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Original Research Article

Prevalence of Salmonella Species and their Antimicrobial Susceptibility Pattern at a Tertiary Care Hospital of Gujarat

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ABSTRACT

Background: Salmonella species are major pathogens causing enteric fever and bloodstream infections in endemic regions like India. Despite improvements in sanitation, the disease burden remains high. Increasing antimicrobial resistance (AMR), particularly fluoroquinolone (ciprofloxacin) resistance, has restricted therapeutic options**.**

Material and methods: This retrospective cross-sectional study was conducted in the Department of Microbiology, GMERS Medical College & General Hospital, Vadodara, Gujarat, using blood culture records for the period September 2024 to September 2025. A total of 1234 blood culture samples from clinically suspected enteric fever cases were processed using the BACTEC FX 40 automated blood culture system. Isolates were identified by biochemical tests and serotyping. Antimicrobial susceptibility was determined by Kirby–Bauer disc diffusion method on muller –hinton agar as per CLSI guidelines 2024.

Results: Out of 1234 blood culture samples processed during the study period, 73 (5.9%) yielded Salmonella isolates. The majority were Salmonella Typhi (91.8%, n=67), followed by Salmonella Paratyphi A (6.8%, n=5) and Salmonella Paratyphi B (1.4%, n=1). Most cases occurred in the pediatric age group (≤12 years), accounting for 65 cases (89.0%). Antimicrobial susceptibility testing showed that all isolates showed susceptibility to ceftriaxone, azithromycin and imipenem. Chloramphenicol retained high susceptibility (97.0%), followed by ampicillin (83.6%) and co-trimoxazole (80.6%). High resistance was observed to ciprofloxacin (90.4%).

Conclusion: Salmonella bloodstream infections remain a major health burden in pediatric patients. High fluoroquinolone resistance highlights the need for continuous surveillance and rational antibiotic use.

Keywords: Salmonella, bloodstream infection, antimicrobial resistance, pediatric infection, India

INTRODUCTION

Enteric fever, caused by Salmonella Typhi and Salmonella Paratyphi, remains a significant public health problem in developing countries. India bears a significant burden of enteric fever with several studies reporting persistent transmission in different regions including Gujarat.[1]

Despite improvements in sanitation and healthcare facilities, the disease burden continues to be high, with South Asia contributing the largest share of the estimated 22 million annual global cases.[1-3]

The therapeutic management of enteric fever has been complicated by the emergence of multidrug-resistant (MDR) strains. Resistance to first-line drugs such as ampicillin, chloramphenicol, and co-trimoxazole was widely reported in the past, leading to a shift towards fluoroquinolones. However, in recent decades, fluoroquinolone resistance has increased alarmingly in India, with reports of more than 90% resistance in some regions.[4-6]

Currently, third-generation cephalosporins such as ceftriaxone and macrolides such as azithromycin are considered reliable choices for empirical therapy. Although resistance to these agents remains relatively uncommon, sporadic reports from Gujarat and other parts of India have raised concern about future treatment failures. Interestingly, older agents like chloramphenicol have shown a partial resurgence of susceptibility in recent studies, suggesting their potential reconsideration in therapy.[7-9]

Given this evolving scenario, continuous surveillance of antimicrobial resistance patterns is essential to guide empirical treatment and to prevent therapeutic failures. The present study was therefore undertaken to determine the prevalence of Salmonella isolates from blood cultures and to analyze their antimicrobial susceptibility profile at a tertiary care hospital in Gujarat.[10]

MATERIAL AND METHODS

Study design and setting: This laboratory-based retrospective cross-sectional study was conducted in the Department of Microbiology, GMERS Medical College and General Hospital, Gotri, Vadodara, Gujarat. Blood culture records for the period September 2024 to September 2025 were retrospectively reviewed.

Blood samples received from clinically suspected cases of enteric fever during the study period were processed using the BACTEC™ FX 40 automated blood culture system. Approximately 8–10 mL of blood was collected from adult patients and 2–3 mL from pediatric patients for blood culture. One blood culture bottle per patient was included in the analysis. Bottles showing positive growth were subcultured onto MacConkey agar and Brain Heart Infusion agar and incubated at 37°C for 18–24 hours. Bottles that did not show any growth signal in the automated BACTEC™ FX 40 blood culture system after 5 days of incubation were considered negative.

Colonies suspected to be Salmonella were identified by colony morphology and biochemical reactions including oxidase test, catalase test, triple sugar iron (TSI) agar, IMViC (Indole, Methyl Red, Voges–Proskauer, Citrate), amino acid decarboxylation tests, and sugar fermentation tests. Final confirmation was carried out by slide agglutination using Salmonella O and H antisera according to the Kauffmann–White scheme. S. Typhi (Group D) was identified using H-d antisera, S. Paratyphi A (Group A) using H-a antisera, and S. Paratyphi B (Group B) using H-b antisera.

Antimicrobial susceptibility testing of all confirmed Salmonella isolates was performed by the Kirby–Bauer disk diffusion method on Mueller–Hinton agar. The results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) M100 guidelines (2024). The antibiotic panel tested included ampicillin, ciprofloxacin, ceftriaxone, chloramphenicol, cotrimoxazole, azithromycin, and imipenem. Ciprofloxacin and azithromycin susceptibility were determined by the disk diffusion method as per CLSI interpretative criteria. Escherichia coli ATCC 25922 was used as the quality-control strain. Duplicate isolates from the same patient were excluded from the analysis.

RESULTS

Out of 1234 clinical blood samples processed during the study period, 73(5.9%) yielded Salmonella isolates. The majority of isolates were Salmonella Typhi (91.8%, n = 67), followed by Salmonella Paratyphi A (6.8%, n = 5) and Salmonella Paratyphi B (1.4%,n= 1).

Demographic profile

The demographic distribution of the 73 culture-confirmed Salmonella cases showed a clear predominance of the pediatric age group (≤12 years), accounting for 65 cases (89.0%), while only 8 cases (11.0%) were observed in the adult group (>12 years).

Table – 1: Demographic distribution of patients with enteric fever (n=73)

Age group (years)	Male	Female	Total n (%)
≤12 (Pediatric)	36	29	65 (89.0)
>12 (Adult)	2	6	8 (11.0)
Total	38	35	73 (100)

Table - 2: Antimicrobial susceptibility pattern of Salmonella isolates (n=73)

Antibiotic (Disc conc.) (µg)	Sensitive n (%)	Resistant n (%)
Ampicillin (10)	61 (83.6)	12 (16.4)
Ciprofloxacin (5)	7 (9.6)	66 (90.4)
Ceftriaxone (30)	73 (100)	0 (0)
Chloramphenicol (30)	71 (97.0)	2 (3.0)
Cotrimoxazole (1.25/23.75)	59 (80.6)	14 (19.4)
Azithromycin (15)	73 (100)	0(0)
Imipenem (10)	73 (100)	0 (0)

Antimicrobial susceptibility pattern of Salmonella isolates shown in table-2. Among the 73 Salmonella isolates, higher resistance was observed against ciprofloxacin (90.4%), followed by co-trimoxazole (19.4%) and ampicillin (16.4%). In contrast, all isolates were found to be susceptible to ceftriaxone, azithromycin and imipenem, while chloramphenicol retained high susceptibility (97.0%).

Table -3: Antimicrobial susceptibility pattern of salmonella typhi (n=67)

Antibiotic (Disc conc.) (µg)	Sensitive n (%)	Resistant n (%)
Ampicillin (10)	55 (82.1)	12 (17.9)
Ciprofloxacin (5)	5 (7.5)	62 (92.5)
Ceftriaxone (30)	67 (100)	0 (0)
Chloramphenicol (30)	65 (97.0)	2 (3.0)
Co-trimoxazole (1.25/23.75)	53 (79.1)	14 (20.9)
Azithromycin (15)	67 (100)	0 (0)
Imipenem (10)	67 (100)	0 (0)

Antimicrobial susceptibility pattern of salmonella typhi shown in table 3.

Among the 67 isolates of Salmonella Typhi, high susceptibility was observed to ceftriaxone, azithromycin, and imipenem. Chloramphenicol also retained excellent activity, with 97% isolates being susceptible. Co-trimoxazole showed moderate effectiveness, with 79.1% susceptibility. In contrast, ampicillin resistance was noted in 17.9% isolates. Ciprofloxacin exhibited the highest resistance, with 92.5% of isolates resistant and only 7.5% remaining susceptible.

Table 4 presents the antimicrobial susceptibility pattern of S. Paratyphi A and S. Paratyphi B Among the five isolates of Salmonella Paratyphi A.

All were susceptible to ampicillin, ceftriaxone, chloramphenicol, co-trimoxazole, azithromycin and imipenem. However, resistance to ciprofloxacin was observed in three isolates (60%). The single isolate of Salmonella Paratyphi B demonstrated resistance to ciprofloxacin while remaining susceptible to all other tested antibiotics.

Table -4: Antimicrobial susceptibility pattern of *Salmonella* Paratyphi A (n=5) and S. Paratyphi B (n=1)

Antibiotic (Disc conc.) (µg)	S. Paratyphi A (n=5) sensitive %	S. Paratyphi B (n=1) sensitive %
Ampicillin (10)	100 %	100%
Ciprofloxacin (5)	40%	0 %
Ceftriaxone (30)	100%	100%
Chloramphenicol (30)	100%	100%
Co-trimoxazole (1.25/23.75)	100%	100%

DISCUSSION

Table -5: Demographic comparison of enteric fever cases

Study (Author, Year)	Total isolates (n)	Pediatric %	Adult %
Present study, Vadodara 2025	73	89%	11%
Patel& Desai,et al. , Gujarat 2022[12]	156	76%	24%
SEFI Surveillance, India 2025 [11]	>2800	70–80%	20–30%
Sahai et al., India 2023[6]	>1250	~72%	~28%

A comparison of the demographic distribution of enteric fever cases with previous studies is presented in Table 5.

Antimicrobial resistance pattern: Ciprofloxacin resistance was very high (90.4%) in our isolates, similar to the findings reported by Talukder et al[9], where resistance also exceeded 90%. This indicates that fluoroquinolones may no longer be reliable for empirical therapy in enteric fever in many endemic settings.

In contrast, ceftriaxone and azithromycin demonstrated complete susceptibility in the present study, which is consistent with findings reported in previous studies. However, sporadic ceftriaxone resistance has been reported by Dahiya et al[7], raising concern regarding possible treatment failures and emphasizing the need for continued antimicrobial resistance surveillance.

Interestingly, older antibiotics such as chloramphenicol, ampicillin, and co-trimoxazole showed encouraging susceptibility rates in the present study (97%, 83.6%, and 80.6% respectively). Similar findings were also observed by Gupta et al[13], suggesting a possible re-emergence of susceptibility to these conventional drugs after years of reduced clinical use. These findings indicate that these antibiotics may be cautiously reconsidered as therapeutic options when guided by antimicrobial susceptibility testing

Table- 6: Antibiotic susceptibility comparison of Salmonella Typhi

Study	CIP	CTR	AZM	CHL
Present study (2025)	90.4% R	100% S	100% S	97% S
SEFI, India (2025)[11]	>90% R	~100% S	High S	94–96% S
Talukder et al. (2023)[9]	High R	High S	Emerging R	94–96% S
Patel & Desai et al. (2022)[12]	88–90% R	98–100% S	~95% S	92–95% S

*****Abbreviations: CIP-ciprofloxacin; CTR- ceftriaxone; AZM- azithromycin; CHL- chloramphenicol; S- susceptible; R- resistant.

Clinical implications:

The findings of the present study highlight the persistent burden of enteric fever, particularly among pediatric patients, along with the increasing resistance to fluoroquinolones. At the same time, sustained susceptibility to ceftriaxone and azithromycin and the re-emergence of susceptibility to older antibiotics provide important insights for treatment strategies. Continuous monitoring of antimicrobial resistance patterns and rational antibiotic use remain essential to prevent therapeutic failures and to guide effective management of enteric fever.

CONCLUSIONS

Our study demonstrated a significant pediatric burden of enteric fever, with 89% of cases occurring in children. Ciprofloxacin resistance was very high (90.4%), suggesting that fluoroquinolones are no longer appropriate for empirical therapy. In contrast, all isolates in the present study were susceptible to ceftriaxone and azithromycin in the present study and remain effective therapeutic options in our clinical setting. Older agents such as chloramphenicol, ampicillin, and co-trimoxazole showed encouraging re-emergence of activity but should be used cautiously under antimicrobial susceptibility testing (AST) guidance. These findings emphasize the need for continuous antimicrobial resistance surveillance and rational antibiotic use to prevent future therapeutic failures.

REFERENCES

1. Crump JA, Mintz ED. Global trends in typhoid and paratyphoid fever. Clin Infect Dis. 2010;50(2):241–246.

2. Ochiai RL, Acosta CJ, Danovaro-Holliday MC, Baiqing D, Bhattacharya SK, Agtini MD, et al. A study of typhoid fever in five Asian countries: disease burden and implications for controls. Bull World Health Organ.2008;86(4):260–268.

3. Marchello CS, Hong CY, Crump JA. Antimicrobial resistance in *Salmonella* Typhi and S. Paratyphi A in South Asia: a systematic review. PLoSNegl Trop Dis. 2020;14(11):e0008969.

4. Parry CM, Threlfall EJ. Antimicrobial resistance in typhoidal and nontyphoidal *salmonella*e. CurrOpin Infect Dis. 2008;21(5):531–538.

5. Walia M, Gaind R, Mehta R, Paul P, Aggarwal P, Kalaivani M, et al. Current perspectives of enteric fever: a hospital-based study from India. Indian J Med Microbiol. 2005;23(4):200–202.

6. Sahai N, John J, Arunachalam DK, et al. antimicrobial susceptibility trends of S. Typhi and S. Paratyphi in a post-COVID-19 India: a multicenter surveillance network. Sci Rep. 2025; 15:13777.

7. Dahiya S, Sharma P, Kumari B, et al. Ceftriaxone-resistant *Salmonella* Typhi from Gujarat, India. J Med Microbiol. 2023;72(8):001658.

8. Thirumoorthy TP, Gopalakrishnan R, Desai A. Emergence of cephalosporin-resistant S. Typhi in India. MicrobiolSpectr. 2025;13(2): e03045-25.

9. Talukder H, Rahman M, Dutta DK, et al. Re-emergence of susceptibility to chloramphenicol in enteric fever pathogens: an observational study from South Asia. Trans R Soc Trop Med Hyg. 2023;117(1):45–52.

10. National Centre for Disease Control (NCDC). Surveillance report on enteric fever in India, 2025. New Delhi: NCDC; 2025.

11. Surveillance for Enteric Fever in India (SEFI). National enteric fever surveillance data, India, 2025. New Delhi: SEFI Network; 2025.

12. Patel R, Desai A, Shah H. Emerging azithromycin resistance in *Salmonella* Typhi from western India. Int J Infect Dis. 2024; 126:89–95.

13. Gupta V, Kumar A, Sharma N, et al. Changing trends of chloramphenicol susceptibility in enteric fever in India. Indian J Med Microbiol. 2023;41(4):456–62.

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