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Evaluating Pediatric Antibiotic Prescribing Patterns And Their Impact On Antimicrobial Resistance In Severe Microbial Infections

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ABSTRACT

Microbial infections in pediatric patients are a major public health concern, especially in cases of critical illness. Overprescription and misuse of antibiotics, particularly broad-spectrum types like ceftriaxone, contribute significantly to the rise in antimicrobial resistance. This study aims to identify the common microbial infections among critically ill children and to analyze the prescribing patterns of antibiotics, especially ceftriaxone, in a pediatric hospital setting. A retrospective cross-sectional study was conducted in the pediatric ward of Ayub Medical Complex, Abbottabad, from February to April 2023. Clinical and demographic data were collected from 100 admitted patients aged 1 month to 14 years. Patients with infectious diseases were included; those with non-infectious conditions were excluded. Data was analyzed using Microsoft Excel. Out of 100 patients, 70% were male and 30% female; 63% belonged to rural areas. The most frequently diagnosed infections were lower respiratory tract infections and sepsis. Ceftriaxone was prescribed to 79% of patients, regardless of confirmed infection status. Although 97% of patients showed clinical improvement, 3% did not respond and remained hospitalized. The median recovery period was 4 days. Ceftriaxone was the most prescribed antibiotic, often used without organism-specific diagnosis. This indicates a pattern of overuse, which can contribute to antimicrobial resistance and unnecessary healthcare costs. The findings underscore the importance of implementing targeted antibiotic prescribing practices based on confirmed microbial identification to improve patient outcomes and reduce resistance risks.

INTRODUCTION

As long back as 3000 BCE, microbial infectious illnesses have been documented. Over the past few centuries, several large pandemics brought on by bacteria have been reported. Despite improvements in medical research and therapies over the past several decades, infectious illnesses still rank among the world's leading causes of mortality in the twenty-first century(Bloom and Cadarette, 2019). When the pathogen that causes an illness is transferred from one person to another, a sickness spreads. A pathogen needs to be able to multiply in the host's body and harm the host in some way in order to cause illness (Doron and Gorbach, 2008). Most microorganisms do not cause infection, but some microbes are significantly impacted on public health by causing microbial infections. Any part of the body can develop an infection, and it can be brought on by the organism itself or by the body's reaction to its existence. Humans can contract bacteria via the air, water, food, or living things (Russell et al., 2015). Bacteria employ a variety of strategies to transmit bacterial illnesses. In order for the infection to propagate, enough organisms must be able to survive in the environment and reach a susceptible host. To survive in water, soil, food, and other settings, many bacteria have developed. Direct contact, aerosol, vehicles in motion, droplets, vectors are the major means of bacterial transmission (Doron and Gorbach, 2008). The external environment, where the illness is disseminated, is generally the site of interaction between the host and the bacterial agent. Bacteria can be acquired by humans via food, water, the environment, or living creatures. It is also feasible to think about how macro-, or microenvironments influence how bacteria propagate. Hospitals and prisons, for example, are only two places where certain types of organisms can be discovered(Budd, 2024). Some bacteria are endemic in some areas and uncommon or nonexistent in others(Lim et al., 2016).

Quantifying the risks of infection, disease, and death linked to environmental pathogen exposure is the aim of the rapidly developing field of quantitative microbial risk assessment. Standards are now being established for food, wastewater recycling, and drinking water. People under the age of 19 are most at risk of developing enteric illnesses, according to a growing body of data (Lim et al., 2016).Recreational activities and using tainted water increase the risk of illness in children. These increased dangers might be brought on by the immunological, neurological, and digestive systems still developing(Lacroix et al., 2021). Additionally, children are more likely to be exposed to environmental pathogens. The population most susceptible to certain gastrointestinal illnesses may be children (Carson et al., 1999). Neisseria meningitides typically infect the meninges of the central nervous system, causing meningitis; it can also infect the lungs, causing pneumonia, but it is not a cause of skin infection; in contrast, Staphylococcus aurous, which people typically carry on their skin or mucous membranes, frequently causes skin infections(Bhowmik, 2023, Moon and Firdous). Each species of bacteria has a preference to infect certain organs and not others. Compared to other illnesses, bacterial infections typically have greater fatality rates from LRTIs(Ibrahim et al., 2017). Disease can be caused by pathogens consuming living tissue or by the immune system responding to an infection. Antibiotics may be useless or even hazardous when sickness symptoms are the result of the body's attempts to get rid of the germs. The systemic inflammatory response syndrome (SIRS), which is usually caused by a bacterial infection, is a strong inflammatory response to an infection marked by the production of a large number of cytokines and the hemodynamic instability(Sikora et al., 2023). If patients with SIRS are permitted to continue, sepsis might eventually set in, which could result in multi organs failure and death. When the cascade of events starts, even the most powerful medications usually fail to prevent(Hamer, 2010, Mancini et al., 2010). precise identification of the pathogen is a vital step in the therapeutic treatment of bacterial infections. Furthermore, as the worldwide burden of antibiotic resistance increases, quick antimicrobial susceptibility testing is essential to assist direct therapy. Given the need to limit overuse of antibiotics, we urgently require diagnostic techniques that may help rule out infection and define non-infectious inflammatory conditions for which antibiotics are not indicated(Murray and Masur, 2012, De Rose et al., 2024).Better healthcare delivery has recently been made possible by the integration of existing quick diagnostic technology and enhanced automated workflow systems into clinical laboratories. At the moment, automated BC systems are the gold standard for identifying bloodstream infection(Peri et al., 2021).

METHODOLOGY

STUDY DESIGN

It is a Retrospective cross-sectional study.

STUDY AREA AND DURATION

The study was conducted in the Pediatric Ward of Ayub Medical Complex, Abbottabad, Khyber Pakhtunkhwa, Pakistan, over a period of three months from February to April 2023.

POPULATION AND SAMPLING

A total of 100 pediatric patients aged 1 month to 14 years were included using non-probability consecutive sampling. All admitted patients diagnosed with infectious diseases during the study period were reviewed.

INCLUSION CRITERIA

- Patients aged 1 month to 14 years.
- Diagnosed with bacterial, viral, or fungal infections and admitted to the pediatric ward.

EXCLUSION CRITERIA

- Patients presenting with non-infectious diseases.
- Patients attending outpatient departments (OPD) without hospitalization.

DATA COLLECTION PROCEDURE

Patient demographic and clinical data, including age, gender, locality, type of infection, prescribed antibiotic, treatment outcome, and duration of hospitalization, were collected from medical records and prescription files.

STATISTICAL ANALYSIS

Data was entered and analyzed using Microsoft Excel. Descriptive statistics (frequencies and percentages) were calculated, and results were presented in tabular and graphical form.

RESULTS

A total of 100 pediatric patients were included in this study to evaluate antibiotic prescribing patterns for severe microbial infections, particularly bacterial infections, in the pediatric ward. The most common infections diagnosed were lower respiratory tract infections (LRTIs), sepsis, pneumonia, bronchiolitis, enteric fever, and urinary tract infections. Among the 100 participants, 70% were male and 30% female. Most patients (63%) were from rural areas, while 37% were from urban settings (Table 1).

FIGURE 1: Presents the month-wise distribution of patient admissions, showing a peak in March 2023.

FIGURE 2: Illustrates the age-wise distribution of patients, revealing that infections were most prevalent in children aged 1 month to 5 years.

FIGURE 3: Shows the distribution of infectious disease categories, with LRTIs and sepsis being the most frequently diagnosed conditions.

FIGURE 4: Demonstrates the pattern of antibiotic prescriptions. Ceftriaxone was prescribed in 79% of the cases, including some patients without confirmed infections, indicating a tendency toward empirical antibiotic use. The clinical response to ceftriaxone was favorable in 97% of patients, who showed improvement and were subsequently discharged. However, 3% of

patients did not respond to ceftriaxone therapy and remained under observation in the hospital. The average duration of hospital stay for recovered patients was approximately 4 days.

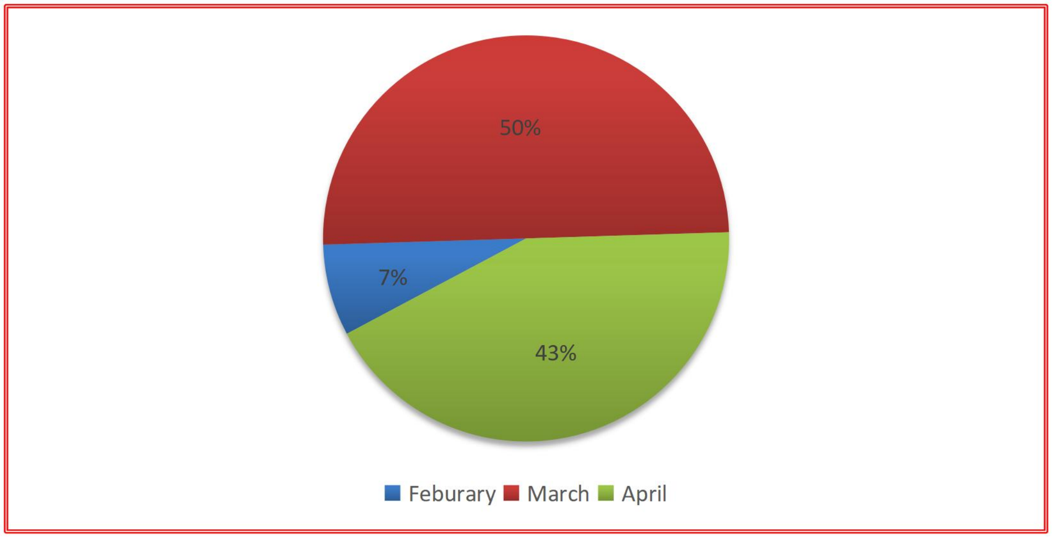
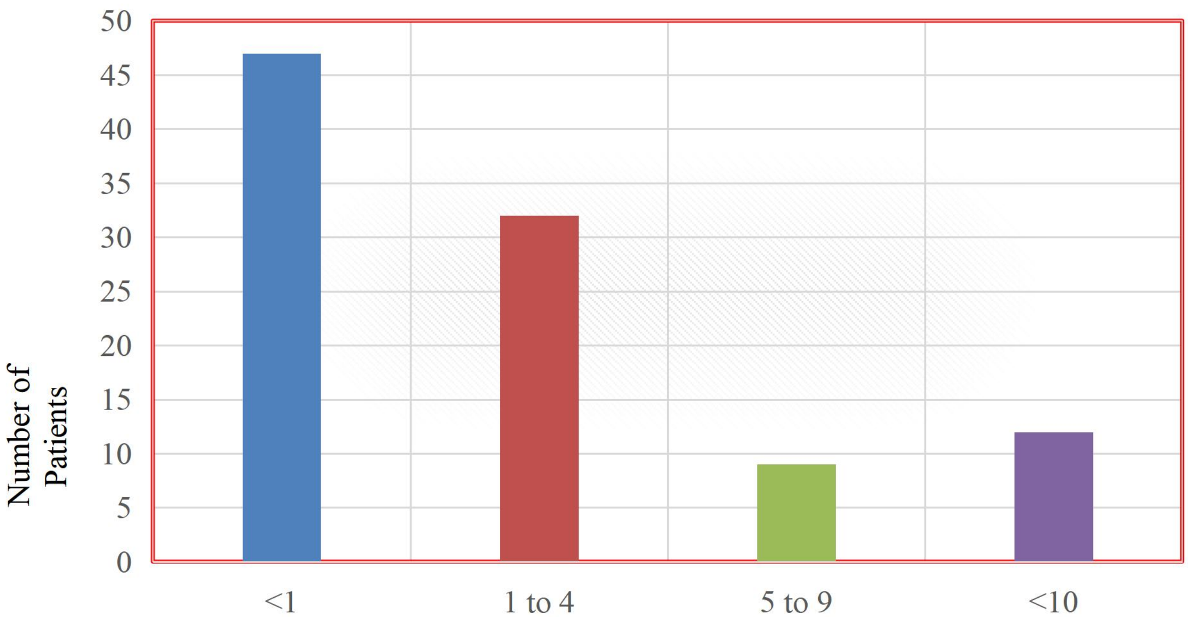


FIGURE 1: MONTH WISE DISTRIBUTION OF DATA COLLECTED SHOWED IN %



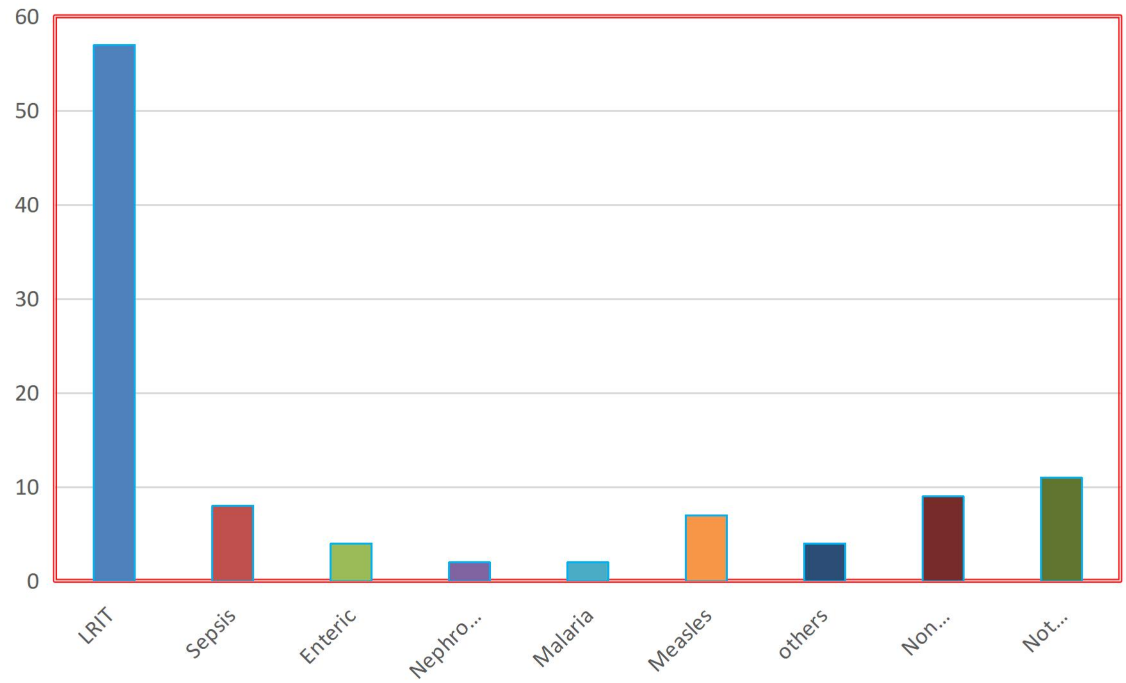


FIGURE 3: CATEGORIES OF DISEASES PRESCRIBED WITH ANTIBIOTIC

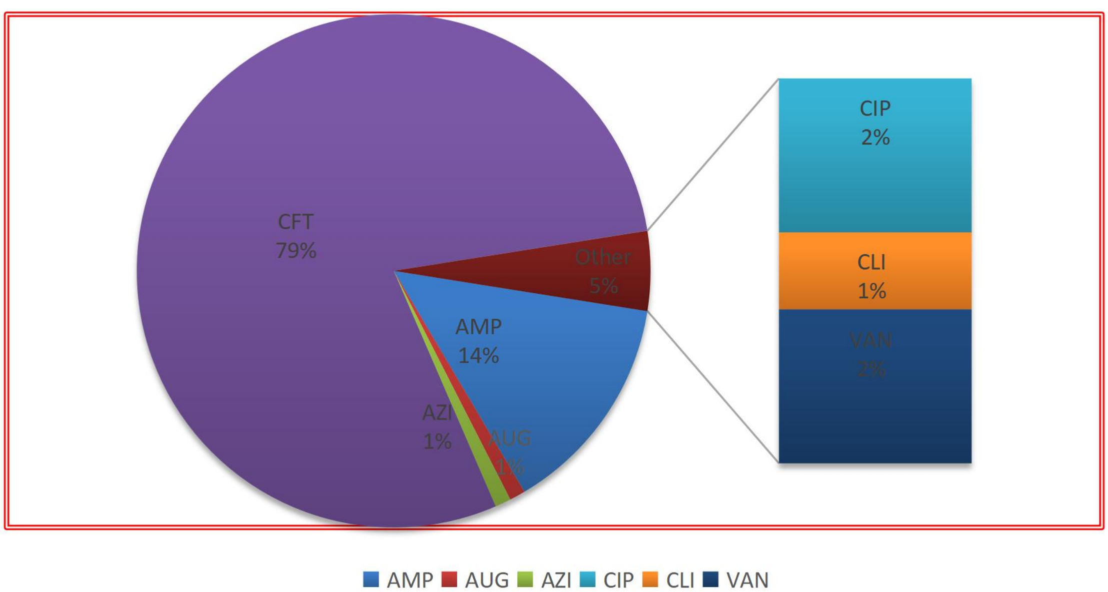


FIGURE: 4 ANTIBIOTIC PRESCRIPTION PATTERNS

TABLE: 1 PERCENT DISTRIBUTION OF GENDER, LOCALITY AND CURRENT STATUS OF STUDY PARTICIPANTS

Variables	Category	Percent
Gender	Male	70%

	Female	30%
Region	Rural	63%
	Urban	37%
Status	Recovered*	97%
	Admitted	3%

DISCUSSION

Globally, 336 million instances of lower respiratory tract infections (LRTIs) were predicted to have occurred in 2016. LRTIs are the sixth-leading cause of death globally and the primary infectious cause of death. LRTIs, which are classified as pneumonia, bronchitis, or bronchiolitis, alone resulted in an estimated 2.38 million fatalities in 2016 children under the age of five were disproportionately affected (Llor and Bjerrum, 2014). In 2011, it was predicted that 70 billion antibiotic doses were directly administered to humans, or roughly 10 antibiotic doses per person, every year (Van Boeckel et al., 2014).The use of antibiotics has been rising steadily on a global scale between 2000 and 2015, antibiotic consumption rose 39% globally, with a 77% increase in LMICs more than compensating. In 2011, the number of direct antibiotic doses administered to humans was predicted to be 70 billion, or roughly 10 antibiotics per doses. Antibiotic use has been rising consistently on a global scale; between 2000 and 2015, antibiotic use rose 39% globally, indicating a 77% increase in LMICs that more than offset a 4% decline in HICs(Klein et al., 2018). Young children use antibiotics at the greatest rate at low-income settings, antibiotic exposure to young infants who are at key developmental phases is widespread(Tefera et al., 2019). Children from eight LMIC nations were exposed to 4.9 courses of antibiotics on average each year during their first two years of life, according to results of a significant longitudinal household-based study(Rogawski et al., 2017). Ceftriaxone is one of the most frequently prescribed antibiotics in sub-Saharan Africa (SSA) due to its affordability and safety profile for treating a variety of infections, such as infections of the urinary tract, bones, skin, and soft tissues, the central nervous system, and the lungs, pneumonia(Demoz et al., 2020, Meresa Bishaw et al., 2021).

A third-generation lactam (cephalosporin) antibiotic called ceftriaxone is effective against Gram-positive and Gram-negative aerobic bacteria as well as some anaerobic ones. Ceftriaxone, which has already received FDA approval for the treatment of a number of infections and meningitis, has a high likelihood of being used as an anti-relapse medication for a number of substances use disorders(Bechard and Knackstedt, 2019).Although it is uncommon in adults, ceftriaxone-induced pseudolithiasis is regularly documented in children. In hemodialysis patients, renal impairment has been documented as a risk factor for ceftriaxone-induced pseudolithiasis(Phillips et al., 2022). It is not advised to give ceftriaxone to newborns under 28 days old within 48 hours of giving them calcium-containing solutions because there may be an interaction that causes crystalline materials to form in the pulmonary or renal vasculature(Gallagher and MacDougall, 2022). Three older studies that documented unfavorable cardiopulmonary events in newborns receiving ceftriaxone were included in a systematic review done in 2016. A prospective case series reported respiratory events for 51 of 86 patients aged 11 to 59 days who received IM ceftriaxone as outpatients(Lacroix et al., 2021).

Another study provided an assessment of eight cardiopulmonary events in neonates receiving concurrent ceftriaxone and calcium-containing products that were filed with the FDA Adverse Event Reporting System. Five patients were < 3 weeks old, 2 patients were 4–8 weeks old and one patient was of unknown age(Nandi and BISWAS, 2024). The ceftriaxone dosage varied and was not consistently reported among cases seven of 8 patients with reported events died and had autopsy findings consistent with the presence of crystalline material or white precipitate in the lungs(Bradley et al., 2009). In a prospective case series, 3 neonate's ≤ 3 days old receiving ceftriaxone died of cardiopulmonary events including asphyxia and persistent pulmonary hypertension. In addition, 11 patients experienced thrombocytosis(Bechard and Knackstedt, 2019). These studies had significant methodological limitations, but further support that concurrent administration of intravenous ceftriaxone and calcium-containing solutions should be avoided in neonates due to the risk of cardiopulmonary adverse events(Buckler et al., 2017).It was observed that pediatric patients at ATH are prescribed with unnecessary antibiotics especially Ceftriaxone (79%) are prescribed in both infectious and non-infectious patients. Their overuse and misuse can lead to the development of antibiotic resistance and other adverse effects. It is essential to identify the specific microorganisms causing the infection and prescribe the antibiotic accordingly.

CONCLUSION

This study highlights a significant trend of empirical and potentially inappropriate antibiotic use, particularly ceftriaxone in pediatric patients with both confirmed and unconfirmed infections. While the high clinical response rate may reflect the broad efficacy of ceftriaxone, its overuse without pathogen-specific diagnosis raises serious concerns about the acceleration of antimicrobial resistance, unnecessary exposure to drug side effects, and increased healthcare costs. The findings underscore the urgent need for stricter antibiotic stewardship in pediatric settings to ensure that antimicrobial therapy is both evidences based, and organism directed.

RECOMMENDATIONS

Encourage the routine use of culture and sensitivity testing before initiating antibiotic therapy to guide targeted treatment. Develop and enforce hospital-specific antibiotic prescribing protocols tailored to local resistance patterns. Conduct regular educational sessions for healthcare providers on rational antibiotic use, especially in pediatrics. Introduce antibiotic audit systems in hospitals to monitor and evaluate prescribing behavior.

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