

Alterations in Serum Electrolytes among Adults with Enteric Fever: A Retrospective Observational Study from a Tertiary Center in New Delhi



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ABSTRACT

Background: Electrolyte abnormalities are frequent in systemic infections such as enteric fever but remain under-recognized in clinical practice. These disturbances may worsen morbidity if not identified and corrected early.

Objective: To determine the prevalence and pattern of serum electrolyte alterations in adult patients hospitalized with enteric fever at a tertiary care center in New Delhi.

Materials and methods: This retrospective observational study analyzed records of 128 adult patients (59 males, 69 females) with laboratory-confirmed enteric fever between January 2023 and March 2024. The first admission values for sodium, potassium, chloride, and bicarbonate were extracted from the hospital laboratory system. Results were categorized as low, normal, or high using standard clinical reference ranges. Descriptive statistics were applied, and gender-based comparisons were performed using Chi-square tests for categorical variables and *t*-tests for continuous measures.

Results: Hyponatremia was present in 58.6% (75/128) of patients, while 57.8% (74/128) had low bicarbonate levels consistent with a trend toward metabolic acidosis. In contrast, potassium and chloride values were predominantly normal, with abnormalities occurring in <10% of patients. The mean \pm standard deviation (SD) values (mmol/L) were: sodium 132.7 ± 6.2 , potassium 4.3 ± 0.6 , chloride 101.1 ± 3.7 , and bicarbonate 20.3 ± 4.7 . No significant gender differences were detected for mean values or abnormality prevalence (all $p > 0.17$).

Conclusion: Hyponatremia and reduced bicarbonate were the most common electrolyte abnormalities in enteric fever, whereas potassium and chloride disturbances were uncommon. Routine electrolyte monitoring should be incorporated into the management of hospitalized enteric fever patients to enable early correction and improved clinical outcomes.

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INTRODUCTION

Enteric fever, caused by *Salmonella enterica* serovars Typhi and Paratyphi, remains a major public health concern in many developing countries, including India. Globally, the World Health Organization (WHO) estimates >11 million cases and 129,000 deaths annually, with the highest burden reported from South Asia and sub-Saharan Africa.¹ In India, the Surveillance for Enteric Fever in India (SEFI) study reported an annual incidence ranging from 360 to 1,200 cases per 100,000 population, underscoring its continued endemicity despite advances in sanitation and antibiotic therapy.²

Electrolyte abnormalities are frequently observed in systemic infections and have been associated with worse clinical outcomes, including prolonged hospitalization and mortality.³ Hyponatremia is particularly common in hospitalized patients with infectious diseases and may result from gastrointestinal fluid loss, renal salt-wasting, or the syndrome of inappropriate

antidiuretic hormone secretion (SIADH).⁴ In addition, metabolic acidosis, reflected by low bicarbonate levels, can occur due to dehydration, tissue hypoperfusion, and accumulation of organic acids during systemic illness.⁵

Previous studies have highlighted the relevance of monitoring serum electrolytes in enteric fever. A study from Bangladesh found a high prevalence of hyponatremia among patients with severe typhoid,⁶ while Garba et al. in Nigeria reported frequent hyponatremia, hypochloremia, hypokalemia, and metabolic acidosis among 60 laboratory-confirmed typhoid patients.⁷ These findings suggest that electrolyte disturbances are a common but under-recognized feature of enteric fever, with potential implications for patient management.

Despite the high burden of disease in India, there is limited contemporary data on the electrolyte profiles of hospitalized adult enteric fever patients. The present study was conducted at a tertiary care center in New Delhi with the aim of characterizing

the prevalence and pattern of serum electrolyte abnormalities—specifically sodium, potassium, chloride, and bicarbonate—at admission. By identifying these disturbances early, clinicians may better anticipate complications and optimize supportive care in affected patients.

MATERIALS AND METHODS

Study Design and Setting

We conducted a retrospective observational study at Max Super Specialty Hospital, Saket, New Delhi, a tertiary care referral center serving both urban and semiurban populations. The study period was from January 2023 to March 2024. Data were obtained from the hospital's laboratory information system (LIS), which records all biochemical and hematological investigations in real time. The study was designed and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observational research.⁸

Participants and Case Definition

All adult patients (≥ 18 years) with a diagnosis of enteric fever (typhoid or paratyphoid fever) and a complete serum electrolyte panel (sodium, potassium, chloride, bicarbonate) performed at the time of admission were eligible for inclusion. Enteric fever was diagnosed by treating clinicians based on microbiological and/or serological evidence, consistent with prior literature.^{3,4} In our setting, this included:

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- Blood culture positive for *Salmonella enterica* serovar Typhi or Paratyphi (gold standard).
- Rapid serological tests, where applicable.
- Patients with only a clinical diagnosis without laboratory confirmation were excluded to minimize misclassification.

After initial extraction of 240 records, duplicate entries and incomplete panels were removed, yielding a final cohort of 128 adult patients. Only the first electrolyte panel at admission was retained to reflect the baseline biochemical profile.

Data Collection and Variables

The following information was extracted: patient registration number, sex, age, hospital location, and electrolyte results. Electrolyte assays were performed using automated biochemistry analyzers following standard laboratory protocols. Each test was conducted with internal and external quality controls in line with institutional policy.

Electrolyte Measurement Methods

- Sodium and potassium were measured using ion-selective electrode (ISE) technology, a widely accepted method for direct quantification of serum electrolytes.⁹
- Chloride concentration was determined via a colorimetric method, based on the formation of a colored complex proportional to chloride ion concentration.¹⁰
- Bicarbonate levels were estimated enzymatically using the modified Forrester method, where bicarbonate reacts with phosphoenolpyruvate in the presence of phosphoenolpyruvate carboxylase (PEPC) and malate dehydrogenase (MDH), with nicotinamide adenine dinucleotide (NADH) oxidation measured spectrophotometrically.¹¹

Reference Ranges and Classification

Electrolyte results were categorized as low, normal, or high based on standard clinical ranges used in prior studies^{6,7}:

- Sodium (Na⁺): 135–155 mmol/L.
- Potassium (K⁺): 3.0–5.0 mmol/L.
- Chloride (Cl⁻): 98–108 mmol/L.
- Bicarbonate (HCO₃⁻): 22–32 mmol/L.

Statistical Analysis

Continuous variables were summarized as mean ± standard deviation (SD), while categorical variables were presented as counts and percentages. Comparisons between male and female patients were performed using Welch's *t*-test for means and Chi-square test for categorical distributions of abnormality (low/high vs normal). A two-sided *p*-value <0.05 was considered statistically significant. Statistical analysis was performed using Python (pandas), and the results are presented as mean ± standard deviation for continuous variables and as counts and percentages for categorical variables.

RESULTS

Study Population

A total of 128 adult patients with laboratory-confirmed enteric fever and complete electrolyte profiles were included in the final analysis. Of these, 59 (46.1%) were male and 69 (53.9%) female.

Distribution of Electrolyte Abnormalities

At admission, sodium and bicarbonate disturbances were most common (Table 1). Specifically, hyponatremia was observed in nearly 6 out of 10 patients (58.6%), making it the most frequent abnormality. Similarly, low bicarbonate levels were recorded in 57.8%, suggestive of a trend toward metabolic acidosis. In contrast, potassium and chloride

values remained largely preserved, with over 95% of patients within normal potassium limits and nearly 90% within normal chloride limits. Only a small fraction showed hypokalemia, hyperkalemia, hypochloremia, or hyperchloremia.

Mean Serum Electrolyte Values

The overall mean concentrations reinforced the categorical findings (Table 2). Sodium levels were slightly below the reference threshold, with a mean of 132.7 mmol/L, while bicarbonate averaged 20.3 mmol/L, again falling below the normal lower limit of 22 mmol/L. In contrast, mean potassium (4.3 mmol/L) and chloride (101.1 mmol/L) values were well within the reference ranges.

Gender-based Comparisons

Tables 3 and 4 summarize gender-based analyses. Across all four electrolytes, mean values did not differ significantly between males and females. Although females showed slightly lower average sodium and bicarbonate values, the differences were not statistically significant (*p* > 0.17). Likewise, the distribution

Table 2: Mean serum electrolyte levels at admission

Electrolyte	Mean ± SD (mmol/L)
Sodium	132.7 ± 6.2
Bicarbonate	20.3 ± 4.7
Potassium	4.3 ± 0.6
Chloride	101.1 ± 3.7

Table 4: Gender vs electrolyte abnormality (Chi-square tests)

Electrolyte	χ ²	<i>p</i> -value
Sodium	1.05 (1)	0.307
Bicarbonate	1.86 (1)	0.172
Potassium	0.04 (1)	0.849
Chloride	<0.01 (1)	0.995

Table 1: Electrolyte distribution (*n* = 128)

Electrolyte	Low <i>n</i> (%)	Normal <i>n</i> (%)	High <i>n</i> (%)
Sodium	75 (58.6)	53 (41.4)	0 (0.0)
Bicarbonate	74 (57.8)	51 (39.8)	3 (2.3)
Potassium	3 (2.3)	122 (95.3)	3 (2.3)
Chloride	7 (5.5)	115 (89.8)	6 (4.7)

Table 3: Mean serum electrolyte levels by gender

Electrolyte	Male (<i>n</i> = 59) Mean ± SD	Female (<i>n</i> = 69) Mean ± SD	<i>p</i> -value
Sodium	133.3 ± 6.3	132.2 ± 6.2	0.314
Bicarbonate	20.9 ± 4.9	19.8 ± 4.6	0.189
Potassium	4.2 ± 0.5	4.4 ± 0.6	0.092
Chloride	100.7 ± 3.7	101.4 ± 3.7	0.314

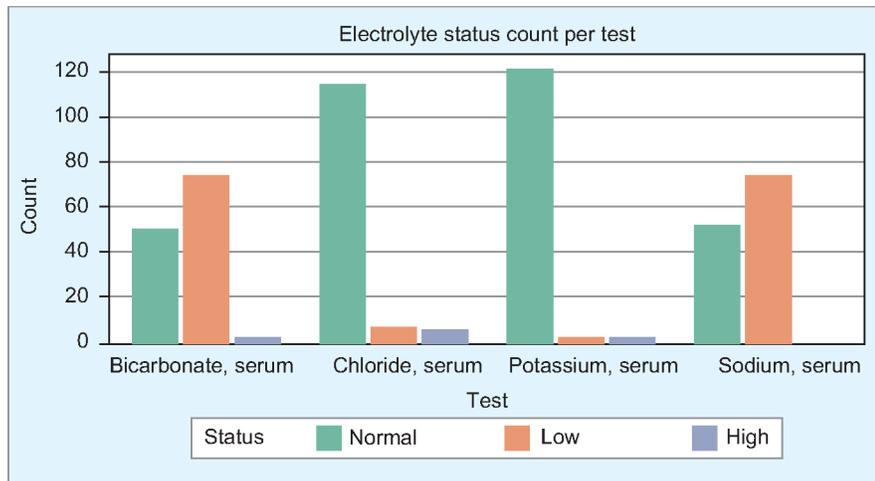


Fig. 1: Distribution of electrolyte abnormalities at admission

of abnormalities (low/high vs normal) did not differ by gender, with Chi-square tests confirming no significant association.

Graphical Presentation

Figure 1 provides a visual overview of the distribution of electrolyte abnormalities. The figure clearly highlights that sodium and bicarbonate imbalances dominate the biochemical profile of enteric fever patients, with more than half of the cohort falling below reference thresholds. In contrast, potassium and chloride abnormalities are far less common, consistent with the tabulated results. This visual representation strengthens the interpretation that targeted monitoring of sodium and bicarbonate may be clinically most relevant in this patient group.

DISCUSSION

This study evaluated electrolyte alterations in 128 adult patients with enteric fever admitted to a tertiary care hospital in New Delhi. The most striking abnormalities observed were hyponatremia (58.6%) and low bicarbonate (57.8%), while potassium and chloride levels were preserved in the majority of cases. These findings indicate that disturbances in sodium and acid–base balance are common features of enteric fever at admission, and they underscore the importance of routine electrolyte monitoring in the clinical management of such patients.

Our results align with previous studies conducted in other endemic regions. Garba et al.⁷ reported that 50% of typhoid patients in Nigeria were hyponatremic and 11% exhibited metabolic acidosis, while Chisti et al.⁶ in Bangladesh also observed significant sodium disturbances among patients with severe enteric fever. Together with our data, these studies highlight that electrolyte imbalances in enteric fever are not geographically restricted and

may represent a consistent pathophysiological response to systemic infection.

The predominance of hyponatremia may be explained by several mechanisms. Gastrointestinal fluid losses (vomiting, diarrhea) contribute to sodium depletion, while SIADH has been reported in systemic infections and may lead to dilutional hyponatremia even in the absence of overt fluid loss.^{3,4} Likewise, the high prevalence of low bicarbonate suggests a tendency toward metabolic acidosis, potentially due to dehydration, tissue hypoperfusion, or accumulation of organic acids.⁵ However, as we did not measure serum osmolality, urine electrolytes, or arterial blood gases, these mechanisms remain speculative and should be interpreted as plausible rather than confirmed explanations.

Unlike sodium and bicarbonate, potassium and chloride abnormalities were uncommon in our cohort, contrasting with Garba et al.,⁷ who reported hypokalemia and hypochloremia in more than one-third of patients. This difference may reflect variations in patient demographics, severity at presentation, or early access to hospital care. Notably, we found no significant gender differences in either mean electrolyte levels or prevalence of abnormalities, consistent with prior reports that biochemical disturbances in typhoid are largely independent of sex.^{6,7}

From a clinical perspective, these findings have important implications. Hyponatremia has been linked to neurological complications, prolonged hospital stays, and increased mortality in infectious diseases.⁴ Early detection and correction of sodium and bicarbonate disturbances could therefore reduce morbidity and improve patient outcomes. Routine electrolyte panels at admission, particularly in endemic regions, should be integrated into the diagnostic and therapeutic workflow for enteric fever.

LIMITATIONS

This study has several limitations. It was conducted at a single center, limiting generalizability. Being retrospective, it relied on available records without the ability to assess longitudinal changes in electrolytes. Clinical outcomes (e.g., complications, duration of hospitalization, mortality) were not captured, precluding analysis of prognostic implications. Furthermore, confounding factors such as hydration status, comorbidities, and prior therapy were not adjusted for. Finally, proposed mechanisms such as SIADH or metabolic acidosis remain hypotheses, as confirmatory investigations (e.g., serum osmolality, arterial blood gases) were not performed.

CONCLUSION

In summary, this study demonstrates that hyponatremia and low bicarbonate are the most frequent electrolyte abnormalities among adult enteric fever patients admitted to a tertiary hospital in New Delhi, while potassium and chloride remain largely unaffected. These findings emphasize the need for routine monitoring of serum sodium and bicarbonate to guide supportive management. Future multicenter, prospective studies with outcome correlation are warranted to validate these findings and clarify their prognostic significance.

ETHICS APPROVAL

The study was approved by the Institutional Ethics Committee of Max Super Specialty Hospital, Saket, New Delhi (approval no. BHR/RS/MSSH/DDF/SKT-2/IEC/IM/26-01/2023).

CONSENT

Informed consent was waived due to the retrospective nature of the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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