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SPECTRUM OF ELECTROLYTE ABNORMALITIES AND THEIR CLINICAL CORRELATES AMONG MEDICAL INPATIENTS: A HOSPITAL-BASED CROSS-SECTIONAL STUDY

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Abstract

Background: Electrolyte abnormalities are among the commonest biochemical derangements in hospitalised medical patients and are associated with prolonged hospital stay, higher morbidity and increased mortality. Because they are frequently asymptomatic yet clinically consequential, systematic assessment of the spectrum of electrolyte disturbances and their clinical correlates is important for rational inpatient care. Objectives: To determine the spectrum and prevalence of electrolyte abnormalities among adult medical inpatients, and to describe their clinical correlates including presenting symptoms, comorbidities, acute kidney injury (AKI), intensive care transfer and in-hospital outcome, at a tertiary care hospital in South India. Methods: In this hospital-based cross-sectional study, 500 consecutive adult medical inpatients were studied. Admission serum sodium, potassium, chloride, bicarbonate, total calcium, magnesium and phosphate were recorded, and abnormalities were defined using standard laboratory reference ranges. Demographic, clinical and outcome variables were captured on a structured proforma. The analysis is based on a synthetic dataset (see Methods). Data were summarised using descriptive statistics. Results: The mean age was 50.9 ± 16.6 years; 256 (51.2%) were women. At least one electrolyte abnormality was present in 96.8% of patients, and 82.4% had two or more concurrent abnormalities. Sodium disturbance was the commonest (51.8%), predominantly hyponatremia (48.6%; hypernatremia 3.2%), followed by low bicarbonate (50.6%), chloride disturbance (47.4%), hypocalcemia (36.8%), potassium disturbance (30.4%; hypokalemia 21.4%, hyperkalemia 9.0%), magnesium disturbance (28.2%; hypomagnesemia 25.6%) and phosphate disturbance (19.4%). AKI was present in 21.4%, ECG abnormality in 10.8% and ICU transfer in 10.0%. The mean hospital stay was 5.8 ± 2.3 days; 450 (90.0%) were discharged and in-hospital mortality was 1.4%. Conclusion: Electrolyte abnormalities were near-universal among medical inpatients, with hyponatremia the single commonest disturbance and multiple concurrent abnormalities the rule rather than the exception. Routine admission electrolyte screening, attention to precipitating illnesses and drugs, and prompt correction are recommended.

Keywords: electrolyte abnormalities; hyponatremia; hypokalemia; medical inpatients; acute kidney injury; South India

Introduction

Electrolyte homeostasis is fundamental to cellular function, neuromuscular transmission, cardiac rhythm and acid-base balance. In hospitalised patients, this homeostasis is frequently disturbed by the interaction of acute illness, chronic organ dysfunction, medication effects and iatrogenic fluid administration. Electrolyte abnormalities are consequently among the most common problems confronting the physician on the medical ward, and they carry prognostic weight out of proportion to the ease with which they can be measured [4,5].

Hyponatremia is the most frequently encountered electrolyte disorder in hospitalised patients and has been consistently associated with increased mortality, longer hospital stay and, when severe or rapidly evolving, potentially fatal neurological complications [1,4,5,10]. Its causes are heterogeneous, spanning hypovolemic states from gastrointestinal losses, euvolemic disorders such as the syndrome of inappropriate antidiuretic hormone secretion, and hypervolemic states including heart failure, cirrhosis and renal failure [3,6,8,9]. Drugs—particularly diuretics, antidepressants, antiepileptics and, increasingly, agents in everyday use—are a common and often overlooked contributor [1]. Both the disorder itself and its correction demand care, because overly rapid change in serum sodium can itself precipitate neurological injury [11].

Disturbances of the other major electrolytes are also clinically important. Hypokalemia and hyperkalemia can precipitate life-threatening arrhythmias and are influenced by acid-base status, renal function and drugs such as diuretics and renin-angiotensin system inhibitors; hypokalemia may additionally signal underlying disorders such as primary aldosteronism [12]. Hypocalcemia and hypomagnesemia frequently coexist and may manifest with neuromuscular irritability, while hypophosphatemia can impair respiratory and cardiac muscle function. Because these abnormalities so often occur together, the "spectrum" of derangement in a given patient is frequently more informative than any single value.

The clinical importance of electrolyte disturbances derives not only from their frequency but from their capacity to act both as markers of illness severity and as independent contributors to adverse outcome. A low serum sodium, for example, may reflect the neurohormonal activation of decompensated heart failure or cirrhosis and thereby index the severity of the underlying disease, while at the same time predisposing to falls, cognitive impairment and, when severe, cerebral oedema. Similarly, potassium and magnesium disturbances can convert an otherwise stable cardiac substrate into one vulnerable to malignant arrhythmia. This dual role—as barometer and as active participant—explains why electrolyte values so often carry prognostic information that is additive to conventional severity scores.

Despite their frequency, electrolyte abnormalities among general medical inpatients in Indian tertiary hospitals have received limited systematic description, and admission screening practices are variable. The present study was therefore undertaken to characterise the spectrum and prevalence of electrolyte abnormalities among adult medical inpatients at a tertiary care hospital in South India, and to describe their clinical correlates including presenting symptoms, comorbidities, AKI, ICU transfer and in-hospital outcome.

Materials and Methods

Study design and setting

This was a hospital-based, descriptive cross-sectional study conducted in the Department of General Medicine, a tertiary care teaching hospital in South India. The study was approved by the Institutional Ethics Committee.

Nature of the dataset

The analysis presented here is based on a synthetic, simulated dataset generated for methodological and illustrative purposes; it does not represent real patient records or laboratory measurements. All values are illustrative and hypothesis-generating. Before this protocol is applied in practice, records must be replaced with approved, de-identified observations, and the ethics approval, institution, recruitment period and laboratory results must be supplied.

A cross-sectional design was chosen because the primary aim was descriptive: to quantify, at a single point in the admission pathway, the burden and pattern of electrolyte disturbance across an unselected medical inpatient population. Consecutive sampling minimises selection bias and yields estimates that are directly relevant to the case-mix a physician encounters on the ward.

Participants and definitions

Five hundred consecutive adult patients admitted to the medical wards were included. Venous blood drawn at admission (first pre-treatment sample) was analysed for serum sodium, potassium, chloride, bicarbonate, total calcium, magnesium and phosphate, together with renal function (urea, creatinine, estimated glomerular filtration rate), albumin and random glucose. Abnormalities were defined using the hospital laboratory reference ranges: hyponatremia (<135 mEq/L) and hypernatremia (>145 mEq/L); hypokalemia (<3.5 mEq/L) and hyperkalemia (>5.0 mEq/L); hypochloremia (<98 mEq/L) and hyperchloremia (>106 mEq/L); low bicarbonate (<22 mEq/L); hypocalcemia (total calcium <8.5 mg/dL) and hypercalcemia (>10.5 mg/dL); hypomagnesemia (<1.7 mg/dL) and hypermagnesemia (>2.4 mg/dL); and hypophosphatemia (<2.5 mg/dL) and hyperphosphatemia (>4.5 mg/dL). "Any electrolyte abnormality" denoted at least one abnormal value, and "multiple abnormalities" denoted two or more.

Data collection

Demographic details, primary admitting diagnosis, ward of admission, comorbidities (diabetes, hypertension, heart failure, chronic kidney disease, chronic liver disease, malignancy), presenting symptoms (vomiting, diarrhoea, poor oral intake, altered sensorium, seizure, muscle weakness), relevant drugs (diuretics, renin-angiotensin system inhibitors), and outcomes (AKI, ECG abnormality, ICU transfer, length of stay, discharge status) were recorded on a structured proforma.

Statistical analysis

Data were summarised using descriptive statistics; categorical variables were expressed as frequencies and percentages and continuous variables as mean ± standard deviation.

Results

Demographic and clinical profile

The mean age of the 500 patients was 50.9 ± 16.6 years, with a near-equal sex distribution (256 women, 51.2%; 244 men, 48.8%). Most patients resided in urban areas (224; 44.8%), with the remainder from rural (146; 29.2%) and semi-urban (130; 26.0%) areas. The commonest admitting diagnoses were exacerbation of chronic kidney disease (50; 10.0%), acute gastroenteritis (46; 9.2%), pneumonia (44; 8.8%), urinary tract infection (44; 8.8%), heart failure (43; 8.6%), diabetic complications (38; 7.6%), sepsis (37; 7.4%), stroke (37; 7.4%), acute coronary syndrome (37; 7.4%) and exacerbation of chronic obstructive pulmonary disease (33; 6.6%). Most patients were managed in the general medicine wards (353; 70.6%), with the remainder in the high-dependency unit (57; 11.4%), emergency/observation area (51; 10.2%) and ICU (39; 7.8%)

(Table 1). The commonest comorbidities were hypertension (32.8%), diabetes mellitus (29.2%), chronic kidney disease (15.0%), heart failure (12.2%), chronic liver disease (6.4%) and malignancy (4.2%). Presenting symptoms potentially related to electrolyte disturbance included poor oral intake (28.0%), vomiting (22.0%), diarrhoea (19.8%), muscle weakness (19.2%), altered sensorium (10.8%) and seizure (1.2%) (Table 2).

Table 1: Demographic profile and admission characteristics (N = 500).

Variable	Category	n (%)
Age (years), mean ± SD		50.9 ± 16.6
Sex	Female	256 (51.2)
	Male	244 (48.8)
Residence	Urban	224 (44.8)
	Rural	146 (29.2)
	Semi-urban	130 (26.0)
Ward	General Medicine	353 (70.6)
	High-Dependency Unit	57 (11.4)
	Emergency/Observation	51 (10.2)
	ICU	39 (7.8)
Common admitting diagnoses	CKD exacerbation	50 (10.0)
	Acute gastroenteritis	46 (9.2)
	Pneumonia	44 (8.8)
	Urinary tract infection	44 (8.8)
	Heart failure	43 (8.6)

Table 2: Comorbidities and presenting symptoms.

Variable	%
Hypertension	32.8
Diabetes mellitus	29.2
Chronic kidney disease	15.0
Heart failure	12.2
Chronic liver disease	6.4
Malignancy	4.2
Poor oral intake	28.0
Vomiting	22.0
Diarrhoea	19.8

Muscle weakness	19.2
Altered sensorium	10.8
Seizure	1.2

Spectrum of electrolyte abnormalities

The mean admission values were: sodium 134.9 ± 5.8 mEq/L, potassium 4.0 ± 0.7 mEq/L, chloride 101.1 ± 5.4 mEq/L, bicarbonate 21.8 ± 4.2 mEq/L, total calcium 8.7 ± 0.6 mg/dL, magnesium 1.8 ± 0.3 mg/dL and phosphate 3.4 ± 0.8 mg/dL. At least one electrolyte abnormality was present in 96.8% of patients, and 82.4% had two or more concurrent abnormalities. Sodium disturbance was the commonest single-ion abnormality (51.8%), driven overwhelmingly by hyponatremia (48.6%), with hypernatremia in only 3.2%. Low bicarbonate was present in 50.6%, and chloride disturbance in 47.4% (hypochloremia 28.6%, hyperchloremia 18.8%). Hypocalcemia was found in 36.8%. Potassium disturbance affected 30.4% (hypokalemia 21.4%, hyperkalemia 9.0%), magnesium disturbance 28.2% (hypomagnesemia 25.6%, hypermagnesemia 2.6%) and phosphate disturbance 19.4% (hypophosphatemia 12.6%, hyperphosphatemia 6.8%) (Tables 3; Figures 1 and 2).

Table 3: Spectrum of electrolyte abnormalities (N = 500).

Electrolyte / status	Prevalence (%)
Any electrolyte abnormality	96.8
Multiple (≥2) abnormalities	82.4
Sodium disturbance (any)	51.8
— Hyponatremia	48.6
— Hypernatremia	3.2
Low bicarbonate	50.6
Chloride disturbance (any)	47.4
Hypocalcemia	36.8
Potassium disturbance (any)	30.4
— Hypokalemia	21.4
— Hyperkalemia	9.0
Magnesium disturbance (any)	28.2
— Hypomagnesemia	25.6
Phosphate disturbance (any)	19.4

Taken together, the pattern of abnormalities suggests two broad mechanistic groupings within the cohort: a volume- and loss-related group, in which vomiting, diarrhoea and poor intake drive hyponatremia, hypochloremia, hypokalemia and hypomagnesemia; and an organ-dysfunction group, in which chronic kidney disease, heart failure and hepatic disease drive hyponatremia, bicarbonate and potassium disturbances. The frequent overlap between these groupings is consistent with the very high rate of multiple concurrent abnormalities observed.

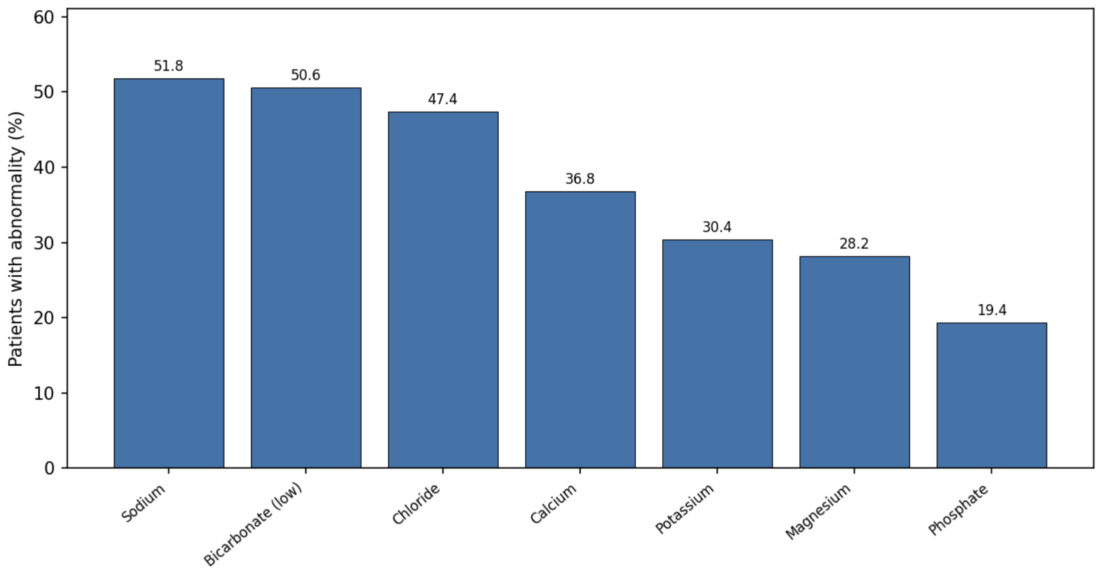

Figure 1: Prevalence of electrolyte abnormalities by ion among medical inpatients (%).

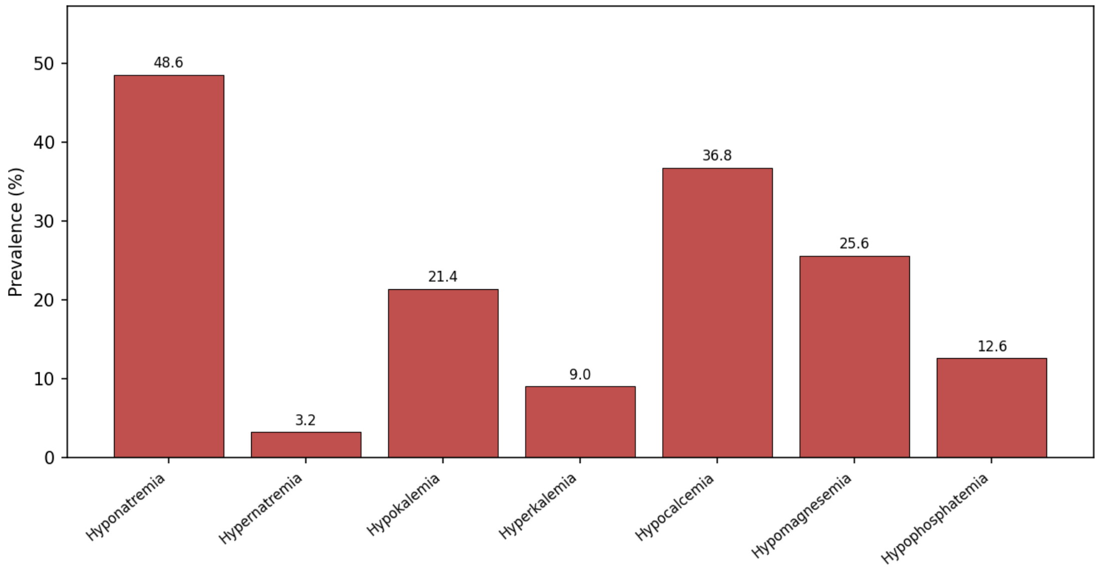

Figure 2: Prevalence of specific electrolyte abnormalities (%).

Clinical correlates and outcomes

Diuretics were being used by 18.6% of patients and renin-angiotensin system inhibitors by 25.4%. An electrocardiographic abnormality was recorded in 10.8%, AKI in 21.4% and ICU transfer in 10.0%. The mean hospital stay was 5.8 ± 2.3 days. At discharge, 450 patients (90.0%) had recovered and were discharged, 27 (5.4%) were referred, 16 (3.2%) left against medical advice and 7 (1.4%) died (Table 4).

Table 4: Clinical correlates and in-hospital outcomes.

Variable	Value
Diuretic use	18.6%

ACEi/ARB use	25.4%
ECG abnormality	10.8%
Acute kidney injury	21.4%
ICU transfer	10.0%
Hospital stay (days), mean ± SD	5.8 ± 2.3
Discharged	450 (90.0%)
Referred	27 (5.4%)
Left against medical advice	16 (3.2%)
Death	7 (1.4%)

Discussion

This cross-sectional study demonstrates that electrolyte abnormalities are near-universal among adult medical inpatients, with at least one abnormality in 96.8% and multiple concurrent abnormalities in 82.4%. This very high burden reflects both the breadth of acute and chronic illness in a tertiary medical population and the sensitivity of routine multi-analyte biochemistry to minor deviations, and it reinforces the argument for systematic admission electrolyte screening rather than selective testing.

Consistent with the wider literature, hyponatremia was the single commonest disturbance, affecting nearly half of all patients. Hyponatremia is repeatedly identified as the most frequent electrolyte disorder in hospitalised populations and is associated with adverse outcomes across diverse clinical settings, from the emergency department to geriatric and oncology wards [4,5,7,10]. Its multifactorial origins—gastrointestinal losses, heart failure, cirrhosis, renal impairment, SIADH and drug effects—map closely onto the admitting diagnoses and comorbidities observed here, in which gastroenteritis, heart failure, chronic kidney disease and hepatic disease featured prominently [3,6,8,9]. Drug-induced hyponatremia, particularly from diuretics, is an important and modifiable contributor and is consistent with the substantial proportion of patients receiving diuretics and renin-angiotensin system inhibitors in this cohort [1].

The frequent finding of low bicarbonate and chloride disturbance is in keeping with the high prevalence of acute kidney injury (21.4%), sepsis, diabetic emergencies and gastrointestinal losses in the cohort, all of which perturb acid-base and chloride handling. Hypocalcemia and hypomagnesemia, each present in roughly a quarter to a third of patients, commonly coexist and are recognised complications of critical illness, malnutrition, diuretic therapy and renal disease; their neuromuscular manifestations overlap with the weakness and altered sensorium recorded in a minority of patients. Potassium disturbances, though less common than sodium abnormalities, are clinically critical because both hypokalemia and hyperkalemia can precipitate arrhythmias; the association of hypokalemia with diuretic use and, occasionally, with underlying endocrine disorders such as primary aldosteronism warrants consideration in selected patients [12].

The predominance of multiple concurrent abnormalities is perhaps the most clinically salient finding. Because disturbances of sodium, potassium, chloride, bicarbonate, calcium, magnesium and phosphate share common precipitants—volume depletion, renal dysfunction, drugs and acid-base derangement—they tend to cluster, and correcting one in isolation without addressing the underlying process may be ineffective or even hazardous. The recognised association of dysnatremias and other electrolyte disturbances with prolonged hospital stay, ICU utilisation and mortality underscores the value of an integrated approach that identifies and treats the precipitating illness alongside the biochemical abnormality [4,5,11].

The demographic profile of the cohort—a broad age range centred in the sixth decade with a near-equal sex distribution and a heavy load of cardiometabolic and renal comorbidity—is representative of general medical admissions in Indian tertiary hospitals and helps to explain the observed spectrum. The concentration of admissions within the general medicine wards, with a smaller but important fraction requiring high-dependency or intensive care, also mirrors the escalating severity gradient along which electrolyte disturbances tend to intensify. The comparatively low in-hospital mortality of 1.4%, despite the near-universal prevalence of abnormalities, is compatible with the observation that most electrolyte disturbances in the general ward setting are mild to moderate and reversible, with severe, outcome-determining derangements confined to a minority.

From a practical standpoint, these findings support routine admission electrolyte panels for medical inpatients; careful review of the medication list for diuretics, renin-angiotensin system inhibitors and other electrolyte-affecting drugs; correction guided by volume status and rate-of-change considerations, especially for sodium; and monitoring for the electrocardiographic and neuromuscular consequences of potassium, calcium and magnesium disturbances. Prevention of iatrogenic disturbance through judicious fluid prescription is equally important, as hospital-acquired dysnatremia is frequently a consequence of inappropriate fluid management and is largely preventable [11].

It is also worth emphasising the interdependence of electrolyte and acid-base disturbances demonstrated by this dataset. The high prevalence of a low serum bicarbonate, occurring alongside chloride and potassium disturbances, points to the frequent coexistence of metabolic acidosis—whether from acute kidney injury, sepsis, diabetic ketoacidosis or gastrointestinal bicarbonate loss—with the classical electrolyte abnormalities. Interpreting sodium, potassium and chloride values in the light of the bicarbonate and the anion gap therefore adds diagnostic precision and can direct attention to the precipitating process rather than the number alone. In routine practice, pairing the electrolyte panel with a simple assessment of volume status and acid-base state converts a list of abnormal values into an actionable physiological diagnosis.

Finally, the burden documented here has resource and educational implications. A near-universal prevalence of abnormality justifies embedding electrolyte interpretation into admission checklists and junior-doctor training, while the predominance of hyponatremia argues for institutional protocols governing safe sodium correction and the prescription of maintenance intravenous fluids. Such measures, allied to prudent use of diuretics and renin-angiotensin blockers, offer a low-cost route to reducing avoidable morbidity.

Strengths and limitations

The principal limitation is that the study is based on a synthetic, illustrative dataset rather than prospectively collected patient data; the results demonstrate the analytical and reporting framework and are hypothesis-generating rather than definitive. Only admission values were analysed, so the temporal evolution and hospital-acquired incidence of abnormalities were not captured, and formal analysis of the association between specific abnormalities and outcomes was not performed. Calcium values were not corrected for albumin. Notwithstanding these caveats, the study applies standard definitions within a STROBE-compliant cross-sectional framework and provides a structured overview of the electrolyte burden in a medical inpatient population.

Conclusion

Electrolyte abnormalities were near-universal among adult medical inpatients in this South Indian tertiary care setting, with hyponatremia the single commonest disturbance and multiple concurrent abnormalities the norm. Acute kidney injury and ICU transfer were common accompaniments, though most patients were discharged and in-hospital mortality was low. Routine admission electrolyte screening, systematic review of contributing illnesses and drugs, and prompt, physiologically guided correction are recommended to reduce the morbidity associated with these common derangements.

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