

Pattern of Electrolytes Including Calcium and Magnesium Imbalance with Etiology Assessment in Patients Admitted in Endocrine Department of a Tertiary Care Hospital

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Abstract: Objectives: Several endocrine disorders have marked effects on fluid, electrolyte, and acid-base homeostasis including diabetic ketoacidosis, hyperglycemic hyperosmolar state, and acute adrenal crisis etc. An understanding of the etiology behind the development of these electrolytes along with calcium and magnesium imbalance helps to guide therapy and improves the clinical outcome. The aim of this study to see the pattern of electrolytes, calcium and magnesium imbalance with etiology assessment in patients admitted in endocrine department of a tertiary care hospital. Study design and methods: This cross sectional observational study was carried out from January 2018 to December 2018, at in-patient department of Endocrinology, BIRDEM General Hospital, Dhaka. Diagnosed (old and new) cases of diabetic and other endocrine disorders having electrolytes, calcium and magnesium imbalance were approached for inclusion of the study. Sampling technique was purposively selected focusing on demographic profile and diagnosis of the disease. Results: Among the 100 participants, mean age of the study population was 46.26±16.97 years, ranging from 14 to 75 years. There were 50%-male and 50%-female. In result the most common electrolyte imbalance was hyponatremia (36%) that was more in type-2 DM patients (n=25) than in Addison's disease (n=4) and rest are in other specific form of DM (n=3), type-1 DM (n=2), DM with hypoparathyroidism (n=1) and hypoparathyroidism (n=1) which may be due to SIADH. Followed by hypokalemia (14%) which mostly encountered in type-2 DM patient (n=6) due to diuretics and in Conn's syndrome (n=4), hyperkalemia (10%) which mostly observed in type-1 DM patient (n=4) due to DKA, and hypercalcemia (8%) was found in non-diabetic endocrine disorders. Hyponatremia, hypocalcemia and hypomagnesemia were present in 7%, in 6%, and 6% cases, respectively. The most common precipitating cause of these electrolyte imbalances was vomiting (30%) due to different causes like urinary tract infection; acute gastritis and pancreatitis. Diuretic (Loop & Thiazide) therapy (10%) and HHS (8%) were the second and third most common cause behind these electrolytes imbalance Conclusion: In conclusion data obtained in this study showed hyponatremia was the most common findings which more observed in diabetic patients. As vomiting is the most common cause behind this so any diabetic patients either present with vomiting or any other illness should routinely advice electrolytes along with magnesium as hypomagnesemia also more observed in this group. To find out the cause of hypokalemia in non-diabetic patients should evaluate the Conn's syndrome and don't forget to measure the parathyroid hormone in hypercalcemic patient. Further study is needed to find out the causes of vomiting.

Keywords: Electrolytes, Diabetes Mellitus, Addison's Disease, Hyperparathyroidism

1. Introduction

Molecules that dissociate in water form cations (positively charged ions) and anions (negatively charged ions) are known as electrolytes which facilitate conduction of electrical current. Na⁺, K⁺, Cl⁻ and bicarbonate are examples of electrolytes [1].

Electrolyte balance is regulated by hormones (such as ADH, aldosterone and PTH) and in general by the kidneys. The most common electrolyte imbalances are hypo- and hyper-states of sodium, potassium, chloride, calcium, and magnesium. The kidneys are the main organ which is responsible for maintaining the electrolyte balance in the healthy individuals [2]. Besides the kidneys, the other mechanisms which are involved in the regulation of fluid and electrolyte balance, such as hormones; like antidiuretic hormone, aldosterone, cortisol, thyroid and parathyroid hormone, and various other factors such as physiological stress and age also play important roles in the regulation of

electrolyte balance [3, 4]. Among the diabetes and endocrine disorders, uncontrolled diabetes mellitus (DM) is most common causes of admission in our endocrinology department of BIRDEM General Hospital. Diabetes mellitus (DM) is rapidly emerging as an important cause of mortality and morbidity in developing countries [5].

2. Methods and Materials

This cross sectional observational study was carried out from January 2018 to December 2018, at in-patient department of Endocrinology, BIRDEM General Hospital, Dhaka. Diagnosed (old and new) cases of diabetic and other endocrine disorders having electrolytes, calcium and magnesium imbalance were approached for inclusion of the study. Sampling technique was purposively selected focusing on demographic profile and diagnosis of the disease.

3. Results

Table 1. Demographic profile of study participants (n=100).

Demographic variable	Percent (%)
Age group	
14 – 25	16
26 – 35	10
36 – 45	26
46 – 55	12
56 – 65	16
66 – 75	20
Sex	
Male	50
Female	50
Occupation	
Student	8
Businessman	18
Day labour	2
Housewife	42
Service	14
Others	16

Table 2. Past history of endocrine disease of study participants (n=100).

Risk factors	Percent
Addison's disease	4
Conn's syndrome	2
Diabetes Insipidus	2
Diabetes Mellitus	6
FCPD	1
Hypothyroidism	8
PCOS	2
Panhypopituitarism	2

Table 3. Diseases of study participants (n=100).

Diagnosis	Percent (%)
Diabetic diseases	58
Type 2 DM	43
Type 1 DM	10
FCPD	1
Other forms of diabetes	4
Non-diabetic diseases	42

Diagnosis	Percent (%)
Hypoparathyroidism	8
Hyperparathyroidism	6
Diabetes Insipidus	5
Addison's disease	5
Conn's syndrome	4
Adrenal crisis	2
Cushing's syndrome	2
Hypercalcemia	2
Panhypopituitarism	2
PCOS	2
Vitamin D deficiency	2
Adrenal insufficiency	2

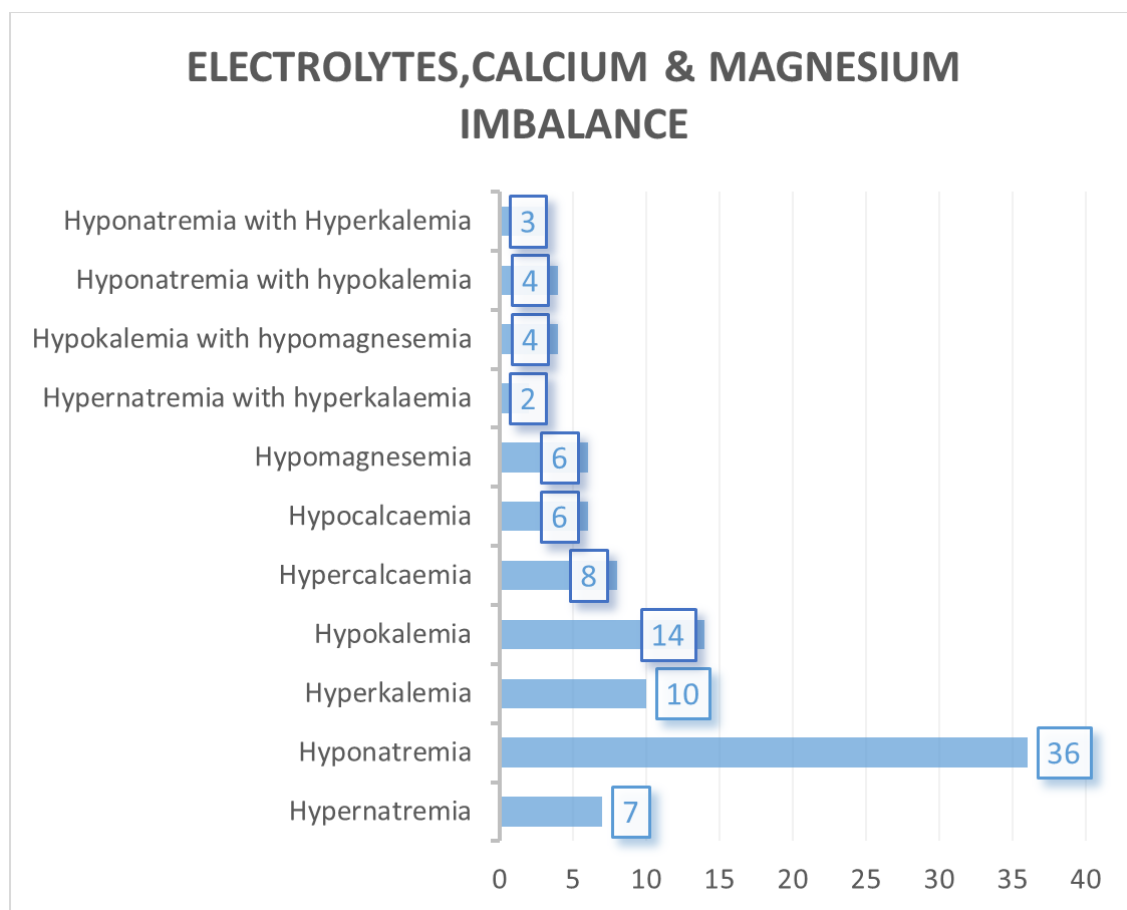


Figure 1. Pattern of electrolytes, calcium and magnesium imbalance in endocrine department (n=100).

Table 4. Pattern of electrolytes, calcium and magnesium imbalance in diabetic and non-diabetic disorders (n=100).

Electrolyte/micronutrient imbalance	Disorders		P value
	Diabetic (n=58) N (%)	Non-diabetic (n=42) N (%)	
Hypernatremia	2 (3.4)	5 (11.9)	0.102
Hyponatremia	30 (51.7)	6 (14.3)	<0.001
Hyperkalemia	6 (10.3)	4 (9.5)	0.893
Hypokalemia	6 (10.3)	8 (19.0)	0.216
Hypercalcaemia	0	8 (19)	0.001
Hypocalcaemia	0	6 (14.3)	0.003
Hypomagnesemia	6 (10.3)	0	0.032
Hyponatremia with hyperkalemia	2 (3.4)	0	0.224
Hyponatremia with hypokalemia	2 (3.4)	2 (4.8)	0.741
Hypokalemia with hypomagnesemia	4 (6.9)	0	0.082
Hypernatremia with hyperkalemia	0	3 (7.1)	0.039

P value determined by Chi-squared test.

Table 5. Pattern of electrolytes, calcium and magnesium imbalance in diabetic patients (n=58)

Electrolytes, calcium & magnesium imbalance	Diabetic disorder				P value
	Type 1 DM	Type 2 DM	FCPD	Other forms	
	(n=10)	(n=43)	(n=1)	(n=4)	
	N (%)	N (%)	N (%)	N (%)	
Hypernatremia	0	2 (4.7)	0	0	0.868
Hyponatremia	2 (20)	25 (58.1)	1 (100)	2 (50)	0.128
Hyperkalemia	4 (40)	2 (4.7)	0	0	0.009
Hypokalemia	0	6 (14)	0	0	0.506
Hypomagnesemia	2 (20)	4 (9.3)	0	0	0.652
Hypernatremia with hyperkalemia	2 (20)	0	0	0	0.019
Hyponatremia with hypokalemia	0	2 (4.7)	0	0	0.868
Hypokalemia with hypomagnesemia	0	2 (4.7)	0	2 (50)	0.005

DM: Diabetes mellitus; DI: Diabetes insipidus; FCPD: Fibrocalcific pancreatic disease, P value determined by Chi-squared test.

Table 6. Pattern of electrolytes, Ca^{2+} and Mg^{2+} imbalance in non-diabetic patients and others (n=42).

Non-diabetic disorders	N	Electrolytes, Ca^{2+} & Mg^{2+} imbalance				
		Hypernatremia	Hyponatremia	Hyperkalemia	Hypokalemia	Hypercalcemia
Addison's disease	5	0	0	2 (40)	0	0
Adrenal crisis	2	0	2 (100)	0	0	0
Adrenal insufficiency	2	0	2 (100)	0	0	0
Conn's syndrome	4	0	0	0	4 (100)	0
Cushing's syndrome	2	0	0	0	0	0
Diabetes Insipidus	5	5 (100)	0	0	0	0
Hyperparathyroidism	6	0	0	0	0	6 (100)
Hypoparathyroidism	8	0	2 (25)	0	2 (25)	0
Vitamin D deficiency	2	0	0	0	0	0
Iatrogenic hypercalcemia	2	0	0	0	0	2 (100)
Polycystic ovary syndrome	2	0	0	2 (100)	0	0
Panhypopituitarism	2	0	0	0	2 (100)	0
P		<0.001	0.002	0.003	0.001	<0.001

Table 6. Continued.

Non-diabetic disorders	Electrolytes, Ca^{2+} & Mg^{2+} imbalance			
	Hypocalcemia	Hyponatremia with hypokalemia	Hypernatremia with hyperkalemia	Hypokalemia with hypomagnesemia
Addison's disease	0	3 (60)	0	0
Adrenal crisis	0	0	0	0
Adrenal insufficiency	0	0	0	0
Conn's syndrome	0	0	0	0
Cushing's syndrome	0	0	0	2 (100)
Diabetes Insipidus	0	0	0	0
Hyperparathyroidism	0	0	0	0
Hypoparathyroidism	4 (50)	0	0	0
Vitamin D deficiency	2 (100)	0	0	0
Iatrogenic hypercalcemia	0	0	0	0
Polycystic ovary syndrome	0	0	0	0
Panhypopituitarism	0	0	0	0
P	0.007	<0.001	0.013	

Table 7. Causes of electrolytes, Ca^{2+} & Mg^{2+} imbalance in study participants (n=100).

Diagnosis	Percent (%)
Vomiting	30
Diuretics	10
Hyperglycemic hyperosmolar state	8
Diabetic ketoacidosis	6
Hyperparathyroidism	6
Hypoparathyroidism	6
ADH deficiency	5
Adrenal crisis	4
Hyperaldosteronism	4
Excess water intake	4
Cortisol deficiency	3
Acute gastroenteritis	2

Diagnosis	Percent (%)
Cushing's syndrome	2
Increased oral intake	2
In vitro hemolysis	2
Laxative abuse	2
SIADH	2
Vitamin D deficiency	2

4. Discussion

Total 100 patients of electrolyte and Ca^{2+} , Mg^{2+} imbalance was included with an average age of 46.26 ± 16.97 years. Majority patients were middle aged with an age between 41 – 60 years (40%). Twenty six percent patients were aged between 20 – 40 years and >60 years. Ahmed et al in their study involving diabetic patients noted that hyponatremia was more common among elderly (>60 years) patients [6]. Haque and her colleagues also noted a prevalence of elderly people among diabetic patients admitted with electrolyte imbalance [7]. On the other hand, middle age bulk in this study was constituted by patients having adrenal disease and parathyroid disease alongside type 1 and 2 DM.

The present study found 58% diabetic, 30% non-diabetic cases and 12% cases of diabetes with other endocrine disorders. Among diabetic patients 43% had type 2 diabetes mellitus. Among non-diabetic patients, parathyroid disorders were relatively common. The most common electrolyte imbalance was hyponatremia (36%) and this was found in significantly higher proportion among diabetic patients. This is concordant with the findings of Ahmed and colleagues who found 63.3% cases of hyponatremia among diabetic patients [6]. It was found to be 80% in a study conducted in one of the largest hospital of Bangladesh mainly for diabetes care named Bangladesh Institute of Research & Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) [7].

The most common precipitating cause for electrolyte imbalance was vomiting (30%). This is also consistent with findings of Ahmed and Haque who reported respectively 54.7% and 51% cases of electrolyte imbalance due to vomiting in their study [6, 7]. In this study most of the diabetic patient suffered from vomiting due to different cause like UTI, acute gastritis & pancreatitis. In some patients the actual cause of vomiting could not find out.

An important cause of dilutional hyponatremia is SIADH and was found in 2 cases of type 2 diabetes in the present study [8]. Other causes of hyponatremia may be diuretic use which was found in 10% cases of the present study. In general practice, diuretic use (specially loop diuretic and thiazide diuretic) is the most common cause of hyponatremia [9]. Present study also noted 7% patients had hypernatremia and 3.4% of diabetic patients had hypernatremia. This is because usually DKA and HHS is associated with hyponatremia at presentation but may also present with hypernatremia [10].

Hypokalemia was the second most common electrolyte imbalance constituting 14% of the total cases. Boysen noted

that total body potassium and phosphorus depletion often is profound in patients that have DKA and HHS ¹⁰. This may explain the 10.3% cases of hypokalemia among diabetic patients in this study. Hypokalemia was also found in 4 cases of Conn's syndrome, 2% cases of panhypopituitarism (one case with DM and one isolated case) due to vomiting and interestingly in two cases of hypoparathyroidism due to laxative abuse. Adrenal steroid excess in Cushing's syndrome and primary hyperaldosteronism (Conn's syndrome) are important renal causes of potassium loss and therefore explains the presence of these cases in the present study [11].

Hyperkalemia alone was found in 10% cases and was the third most common cause of electrolyte imbalance in this study. Hyperkalemia was found in Addison's disease among non-diabetic cases, in PCOS with DM (due to spironolactone) and in type 2 DM patients due in vitro hemolysis. The second most common cause of electrolyte imbalance was diuretic use (10%), including thiazide diuretics and spironolactone. Hyperkalemia was associated with hyponatremia in 3% cases found in Addison's disease with DM and with hypernatremia in 2% cases found in HHS (type 2 DM). Aldosterone deficiency causes loss of sodium and increased potassium in the blood and hyperkalemia in HHS may be due to hyperosmolar state [12, 13]. Two cases of hyperkalemia associated with PCOS were due to use of spironolactone.

Imbalance in calcium metabolism was exclusively found in non-diabetic patients and in patients with combined diabetes and other endocrine disorders. There were 8 cases of hypercalcemia all of which was associated with hyperparathyroidism. Among 6 cases of hypocalcemia 4 were due to hypoparathyroidism (two isolated case and two cases with DM) and 2 were due vitamin D deficiency alongside diabetes.

In this study total 8% cases of isolated hypomagnesemia were found. Among them 6% were isolated cases and 2% was associated with hypokalemia. Six cases of isolated hypomagnesemia were diabetic which may due to HHS and GI loss. Two cases hypomagnesemia with hypokalemia were non-diabetic (due to Cushing's syndrome). Dasgupta et al studied 150 cases of non-critical type 2 DM and found hypomagnesemia in 11.33% patients [14].

The reason is among the endocrine and metabolic disorders associated with magnesium deficiency, diabetes mellitus is the most common [15]. Cushing's syndrome cases presented with hypomagnesemia and hypokalaemia simultaneously in the present study. This type of cases were reported in Cushing's syndrome and Pseudo-Cushing's syndrome in previous studies validating the finding of this study [16].

5. Limitations

1. Data collection primarily confined with the BIRDEM general Hospital
2. Sample size was not representative
3. No follow up was done and it was beyond the scope of the study.
4. Immunological confirmation of type-1 DM cannot be done.
5. Regarding etiology assessment of all vomiting case patients were not evaluated properly.

6. Conclusion

Data obtained in this study showed hyponatremia was the most common findings which more observed in diabetic patients. As vomiting is the most common cause behind this so any diabetic patients either present with vomiting or any other illness should routinely advice electrolytes along with magnesium as hypomagnesemia also more observed in this group. To find out the cause of hypokalemia in non-diabetic patients should evaluate the Conn's syndrome and don't forget to measure the parathyroid hormone in hypercalcemic patient. Further study is needed to find out the causes of vomiting.

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