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ORIGINAL ARTICLE

Antimicrobial Susceptibility Patterns of Salmonella Typhi and Salmonella Paratyphi in Tertiary Care Hospitals

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ABSTRACT

Background: Salmonella typhi and Salmonella paratyphi are significant causes of enteric fever, posing substantial public health challenges globally. Monitoring their antimicrobial susceptibility patterns is crucial for guiding treatment strategies and combating antimicrobial resistance, particularly in tertiary care hospitals where severe cases are managed.
Aim: To determine the antibiogram profile of Salmonella typhi and Salmonella paratyphi isolated from blood cultures of paediatrics patients presenting in Lady Reading Hospital Peshawar.
Methodology: The study examined the prevalence, clinical characteristics, and antibiotic susceptibility patterns of Salmonella typhi and Salmonella paratyphi infections among 530 participants aged 13 to 18 years presenting in Lady Reading Hospital Peshawar. Over the course of two years using a prospective observational cohort design. Recruitment, clinical evaluations, and laboratory validation using accepted methods were all part of the data gathering process. Testing for antibiotic susceptibility was done, and statistical analysis was done using SPSS version 28. Both informed consent and ethical approval were obtained.
Results: The research included 530 instances of enteric fever, of which 318 cases (or 60%) were due to Salmonella typhi and 212 cases (or 40%) to Salmonella Paratyphi. There were 40.25% female cases and 59.75% male cases among them. The age group of 15–16 years old accounted for the largest percentage of cases (38.68%), followed by 13–14 years old (33.02%) and 17–18 years old (28.30%). Different patterns emerged from antimicrobial susceptibility tests; drugs such as ampicillin (66.04%), azithromycin (74.26%), cefixime (87.47%), ceftriaxone (92.77%), chloramphenicol (91.51%), ciprofloxacin (92.40%), and co-trimoxazole (55.03%) showed substantial susceptibility rates. Compared to Salmonella typhi, Salmonella paratyphi showed notably greater sensitivity rates for azithromycin (94.47%) and ceftriaxone (95.45%).
Practical implication: This research provided the community with important advantages and practical consequences. The study helps healthcare professionals choose efficient treatment plans by identifying the antibiotic susceptibility patterns of Salmonella typhi and Salmonella paratyphi, particularly in tertiary care facilities.
Conclusion: This study highlights the importance of continuous surveillance and species-specific treatment strategies to combat antimicrobial resistance and improve patient outcomes in enteric fever, particularly in tertiary care settings.
Keywords: Antimicrobial susceptibility, Salmonella typhi, Salmonella Paratyphi, Tertiary care hospitals

INTRODUCTION

There are serious global public health concerns associated with Salmonella typhi and Salmonella paratyphi, the causative organisms of typhoid and paratyphoid fever, respectively[1,2]. Particularly in areas with poor sanitation and hygiene standards, these bacterial infections bear a significant cost of illness and death[3]. Comprehending the patterns of antimicrobial susceptibility shown by these organisms is crucial in order to steer effective treatment approaches and counteract the establishment of antibiotic resistance[4]. Monitoring the susceptibility profiles of these infections becomes crucial to ensuring the best possible patient treatment and outbreak management in tertiary care centers, where severe cases are often referred[5].

Concerns have been expressed worldwide about the growth and spread of antibiotic resistance among Salmonella species, which has limited treatment choices and complicated enteric fever care[6,7]. Typhoid and paratyphoid fever are frequently treated with a variety of antimicrobial medicines, yet concerns of rising resistance to these drugs have surfaced in recent years. In order to monitor resistance trends and provide guidance for empirical treatment, it is essential that antimicrobial susceptibility patterns be continuously monitored[8]. Because of their involvement in treating complex and severe cases, tertiary care institutions are crucial hubs for this kind of monitoring and are thus perfect places to research antibiotic resistance in Salmonella typhi and Salmonella paratyphi[9,10].

Like many other low- and middle-income nations, Pakistan is plagued by enteric fever, with several outbreaks documented across different areas[11]. Many patients in tertiary care institutions show signs of probable typhoid and paratyphoid fever, which calls for a thorough examination of the antibiotic susceptibility profiles of the causing agents[12]. Comprehending the regional prevalence of antibiotic resistance is crucial for customizing therapy plans and putting in place efficient infection control strategies in medical institutions[13].

The purpose of this research is to close current gaps in our understanding of Salmonella typhi and Salmonella paratyphi's antibiotic susceptibility patterns in tertiary care settings, specifically in Pakistan. Moreover, the identification of particular resistance patterns and trends might facilitate the optimization of treatment regimens and the development of evidence-based recommendations for the local management of enteric fever.

This study aimed to determine the antibiogram profile of Salmonella typhi and Salmonella paratyphi isolated from blood cultures of paediatrics patients presenting in Lady Reading Hospital Peshawar.

MATERIAL AND METHODS

Study Design and Settings: This research used a prospective observational cohort design and was carried out over a two-year period at Lady Reading Hospital, Peshawar. Investigating Salmonella typhi and Salmonella paratyphi infection frequency, clinical features, and antibiotic susceptibility patterns in the targeted group was the goal.
Sample Size: The research had 530 individuals in all. Of these, 318(60%) cases had S. typhi recovered from them, while 212(40%) cases had S. paratyphi identified. Patients between the

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ages of 13 and 18 who had blood cultures that tested positive for S. typhi or S. paratyphi were included in this research.

Inclusion and Exclusion Criteria: The inclusion criteria consisted of individuals of all ages who presented with fever, abdominal discomfort, and gastrointestinal symptoms, all of which are suggestive of enteric fever. It was also a requirement for eligible participants to live in the designated catchment region of the involved medical institutions. In order to ensure that participants were fully informed of the research's methods, goals, and possible dangers before enrolling, informed consent was required for participation in the study. On the other hand, those who had received antibiotic treatment for suspected enteric fever in the two weeks before to the trial were excluded, since this might potentially skew the results. Due to possible intricacies in their clinical presentation, those with known immunosuppressive disorders or chronic medical illnesses were also disqualified. In addition, the research excluded individuals who were unable or unwilling to provide informed permission, upholding moral principles and guaranteeing voluntary involvement..

Data Collection: There were numerous important steps in the data gathering procedure. First, participants exhibiting symptoms consistent with enteric fever were gathered at Lady Reading Hospital, the chosen study location. After recruiting, each participant's age, gender, and other pertinent information were gathered along with other pertinent data. A thorough clinical evaluation was then carried out, during which the symptoms, length of the illness, and pertinent medical history were recorded. The subjects' biological samples—blood, feces, and/or urine were then taken for analysis at a lab. Salmonella typhi and Salmonella paratyphi infections were confirmed in the lab using normal microbiological methods, such as biochemical identification and culture. Furthermore, in compliance with recognized protocols, antimicrobial susceptibility testing was carried out on the isolated pathogens using the broth microdilution technique or disk diffusion method. Complete data collection and analysis were ensured by the careful documenting of antibiotic treatment regimens and clinical outcomes during follow-up visits throughout the trial.

Statistical Analysis: The statistical software package known as SPSS version 28 was used to examine the data that had been gathered. The research population's clinical presentations, antibiotic susceptibility patterns, and demographics were all summarized using descriptive statistics. Furthermore, based on the suitability of the data, categorical variables were compared across groups using either the chi-square test.

Ethical Approval: The Institutional Review Board (IRB) had granted ethical clearance for this project. Prior to their registration in the research, all participants or their legal guardians will be asked for their informed permission.

RESULTS

A total of 530 instances of enteric fever were found in the demographic data; 318(60%) of these cases were caused by Salmonella typhi, and 212 (40%) by Salmonella Paratyphi (figure 1). There were 210 (40.25%) female patients and 320(59.75%) male patients among the cases. In terms of age distribution, the age group of 15–16 years had the greatest number of cases—205 (38.68%)—followed by that of 13–14 years, which had 175 (33.02%) cases, and that of 17–18 years, which had 150 (28.30%) cases.

The antimicrobial susceptibility patterns of several drugs against bacterial strains are shown in figure 2. For example, 210 instances of ampicillin showed susceptibility; 20 cases had intermediate resistance, and 88 cases were resistant; this led to a susceptibility rate of 66.04%. Comparably, 240 instances of azithromycin showed susceptibility; 10 cases had intermediate resistance, and 68 cases were resistant; this translated into a percentage susceptibility of 74.26%. With 275 instances exhibiting susceptibility to cefixime, 5 cases exhibiting intermediate resistance, and 38 cases exhibiting resistance, the percentage susceptibility was 87.47%. With 295 instances (92.77%), ceftriaxone showed the maximum susceptibility, while chloramphenicol showed a 91.51% percentage susceptibility. In 280 instances (92.40%), ciprofloxacin showed susceptibility, while co-trimoxazole showed the lowest rate of susceptibility (55.03%).

Figure 3 depicted Salmonella paratyphi's patterns of antibiotic susceptibility. Significantly, the susceptibility rate to chloramphenicol was greatest at 96.69%, closely followed by that to ceftriaxone at 95.45%, azithromycin at 94.47%, and ciprofloxacin at 94.33%. On the other hand, co-trimoxazole had the lowest susceptibility percentage (61.32%), indicating a high level of bacterial resistance.

The antimicrobial susceptibility profiles of Salmonella typhi and Salmonella paratyphi are shown in Table 1, together with the significance of the variations in susceptibility between the two pathogens as indicated by the results of the chi-square test. Interestingly, Salmonella paratyphi showed more sensitivity to azithromycin than did Salmonella typhi (94.47% vs. 74.26%, $p = 0.001$). In a similar vein, Salmonella paratyphi (95.45%) showed a considerably greater sensitivity to Ceftriaxone than did Salmonella typhi (92.77%, $p = 0.049$). On the other hand, there was a significant difference in the susceptibility of Co-trimoxazole to both infections (61.32% vs. 55.03%, $p = 0.032$).

The distribution of cases of Salmonella typhi and Salmonella paratyphi in relation to age and gender is shown in Table 2, along with the corresponding statistical comparison shown by p-values. Significant statistical differences were noted ($p = 0.005$) between the 100 cases of Salmonella typhi among men and the 70 cases among females in the 13–14 age group, as well as the 60 cases of Salmonella paratyphi among males and 45 cases among females. Similarly, there were 120 cases of Salmonella typhi in men, 85 in females, 70 instances of Salmonella paratyphi in males, and 45 in females in the 15–16 age group. A statistically significant difference was shown by the p-value of 0.049. Significant variations were also seen ($p = 0.001$) in the 17–18 age range, where there were 98 instances of Salmonella typhi in men, 65 in females, 40 in males, and 25 in females.

Figure 1: Age and gender distribution of cases of Salmonella typhi and Salmonella paratyphi

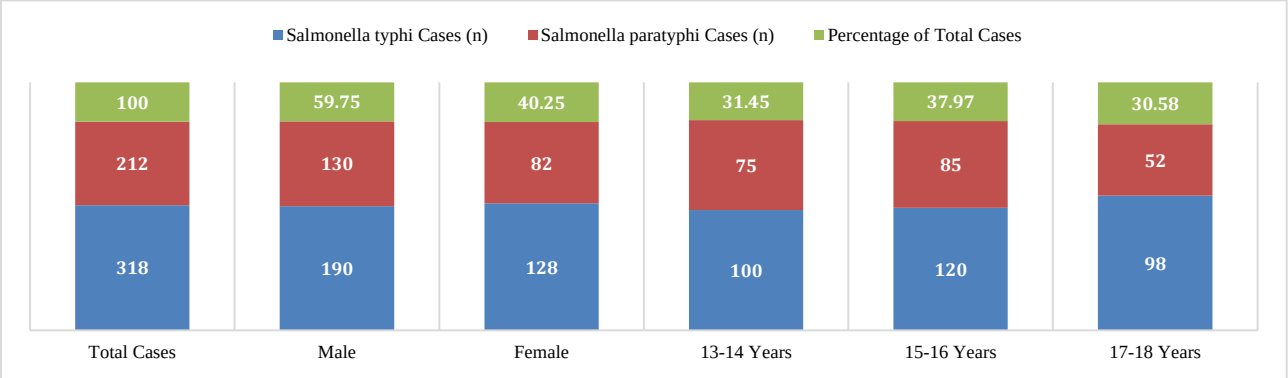

Figure 2: Antimicrobial Susceptibility Patterns of Salmonella typhi

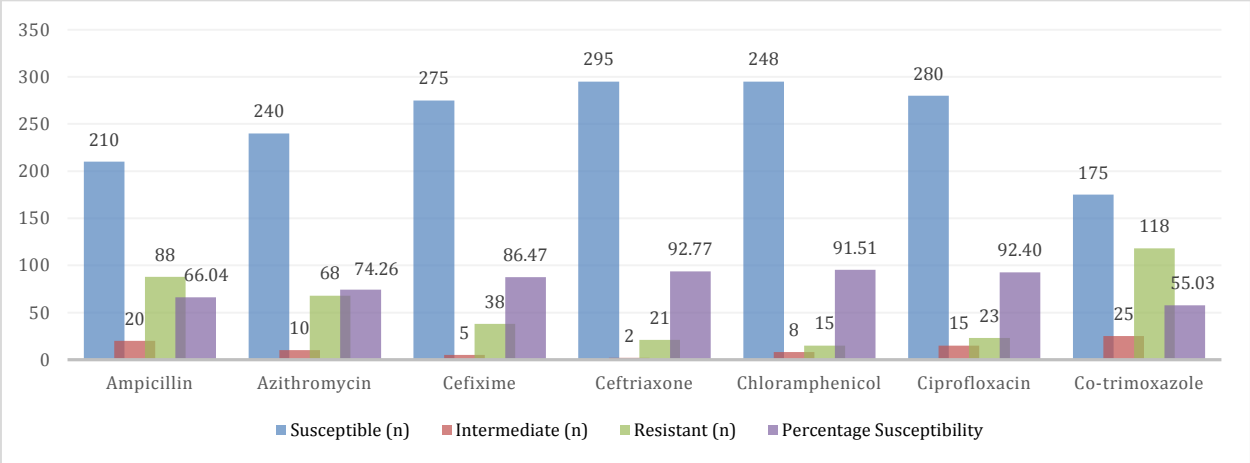

Figure 3: Antimicrobial Susceptibility Patterns of Salmonella paratyphi

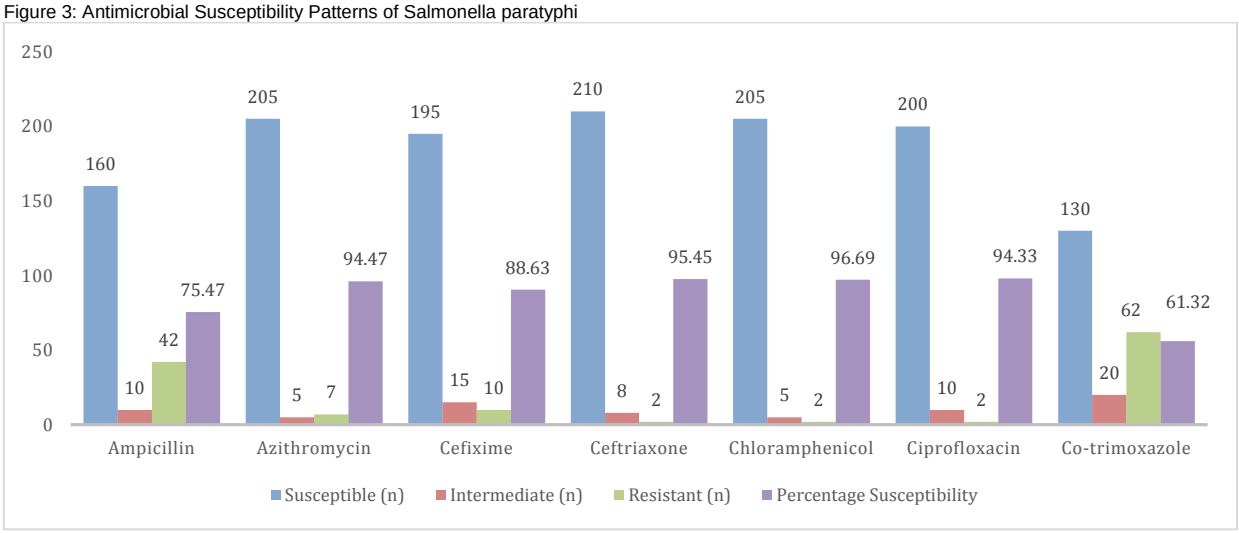

Table 1: Antimicrobial Susceptibility Comparison between Salmonella typhi and Salmonella paratyphi

Antimicrobial Agent	Salmonella typhi (Susceptible)(n; %)		Salmonella paratyphi (Susceptible)(n; %)		Chi-square test (p-value)
Ampicillin	210	66.04	160	75.47	0.007
Azithromycin	240	74.26	205	94.47	0.001
Cefixime	275	86.47	195	88.63	0.290
Ceftriaxone	295	92.77	210	95.45	0.049
Chloramphenicol	248	91.51	205	96.69	0.323
Ciprofloxacin	280	92.40	200	94.33	0.081
Co-trimoxazole	175	55.03	130	61.32	0.032

Table 2: Demographic distribution of cases of salmonella typhi and salmonella paratyphi by age and gender

Age Group	Salmonella typhi (Male)	Salmonella typhi (Female)	Salmonella paratyphi (Male)	Salmonella paratyphi (Female)	Chi-square test (p-value)
13-14 Years	100	70	60	45	0.005
15-16 Years	120	85	70	45	0.049
17-18 Years	98	65	40	25	0.001

DISCUSSION

This research examined the trends of antibiotic susceptibility to Salmonella typhi and Salmonella paratyphi in tertiary care facilities, Pakistan. A total of 530 cases of enteric fever were found based on the demographic distribution, with Salmonella typhi accounting for 60% of the cases and Salmonella paratyphi for 40%. In line with earlier research, the age group of 15 to 16 years old had the greatest number of cases out of all the age groups, suggesting a considerable illness burden in teenagers[14,15].

Significant variations were found in the susceptibility profiles of Salmonella typhi and Salmonella paratyphi with respect to antibiotics. Ceftriaxone (92.77%) and chloramphenicol (91.51%) showed the maximum susceptibility to Salmonella typhi, whereas co-trimoxazole (55.03%) showed the lowest susceptibility. These results are in line with a prior study that found that isolates of Salmonella typhi were becoming less susceptible to older antimicrobial treatments[16].

Compared to Salmonella typhi, Salmonella paratyphi showed greater overall susceptibility rates, especially for azithromycin (94.47%) and ceftriaxone (95.45%). In line with other studies, both infections, however, showed comparatively poor resistance to co-trimoxazole[17,18]. Interestingly, chloramphenicol showed the greatest susceptibility rate at 96.69%, which contradicts other research findings[19] but is compatible with certain previous studies (Sharma et al., 2019).

Comparing Salmonella typhi and Salmonella paratyphi to earlier research investigations shows continuous patterns of diminishing susceptibility to older antimicrobial agents and comparatively increased susceptibility to newer agents. To direct empirical treatment and stop the evolution of resistance, the study's results emphasize the need of ongoing surveillance and monitoring of antimicrobial resistance trends. Interestingly, ceftriaxone showed noticeably greater susceptibility in Salmonella paratyphi (95.45%) than in Salmonella typhi (92.77%, p = 0.049), whereas azithromycin showed higher susceptibility in Salmonella paratyphi compared to 74.26% (74.47% vs. 74.26%). On the other hand, co-trimoxazole demonstrated reduced susceptibility in both infections, with a significant difference (61.32% vs. 55.03%, p = 0.032), in line with some earlier research[20].

Overall, this work adds to the expanding body of knowledge on Salmonella typhi and Salmonella paratyphi's antibiotic susceptibility patterns in tertiary care settings, offering crucial information that will guide treatment recommendations and public health initiatives. The observed variations in susceptibility profiles between the two pathogens highlight the significance of species-specific management measures in containing enteric fever outbreaks and highlight the complexity of the dynamics of antibiotic resistance. In order to address the growing danger of antibiotic resistance in enteric fever pathogens, future research should concentrate on clarifying the underlying mechanisms of resistance and assessing the effectiveness of alternate treatment regimens.

CONCLUSION

There were noticeable distinctions between the two organisms, with Salmonella typhi showing lower overall susceptibility rates and Salmonella paratyphi showing greater rates. Although the sensitivity of both infections to older antimicrobial drugs declined, the effectiveness of newer medicines such as ceftriaxone and azithromycin was comparatively greater. These results highlight the need of ongoing monitoring and species-specific treatment considerations in directing empirical therapy and preventing antibiotic resistance in enteric fever pathogens. In tertiary care settings, this study helps to improve patient outcomes and inform public health actions.

Authorship and contribution declaration: Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.

All authors agree to be responsible for all aspects of their research work.

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