Original Article

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Electrolyte Disturbances among Diabetic Patients Admitted in a Multi-specialty Hospital in Southern India

Internal Medicine Section

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ABSTRACT

Introduction: Diabetes mellitus (DM) is one of the most common non-communicable diseases associated with high morbidity and mortality. Electrolyte disturbances are not uncommon among in-hospital patients with DM. However, there are limited data on the magnitude of electrolyte disturbances in the diabetic population.

Aim: To identify the common electrolyte disturbances among diabetic in-patients and to determine if there is an association of blood sugar control with electrolyte disturbances.

Materials and Methods: A cross-sectional study was performed among patients admitted with a diagnosis of diabetes and without any restriction of any concomitant illness. Fasting, post prandial blood glucose, HbA1c, serum sodium, potassium, chloride, urea and creatinine were measured. The frequency of electrolyte disturbances was compared between those patients with well controlled vs. inadequately controlled blood sugar.

Results: A total of 342 subjects participated in the study, of which 195 (57%) had uncontrolled DM. The frequency of hyponatremia, hypokalemia, hyperkalemia, hypochloremia and hyperchloremia was 33%, 16%, 6%, 31% and 2.7% respectively. In diabetic patients, hyponatremia was seen more commonly in patients with uncontrolled DM than those with well controlled blood sugars (38.46 vs 27.73%, p=0.01). Hypochloremia was more common among subjects with uncontrolled DM (23.65% vs 17.55%, p=0.01). The proportion of patients with hypokalemia or hyperkalemia did not differ between the two groups. Patients on insulin therapy were more likely to have hyponatremia than non-insulin users (p=0.01).

Conclusion: Diabetic patients have an increased predilection to develop electrolyte disturbances. The most common electrolyte disturbance seen was hyponatremia and hypochloremia and they were widely prevalent among patients with uncontrolled DM.

Keywords: Dyselectrolytemia, Hypochloremia, Hypokalemia, Hyponatermia, Uncontrolled blood sugar

INTRODUCTION

Currently, diabetes is the biggest pandemic and an alarming issue worldwide because of its increasing prevalence rate. As per International Diabetes Federation, diabetes is a global health concern affecting 425 million people, and it is expected to reach 629 million by 2045 [1]. DM is associated with numerous micro and macrovascular complications and when not appropriately managed, can result in frequent hospitalisation and early death [2]. Electrolytes play a pivotal role in maintaining the homeostasis of the body as in muscle coordination, heart function, fluid absorption and excretion and nerve function [3]. Diabetic patients are more prone to develop Electrolyte Disturbances (ED), which is due to hyperglycaemia induced osmotic fluid shifts or by osmotic diuresis [4]. The most frequently seen electrolyte abnormality in clinical practice is hyponatremia which is associated with increased morbidity and mortality, although potassium, chloride, calcium and magnesium disturbances are not uncommon [5]. Electrolyte disorders are mainly encountered in hospital populations with broad spectrum of patients probably due to the complications they develop and the medications they receive [6]. To the best of authors' knowledge there are only limited studies that have focused on electrolyte disturbances in hospitalised diabetic patient. For instance, a study which observed the pattern of electrolyte disturbances in tertiary care hospital settings in Bangladesh among 100 diabetic patients concluded that hyponatremia was found to be the most commonest electrolyte disturbances with 80% followed by hypokalemia (36%) and hyperkalemia (14%). Vomiting was the common precipitating factor while diarrhea and renal failure were also seen in few cases [7]. Similarly, Balcı AK et al., reported a study of 996 Turkish patients admitted in the emergency department, out of which 55% patients were males. The most frequent ED was hyponatremia and the least frequent ED was hypermagnesemia of which the common comorbidity was malignancy followed by sepsis, pneumonia and acute renal failure [8]. In another study reported by Deepti GN et al., in hospitalised diabetic patients in India, hypomagnesemia was more prevalent in diabetic population than the other electrolytes and there was no significant variation in ED levels between diabetic and non-diabetic patients [9].

So, it is imperative that electrolytes are assessed in DM subjects and its relationship with glucose control is understood. Hence, we sought to perform a study to identify the common electrolyte disturbances among in-patients admitted in a multi-specialty hospital in Tamil Nadu. Authors also looked for the association of blood sugar control with electrolyte disturbances.

MATERIALS AND METHODS

The study utilised a cross sectional design and was carried out at Hindu Mission Hospital, West Tambaram, Chennai. In-patients admitted in a hospital with diabetes and between the age of 18-75 of either gender were included in the study. The average duration of admission was three days. The study was approved by institutional ethics committee of the hospital in December 2017 (HMH/IEC/2017/EA32). All study procedures were carried out in accordance with guidelines as laid out in the Declaration of Helsinki. All the patients included had provided written informed consent and were explained about the study and its nature.

The biochemical parameters such as blood glucose levels (fasting, postprandial and random) were estimated by GOD-POD method [10], HbA1C- was assessed using nephelometry method [11], all electrolytes such as sodium, potassium, chloride and bicarbonate were assessed using direct and indirect Ion Selective Electrodes (ISEs) method [12]. Urea was measured by UV Kinetic method [13] and Creatinine by Jaffe Method [14]. Patients with HbA1C level above 7% were considered as uncontrolled diabetics. Hyponatremia was defined as sodium concentration less than 135 mmol/L, with severe hyponatremia less than 120 mEq/L. Hypochloremia was defined as chloride ion lower than 97 mEq/L while hyperchloremia was defined as a chloride level higher than 107 mEq/L. Hyperkalemia was defined as potassium level greater than 5 mEq/L. Hypokalemia was diagnosed when serum potassium level was lesser than 3.5 mEq/L. Elderly was defined as patients above 65 years of age.

STATISTICAL ANALYSIS

Data were represented as mean±SD or median with inter-quartile range or frequency with percentage. Normality of data was assessed using Q-Q plot. Independent t-test or Mann-Whitney test was used to assess if there was significant difference in means or median. Chi-square test was used to see if there was a significant difference in the frequency of electrolyte disturbances between the groups. A p-value of less than 0.05 was considered statistically significant. The calculations were performed using a statistical program (SPSS V.16.0, Chicago, IL).

RESULTS

A total of 342 subjects were included in the study, of which 195 (57%) had uncontrolled DM. Patients with uncontrolled DM had a significantly longer duration of the illness (p=0.02). There were no major differences in the baseline characteristics between uncontrolled and controlled diabetic subjects [Table/Fig-1]. The frequency of hyponatremia, hypokalemia, hyperkalemia, hypochloremia and hyperchloremia was 33%, 16%, 6%, 31% and 2.7% respectively.

Parameter	Uncontrolled DM (n=195)	Controlled DM (n=141)	Significance
Age (yrs)	62.08±11.52	64.43±12.97	0.08
Duration of diabetes (yrs)	10 (4,14)	7 (3,10)	0.02
Hypertension (mmHg)	125 (73.96%)	93 (78.15%)	0.25
Pulse rate (bpm)	93.01±19.08	87.07±16.23	0.003
Systolic B.P (mmHg)	136±23.56	138±29.50	0.52
Diastolic B.P (mmHg)	83.27±11.87	84.99±15.78	0.27
FBS (mg/dL)	195±80.47	130±55.66	0.0001
PPBS (mg/dL)	234±94.30	202±90.0	0.001
RBS (mg/dL)	229±164.44	182±78.74	0.005
HbA_{1C} (%)	8.85±1.58	6.00±0.63	0.0001
Respiratory rate (rpm)	23.07±5.95	22.2±2.04	0.09

[Table/Fig-1]: Baseline characteristics of study patients.
Values are expressed as mean±SD or median with IQR or frequency with %.
DM: Diabetes mellitus; FBS: Fasting blood sugar; PPBS: Post prandial blood sugar; RBS: Random blood sugar

In patients with diabetes, Hyponatremia was more common in patients with uncontrolled sugars than those with well controlled blood sugars. (38.46 vs 27.73%, p=0.01) Hypochloremia was more common among subjects with uncontrolled DM (23.6 vs 17.55%, p=0.01) [Table/Fig-2]. A 22% of the present study population had hypochloremic metabolic alkalosis.

Condition	Uncontrolled DM (n=195)	Controlled DM (n=141)	p-value
Hyponatremia	75 (38.46%)	38 (27.73%)	0.04
Hypokalemia	31 (15.89%)	24 (17.26%)	0.40
Hyperkalemia	9 (4.73%)	11 (7.91%)	0.40
Hypochloremia	44 (23.65%)	23 (17.55%)	0.19
Hyperchloremia	2 (1.07)	4 (3.05)	0.19

[Table/Fig-2]: Comparison of Electrolyte disturbances with the control of diabetes.

The proportion of patients with hypokalemia or hyperkalemia did not differ between the two groups. Hypokalemia was more common among users of loop diuretics. Hyponatremia was not seen at a greater frequency among loop diuretic users. Patients on insulin therapy were more likely to have hyponatremia than non-insulin users. (p=0.01) [Table/Fig-3]. Present study showed that the severity of hyponatremia did not differ significantly between patients with controlled and uncontrolled blood sugars [Table/Fig-4]. There was no difference in the severity of hyponatremia between elderly and non-elderly subjects [Table/Fig-5].

DISCUSSION

Although, it is well known from literature that electrolyte disturbances can possibly occur in diabetic patients, there are limited studies that have documented the magnitude of electrolyte disturbances in South Indian population. There are substantial differences in the dietary habits, lifestyle and genetics among patients in the Indian sub-continent. Hence, it is worthwhile to perform a region based study.

In this study, the most common electrolyte abnormality seen was hyponatremia, with almost one third of the subjects reporting with sodium under 130 mEq/L. There is a significant variability in the incidence of hyponatremia among hospitalised subjects ranging from 5 to 35% [15]. In this study, 9% of subjects reported severe hyponatremia while 25% reported moderate hyponatremia. As expected, patients with uncontrolled blood sugar were at a greater risk to develop hyponatremia, due to the inability of kidney to maintain control of homeostatic mechanisms involving stimulation of thirst, secretion of Antidiuretic Hormone (ADH), and renal handling of filtered sodium.

The frequency of hyponatremia was higher in elderly as compared to non-elderly participants. However severe hyponatremia was not found to be higher among elderly subjects, which could be because of the lack of significant difference in usage of diuretics between these populations. Some of the drugs which have been shown to be associated with high risk of hyponatremia besides diuretics include selective

Medication	Hypokalemia			Hyperkalemia			Hyponatremia			Hypochloremia			Hyperchloremia		
	Users	Non-users	p-value	Users	Non-users	p-value	Users	Non-users	p-value	Users	Non-users	p-value	Users	Non-users	p-value
Loop Diuretics	11 (10.67%)	17 (10.89%)	0.07	6 (5.82%)	6 (3.84%)	0.07	26 (25.49%)	48 (30.96%)	0.18	23 (23.97%)	46 (31.09%)	0.07	5 (5.20%)	1 (0.67%)	0.07
Potassium sparing Diuretics	4 (13.79%)	24 (10.43%)	0.06	2 (6.89%)	10 (4.34%)	0.06	10 (35.71%)	64 (27.94%)	0.20	7 (26.79%)	62 (28.43%)	0.50	0	6 (2.75%)	0.50
Insulin	12 (10.16%)	15 (12.6%)	0.79	5 (6.18%)	6 (4.23%)	0.79	41 (34.74%)	24 (20.51%)	0.01	37 (33.63%)	25 (12.32%)	0.01	0	6 (5.35%)	0.01

[Table/Fig-3]: Electrolyte disturbances among subset of patients receiving diuretics and insulin.

Condition		Uncontrolled DM	Controlled DM	Total
Hyponatremia	Normal	51 (26.16%)	46 (33.53%)	130 (38%)
	Mild	68 (34.87%)	53 (38.55%)	92 (26.9%)
	Moderate	57 (29.23%)	28 (20.43%)	86 (25.1%)
	Severe	19 (9.74%)	10 (7.2%)	30 (9%)

[Table/Fig-4]: Severity of Hyponatremia among study subjects.

Grading of Hyponatremia	Elderly	Non elderly	p-value
Severe	12 (8.4%)	18 (9.2%)	0.46
Moderate	41 (28.9%)	44 (22.5%)	
Mild	53 (37.3%)	71 (36.4%)	
Normal	36 (25.3%)	62 (31.8%)	

[Table/Fig-5]: Frequency and grading of Hyponatremia among elderly and non-elderly participants.

serotonin reuptake inhibitors, angiotensin-converting-enzyme inhibitors, opioids and anti-arrhythmics [16]. Present study participants did not have any known chronic usage of these drugs. However drug induced hyponatremia is more prevalent as a chronic presentation and as we measured the sodium levels on admission, the possibility of some of these subjects to have chronic hyponatremia cannot be ruled out. Present study did not show a mortality difference between patients with hyponatremia and normonatremia. Previous studies have documented that hyponatremia is a risk factor for increased mortality in the hospitalised patients [17,18]. It is possible that the correction of sodium levels during hospitalisation could have reversed the potential risk caused by hyponatremia as a risk factor for mortality in diabetic subjects.

Present study also showed that the frequency of hypokalemia was 16% and that of hyperkalemia was 6% in the study population. There was no significant difference in the frequency of these electrolyte disturbances between controlled and uncontrolled diabetic subjects. In a large Swedish health care system, where data was obtained from 364,955 patients, the incidence of hypokalemia was found to be 13% and that of hyperkalemia in 7% of the population [19]. The study had also reported that the odds of developing hyperkalemia were 1.62 in diabetic subjects compared to non-diabetic subjects. Previous studies have reported that some of the strong risk factors for hypokalemia include diuretic usage, losses from the gastrointestinal tract including diarrheal episodes and the use of laxatives and diabetic ketoacidosis [20]. However, in the present study population, we did not observe significant increase in the risk of hypokalemia with insulin usage. The usage of potassium sparing diuretics did not have an effect on the incidence of hypokalemia in our population. It is not known if these results were so because of the reduced duration of intake of these drugs in this study population, a variable which was not measured in the study.

Present study also revealed that 31% of the subjects had hypochloremia and 2% of them presented with hyperchloremia during admission. These findings are in agreement with a study done among critically ill patients with septic shock where the frequency of hypochloremia was found to be 35% [21]. However, a study done among 488 Japanese patients with critical illness showed a much lesser percentage of 8% [22]. In a retrospective study that assessed hospital admissions, those subjects with a serum chloride above 108 and below 100 mmol/L were at a greater predilection for succumbing to in-hospital mortality [23]. Nevertheless, this study did not show any association between the occurrence of hypochloremia and mortality. It is possible that the correction of chloride during hospital stay could have reduced the mortality risk. One of the most common causes for hypochloremia is excess use of diuretics, but this study did not show a greater preponderance of hypochloremia among diuretic users. It is possible that the increased frequency of hypochloremia seen among this study population could be due to other factors such as excess vomiting or nasogastric suctioning [24]. Nearly 22% of this study population had hyperchloremic metabolic alkalosis as defined by a chloride: sodium ratio <0.75 and sodium-chloride difference >37 mmol/L and of these 17.5% had hypokalemia. Thus, it is pertinent to study the electrolyte disturbances among diabetic subjects admitted in the hospital as they are at a greater risk of developing complications due to the same.

LIMITATION

The present study did not look for the changes in the electrolyte concentration during the hospital stay and thus those patients who developed electrolyte disturbances after few days of hospital stay were not identified. Authors did not measure the urine concentration of electrolytes and having these variables would help us to characterise patients better.

CONCLUSION

Diabetic patients have a greater predilection to develop electrolyte disturbances. The most common electrolyte disturbances seen were hyponatremia and hypochloremia.

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