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Original Research Article

Serum sodium abnormality profile in hospitalized elderly patients in a tertiary care centre from north India: a cross sectional observational study

Soni Kumar[1]*, Trilok C. Guleria[2], Laxmi Nand[1], Dalip Gupta[1], Manish Thakur[1]

[1]Department of Medicine, [2]Department of Otolaryngology - Head and Neck Surgery, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India

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***Correspondence:**
Dr. Soni Kumar,
E-mail: drsonikumar335@yahoo.com

ABSTRACT

Background: Serum sodium disorder is most common electrolyte disorder in hospitalized patients. It is associated with significant morbidity and mortality. In developing countries like India; there is continuous increase in elderly population due to improving health care. There is lack of sufficient Indian data on clinical profile, causes, and outcome in elderly hospitalized patients with sodium disorder. We studied incidence, etiology, clinical profile, and outcome of sodium disorders after the treatment during the hospital stay in elderly patients at our institution so that guidelines could be formulated to manage the patients.
Methods: 100 consecutive patients of serum sodium abnormality coming to indoor wards of medicine department over a period of one year were enrolled. Detailed history was taken, clinical presentation reviewed and examination were carried out. All patients were followed closely during hospital stay and necessary investigations were done to establish the cause.
Results: The mean age of patients in the study was 71.26 ±7.8 years (range 60-96 years). Maximum numbers of patients were in the age group of 61-65 years (31%). Out of 100 patients, 54% were males and 46% were females. Out of 100, 48% patients had HTN,38% had DM, 19% had CKD. Abnormal behavior, nausea, vomiting were the predominant symptoms. CKD and drugs intake were the chief causes of the serum sodium abnormality due to abnormal fluid and water homeostasis. The mortality rate was significantly higher in Hypernatremia patients i.e.62 % as compared to hyponatremia patients 26% which was related to severity of serum sodium abnormality, rapid onset, long hospital stays and severity of underling illness.
Conclusions: In our study CKD, drugs chiefly thiazide like diuretics were the most common causes of hyponatremia and dehydration was most common cause for hypernatrmia. Serum sodium disorders were associated with high mortality and morbidity in elderly hospitalized patients.

Keywords: Hyponatremia, Hypernatremia, Morbidity, Sodium, Thiazide

INTRODUCTION

The demography of the world has changed rapidly in the recent years. In almost every country, the elderly population has been growing rapidly over the past few decades, with improvements in health care, resulting in longer life expectancy.[1] As with any other age group; health problems in elderly are diverse. One of such common problems affecting the elderly group is abnormalities in water and electrolyte balance. Age is an

independent risk factor for the occurrence of dyselectrolytemia. Although dysnatraemia is the most common electrolyte abnormality found in elderly, abnormalities in other electrolytes may also occur in various settings.[2] In geriatric population severe hyponatremia and hypernatraemia are associated with significantly high mortality and morbidity.[3] Moreover, inappropriate treatment may result in treatment related complications such as osmotic demyelination syndrome.[4] Furthermore; recent and new development of serum sodium abnormalities is associated with more increased morbidity and mortality in hospitalized affected patients.[5]

Hyponatraemia which is defined as a serum sodium level <135 mEq/L, is the most commonly observed electrolyte imbalance in hospitalized patients, occurring in up to six percents of all age patients.[6] Hyponatremia has been linked to higher mortality risk in numerous medical conditions, including heart failure, liver cirrhosis, cancer, congenital heart disease, community-acquired pneumonia, pulmonary arterial hypertension and pulmonary embolism, as well as in liver transplant candidates.[7, 8]

Hypernatremia; which is defined as a serum sodium level >145 mEq/L, is a rare entity. When hypernatremia does occur, it is associated with a high mortality rate (>50% in most studies).[9] In hospitalized patients, it is persistent severe hypernatremia and later on protracted hypotension; which has been associated with a very poor prognosis.[10]

Among the sodium disorders it is hyponatremia, an excess of water in relation to the sodium in the extracellular fluid, is the most common electrolyte disorder in hospitalized patients and particularly so in the elderly patients.[11]

There is a lack of Indian data on clinical spectrum of sodium disorders in hospital setting and outcome of treatment strategies adopted in various clinical studies. Hence the aim of this study was to evaluate clinical profile of sodium disorder in elderly hospitalized patients and to determine the common etiology, relationship between serum sodium levels and length of stay in the hospital, and finally; outcome in the form of morbidity and mortality.

METHODS

This prospective cross sectional observational study was carried out in elderly patients of age ≥ 60 years who were admitted to Department of Medicine, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India during one year period from 1st July 2015 to 30th June 2016. All serum sodium values were adjusted for concomitantly measured serum glucose levels. A total number of 100 patients with different medical disorders with documented abnormal serum sodium on admission were enrolled. Informed consent was taken. A detailed history with duration of symptoms and examination was taken in all the patients as per the Performa.

Pattern of sodium abnormality among hospitalized elders was classified on the basis of serum sodium levels. Patients with hyponatremia were classified based on serum sodium levels into following categories:

- Mild hyponatremia = 131 - 134 mEq/L,
- Moderate hyponatremia = 120 - 130 mEq/L,
- Severe hyponatremia = <120 mEq/L.

There is no clearly defined classification of hypernatremia in the literature; but serum sodium levels more than146-160 are considered as mild and levels > 160mEq/L are considered severe as it is associated with high mortality. Total body water was calculated on the basis of age, sex, and weight. The following formulas were used to calculate total body water deficit and plasma osmolality: water deficit = TBW (plasma Na - 140)/ 140; and plasma osmolality = 2Na + BUN/2.8 + glucose/18, where TBW = total body water; Na = sodium; and BUN = blood urea nitrogen.

On the basis of preliminary investigation further investigations were planned according to probable causes of sodium abnormality. All data were coded, checked, entered and analyzed; variables were described as means and standard deviations (SDs). Methods included the Chi-square test, Odds ratio, student's t test and relative risk (RR). A p value <0.05 was considered statistically significant.

RESULTS

Successive patients of serum sodium disorders who were admitted to the medicine ward in this period were included in the study. 100 patients were studied during this period of which 97 were symptomatic. Male and female ratio was 1.1:1. So males were more commonly affected. Hyponatraemia was the most common electrolyte abnormality encountered in 84% (100) of the patients in the study group. Hypernatraemia was present in 16 % (100) of the cases.

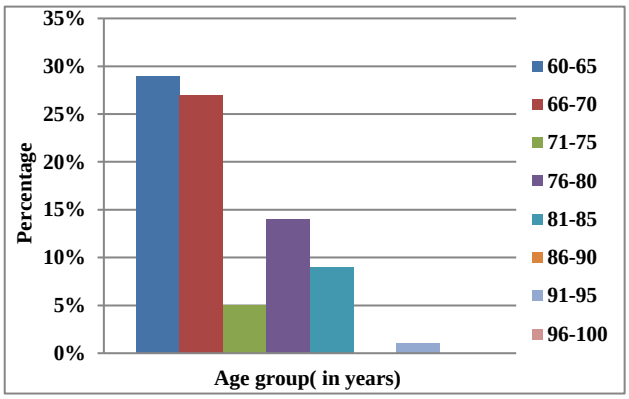

Figure 1: Show age distribution of patients with hyponatremia.

Among 84 (100) patients of hyponatremia 52 % (44) were male and 48% (40) were females. In hypernatremia group among 16 patients 62% (10) were male and 38 % (6) were females. The maximum number of patients was in the age group 64 to 78 years. 32% (100) of patients were between 70-80 years. The oldest patient was 97 years. Mean age was 71.26 years with SD 7.89.21% (100) of patients have been affected between 80-90 years (Figure 1 and 2).

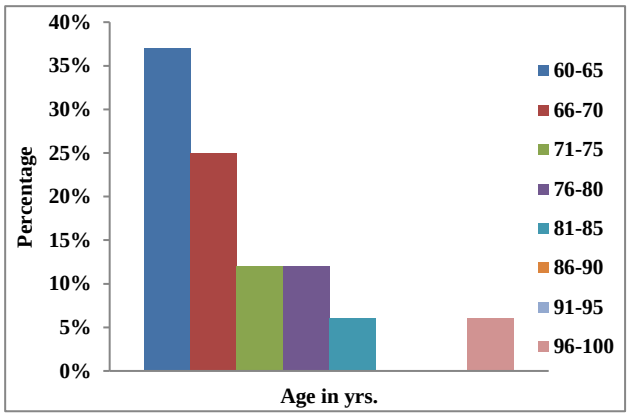

Figure 2: Show age distribution of patients with hypernatremia.

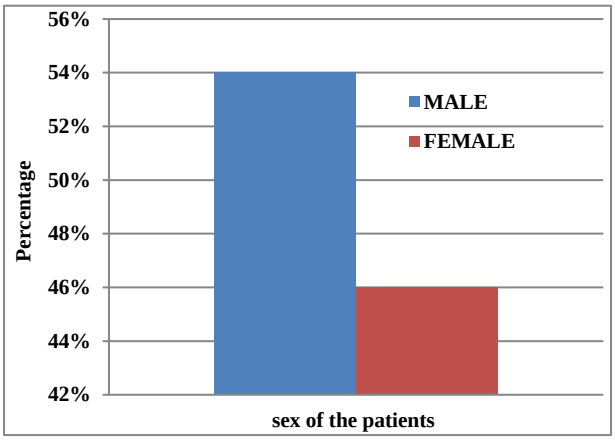

Figure 3: Sex distribution of the patients.

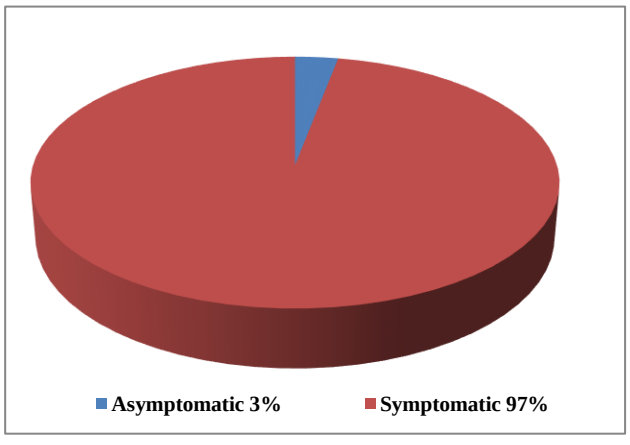

Figure 4: Symptoms of patients.

Most of patients had more than one symptom on the admission and during the course in hospital stay. Most of patients had more than one symptom in the present study. Nausea and abnormal behavior were the most prominent symptoms. Many of patients had similar symptoms both in hypo- and hypernatremia. Abnormal behavior was the leading symptom in both disorders (Figure 3 and 4).

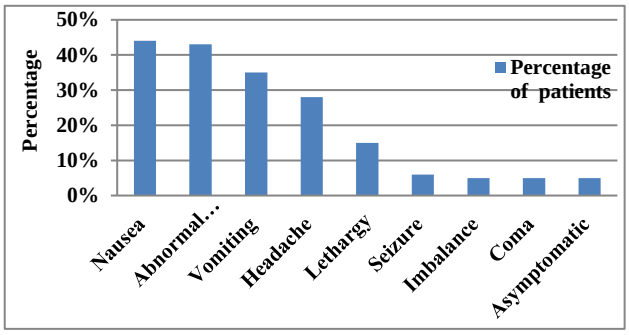

Figure 5: Symptoms of hyponatremia.

Many of patients had multiple co morbid illness at the time of presentation to the hospital. The most common co morbid conditions encountered in the elderly were hypertension (48%), followed by diabetes (38%), CKD (19%), CAD (15%), COPD (13%), Malignancy (13%), CCF (9%), CLD (7%), CVA (4%), RHD (3%), Hypothyroidism (3%), RA (3%), PD (1%), HIV (1%), Seizure (2%) and no co morbid condition seen in (3%). In 50 % (100) of the cases more than one co morbid factor was present (p<0.5280) (Figure 5).

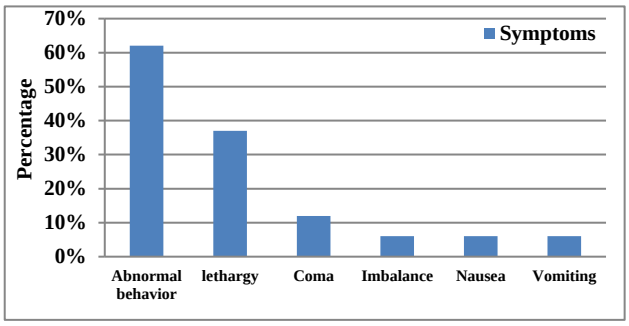

Figure 6: Symptoms of hypernatremia.

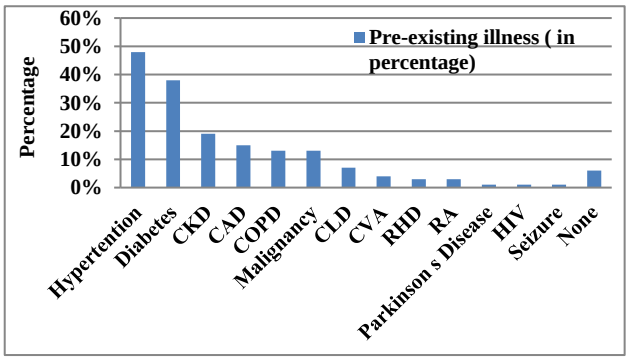

Figure 7: Distribution of pre-existing co morbid illness in patients with sodium disorders.

Hydration status of the patients was calculated on the basis of physical examination. The mean weight (+ SD) for the patients in the study was 61.9 + 1.1 kg. Water deficit replacement rates were based on recorded input and output data, and did not include estimates of ongoing insensible loss. Patients were classified into three categories on the basis of total body volume status as hypovolumic, hypervolumic, euvolumic. In patients with hyponatremia most patients had hypovolumia 40 % (33/84), 38% (31/84) had hypervolumia, 22% (18/84) had euvolumic state (Figure 6). Most of the patients in hypernatremia group were in hypovolumic state because of underling dehydration.

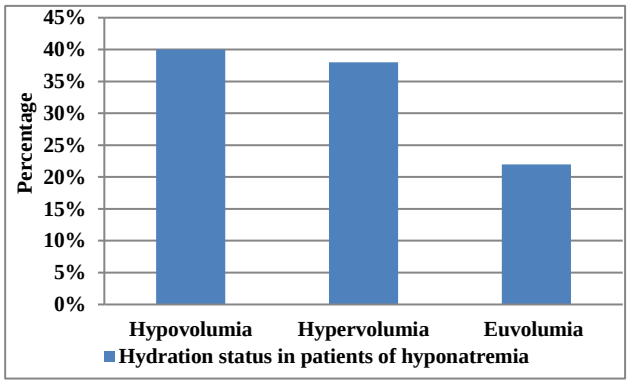

Figure 8: Hydration status of patients with hyponatremia.

In our study most of the patients had multi-factorial etiology for deranged sodium levels. In 21 % (100) of cases history revealed the presence of at least one drug which could contribute to the development of electrolyte disturbance particularly hyponatremia.

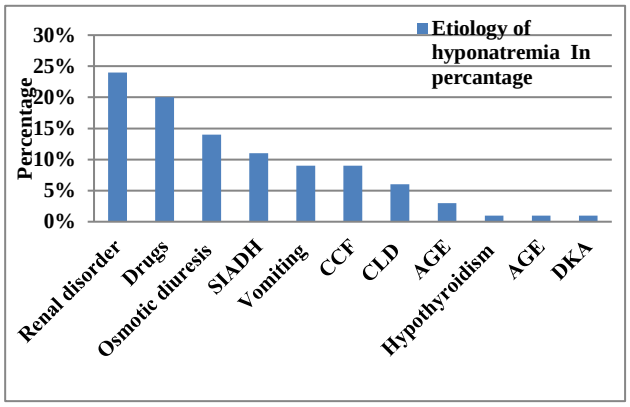

Figure 9: Etiology of hyponatremia.

Most common of these drugs were diuretics 13% (100) followed by other antihypertensive and antidepressant medications. Most common etiology for hyponatremia is due to renal disorder 28% (84), due to drugs 23% (84), Hyperosmolality leading to osmotic diuresis with increased urinary loss of sodium 16% (84), due to SIADH 13% (84), Vomiting 10% (84), CCF10% (84), cirrhosis of liver 7% (84), AGE3% (84), Adrenal insufficiency 1 (1%), due to hypothyroidism1% (84), due to diabetic ketoacidosis 1% (84). Dehydration was the main cause for hypernatremia in our study.

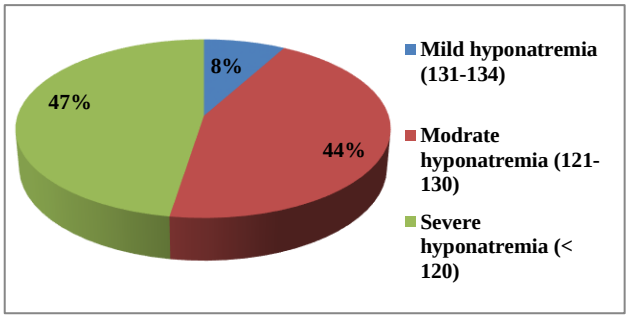

Figure 10: Severity of hyponatremia.

There were 84 patients who had hyponatremia. Distribution of sodium level as per severity were: Mild hyponatremia (131 - 134 mEq/L) 8%, Moderate hyponatremia (120 - 130 mEq/L) 44% and Severe hyponatremia (<120 mEq/L) 47%. (Figure 7). There were 16 patients who had hypernatremia. Distribution of sodium level as per severity is given as; (146-150mEq/L) was seen in 1/16 (6%) patients. (151-155mEq/L) was seen in7/16 (43%) patients. (156-160mEq/L) was seen in 3/16 (18%) patients. (161-165)0-none, (166-170) 4/16 (25%), >170, 1/16 patient (6%) (Figure 8).

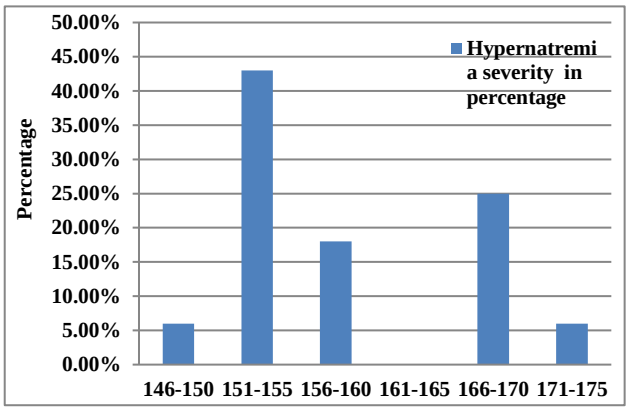

Figure 11: Severity of hypernatremia.

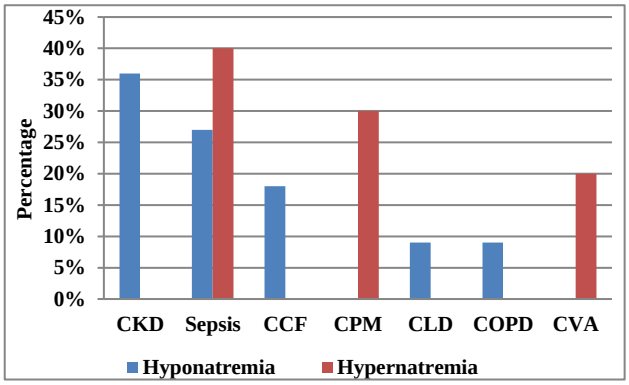

Figure 12: Causes of death in patients with sodium disorder.

In the outcome after hospital stay revealed that the mortality rate was significantly higher in hypernatremia patients i.e. 62% (10/16) as compared to hyponatremia patients 26% (22/84) (Table 1 and 2).

Table 1: Outcomes in hyponatremia group.

Hyponatremia Severity	No. of patients n= 84	Death n=22	Discharge n=62
Mild (131-134mEq/L)	6 (7%)	0	6 (100%)
Moderate (120-130mEq/L)	35 (41%)	5 (14%)	30 (85%)
Severe (< 120mEq/L)	43 (51%)	17 (39%)	26 (60%)

Table 2: Outcomes in hypernatremia group.

Hypernatremia Severity (in mEq/L)	No. of patients (n=16)	Outcome Death (n=10)	Discharge (n=6)
(146-150)	1 (16%)	1 (100%)	0
(151-155)	7 (43%)	3 (42%)	4 (57%)
(156-160)	3 (18%)	1 (33%)	2 (66%)
(161-165)	0	0	0
(166-170)	4 (25%)	4 (100%)	0
(171-175)	1 (6%)	1 (100%)	0

Among the 44% patients with more than one co morbid condition at the admission we divided data in no. of patients with two or more than two co morbidities which predicted that multiple co morbidities present at the time of admission were significantly associated with increase in morbidity and mortality.

The association between Na levels on admission and outcome (length of stay and discharge or death) was calculated. The average length of hospital stay in the elderly patients was 8.14 days (Table 3).

Table 3: The association between hospital stay duration and outcome in patient with sodium abnormalities.

Length of stay	Serum Na status on admission	
	Hyponatremia	Hypernatremia
Less than one week	55 (65%)	5 (31%)
More than one week	29 (35%)	11 (69%)
Discharge	62 (74%)	6 (37%)
Mortality	22 (26%)	10 (63%)

There were 32 deaths in this study in 100 patients during hospital stay.

There were 22 (26%) deaths in patients with hyponatremia and 10 (62%) deaths in patients with hypernatremia with various causes (Figure 9).

DISCUSSION

Age is independent risk factor for sodium and electrolyte imbalance. With increasing age there is impaired physiological reserve and reduced ability to compensate for the fluctuations in the environmental conditions. Maitra T et al. performed a hospital based study on dyselectrolemia in elderly patients, where he studied electrolyte imbalance in 200 patients below and 200 patients above 60 years of age.[12] This study was in agreement to our study that elderly are more predisposed to develop electrolyte imbalance and increasing age is an independent risk factor for sodium disorder. Incidence and prevalence of hyponatremia was more than hypernatremia. In our study there were 84% having hyponatremia and 16% had hypernatremia; this is in agreement with Goh et al. who found in elderly hospitalized patients that hyponatremia is more common in the elderly population because of the increased incidence of co-morbid conditions (e.g., cardiac, hepatic, or renal failure) that can be complicated by hyponatremia.[12,13]

In our study prevalence of sodium disorder was more in male patients; with male: female ratio of 1.17:1 (54 males and 46 females). This observation was against the agreement with a study by Ayus and Arieff et al. who reported that the risk of developing hyponatremia and its complications is higher in women and children compared with men, and this is because of differences in respect of muscle mass, hormonal and anatomical factors.[14] But Another study by Goh found that hyponatremia affects all races with no sexual predilection exists.[13,14]

In our study 97% patients were symptomatic and 3% patients did not had any symptoms possibly due to most of patients presenting to the wards had acute (< 48hrs) sodium imbalance; which did not allowed time to brain for the adaptation as seen in patients of chronic sodium imbalance. There were many patients in our study who had one or more than one co morbid condition which ultimately affected the cause, morbidity and outcome in these patients. Patients with hypertension who were on diuretics had predisposition to develop hyponatemia. In our study hypertension, CKD, DM, were most common co morbid illnesses. There was a significant association between sodium disorders with seizure, CKD and Patients having more than one co morbidity on admission with the final outcome. In a study by Clyton J A et al. they had found no direct correlation between hyponatremia and hypertension but correlation between hypertension with age and use of diuretics is evident.[15]

Most of the patients had neurological symptoms in both groups of sodium disorder. These findings were consistent with NaureenTareen, David Martin et al in their research in “sodium disorders in elderly’’ in which they had described that depending on the magnitude and rate of development of hyponatremia, the clinical presentation may range from asymptomatic to overt

central nervous system symptoms, such as lethargy, confusion, seizures, coma and death. Subtle findings, such as loss of attention, may be one of the earliest signs of altered sensorium, and this should be specifically evaluated in the older patients with hyponatremia or other metabolic abnormalities.[16]

In our study, in the hyponatremia group renal disorder were the most common etiology (28%), most of them were having already established CKD, second most common cause was use of drugs (16%); particularly continuous use of diuretics. 16% patients had serum hyperosmolality leading to osmotic diuresis with renal salt wasting, 13% patients had SIADH; most commonly caused by pneumonia followed by CNS malignancy, 10% had CCF and 7% in CLD. Most patients admitted in hospital with dilutional hyponatremia in CLD, CKD, CCF were non-compliant to medications and were taking inappropriate fluids; leading to volume expansion. A study done by Saeed et al. 37% patients had hyponatrima due to this disorder (21% renal disorder, 9% CHF, 7% CLD) which also supports finding in our study.[17]Of 23% patients with drugs induced hyponatremia, Diuretics (13%) were main cause and among them thiazide, and thiazide like diuretics were associated with severe hyponatremia. These findings were supported by similar results in a study by Prabhu T et al. done in elderly patients in which14% with hyponatremia were using thiazide diuretics rather than loop diuretics.[18] In our study two patients were using SSRIs and two patients using anti convulsants; levetiracetam developed hyponatremia (4%) which was lesser in percentage as compared to study by Prabhu T et al (11%).[18]

In our study 16% patients had hyperosmolar hyponatremia associated with osmotic diuresis with renal salt wasting. Most commonly associated with hyperglycemic states like diabetic ketoacidosis, ketonuria, hyperosmolar hyperglycemic state and osmotic diuretics use like mannitol. The renal loss of sodium in these disorders is further compounded by underling renal disorder. These patients were mostly hypovolumic to euvolumic and had increased solute load in the urine.[19]

In support of this; in an ambulatory geriatric population, Miller et al. reported that 46/405 subjects (11%) had hyponatremia, with SIADH the apparent cause in 27/46 (59%); one-quarter of these subjects had no apparent underlying etiology and were considered to have idiopathic SIADH.

This SIADH-like hyponatremia occurred more commonly among the old elderly (individuals 75 years of age or older), suggesting that aging might be a risk factor for the development of SIADH-like hyponatremia[16,19].In support of these findings, we had 13 % patients who had hyponatremia caused by SIADH; most common cause for which was chest infections followed by malignancy of the brain and lastly CVA and CNS infections.

Since the percentage of body water fall with age, equal volumes of fluid loss in older individuals represent more severe dehydration than in younger individuals. Dehydration associated with hypenatremia or hyponatremia is common in older individuals. In one study, dehydration occurred in approximately 7% of hospitalizations among patients older than 65 years of age and was associated with significant morbidity.[16,19]

In our study; 20% (100) of the patient had multiple etiological factors for sodium abnormality. 17 (20%) of these belongs to hyponatremia and 3 (18%) of these were seen in hypernatrmia group. In recent studies varying proportions of the patient have been associated with multiple etiologies of hyponatremia. In comparison to this, in a study by Clayton et al. 75% of the patients of hyponatremia had multiple etiologies[15,19] while in study by Nzerue et al. only 10.9% of the patients had multiple etiological factors which nearly supports our study.[20]

In a study on elderly patients on hypernatremia by NEAL A et al. found that out of 162 patients of hypernatremia, 72 (44%) patients had three or more causal factors leading to hypernatremia which was supporting our study, though no. of patient with multiple etiology was higher to that of our study.[21]

In our study the average length of hospital stay was 8.14 days (SD-4.40). In the elderly patients there was increased mortality seen in patients with longer hospital stay. We observed that increase in length of hospital stay was associated with increased mortality, we found 40% (4/10) patients admitted with hypernatremia; had more than a week hospital stay before the death as compared to 42% in a study by NEAL et al on hypernatremia in elderly.[21] Also mortality was 36% in patients with hyponatremia, who had hospital stay of more than one week, these findings were supported by a study on acquired dysnatremia in ICU patients by Medhat I. Mahmoud et al. which states that there is increased risk of mortality with length of stay with sodium disorders.[22]

Acute change in serum sodium levels and rapid correction of the sodium imbalance associated with high Mortality and morbidity in severe hyponatremia particularly if sodium levels are less than 110meq/l and in hypernatremia is severe (>160mEq/L).[21-23]

We found that most of patients succumbed to death because of underling systemic illness further compounded by sodium abnormality. Most common underling systemic illness in our study was severe sepsis precipitated by pneumonia followed by CAD, CVA and advanced malignancy. The association of hyponatremia with these patients could be incidental or secondary to medications used by these patients for their pre existing illness, as even those patients who succumb to their illness had received correction for hyponatremia as per standard regimen of treatment. Punith et al. reported in their study that the association of hyponatremia and

outcome was not causal; rather it appears to be marker of underling disease and carries poor prognosis.[24] Many studies have reveled high mortality rates from 33%-86% in elderly patients with severe hyponatremia.[23]

CONCLUSION

Hypo- and hypernatremia are common in elderly individuals and are usually successfully treated if approached correctly. A greater understanding of the changes in renal physiology and the related neurohormonal responses that occur with aging can help to guide the clinician toward a more timely and appropriate response to sodium disorders in the elderly patients. Hyponatremia is important to recognize because of the potential morbidity, mortality and the economic impact on the patient and the health care. Studying the etiology, risk factors and management of hyponatremia in hospitalized patients will help in reducing its incidence and minimize the complications associated with hyponatremia. Osmotic demyelination syndrome is a rare complication related to the treatment of hyponatremia and should be suspected in a case of who develop fresh neurological deficits while on treatment or after correction of hyponatremia. Hypernatremia though less common in the hospital admissions; is associated with high mortality rate. Rapid correction of this disorder further endangers life and increased chances of permanent neurological impairment and morbidity.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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