Original Research Article

To study clinical features of Electrolyte abnormalities in Intensive Care Unit patients at Base Hospital Delhi Cantt

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Abstract

Background: Electrolytes are involved in many metabolic and homeostatic functions, including enzymatic and biochemical reactions. **Objective:** To study clinical features of Electrolyte abnormalities in Intensive Care Unit patients, Base Hospital Delhi Cantt**. Materials and methods:** A prospective observational study of Clinical Profile of Electrolyte Abnormalities in patients admitted in Intensive Care Unit and their management and outcome at Base Hospital Delhi Cantt. The study was carried out over a period starting 01 Apr 2013 to 31 Sep 2014 at Intensive Care Unit at Base Hospital Delhi Cantt.**Results:**Hyperkalemia was more common electrolyte disorder in the ICU followed by Hypokalemia & hyponatremia. Hypermagnesemia and hypernatremia was the least common electrolyte disorder in our study. Muscle weakness and peaked T waves for hyperkalemia. Fatigue, muscle weakness, leg cramps and T wave flattening was the most common association with hypokalemia. Nausea, vomiting, headache, lethargy and altered sensorium for hyponatremia. Coma occurred in 2 patients and seizure in only one patient. Nausea, vomiting, headache and altered sensorium for hypernatremia.**Conclusion:**Clinical symptoms and findings of dyselectrolytemias in the ICU are a reflection of multiple interactions of electrolytes and regulatory systems. Therefore, it is suggested that clinicians working in emergency department should have good knowledge of fluid and electrolyte balance dynamics.

Keywords: Clinical features, Electrolyte abnormalities, Intensive Care Unit patients, Hyperkalemia, Hypokalemia, hyponatremia.

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Introduction

Electrolytes are required the maintenance of cell membrane structure and function, neurotransmission, nerve signal conduction, hormone function, muscle contraction, cardiovascular function, bone composition, and fluid and acid–base regulation. [1] Every electrolyte imbalance must be considered in a combined and associated fashion, and examinations must aim to clarify the clinical scenario for an effective and successful treatment. Imbalances of sodium, potassium, calcium, and magnesium are the most important and prevailing electrolyte imbalance. Electrolyte imbalances are common findings in many diseases. [2, 3]Fluid and electrolytes disturbances are among the most common clinical problems encountered in the intensive care unit (ICU). [4] Studies among critically ill patients have shown that fluid and electrolyte imbalances are associated with increased morbidity and mortality. Health care providers should be familiar with the principles and practice of fluid and electrolyte physiology and pathophysiology for providing optimal care. Fluid resuscitation should be aimed at restoration of normal hemodynamics and tissue perfusion. Early goal directed therapy has been shown to be effective in patients with severe sepsis or septic shock. [4]The severity of symptoms related to electrolyte disorders generally correlates with the severity of the disorder and the rate at which the disorder developed. Electrolyte abnormalities involve multiple mechanisms in adult patients in the intensive care unit (ICU), including altered absorption and distribution; excessive or inadequate administration; alterations in hormonal, neurologic, and homeostatic mechanisms; or altered excretion via gastrointestinal (GI) and renal losses, as well as changes in fluid status and fluid shifts. [1]The stress of critical illness including trauma, sepsis, AKI, positive pressure ventilation and administration of vasoactive medications all disturb the neuroendocrine systems that control the electrolyte balance. [1,4, 5] In this study we have evaluated the general characteristics of patients admitted to our Intensive care Unit (ICU), and diagnosed as having electrolyte imbalance. The etiology, clinical manifestations and management of specific electrolyte disorders is being studied. Literature data generally focused on imbalances of specific electrolytes, and the majority of the studies recruited patients of a specific disease or risk group. To our knowledge, only three studies focused on electrolyte imbalances in emergency department patients, and two of them conducted with elderly patients. [6,7] There are not many studies been done on the electrolyte abnormalities in ICU setup. This study is the second study of its kind which investigates the generic electrolyte disturbances in intensive care unit admissions, and it will contribute to the literature data by providing valuable information for the ICU physicians. This study focuses on the clinical profile, treatment and outcome of such disorders in adult patients in the Intensive Care Unit (ICU). So the present study has been planned to study clinical features of Electrolyte abnormalities in Intensive Care Unit patients at Base Hospital Delhi Cantt**.**

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Materials & Methods

A prospective observational study of Clinical Profile of Electrolyte Abnormalities in patients admitted in Intensive Care Unit and their management and outcome at Base Hospital Delhi Cantt. The study was carried out over a period starting 01 Apr 2013 to 31 Sep 2014 at Intensive Care Unit at Base Hospital Delhi Cantt.

Study population and sample size: Based on the statistical calculation study population was included a total number of 100 patients admitted in Intensive Care Unit, Base Hospital, Delhi Cant. Calculation of the sample size as the outcomes is being studied on a dichotomous scale:-

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta}) \times 2 \times p \times q}{d^2}$$

Where Z 1-α is constant set by convention according to the accepted α error and whether it is a one-sided or two-sided effect and Z1-β, is a constant set by convention according to power of the study. P is the prevalence of the disease and q=1-P. prevalence of electrolyte taken for overall abnormalities in electrolytes (50%).Hence based on the statistical calculation a minimum of 100 cases is required in the study groups.

Inclusion criteria:

1. All patients admitted in Intensive Care Unit Base Hospital Delhi Cantt having imbalance in Sodium, Potassium, Calcium, Phosphate and Magnesium levels.

Exclusion criteria:

1. Non availability of consent of individuals/next of kin for participating in study.
2. Patients on electrolyte supplements

Methods of study: The patients presenting with or developing abnormalities in Sodium, Potassium, Calcium, phosphate and Magnesium levels in Intensive Care Unit were evaluated for clinical profile, management outcomes. Laboratory evaluation for the cause of electrolyte abnormalities and other relevant work up including Renal/ Neurological/ Endocrinal work up was done.

Ethical Consideration: We have obtained the necessary approval to conduct the study from the institutional ethics committee of Base Hospital, Delhi Cantt. New Delhi. The participants/ next of kin were given a full explanation about the purpose of the study and assurance about the confidentiality of the information and that the participation was optional.

Statistical analysis: All the statistical analysis was performed using SPSS version 20. The clinical profile of patients was analyzed by chi-square test for qualitative variables. Student t test was performed for comparison of quantitative variables. 5% probability level was considered as statistically significant i.e., $p<0.05$.

Results: Hundred (100) serial patients admitted to the ICU with electrolyte imbalances were taken for study purpose. The required sample size was completed over 8 months during which there were total of 198 admissions (50 % were having electrolyte imbalance). Of these 64 patients (32%) had single electrolyte imbalance and 36 patients (18%) had more than one electrolyte imbalance.In the 100 patients with electrolyte imbalance, 66% (*n*=66) were male and 34% (n=34) were females. The mean age of patients was 64.28 ±1.51 years. Hypertension (78%), followed by Diabetes (64%) and CAD (48%) were the commonest co-morbidities in these patients.Our study was a prospective observational one aimed at studying the clinical profile of electrolyte disorders in ICU patients admitted to Intensive Care Unit of our hospital. Hyperkalemia was more common electrolyte disorder in the ICU followed by Hypokalemia & hyponatremia. Hypermagnesemia and hypernatremia was the least common electrolyte disorder in our study. Table 1

Table 1: **Electrolyte abnormalities in the study group (n = 100)**

Dyselectrolytemia	Abnormalities in No.
Hypokalemia	24
Hyperkalemia	26
Hyponatremia	22
Hypernatremia	5
Hypophosphatemia	17
Hyperphosphatemia	16
Hypocalcemia	14
Hypercalcemia	8
Hypomagnesemia	11
Hypermagnesemia	6

Table 2: **Incidence of electrolyte imbalance in ICU (n = 198)**

Dyselectrolytemia	Number of patients	Incidence
Hypokalemia	24	12.12
Hyperkalemia	26	13.13
Hyponatremia	22	11.11
Hypernatremia	5	2.52
Hypophosphatemia	17	8.58
Hyperphosphatemia	16	8.08
Hypocalcemia	14	7.07
Hypercalcemia	8	4.04
Hypomagnesemia	11	5.55
Hypermagnesemia	6	3.03

Since a large number of patients had mixed electrolyte disorders with multiple comorbidities it was difficult to attribute the clinical features to any one particular electrolyte imbalance. However the likely attributable features include Muscle weakness and peaked T waves for hyperkalemia. Fatigue, muscle weakness, leg cramps and T wave flattening was the most common association with hypokalemia. Table 3,4,

Table 3: Features of Hypokalemia (n = 24)

Features	No of patients	Percentage of patients
Fatigue	15	62.5
Weakness	13	15.85
Flattened T waves	13	54.16
Leg cramps	10	41.66
Paralytic ileus	9	37.5
ST-segment depression	4	16.66
U waves	4	16.66
Atrial ectopics	4	16.66
VT	1	4.16

Table 4: Features of Hyperkalemia (n = 26)

Features	No of patients	Percentage of patients
Weakness	19	73.07
Peaked T waves (tenting)	13	50
Prolonged PR interval	6	23.07
Bradycardia	3	11.52
Wide QRS	2	7.69
VT	1	3.84

Nausea, vomiting, headache, lethargy and altered sensorium for hyponatremia. Coma occurred in 2 patients and seizure in only one patient. Nausea, vomiting, headache and altered sensorium for hypernatremia Table 5,6

Table 5: Features of Hyponatremia (n = 22)

Features	No of patients	Percentage of patients
Nausea	13	59.09
Vomiting	10	45.45
Headache	8	36.36
Lethargy	7	31.81
Altered sensorium	5	22.72
Coma	2	9.09
Seizures	1	4.54

Table 6: Features of Hypernatremia (n = 5)

Features	No of patients	Percentage of patients
Nausea	3	60
Headache	3	60
Vomiting	2	40
Altered sensorium	2	40
Weakness	1	20
Coma	1	20

Discussion

The most common electrolyte imbalance among study subjects was hyperkalemia in 26 patients followed by hypokalemia in 24 patients, hyponatremia in 22 patients, hypophosphatemia in 17 patients, hyperphosphatemia in 16 patients, hypocalcemia in 14 patients, hypomagnesemia in 11 patients, hypercalcemia in 8 patients, hypermagnesemia in 6 patients and the least common was hypernatremia in 5 patients.In our study, we evaluated the general characteristics of patients admitted to our Intensive care Unit (ICU), and who were diagnosed to have electrolyte imbalance.

Balc AK et al., in their study conducted in 2013 in the Emergency Department of Uludag University faculty of Medicine, Bursa, Turkey, [8], included 996 patients over 18 years of age. All patients had electrolyte imbalance, of various etiologies other than trauma. The mean age of patients was 59.28±16.79, and 55% of the patients were male. The common symptoms of the patients were dyspnea (14.7%), fever (13.7%) and systemic deterioration (11.9%).

The most common electrolyte imbalance in their study was hyponatremia (60%) followed by hypocalcemia (51%), hypokalemia (15%), hyperkalemia (8%) hypernatremia (5%), hypomagnesemia (5%), hypercalcemia (4%) and least frequent hypermagnesemia (1%).

However, in my study, the most common electrolyte disorder was hyperkalemia (26 patients) and hypokalemia (24 patients) followed by Hyponatremia (22 patients). The least common was hypermagnesemia (6%) & hypernatremia (5%). The difference in prevalence of various dyselectrolytemia in my study may be attributed to the small sample size (100) compared to theirs (996),

and different characteristics of the patient being studied as most of our patients were cardiac cases on drugs either diuretics or ACEI/ARBs resulting higher potassium imbalances. Similar to the findings of above study, our results also reflected the least prevalence of electrolyte disorders of Magnesium (Hypermagnesemia and hypomagnesaemia) and Calcium (Hypocalcemia + Hypercalcemia). Among those 50 patients with potassium imbalance in my study, twenty six patients had hyperkalemia and 24 had hypokalemia. In patients with hypokalemia, the most common symptom was fatigue (15 patients), followed by weakness (13 patients), leg cramps (10 patients) and paralytic ileus (9 patients). ECG changes were seen in the form of T wave flattening (13 patients) & atrial ectopics (4 patients). One patient had VT. The likely etiology of hypokalemia were diuretics (12 patients), polyuria post AKI (5 patients), diarrhea (4 patients) and insulin infusion (3 patients). 8 patients on diuretics were managed with withdrawal of diuretics, 4 of them were started on potassium sparing diuretics and 6 of them required further treatment with oral KCl. Ten patients required IV KCl supplementation.My study shows the incidence of hypokalemia to be similar to that of Marti G et al., who their study conducted from Apr 2008 to Mar 2011 in 43805 patients presenting to their emergency department, and found the incidence of hypokalemia to be 11%. The most common symptoms were weakness and muscle pain. 1% had severe hypokalemia, 20 of them had ECG changes with presence of U wave & ST depression. Diuretics & malnutrition were the main causes of severe hypokalemia. [9] However Gercek et al., in their retrospective study in the surgical ICU between 01 Jan 1999 and 31 Dec 2000, found hypokalemia in 192 of 440 patients (40%).[10] It is possible that post operative patients tend to have a much higher incidence of hypokalemia due to them being nil orally or on nasogastric tube drainage and various other drugs, besides malnutrition and post-operative respiratory alkalosis.Among patients with Hyperkalemia, weakness was the most common symptom (19 patients). ECG changes most commonly seen were peaked T waves (13 patients), followed by prolonged PR (6 patients) and Ventricular Tachycardia (1 patient). The likely etiology were use of ACEI/ARBs (10 patients), oliguric AKI (10 patients) and potassium sparing diuretics (6 patients). All patients with drug induced Hyperkalemia were treated with withdrawal of the offending drug. All the patients were managed medically with Salbutamol nebulization, IV Frusemide, IV Calcium & IV Insulin + Dextrose. Two patients required hemodialysis.My study shows incidence of hyperkalemia and hypokalemia to be similar to Pfortmüller CA et al., who in their study between 01 January 2009 and 31 December 2010 in 29,250 patients admitted to the ED, University Hospital Bern, found to have hyperkalemia in 2585 patients (8.8%), and hypokalemia in 3252 patients (11%). [11] Hyponatremia was the third most frequent electrolyte imbalance observed (22 patients) of study population (100 patients). Hypernatremia was the least frequent (5 patients) among the patients studied.

The most common symptoms with hyponatremia were nausea (13 patients), vomiting (10 patients) followed by headache (8 patients) and altered sensorium (5 patients). Less frequently seen was seizure (1 patient) and coma (2 patients both of whom died. Among these patients 8 each were Euvolemic and hypovolemic while 6 were hypervolemic. The likely etiology among hypovolemic patients was pancreatitis (3 patients), thiazide diuretics use (2 patients) and GI loss (2 patients). The most common cause among Euvolemic hyponatremia was likely due to glucocorticoid deficiency (4 patients) secondary to sepsis. The most common cause among hypervolemia was CCF (3 patients) and AKI (2 patients). Of these 16 patients were managed with NS and withdrawal of diuretics, only 7 patients required use of 3% saline.

My study has incidence of hyponatremia close to that of Vandergheynst F et al., and Lindner G et al. Vandergheynst F et al., in their study, on evaluating 13796 critically ill patients found the incidence of hyponatremia in 12.9% and hypernatremia in 15.8 % . [12]Lindner G et al., in their retrospective analysis showed that the incidence of hyponatremia in ICU was 9 %, among them 75% was present on admission and 25% developed after admission. [13]However various other studies have found varied incidences of hyponatremia in ICU. Rao et al., in their study from Apr 2007 to Oct 2008 in MSR medical college Bangalore found that out of 1440 elderly patients admitted to the medical ICU, 518 (36%) had hyponatremia. The symptoms included drowsiness, lethargy, confusion, seizures and coma. SIADH was the common cause of hyponatremia, followed by diuretics use. [14]Padhi R et al., in their study showed that the frequency of hyponatremia in ICU was 34.3% and of which most were Euvolemic (59%).[15] Among the patients with hypernatremia, the most common symptoms were nausea (3 patients) and headache (3 patients), vomiting (2 patients) and altered sensorium (2 patients).

The incidence of hypernatremia is less compared to Vandergheynst F et al[12]& Lindner G et al[13]. the difference is likely due to different patient characteristics and small sample of 100 patients compared to 13796 patients in study by Vandergheynst F et al, 2300 patients in study by Lindner G et al.

Conclusion

We conclude that clinical symptoms and findings of dyselectrolytemias in the ICU are a reflection of multiple interactions of electrolytes and regulatory systems. Therefore, it is suggested that clinicians working in emergency department should have good knowledge of fluid and electrolyte balance dynamics.

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