International Journal of Research in Medical Sciences
Bhutto MG et al. Int J Res Med Sci. 2021 Jan;9(1):112-120
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20205466

Original Research Article

Study of clinical features and laboratory investigations for effective management of hyponatremia

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Received: 25 November 2020
Accepted: 17 December 2020

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ABSTRACT

Background: Hyponatremia, a common electrolyte disorder is mostly observed in hospitalized elderly patients. It is a potential cause of morbidity, mortality and has significant economic impact on the patient and health care system. The aim of the present study was to investigate the risk factors, clinical features and management of hyponatremia in hospitalized patients to reduce its incidence and minimize the associated complications.
Methods: Current study was conducted in a tertiary care hospital SSMC, Tumkur). Patients were evaluated for the underlying cause of hyponatremia through detailed history and physical examination followed by appropriate laboratory investigations based on urine sodium, serum and urine osmolality. Patients with hyponatremia were classified into categories based on clinical investigations and accordingly treated with suitable therapy.
Results: Constitutional symptoms, confusion, fever, vomiting, respiratory symptoms, abdominal pain, loose stools, coma, convulsions and other miscellaneous symptoms were observed in history of hyponatremic patients. Most common etiology was found to be SIADH followed by extrarenal losses, renal failure, cirrhosis, CCF, drug in take and glucocorticoid deficiency. Management of hyponatremia was done using hypertonic saline, administration of diuretics, fluid restriction therapy, administration of vaptans and combination of hypertonic saline and vaptans as treatment alternatives, no potential complications were observed during treatment of hyponatremia.
Conclusions: The possible cause of hyponatremia should always be determined, asoutcomeinsevere hyponatremiais governed by etiology and not merely by serum sodium levels. The correction of hyponatremia helps to improve the prognosis of the underlying disease and to prevent further complications.

Keywords: Hyponatremia, Electrolyte imbalance, Serum and plasma osmolality, SIADH, CSW

INTRODUCTION

Sodium is considered an essential electrolyte that helps to maintain the balance of water in and around the cells.[1] Maintained water and sodium levels are important for proper nerve and muscle functions and for stable blood pressure.[1] Normal serum sodium concentration is between 135-145 mEq/l, serum sodium concentrations less than 135 mEq/l is a condition of electrolyte imbalance known as hyponatremia.[2,3] In normal circumstances, the plasma sodium concentration is maintained within a narrow range through anintegration of thirst, renal responsiveness of the vasopressin and vasopressin in secretion.[4] Hyponatremia is a common clinical problem where water levels increases and subsequent serum sodium levels decreases. If total bodywater content changes without any change into talbody solute, plasma osmolality changes and complications like hyponatremia orhypernatremia occurs.[5] The etiology of hyponatremia is multifactorial. Inability of kidney to excrete water or excess water intake results in hyponatremia. Water intake depends upon thirst mechanism that is stimulated by increase or decrease in

osmolality. Osmoreceptors in the hypothalamus senses the feeling of thirst and release anti diuretic hormone (ADH) vasopressin.[6] ADH reacts with V2 receptors leading to increased aquaporin expression; this in turn increases water absorption from kidneys and abolishes the feeling of thirst. Hyponatremia occurs if there is persistent ADH stimulation and release.[4-6]

Hyponatremia is one of the most common biochemical electrolyte abnormalities in hospitalized patients with a prevalence rate of 15% and 22%.[7] Hyponatremia is associated with in creased morbidity and mortality, especially in the adult population owing to impaired ability to maintain water and electrolyte homeostasis in response to diet, environmental changes and drugs upon ageing.[7,8] Patients with acute hyponatremia exhibit neurologic symptoms like seizures, impaired mental status or coma and death in less than 48 hours. Most patients have chronic hyponatremia that is mainly mild and asymptomatic. Mild hyponatremia is characterized by gastrointestinal tract symptoms nausea, vomiting, loss of appetite and subtle neurologic abnormalities.[9,10]

Hyponatremia is classified on the basis of serumos molality in to hypertonic, isotonicandhypotonic. Hypotonichyponatremiais further classified in to hypervolemic, euvolemic/normovolemic and hypovolemic.[10] In hypervolemic disorder there is excess of total body sodium and a larger excess of total body water, in euvolemic condition there is normal total body sodium and a modest excess of total body water and in hypovolemic disorder there is adeficit of total body water and a larger deficitof total body sodium.[11] Assodium is the predominan textra cellularosmole, most case sofhyponatremiaarehypotonic, although the rearemany cause sofhypovolemic-hypotonichyponatremia, the two most common etiologies are diuretic induced; syndrome of inappropriate antidiuretic hormone secreation (SIADH) and cerebral salt wasting (CSW), difference in clinical features between SIADH and CSW is listed in (Table 1).[6]Type of hyponatremia can be differentiated and interpreted through laboratory investigations like measurement of serum sodium and serum osmolality, measurement of urine sodium and osmolality, urine to serum electrolyte ratio, fractional excretion of sodium, serum uric acid and urea concentrations, thyroid profile, liver function tests, adrenocorticotropic hormone (ACTH) levels and ACTH stimulation tests and brain and chest imaging.[12-15]

Treatment of hyponatremia varies with the nature (acute or chronic), severity and symptoms. Since SIAD Histhemostcomm on cause of hyponatremia in patients with in tracranialdisease, appropriate treatment should be given after carefully differentiating it fromCSW.[16]Hyponatremia in SIADH is usually chronic requiring slow corrections, water restriction would be the main line of treatment in such cases. If water restriction and salttablet therapyare ineffective drug the rapy to antagonize the effect of ADH could be attempted.[17] Loop diurectics, demeclocyclin, urea, lithium carbonate and vaptans are mostly used in drug therapies to treat chronic SIADH, only symptomatic or acute cases of SIADH can be treated with 3% NaCl infusions.[18]TreatmentofCSWshouldbedonewithisotonicsaline, asCSW is usuallytransient,long-term therapy is not necessary. Salttablets and fludrocortisonecanalsobeused totreatCSW.[18-20]

Table 1: Comparative clinical features based profileofthe SIADH and CSW.

Clinical features	SIADH	CSW
Plasmasodium	Low	Low
ECF volume	Normal or slightly increased	Decreased
Total body water volume	Increased	Increased
Bloodpressure	Normal	May below
Posturalhypotension	Absent	Present
Antidiuretichormone	Increased	Increased
Urineosmolality	Inappropriatelyhigh	Appropriately high
Urineosmolalityaftervolumeexpansion	Relativelyfixed	Decrease to <100 mOsm/kg
Urinary sodiumexcretion	Increased>40mEq/lbecauseofvolumeexpansion	Increased >40mEq/lbecause of salt wasting
Plasma uricacidlevel	Lowduetovolumeexpansion	Due to urinary losses
Fractionalexcretionofurate	Normalaftercorrectionofplasmasodium	Elevatedaftercorrectionofplasmasodium
Brainnatriureticpeptide	Normal	Normal to high
Effect ofisotonicsaline	Mayworsenhyponatremia	Improves hyponatremia

Aim and objectives

Due to the lack of larges calestudies, limited data exists regarding the incidence of hyponatremia. Therefore, the aim of the present study was to determine the clinical profile and laboratory spectrum of hyponatremia in patients admitted to tertiary care hospital. Specific objectives of the current study were to investigate the clinical feature so fhyponatremiainadults, to identify and assess the risk factor so fhyponatremia in adults and management of hyponatremia.

METHODS

Study place and duration

The present study was conducted on 107 patients admitted to ICU, emergency and medical wards of Sri Siddhartha medical college and hospital, Tumkur, from November 2016 to October 2018.

Inclusion criteria

Patientsaged ≥18 years of either sex with serum sodium <135 mEq/l, irrespective of duration and type of treatment received, were included in the study.

Exclusion criteria

All patients with ageless than18yearswere excluded from the study.

Clinical assessment

Detailed patient history regarding symptos of hyponatremia, predisposing factors and pre-existing illness was documented. The definition of symptomatic hyponatremia was made based on clinical assessmen to fsymptomatology including the presence of alteredsensorium, posturaldizziness, lethargy and seizures. Sensorium changes includeda cute confusionstates, memory disturbances, stupor, delirium and coma. Drugs that can cause hyponatremia were recorded. History of illness causing hyponatremia such as congestive cardiac failure, chronic kidney disease, chronic liver disease, hypothyroid is man do there conditions which are associated with SIADH such as small cellcarcinoma, CNS disease was documented. History of fluid loss through vomiting, diarrhea, diureticuse, excessive sweating was noted for all patients. Detailed clinical examination was done for every patient. Hydration status of patients was determined and the signs of hypovolemia including tachycardia, decreased skin turgor, drymucous membranes and decreased peripheral perfusion were observed and recorded. Hypervolemic state was defined by the presence of anasarca, ascites, bilateral pitting pedale demaandraisedjugular venous pulse, accordingly patients were divided in to hypervolemic, hypovolemic and euvolemic. At the time of diagnosis, detailed CNS examination was done to documentmental status of the patient and other focal neurological deficit. CNS examination was repeated after the correction of hyponatremiaand the presence of symptoms such as dizziness, lethargy, altered sensorium and seizures were attributed to hyponatremia unless there was aco-existing medical condition or medication effect to account for these symptoms. Patients were screened for central pontinemyelinolysis (CPM) based on development to fsymptoms like confusion, agitation and flaccid orspasticparalysis during oraftercorrection of hyponatremia. Laboratory investigations like; complete blood count, hemoglobin content, total leucocytes count, differential count of WBC, platelet count, urine analysis and microscopic examination, specific gravity, serum so diumlevel determinations (daily for symptomatic cases, alternate days for a symptomatic patients), serum BUN (blood urea nitrogen) and glucose level determination to calculate serumosmolality, urine sodium and osmolality determination were done in patients with hypotonichyponatremia. Brainimaging and CSF analysis were done in patients with altered sensorium to exclude structuralabnormalities and meningealinfection chances, serum protein and lipid profile were also determined to rule out pseudohyponatremia. Patients with hyponatremia were classified into categories based on clinical these investigations (Table 2).

Table 2: Patient's classification categories based on clinical assessment outcomes.

Category	Serum sodium levels
Mild	127-135bmEq/l
Moderate	121-126bmEq/l
Severe	<120bmEq/l
Isotonic	280-295nmOsm/l
Hypertonic	>295nmOsm/l
Hypotonic	<280nmOsm/l

Treatmentstrategy

Decisions on the treatment modality were made based on the cause and severity of hyponatremia and presence of neurological symptoms of hyponatremia. Fluidrestriction therapy (total fluid in take in 24hrs equal to the volume of urine output of previous 24hrs), was advised in patients with hypervolemia and SIADH, normals aline (0.9%) was given to hypovolemic patients, loop diuretics were recommended in cases of excretion of free water in SIADH and hypervolemia, 3% saline was advised in severe hyponatremic patients with neurological symptoms of hyponatremia.

Data collection and statistical analysis

For all the patients clinical and demographic details final diagnosis, investigations and management were recorded in a standard data collections heetasper the study proforma and later transferred to Microsoft excel spread sheet for analysis. Statistical analysis was done using SPSS (version 18.0) and R environment version 3.2.2. Descriptive statistics was used as statistical method. Data were presented in the form of frequency distribution and percentages.

RESULTS

Total 107 patients with hyponatremia who were admitted to ICU, emergency and medical wards of Sri Siddhartha Medical College and Hospital were investigated in current study. Numbers of patients with severe hyponatremia (sodium less than 120 mmol/l) were 45 (42.1%).

Maximum numbers of patients; 34 (31.8%) were in the age group 59-68 years and minimum numbers of patients were in the age group 89-99years; 1(0.9%). Meanage of patients admitted was 57.50±15.70 years. 71 (66.4%) patients were males and 36(34%) were females. In both male and female patients maximum number of cases 20 (28.2%) and 14 (38.9%) respectively, were observed in the age group of 59-68years. Out of 107cases, 71males were with ameanage of 56.42years and 36 females were with ameanage of 59.61 years (Table 3).

Table 3: Age and gender distribution in hyponatremia patients.

Age group (years)	Gender		Total
	Male, N (%)	Female, N (%)	
18-28	3 (4.2)	2 (5.6)	5 (4.7)
29-38	9 (12.7)	1 (2.8)	10 (9.3)
39-48	9 (12.7)	4 (11.1)	13 (12.1)
49-58	13 (18.3)	6 (16.7)	19 (17.8)
59-68	20 (28.2)	14 (38.9)	34 (31.8)
69-78	12 (16.9)	3 (8.3)	15 (14)
79-88	4 (5.6)	6 (16.7)	10 (9.3)
89-99	1 (1.4)	0 (0)	1 (0.9)
Total	71 (100)	36 (100)	107 (100)

Out of total 107 patients, 69(64.5%) were reported with constitutional symptoms, 56 (52.3%) had confusion, 53 (49.5%) had fever, 44(41.1%) suffered from vomiting, 40 (37.4%) had respiratory symptoms, 39 (36.4%) complained to have abdominal pain, 16(15%) had looses tools, 5(4.7%) were in coma, 3 (2.8%) had convulsions and 54 (50.5%) exhibited other symptoms. Most common risk factor observed among patients was SIADH; 35(32.7%). Risk factor associated to hyponatremia in 24(22.4%) patients was excess renal losses, in 14 (13.1%) patients risk factor was renal failure, 13(12.1%)patients were with mild renal losses, 12(11.2%) patients had cirrhosis, 5(4.7%) patients were with history of cardiac failure, 3(2.8%)patients were with drug induced hyponatremia and 1(0.9%) patient was with glucocorticoid efficiency. None of the patients exhibited hypothyroidismorn ephroticsyn dromeas risk factors (Table 4).

All the patients were observed to have hypotonichyponatremia, out of which 37(34.6%) patients were hypovolemic, 38(35.5%) were euvolemic and 32 (29.9%) patients were hypervolemic. 52(48.6%) patients were having moderate hyponatremia, 45(42.1%) were having severe hyponatremia and10(9.3%) were with mild hyponatremia. In current study most common age group was 59-68 years with total 34 patients, out of which 9 (24.3%) patients were hypovolemic, 13(34.2%) were euvolemic and 12(37.5%) patients were hypervolemic. Out of total 71 male patients 21(56.8%) were hypovolemic, 27(71.1%) were euvolemic and 23(71.9%) were hypervolemic. Out of total 36 females patients 16(43.2%)were hypovolemic,11 (28.9%)were euvolemicand 9(28.1%)were hypervolemic (Table 5).

Table 4: Distribution of hyponatremia patients based on clinical features, risk factors, volume status and severity.

Parameter, (n=107)	Frequency	Percentage
Clinical features		
Fever	53	49.5
Painabdomen	39	36.4
Vomiting	44	41.1
Loosestools	16	15
Respiratory symptoms	40	37.4
Constitutional symptoms	69	64.5
Convulsions	3	2.8
Confusion	56	52.3
Coma	5	4.7
Others	54	50.5
Risk factors		
Renal losses	13	12.1
Extrarenal losses	24	22.4
Drugs	3	2.8
SIADH	35	32.7
Hypothyroidism	0	0
Glucocorticoiddeficiency	1	0.9
Renalfailure	14	13.1
Cirrhosis	12	11.2
Cardiacfailure	5	4.7
Nephroticsyndrome	0	0
Volume status		
Hypovolemia	37	34.6
Euvolemia	38	35.5
Hypervolemia	32	29.9
Severityof hyponatremia in terms of serum sodium		
<120(severe)	45	42.1
121-126(moderate)	52	48.6
127-135(mild)	10	9.3

Out of 69 (64.5%) patients with constitutional symptoms, 20 (54.1%) were hypovolemic, 25 (65.8%) euvolemic and 24 (75%) were hypervolemic. Out of 56 (52.3%) patients who had confusion, 16 (43.2%) were hypovolemic, 18 (47.4%) euvolemic and 22 (68.8%) were hypervolemic. In 54 (50.5%) patients with other symptoms, 18 (48.6%) were hypovolemic, 20 (52.6%) euvolemic and 16 (50%) were hypervolemic (p=0.080). Among 53 (49.5%) patients who had fever, 19 (51.4%) were hypovolemic, 22 (57.9%) euvolemic and 12 (37.5%) were hypervolemic. Out of 44 (41.1%) patients who suffered from vomiting, 24 (64.9%) were hypovolemic, 13 (34.2%) euvolemic and 44 (41.1%) were hypervolemic (p=0.001). Out of 40 (37.4%) patients with respiratory symptoms, 4 (10.8%) were hypovolemic, 25 (65.8%) euvolemic and 11 (34.4%) were hypervolemic (p<0.001). Among 39 (36.4%) patients with abdominal pain, 21 (56.8%) were

hypovolemic, 6 (15.8%) euvolemic and 12 (37.5%) were hypervolemic (p=0.001). Out of 16 (15%) patients who had loose stools, 12 (32.4%) were hypovolemic, 1 (2.6%) euvolemic and3 (9.4%) were hypervolemic (p=0.001). Among 5 (4.7%) patients who were in coma, 1 (2.7%) were hypovolemic, 2 (5.3%) euvolemic and 2 (6.3%) were hypervolemic. Out of 3 (2.8%) patients who had convulsions, 1 (2.7%) was hypovolemic, 1 (2.6%) euvolemic and1 (3.1%) hypervolemic. Out of 37 (34.6%) patients with hypovolemic hyponatremia, 24 (64.9%) patients had hypovolemic hyponatremia due to excess renal losses (p<0.001) and13 (35.1%) patients due to mild renallosses (p<0.001). Out of 38 (35.5%) patients with euvolemichyponatremia, 34 (89.5%) patients had euvolemichyponatremia due to SIADH (p<0.001), 3 (7.9%) due to drugs used and 1 (2.6%) due to glucocorticoid efficiency, none of the patients had hypothyroidism. Out of 32 (29.9%) patients with hypervolemichyponatremia, 14 (43.8%) patients had hypervolemichyponatremia due to renal failure (p<0.001), 12 (37.5%) due to cirrhosis (p<0.001), 5 (15.6%) due to cardiac failure (p=0.002) and1 (3.1%) due to SIADH (p<0.001), none of the patients exhibited nephrotic syndrome. Out of 38euvolemic subjects 22 (57.9%) had moderate hyponatremia, 15 (39.5%) had severe hyponatremia and 1 (2.6%) had mild hyponatremia. Out of 37 hypovolemic subjects 20 (54.1%) had moderate hyponatremia, 13 (35.1%) had severe hyponatremia and 4 (10.8%) had mild hyponatremia. Out of 32 hypervolemic subjects 19 (59.4%) had severe hyponatremia, 11 (34.4%) had moderate hyponatremia and 2 (6.3%) had mild hyponatremia (Table 6). On days1 to 4 of investigation number of patients with severe, moderate and mild hyponatremia and number of hypervolemic, euvolemic and hypovolemic patients are depicted in (Table 7).

Table 5: Age and gender distribution of hyponatremia with respect to volume status.

	Volume status, frequency (%)			Total (%) (n=107)	P value
	Hypovolemia (n=37)	Euvolemia (n=38)	Hypervolemia (n=32)		
Age group (years)					
18-28	3 (8.1)	2 (5.3)	0 (0)	5 (4.7)	0.749
29-38	3 (8.1)	3 (7.9)	4 (12.5)	10 (9.3)	
39-48	4 (10.8)	4 (10.5)	5 (15.6)	13 (12.1)	
49-58	7 (18.9)	7 (18.4)	5 (15.6)	19 (17.8)	
59-68	9 (24.3)	13 (34.2)	12 (37.5)	34 (31.8)	
69-78	4 (10.8)	7 (18.4)	4(12.5)	15 (14)	
79-88	6 (16.2)	2 (5.3)	2 (6.3)	10 (9.3)	
89-99	1 (2.7)	0 (0)	0 (0)	1 (0.9)	
Gender					
Male	21 (56.8)	27 (71.1)	23 (71.9)	71 (66.4)	0.310
Female	16 (43.2)	11 (28.9)	9 (28.1)	36 (33.6)	

Table 6: Correlation of clinical features and risk factors and severity with volume status.

Parameters	Volume status, frequency (%)			Total (%) (n=107)	P value
	Hypovolemia (n=37)	Euvolemia (n=38)	Hypervolemia (n=32)		
Clinical features					
Fever	19 (51.4)	22 (57.9)	12 (37.5)	53 (49.5)	0.227
Pain abdomen	21 (56.8)	6 (15.8)	12 (37.5)	39 (36.4)	0.001
Vomiting	24 (64.9)	13 (34.2)	7 (21.9)	44 (41.1)	0.001
Loosestools	12 (32.4)	1 (2.6)	3 (9.4)	16 (15)	0.001
Respiratory symptoms	4 (10.8)	25 (65.8)	11 (34.4)	40 (37.4)	<0.001
Constitutional symptoms	20 (54.1)	25 (65.8)	24 (75)	69 (64.5)	0.189
Convulsions	1 (2.7)	1 (2.6)	1 (3.1)	3 (2.8)	1.000
Confusion	16 (43.2)	18 (47.4)	22 (68.8)	5 (52.3)	0.080
Coma	1 (2.7)	2 (5.3)	2 (6.3)	5 (4.7)	0.738
Others	18 (48.6)	20 (52.6)	16 (50)	54 (50.5)	0.940
Risk factors					
Renal losses	13 (35.1)	0 (0)	0 (0)	13 (12.1)	<0.001
Extrarenal losses	24 (64.9)	0 (0)	0 (0)	24 (22.4)	<0.001
Drugs	0 (0)	3 (7.9)	0 (0)	3 (2.8)	0.107
SIADH	0 (0)	34 (89.5)	1(3.1)	35 (32.7)	<0.001

Continued.

Parameters	Volume status, frequency (%)			Total (%) (n=107)	P value
	Hypovolemia (n=37)	Euvolemia (n=38)	Hypervolemia (n=32)		
Hypothyroidism	0 (0)	0 (0)	0 (0)	0 (0)	1.000
Glucocorticoid deficiency	0 (0)	1 (2.6)	0 (0)	1 (0.9)	1.000
Renalfailure	0 (0)	0 (0)	14 (43.8)	14 (13.1)	<0.001
Cirrhosis	0 (0)	0 (0)	12 (37.5)	12 (11.2)	<0.001
Cardiac failure	0 (0)	0 (0)	5 (15.6)	5 (4.7)	0.002
Nephrotic syndrome	0 (0)	0 (0)	0 (0)	0 (0)	1.000
Severity					
Mild	4 (10.8)	1 (2.6)	2 (6.3)	7 (6.5)	-
Moderate	20(54.1)	22 (57.9)	11 (34.4)	53 (49.5)	-
Severe	13 (35.1)	15 (39.5)	19 (59.4)	47 (43.9)	-

Table 7: Day wise distribution of serum sodium according to severity with volume status.

Serum sodium (mEq/l)	Volume status, frequency (%)			Total (%) (n=107)	P value
	Hypovolemia (%) (n=37)	Euvolemia (%) (n=38)	Hypervolemia (%) (n=32)		
Day 1					
<120	13 (35.1)	14 (36.8)	18 (56.3)	45 (42.1)	
121-126	19 (51.4)	22 (57.9)	11 (34.4)	52 (48.6)	0.231
127-132	5 (13.5)	2 (5.3)	3 (9.4)	10 (9.3)	
Day 2					
<120	7 (18.9)	10 (26.3)	6 (18.8)	23 (21.5)	
121-126	9 (24.3)	6 (15.8)	9 (28.1)	24 (22.4)	0.739
127-132	21 (56.8)	22 (57.9)	17 (53.1)	60 (56.1)	
Day 3					
<120	2 (5.4)	3 (7.9)	2 (6.3)	7(6.5)	
121-126	6 (16.2)	7 (18.4)	6 (18.8)	19(17.8)	1.000
127-132	21 (56.8)	22 (57.9)	18 (56.3)	61(57)	
Day 4					
<120	0 (0)	0 (0)	1 (3.1)	1 (0.9)	
121-126	1 (2.7)	1 (2.6)	1 (3.1)	3 (2.8)	0.831
127-132	10 (27)	11 (28.9)	8 (25)	29 (27.1)	

Table 8: Distribution of urine sodium, urine osmolality and serum osmolality based on volume status.

Parameters	Volume status, frequency (%)			Total (%) (n=107)	P value
	Hypovolemia (%) (n=37)	Euvolemia (%) (n=38)	Hypervolemia (%) (n=32)		
Urinesodium (mmol/l)					
<20	13 (35.1)	0 (0)	15 (46.9)	28 (26.2)	<0.001**
>20	24 (64.9)	38 (100)	17 (53.1)	79 (73.8)	
Urineosmolality (mOsm/kg)					
<500	16 (43.2)	15 (39.5)	26 (81.3)	57 (53.3)	
500-850	19 (51.4)	14 (36.8)	4 (12.5)	37 (34.6)	<0.001**
>850	2 (5.4)	9 (23.7)	2 (6.3)	13 (12.1)	
Serum osmolality (mOsm/kg)					
<275	14 (37.8)	33 (86.8)	20 (62.5)	67 (62.6)	
275-300	2 (5.4)	3 (7.9)	2 (6.3)	7 (6.5)	<0.001**
>300	21 (56.8)	2 (5.3)	10 (31.3)	33 (30.8)	

Out of 28 (26.2%) patients have in gurine sodium <20 mmol/l, 15 (46.9%) were hypervolemic, 13 (35.1%) were hypovolemic and none areeuvolemic. In 79 (73.8%) patients with urine sodium>20 mmol/l, 38 (100%) were euvolemic, 24 (64.9%) were hypovolemic and 17 (53.1%) were hypervolemic (p<0.001). Out of 57 (53.3%) patients having urine osmolality<500mOsm/kg, 26 (81.3%) were hypervolemic, 16 (43.2%) hypovolemic and 15 (39.5%) were euvolemic. In 37 (34.6%) patients with urine osmolality between 500-850 mOsm/kg19 (51.4%) were hypovolemic, 14 (36.8%) euvolemic, and 4 (12.5%) were hypervolemic. Among 13 (12.1%) patients with urine osmolality>850 mOsm/kg, 9 (23.7%) were euvolemic, 2 (6.3%) were hypervolemic and 2 (5.4%) were hypovolemic (p<0.001). Out of 67 (62.6%) patients having serum osmolality <275 mOsm/kg, 33 (86.8%) were euvolemic, 20 (62.5%) were hypervolemic and14 (37.8%) were hypovolemic. In 7 (6.5%) patients with serum osmolality in between 275-300 mOsm/kg, 3 (7.9%) were euvolemic and 2 (6.3%) were hypervolemic and 2 (5.4%) were hypovolemic. Out of 33 (30.8%) patients having serumosmolality >300 mOsm/kg, 21 (56.8%) were hypovolemic, 10 (31.3%) were hypervolemic and2 (5.3%) were euvolemic (p<0.001) (Table 8).

In current study total 46 (43%) patients received 3% NaCl as treatment alternative for management of hyponatremia, 33 (30.8%) received diuretics and fluid restriction therapy, 22 (20.6%) received both 3%NaCl and vaptansand6 (5.6%) received only vaptans as treatment alternatives for hyponatremia. Out of 46 (43%) subjects who received 3%NaCl as treatment, 16 (43.2%) were hypovolemic, 15 (46.9%) were hypervolemic and 15 (39.5%) were euvolemic. Out of 33 (30.8%) patients who received other treatment liked iuretics and fluid restriction, 14 (37.8%) were hypovolemic, 13 (34.2%) euvolemic and 6 (18.8%) were hypervolemic. Among 22 (20.6%) patients who received both 3%NaCl and vaptans as treatment alternative 8 (25%) were hypervolemic, 8 (21.1%) were euvolemic and 6 (16.2%) were hypovolemic. Out of 6 (5.6%) patients who received only vaptans3 (9.4%) were hypervolemic, 2 (5.3%) were euvolemic and 1 (2.7%) were hypovolemic (Table 9).

Table 9: Correlation of management of hyponatremia with volume status.

Management method	Volume status, frequency (%)			Total (%)
	Hypovolemia (%)	Euvolemia (%)	Hypervolemia (%)	
3% NaCl	16 (43.2)	15 (39.5)	15 (46.9)	46 (43)
3% NaClandvaptans	6 (16.2)	8 (21.1)	8 (25)	22 (20.6)
Vaptans	1 (2.7)	2(5.3)	3 (9.4)	6 (5.6)
Others	14 (37.8)	13 (34.2)	6 (18.8)	33 (30.8)
Total	37 (100)	38 (100)	32 (100)	107 (100)

DISCUSSION

The present study was conducted on 107 patients, admitted to ICU, emergency and medical wards of SSMC hospital, from November2016 to October2018. The study was under taken keeping in view of the frequent occurrence of hyponatremia in adult sick patients who were at higher risk of developing electrolyte disturbances due to age related physiological changes. Out of 107 patients included in present study, 66.4% were males and 33.6% were females, in similar kind of study reports by Mahaviretal, Vurgheseetaland Rubioetalfrequency of male patients were reported as 64.3%, 56% and 47.3% respectively and that of female patients were reported to be 53.7%, 44% and 52.7% respectively. Vurgheseetal also reported the patients of age group 45-64years as commonly affected people.[21-23] In the present study, majority of the cases were observed to be in the age group of 59-68 years.

In the study report by Raoetallethargy, drowsiness with slow response and irrelevanttalk were the commonly observed symptoms of hyponatremia and only4% patients exhibited seizures.[24] Mahaviretal reported 14%of patients as a symptomatic and only 2% patients exhibited seizures, confusion was the common symptom in their report followed by altered sensorium.[21]Inthestudy by Hochman43.4% patients were a symptomatic, 39.9%had mild symptoms and16.7% patients exhibited severe neurological symptoms with stuporandcoma.[25] In present study 64.5% patients exhibited constitutional symptoms, 52.3%hadconfusion, 49.5%hadfever, 41.1% suffered from vomiting, 37.4% had respiratory symptoms, 36.4% had abdominal pain, 15% suffered from loose stools, 4.7%were in coma, 2.8%had convulsions and 50.5% exhibited other symptoms.

Raoetal reported SIADH and drug intake as themostcommoncauseforhyponatremia.[24] Chatterjeeetal reported gastro-intestinal fluid loss followed by cerebro vascular accidents and pulmonary sepsis as the common causes of hyponatremia.[26] According to Vurgheseetal report SIADH, chronic kidney disease and congestive cardiac failure were prominent causes of hyponatremia.[22] In the study report by Mahaviretal decreased sodium in take and increased sodium loss were the common causes of hyponatremia. In the present study SIADH was observed to be the most common cause of hyponatremia followed by excess renal losses, renal failure, cirrhosis, cardiac failure, drug intake and glucocorticoidd eficiency.

According to current study hypothyroidism and nephroticsyndrome were not observed as risk factors.

Raoetal reported 61% patients aseuvolemic and is ovolemichypo-osmolarhyponatremiaas the most common type of hyponatremia.[24] In the study report by Miyashita etal95%patients had hypotonichyponatremia out of which 63% were hypovolemic.[27] In the present study all 107 patients were having hypotonic hyponatremia, out of which 34.6% were hypovolemic, 35.5%were euvolemic and 29.9% were hypervolemic. In current study on the day of admission, out of 107 patients, 52(48.6%) were having moderate hyponatremia; out of which 22(57.9%) cases were euvolemic, 19 (51.4%) hypovolemicand 11 (34.4%)werehypervolemic.45(42.1%) patients were having severe hyponatremia amongst which maximum were hypervolemic followed by euvolemic and hypovolemic and only 10(9.3%) patients were having mild hyponatremia with maximum number of patients having hypovolemia followed by hypervolemia and euvolemic, these observations could not becom pared with other reports as the range of mild, moderate and severe hyponatremia was different in current study.

In current study among 26.2% patients who had urine sodium levels<20 mmol/l, maximum patients were hypervolemic followed by hypovolemic patients, none of the patients were euvolemic and among 73.8% patients with urine sodium levels >20 mmol/l, maximum patients were euvolemic followed by hypovolemic and hypervolemic patients. In 53.3% patients having urine osmolality <500 mOsm/kg, 81.3%were hypervolemic, 43.2% hypovolemic and39.5%were euvolemic, where as in 34.6% patients with urine osmolality in between 500-850 mOsm/kg, maximum patients were hypovolemic followed by euvolemic andhypervolemic patients respectively. Among patients with urine osmolality>850 mOsm/kg maximum were euvolemic followed by hypervolemic and hypovolemic patients. Inpatients with serum osmolality<275 mOsm/kg and 275-300 mOsm/kg, maximum patients were euvolemic, followed by hypervolemic and hypovolemic patients, while in patients with serum osmolality >300 mOsm/kg, maximum were hypovolemic followed by hypervolemic and euvolemic patients.

In the study report of Mahaviretal 3% saline was the treatment strategy employed on 48.5% patients; normal saline was used for treating 48.6% patients and fluid restriction was used as treatment method on 40% patients.[21] In the present study 43% patients were treated with 3% Nacl, 30.8% with diuretics and fluid restriction therapy, 20.6% patients received both 3% NaCl and vaptans for therapyand5.6% patients received only vaptans for treating hyponatremia.

Limitations

Limitations of the current study were the small sample size of the study group was no tade quate to make concrete recommendations. Follow up investigations could have aided to establish more significant correlations between treatment strategies and outcomes with a more clear insight on side effects if any. Since the range of mild, moderate and severe hyponatremia used in the current study was different than the published reports all study observations could not be compared with reported literature to generalize the current study findings.

CONCLUSION

Hyponatremias an electrolyte abnormality, commonly found in the hospitalized elderly patients. Constitutional symptoms like lethargy, fever, malaise, neurological symptoms like confusion, respiratory symptoms and other symptoms like vomitingare observed in hyponatremic patients. The most common form of hyponatremia was found to be euvolemic hyponatremia. Major risk factors identified for hypomatremia were extrarenal and renallosses, renal failure, cirrhosis, cardiac failure and SIADH was most common risk factor. Treatment alternatives for management of hyponatremia included hypertonicsa line, administration of diuretics, fluid restriction therapy, administration of vaptans and combination of hypertonicsa line and vaptansas, nopotential complications were observed during treatment of hyponatremia. It was concluded that, application of simple diagnostical gorithms (plasmaosmolality), studying patient's history, clinical examination and laboratory finding stoestablish mechanism of hyponatremia, significantly improves the management and out come of hyponatremia.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Bhutto MG, Sandeep BR, Shah SKD, Shabaz. Study of clinical features and laboratory investigations for effective management of hyponatremia. Int J Res Med Sci 2021;9:112-20.