align with WHO treatment guidance favoring first-line agents such as amoxicillin or ampicillin, with broader-spectrum agents reserved for more severe presentations. The absence of a statistically significant outcome difference across agents is a reassuring signal from an antimicrobial stewardship perspective: it suggests that clinicians at the participating hospitals were not systematically escalating to broader-spectrum antibiotics to compensate for poor first-line efficacy, but rather selecting among agents with comparable real-world effectiveness in this population.

Numerically, Azithromycin and Cefotaxime showed the highest favorable-outcome rates (around 89%) and Amoxicillin the lowest (67.6%), a gap that, while not statistically significant given the sample size, may still merit clinical attention — particularly since Amoxicillin recipients also showed the highest death count (6/37) in raw terms. This pattern could reflect differences in baseline severity of patients selected for each regimen (e.g., oral Amoxicillin may have been reserved for less unwell or non-severe cases in some instances, or conversely used empirically before severity was fully apparent) rather than a true difference in drug efficacy; the cross-sectional design cannot distinguish between these explanations, and severity-adjusted analysis was beyond the scope of the available data.

Taken together, these results support the conclusion that antibiotic prescribing for pediatric pneumonia at the participating hospitals was broadly stewardship-consistent, while highlighting the value of continued outcome monitoring — ideally with severity-adjusted analysis in future work — to detect any emerging signal of differential effectiveness before it becomes clinically important.

4.1 Strengths and Limitations

This analysis benefits from complete antibiotic and outcome data across a well-defined hospital cohort and the use of three complementary statistical approaches to test for an antibiotic–outcome association. Limitations include the retrospective, single-city design; the

inability to adjust for baseline disease severity, pathogen identification, or dosing/duration of therapy, all of which could confound the antibiotic–outcome relationship; and a sample size that, while adequate for the overall comparison, offers limited power to detect smaller differences between individual antibiotic pairs.

5. Conclusion

Antibiotic prescribing for pediatric pneumonia at the participating tertiary care hospitals in Peshawar followed established first- and second-line regimens, and no single antibiotic agent was associated with a statistically significant difference in treatment outcome. These findings support the continued use of current guideline-concordant prescribing practice as a foundation for antimicrobial stewardship in this setting.

5.1 Recommendations

- Maintain and reinforce adherence to evidence-based antibiotic selection guidelines for pediatric pneumonia rather than empirical escalation to broader-spectrum agents.
- Institute routine, severity-adjusted outcome monitoring by antibiotic agent to detect any emerging effectiveness differences early.
- Strengthen local antimicrobial stewardship programs, including prescribing audits and feedback, to sustain rational antibiotic use and limit resistance pressure.
- Pursue future studies incorporating pathogen identification and dosing data to more precisely evaluate comparative antibiotic effectiveness.

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