



Susceptibility Pattern of Salmonella Typhi in Culture Proven Enteric Fever in Children

Muhammad Zabih Ullah¹, Muhammad Shahan Jan², Haji Gul³, Waqar Ahmad⁴, Muhammad Rizwan⁵, Ikram Ali⁶

¹⁻⁶Department of Paediatrics & Neonatology, Bacha Khan Medical Complex / Gajju Khan Medical College, Swabi, KP, Pakistan.

ARTICLE INFO

Keywords: *Salmonella Typhi*, Enteric Fever, Antibiotic Resistance, Multidrug-resistant (MDR), Extensively Drug-resistant (XDR), Paediatric Population.

Correspondence to: Waqar Ahmad, Department of Paediatrics & Neonatology, Bacha Khan Medical Complex / Gajju Khan Medical College, Swabi, KP, Pakistan.

Email: Waqar4244@gmail.com

Declaration

Authors' Contribution

All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 05-01-2025 Revised: 04-04-2025
Accepted: 17-04-2025 Published: 30-04-2025

ABSTRACT

Background: Enteric fever, primarily caused by *Salmonella Typhi*, remains a significant public health challenge, particularly among children. The World Health Organization estimates 11 to 20 million cases annually, with over 100,000 deaths. Children aged 1 to 5 years are especially vulnerable, with seasonal peaks observed during spring. Rising antibiotic resistance, including multidrug-resistant (MDR) and extensively drug-resistant (XDR) strains, complicates treatment and increases morbidity and mortality. **Methods:** A prospective analysis of 160 blood culture samples from paediatric patients at MTI-GKMC/BKMC Swabi was conducted. The study aimed to assess antibiotic resistance prevalence among *S. Typhi* isolates. Blood samples were cultured using standard microbiological methods, and susceptibility was determined via disk diffusion and minimum inhibitory concentration (MIC) testing against antibiotics such as azithromycin, meropenem, and imipenem. **Results:** Of the 160 positive samples, 136 (85%) exhibited extensive drug resistance (XDR), while 24 (15%) were classified as multi-drug resistant (MDR). All isolates remained sensitive to azithromycin, meropenem, and imipenem, suggesting these as viable treatment options despite widespread resistance. **Conclusion:** The study highlights the alarming prevalence of antibiotic resistance in paediatric enteric fever cases, particularly the high proportion of XDR strains. Continuous surveillance, judicious antibiotic use, and stringent infection control measures are essential to mitigate the spread of resistant strains. Public health interventions, including improved sanitation, vaccination programs, and targeted therapeutic strategies, are critical to reducing the burden of enteric fever in vulnerable populations.

INTRODUCTION

Enteric fever, mainly caused by *Salmonella Typhi*, is a major global health issue. According to the World Health Organization (WHO), there are an estimated 11 to 20 million cases of typhoid fever annually, resulting in over 100,000 deaths [1]. Children, especially those aged 1 to 5 years, are at the highest risk of infection [2]. A retrospective study analysing 39,771 blood cultures found that 91 isolates were positive for *Salmonella spp.*, with *S. Typhi* accounting for 79 cases (7.49%), highlighting the significant disease burden in children [3]. The incidence of enteric fever varies seasonally, with peaks typically occurring in spring (March to May), linked to increased exposure to contaminated food and water, which are primary transmission routes [5].

Epidemiological data reveal that while older children and adolescents also experience high infection rates, younger children, particularly those under five, are the most vulnerable [4]. Preschool children contribute significantly to the disease burden but are often excluded from vaccination campaigns, which usually target school-aged children [5]. This disparity calls for a reassessment of

vaccination strategies and public health policies to ensure younger populations are adequately protected [6].

Beyond clinical management, these findings emphasize the need for improved sanitation and access to clean water in endemic regions [3]. Continuous surveillance is also critical to monitor antibiotic resistance trends in *S. Typhi* strains, as resistance can complicate treatment and increase morbidity and mortality. Recent studies show rising resistance to commonly used antibiotics, necessitating a shift toward more effective treatments and preventive measures like vaccination. Addressing these challenges requires a collaborative effort involving healthcare providers, policymakers, and communities to combat enteric fever and protect vulnerable populations, particularly children [7].

The clinical symptoms of enteric fever, caused by *S. Typhi*, range from mild to life-threatening [8]. Early signs include prolonged fever, abdominal pain, headache, and gastrointestinal issues like diarrhoea or constipation [9]. Without treatment, the disease can lead to severe complications such as intestinal perforation and gastrointestinal bleeding, caused by inflammation and

tissue necrosis. In about 10% of untreated cases, complications like intestinal perforation can occur by the third week, potentially leading to peritonitis, sepsis, and organ failure if not treated promptly.

The rise in antibiotic resistance among *S. Typhi* strains has further complicated treatment [10]. Studies from Pakistan report resistance rates of 80.1% for amoxicillin/clavulanate and 86.9% for chloramphenicol, raising concerns about treatment efficacy. In contrast, newer antibiotics like meropenem and polymyxin B show much lower resistance rates (2.2% and 0.6%, respectively), underscoring the need for ongoing resistance monitoring to guide clinical decisions.

The growing prevalence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) *S. Typhi* strains poses a significant challenge to global health systems [11]. Recent data indicate that 70.6% of *S. Typhi* isolates are MDR, and 63% are XDR, meaning they are resistant to multiple antibiotics, including fluoroquinolones and third-generation cephalosporins [12]. This resistance complicates treatment and increases the risk of severe outcomes, particularly in regions like Pakistan, where healthcare resources are limited [8].

To address this crisis, a comprehensive approach is needed, including improved sanitation, expanded vaccination programs, and enhanced surveillance to track resistance patterns. Better sanitation can reduce transmission, especially in areas with poor water and sanitation infrastructure [13]. Vaccination is crucial for high-risk groups, such as children in endemic regions. Surveillance systems are essential for monitoring resistance trends and informing treatment guidelines [14].

Demographic factors, such as higher infection rates among males and in low-income communities, also play a role. Males may face greater exposure risks due to occupational or lifestyle factors, while impoverished communities often lack access to clean water and healthcare, increasing their vulnerability. Tailoring public health interventions to these at-risk groups can help reduce the overall burden of enteric fever and its complications. Combating MDR and XDR *S. Typhi* requires a multifaceted strategy to ensure effective prevention and treatment, safeguarding public health.

METHODOLOGY

The study employed a prospective analysis of blood culture samples collected from paediatric department MTI-GKMC/BKMC Swabi. The primary objective was to assess the prevalence of antibiotic resistance among isolates and identify *S. Typhi*. The study focused on children, who are known to be at higher risk for enteric fever. A total of 160 blood cultures were analysed. Blood samples were cultured using standard microbiological methods to isolate. The results were categorized based on these definitions to identify the prevalence of MDR and XDR strains among the samples. The susceptibility of the isolates was determined using the disk diffusion method and minimum inhibitory concentration (MIC) testing against a panel of antibiotics, including azithromycin, meropenem, and imipenem. Descriptive statistics were used to summarize the prevalence of resistance patterns.

RESULTS

Out of 160 positive samples, 136 samples (85%) showed extensive drug resistance. XDR bacteria are resistant to multiple antibiotics, typically all but one or two classes, making infections caused by them particularly difficult to treat. The remaining 24 samples (15%) were classified as multi-drug resistant. MDR bacteria are resistant to at least one agent in three or more antimicrobial categories, but they are generally less resistant than XDR strains.

Figure 1

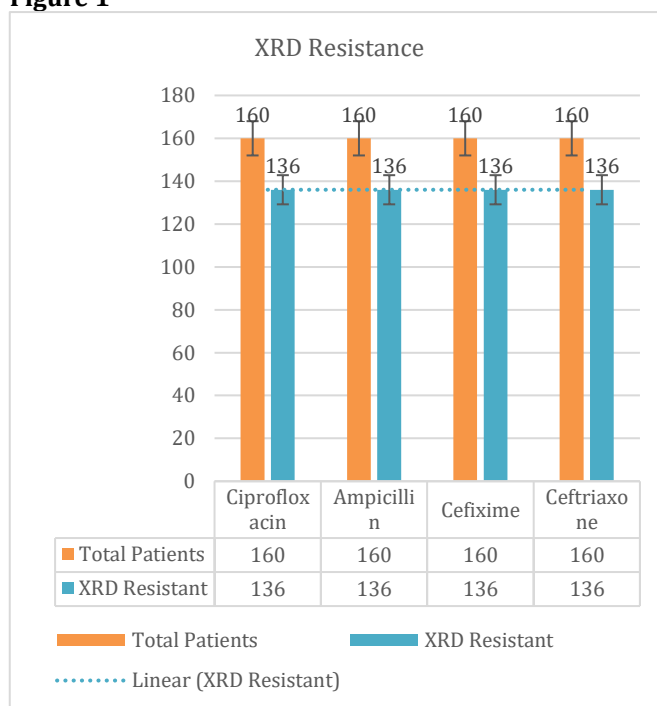


Figure 2

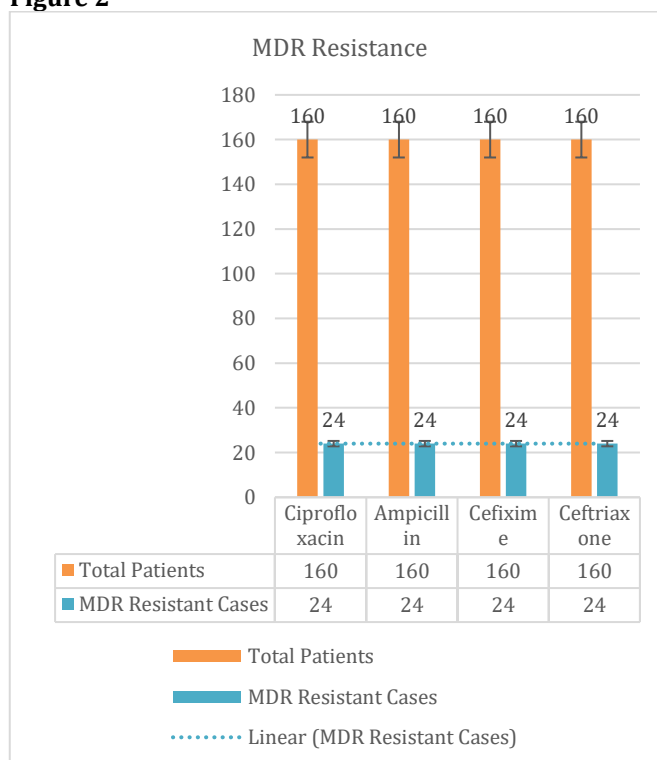


Figure 3

shows that all 160 cases are sensitive to azithromycin, meronem and imipenem significantly. It suggests that despite extensive resistance, these antibiotics remain viable treatment options for affected children.

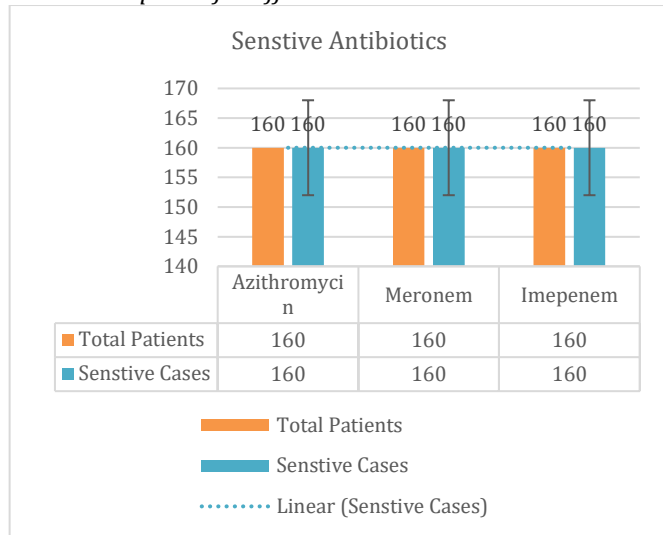
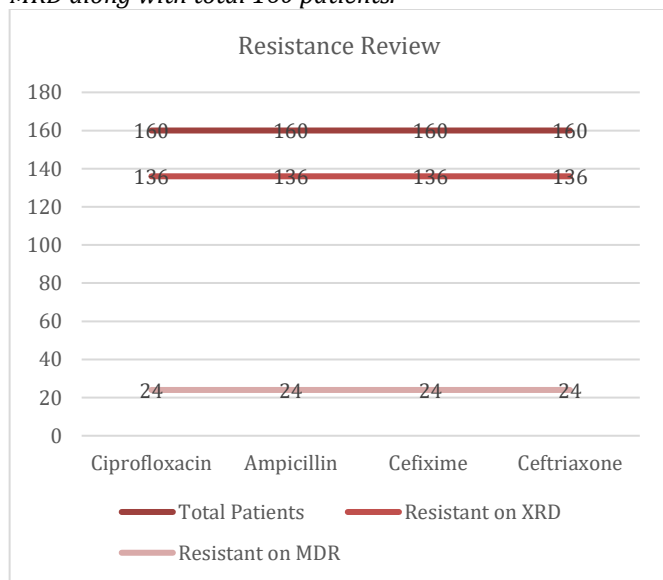


Figure 4 shows the Over All review for resistant cases on XRD and MRD along with total 160 patients.



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DISCUSSION

This study offers important insights into the prevalence of antibiotic resistance among paediatric patients with enteric fever at MTI-GKMC/BKMC Swabi. The high rate of extensively drug-resistant (XDR) isolates (85%) highlights the growing issue of antimicrobial resistance in this vulnerable group. XDR strains, which are resistant to multiple antibiotic classes except for a few, emphasize the urgent need for focused treatment strategies and strict antibiotic stewardship programs.

A key finding is the sensitivity of XDR isolates to azithromycin, meropenem, and imipenem. This indicates that, despite widespread resistance, these antibiotics remain effective treatment options for affected children. Azithromycin, a macrolide antibiotic, is often used in paediatric care due to its safety and ease of oral administration, making it suitable for outpatient treatment. On the other hand, meropenem and imipenem, both broad-spectrum carbapenems, provide strong bactericidal effects against resistant strains and are essential for severe or complicated cases. However, relying on these limited options raises concerns about the potential development of resistance to these last-resort treatments, which could further challenge clinical management.

Although multi-drug resistant (MDR) strains were found in only 15% of cases, they still represent a significant public health risk. MDR bacteria, which are resistant to at least one antibiotic in three or more categories, may require combination therapies and extended treatment periods, leading to higher healthcare costs and increased morbidity.

While the prospective design of the study provides valuable epidemiological data, it has some limitations, such as potential biases in sample collection and the inability to track changes in resistance patterns over time.

CONCLUSION

In conclusion, this study highlights the alarming prevalence of antibiotic resistance in paediatric enteric fever cases and underscores the critical need for continuous surveillance, judicious antibiotic use, and the implementation of infection control measures to mitigate the spread of resistant strains.

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