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Prevalence of Dysnatremia in ICU Patients – An observational study

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Abstract:
Background*: Disturbances in fluid and electrolytes are among the most common clinical problems encountered in the intensive care unit (ICU). Recent studies have reported that fluid and electrolyte imbalances are associated with increased morbidity and mortality among critically ill patients.*
Materials and Methods*: In this observational study 400 patients admitted in the Medical Intensive Care Unit (MICU) under Departments of General Medicine, Nephrology, Respiratory Medicine, Neurology and Cardiology were selected for study. All the needed information collected using a pre tested semi structured Questionnaire. Serum sodium, Potassium, chloride, plasma urea, Creatinine and sugar done in all patients. Urine sodium carried out in each case of dysnatremia to assess the cause and relevant information gathered and tabulated. Hyponatremia is further classified according to the volume status of the patient and using the working guidelines.*
Results*: Among the 400 patients evaluated 276 (69%) patients were found to have a serum Sodium level between 135-145mEq/L and so considered normonatremic. Remaining 124(31%) patients were found to be having Dysnatremia with serum Sodium level either <135mEq/L or >145mEq/L.*
Conclusion: *In this study we found out that the prevalence of Dysnatremia is high in Medical ICU admissions, ie 31%. Predominantly females were more affected with hyponatremia but hypernatremia was more common in males.*
Key Word*: Hyponatremia, Hypernatremia,Dysnatremia*

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I. Introduction

Hyponatremia and hypernatremia represent disorders of water balance. Impaired renal water excretion and ADH play an important role in hyponatremia, while excess water loss leads to hypernatremia. Both hyponatremia and hypernatremia present with non-specific neurological symptoms and the physician must recognize these electrolyte imbalances as a cause for reversible encephalopathy. Meticulous clinical history and physical examination with the help of laboratory studies point to the cause for hypo- or hypernatremia and guide therapy. Careful correction of sodium level is warranted to avoid fatal neurological sequelae.

Development of hyponatremia in critically ill patients is associated with disturbances of the renal mechanism of urinary dilution. Removal of non-osmotic stimuli for vasopressin secretion, judicious use of hypertonic saline, and close monitoring of plasma and urine electrolytes are essential components of therapy.
As the expectancy of life increased, there is increasing incidence of hyponatremia in elderly individuals who gets admitted with alteration in sensorium. High degree of awareness is required to recognize this electrolyte abnormality and correction should be very judicious. Hypernatremia is also a commonly recognized dysnatremia. Hence this study is aimed to look at the incidence of dysnatremia in the Intensive Care Unit.[1-4]

II. Material And Methods

This study was carried out on patients admitted in Medical Intensive Care Unit (MICU) under Departments of General Medicine, Nephrology, Respiratory Medicine, Neurology and Cardiology, Dr. S.M C.S.I Medical College, Karakonam, Thiruvananthapuram from January 2010 to January 2011. A total of 400 adult subjects (both male and females) of age ≥ 20 years were selected for the study.
Study Design: Observational study
Study Location: This was a tertiary care teaching hospital based study done in Department of General Medicine, at Dr. S.M C.S.I Medical College, Karakonam, Thiruvananthapuram.
Study Duration: January 2010 to January 2011.
Sample size: 400 patients.

Sample size calculation: 400 patients who fits into the inclusion and exclusion criteria were selected by convenient sampling technique.

Subjects & selection method: Patients admitted in Medical Intensive Care Unit (MICU) under Departments of General Medicine, Nephrology, Respiratory Medicine, Neurology and Cardiology, Dr. S.M C.S.I Medical College, Karakonam, Thiruvananthapuram.

Inclusion criteria:

1. Patients aged above 16 years of either sex admitted in ICU for any illness willing to participate in the study.
2. If the patient is confused or disoriented and is unable to give the consent then with the consent of the relatives, they are included.
3. Patients transferred in after cardiac or respiratory or renal procedures willing for the study.

Exclusion criteria:

1. Patients on Maintenance Hemodialysis.

Procedure methodology

Hypovolemic Hyponatremia:

1. Clinical criteria of Hypovolemia
2. CVP <5cm
3. Serum Sodium <135mEq/L
4. Urine Sodium < 20

Euvolemic Hyponatremia/SIADH

1. Normal volume status
2. Absence of clinical evidence of Hyper/Hypovolemia
3. Serum Sodium <120 mEq/L
4. Urine Sodium >20
5. Uric Acid and Creatinine low normal values.
6. Whenever possible T3,T4 and TSH studies are done

Hypervolemic Hyponatremia

1. Presence of edema
2. Other evidence of volume overload
3. Associated with Sodium <135

Tools for study

A pretested semi structured questionnaire used for collecting socio demographic, dietary, drug history and clinical details of the subjects, comorbid illness, treatment history etc.

Lab Tests:
a. Hb, TC, DC, ESR
b. Routine Urine Examination – Albumin, Sugar, Casts.
c. Urine electrolytes – Na^+, K^+, Cl^-.
d. Serum electrolytes – Na^+, K^+, Cl^-.
e. Blood Urea, Serum Creatinine.
f. FBS, 2 Hour PPBS, RBS
g. Liver Function test.
g. ECG all leads.
h. Arterial Blood Gas Analysis
i. Serum Osmolality, Urine osmolality

Syndrome of inappropriate antidiuretic hormone secretion **(SIADH)** is diagnosed by confirming

(a) Hypo osmotic hyponatremia
(b) Inappropriately concentrated urine (urine osmolality >100 mOsm/L)
(c) Euvolemia
(d) Absence of adrenal, and thyroid dysfunction or other conditions associated with increased ADH actions, like Pharmacologic agents, Physical/emotional stress and pain, Acute hypoxemia or hypercapnia.

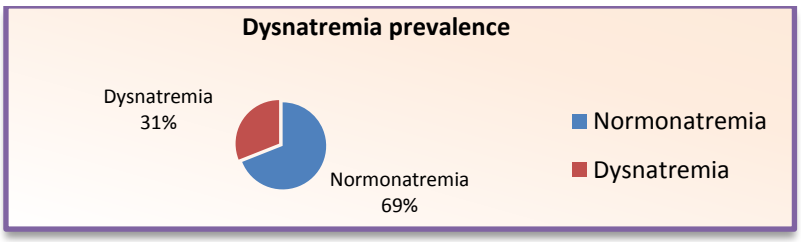
Statistical analysis

Statistical analysis done using Statistical Package for the Social Sciences (SPSS) software version 20 (IBM Corp. Released 2010. IBM SPSS Statistics for windows, Version 20.0. Armonk, NY: IBM Corp). The statistical analysis applied included Chi square test and Mann-Whitney U test.

III. Result

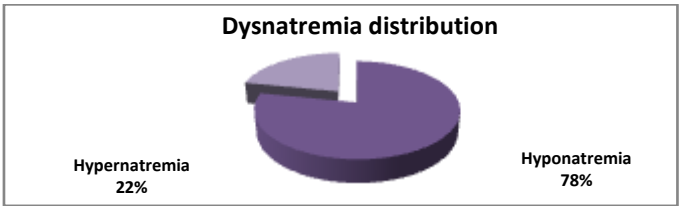
Of the 400 patients fulfilling the inclusion and exclusion criteria and willing to participate in the study, 242(60.5%) patients were male and 158(39.5%) patients were females.

Among the 400 patients evaluated 276 (69%) patients were found to have a serum Sodium level between 135-145mEq/L and so considered normonatremic. Remaining 124(31%) patients were found to be having Dysnatremia with serum Sodium level either <135mEq/L or >145mEq/L.



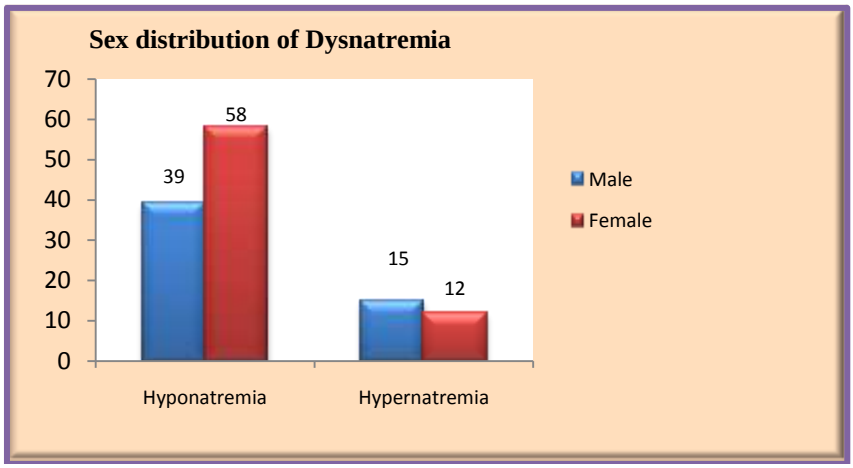
Graph 1: Dysnatremia Prevalence

97 (78.23%) Patients out of the 124 patients with dysnatremia were found to have hyponatremia and remaining 27 (21.77%) patients were having hypernatremia.



Graph 2: Dysnatremia distribution

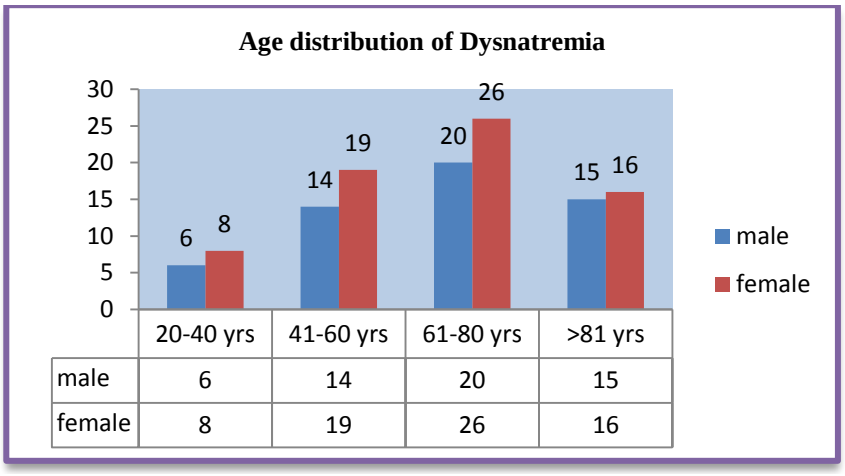
Among the 97 patients with hyponatremia, 58 (60.41%) patients were females and remaining 39 (39.59%) patients were males giving a slight female predominance. Hypernatremia was seen in 15 (55.56%) males and in 12 (44.44%) females.



Graph 3: Sex distribution of Dysnatremia

Age distribution of Dysnatremia

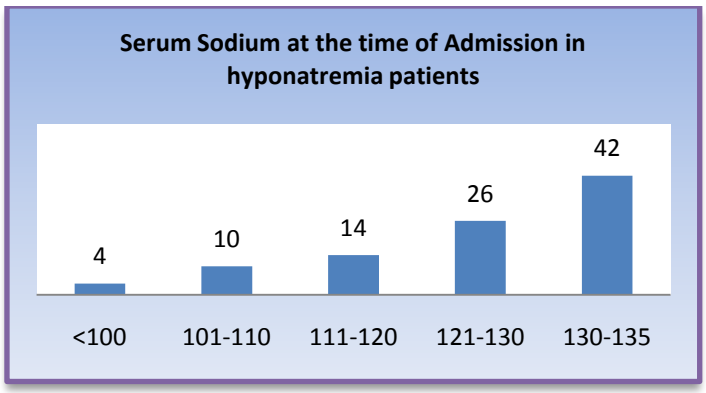
The age wise distribution of dysnatremia is shown below. The peak incidence is in the age group between 61 to 80 yrs with 46 patients (37.10%), 41 to 60yrs with 33 patients (26.61%), 20-40 yrs with 14 patients (11.29%), followed by 31patients (25.00%) in age group above 81yrs.



Graph 4: Age distribution of Dysnatremia

Serum Sodium at the time of Admission in hyponatremia patients

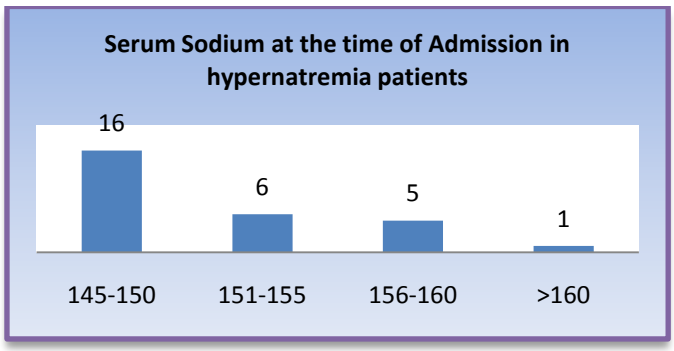
The serum Sodium at time of admission was between 130-135 mEq/L in 42 patients (43.75%), between 121-135mEq/L in 26patients (27.08%) and between 111 -120 mEq/L in 14 (14.58%) patients. The serum sodium level between 101-111 mEq/L in 10patients (10.43%) and in 4 patients (4.16%) it was below 100mEq/L.



Graph 5: Serum Sodium at the time of Admission in hyponatremia patients

Serum Sodium at the time of Admission in hypernatremia patients

In Hypernatremia patients at time of admission, most of them 16 patients (57.14%) presented with Serum sodium between 145 – 150 mEq/l, 6 patients (21.43%) presented with Serum Sodium between 151 – 155 mEq/l, and 5 patients (17.85%) presented with serum sodium between 155 – 160 mEq/l. Only 1 patient (3.58%) presented with very severe hypernatremia with Serum Sodium >160mEq/L.

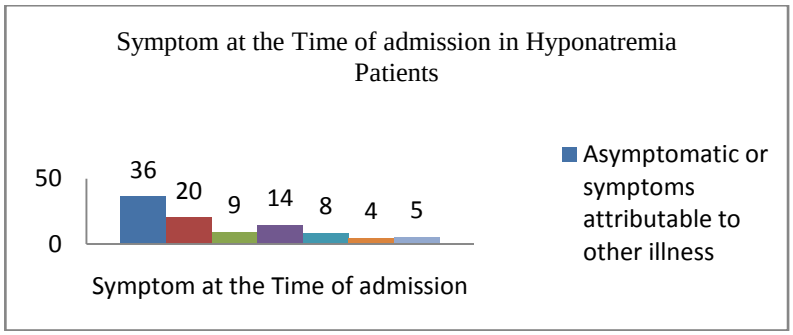


Graph 6: Serum Sodium at the time of Admission in hypernatremia patient

Symptom at the Time of admission in Hyponatremia Patients

In 36 patients (37.5%) hyponatremia was asymptomatic or had only symptoms attributable to basic disease. Symptoms were Drowsiness in 20 patients (20.83%), Headache in 14 patients (14.58%), irrelevant

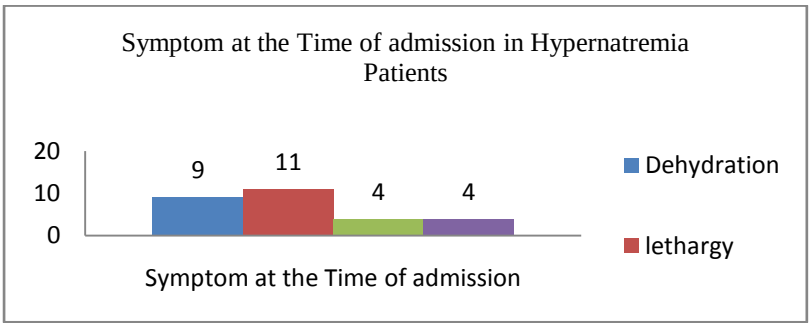
speech in 9 patients (9.38%), confusion in 8 patients (8.33%), Seizures in 5 patients (5.21%) and unresponsiveness in 4 patients 4.17%).



Graph 7: Symptom at the Time of admission in Hyponatremia Patients

Symptom at the Time of admission in Hypernatremia Patients

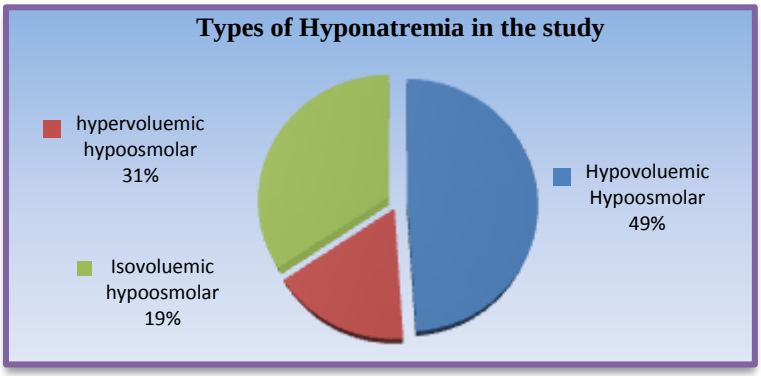
Hypernatremia patients presented with lethargy in 11 patients (39.28%), dehydration in 9 patients (32.14%), weakness and irritability in 4 patients (14.29%) and seizure in 4 patients (14.29%).



Graph 8: Symptom at the Time of admission in Hypernatremia Patients

Types of Hyponatremia

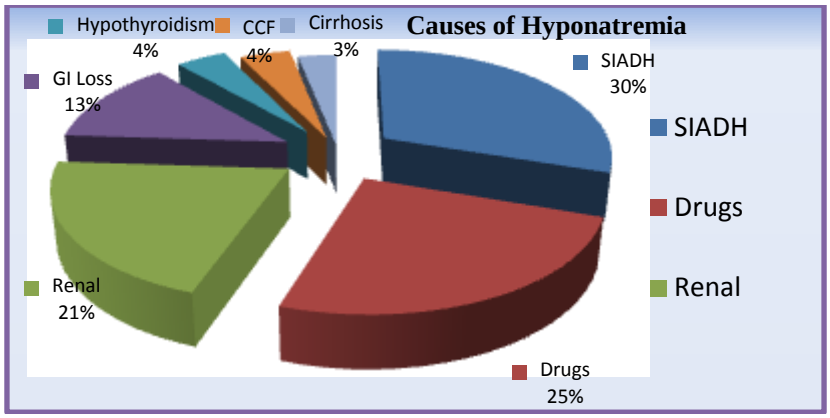
47 patients (48.96%) had Hypovolemic hyponatremia, 16 patients (16.67%) had Hypervolemic hyponatremia and Euvolemic hyponatremia in 33 patients (34.37%).



Graph9: Types of Hyponatremia

Causes of Hyponatremia

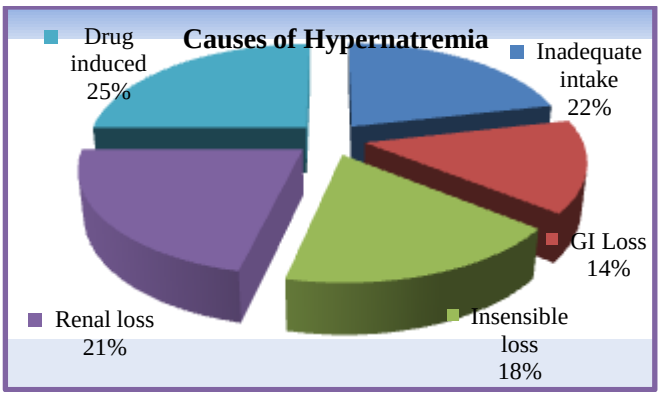
The causes of Hyponatremia were evaluated with history, past history, body fluid status, serum Sodium and Urine sodium. The most common cause of hyponatremia was Syndrome of inappropriate antidiuretic hormone secretion (SIADH) in 29 patients (30.20%), Drugs in 24 patients (25%), Renal in 20 patients (20.83%), GI loss in 12 patients (12.5%), hypothyroidism in 4 patients (4.17%), Congetive Cardiac Failure (CCF) in 3 patients (4.13%) and cirrhosis in 2 patients (3.08%)



Graph10: Causes of Hyponatremia

Causes of Hypernatremia

The causes of Hypernatremia were Inadequate fluid intake in 6 patients (21.43%), Gastrointestinal loss in 4 patients (14.29%), Insensible loss due to fever in 5 patients (17.86%), Renal loss in 6 patients (21.42%) and drug induced in 7 patients (25%).



Graph 11: Causes of Hypernatremia

Comparison of Hypertension (HTN) based on category

Hypertension is present among 77 (59.7%) patients in the normonatremia group and 52 (40.3%) patients in the dysnatremia patients which is statistically significant (p-0.005). Hypertension is present in 41 patients (31.8%) with Hyponatremia (Z value of 2.61, p=0.009) and 11(8.5%) patients with Hypernatremia (Z=1.4, p=0.161).

Table Comparison of HTN based on category

HTN	Normal		Hyponatremia		Hypernatremia	
	Count	Percent	Count	Percent	Count	Percent
Absent	199	73.4	56	20.7	16	5.9
Present	77	59.7	41	31.8	11	8.5

Graph 15: Comparison of HTN based on category

Normal vsHyponatremia Z=2.61**, p=0.009 ; Mann-Whitney U Test
Normal vsHypernatremia Z=1.4 , p=0.161; Mann-Whitney U Test

Comparison of DM based on category

Diabetes Mellitus is present among 54 (55.1%) patients in the normonatremia group and 44 (44.9%) patients in the dysnatremia patients is statistically significant (χ^2=11.72, p=0.001). Diabetes Mellitus is present in 33 patients (33.7%) with Hyponatremia (Z value of 2.89, p=0.004) and in 11(11.2%) patients with Hypernatremia (Z=2.55, p=0.011).

Table Comparison of DM based on category						
DM	Normal		Hyponatremia		Hypernatremia	
	Count	Percent	Count	Percent	Count	Percent
Absent	222	73.5	64	21.2	16	5.3
Present	54	55.1	33	33.7	11	11.2

Graph 16: Comparison of DM based on category

Normal vsHyponatremia Z=2.89**, p=0.004 ; Mann-Whitney U Test
Normal vsHypernatremia Z=2.55* , p=0.011 ; Mann-Whitney U Test

Comparison of Renal causes based on category

Renal causes were present among 54 (55.1%) patients in the normonatremia group and 44 (44.9%) patients in the dysnatremia patients is statistically significant (χ^2=11.72, p=0.001). Renal causes were present in 6 patients (37.5%) with Hyponatremia (Z value of 1.26, p=0.208) and in 1 (6.3%) patients with Hypernatremia (Z=0.12, p=0.902).

Table Comparison of renal causes based on category						
Renal	Normal		Dysnatremia		χ^2	P
	Count	Percent	Count	Percent		
Absent	267	69.5	117	30.5	1.27	0.260
Present	9	56.3	7	43.8		

Graph 17: Comparison of Renal causes based on category

Comparison of Cerebrovascular disease based on category

Cerebrovascular disease were present among 27 (81.8%) patients in the normonatremia group and 6 (18.2%) patients in the dysnatremia patients is statistically significant (χ^2=2.76, p=0.096). Cerebrovascular disease were present in 5 patients (15.2%) with Hyponatremia (Z value of 1.4, p=0.162) and in 1 (3%) patients with Hypernatremia (Z=1.04, p=0.299).

Table Comparison of CVA based on category						
CVA	Normal		Dysnatremia		χ^2	P
	Count	Percent	Count	Percent		
Absent	249	67.8	118	32.2	2.76	0.096
Present	27	81.8	6	18.2		

Graph 18: Comparison of Cerebrovascular disease based on category

Table Comparison of CVA based on category						
CVA	Normal		Hyponatremia		Hypernatremia	
	Count	Percent	Count	Percent	Count	Percent
Absent	249	67.8	92	25.1	26	7.1
Present	27	81.8	5	15.2	1	3.0

Graph 19: Comparison of Cerebrovascular disease based on category

Normal vs Hyponatremia Z=1.4 , p=0.162 ; Mann-Whitney U Test
Normal vs Hypernatremia Z=1.04 , p=0.299 ; Mann-Whitney U Test

IV. Discussion

400 patients were selected randomly from Patients admitted in Medical Intensive care unit under Department of General Medicine, Nephrology, Respiratory Medicine, Neurology and Cardiology, Dr. S.M C.S.I Medical College, Karakonam, Thiruvananthapuram.

Among the 400 patients evaluated 276 (69%) patients were found to have a serum Sodium level between 135-145mEq/L and so considered normonatremic. Remaining 124(31%) patients were found to be having Dysnatremia with serum Sodium level either <135mEq/L or >145mEq/L.[(1-4)]

In a study by Y Sakr, S Rother,10,923 surgical ICU patients included in the study, 1,215 (11.2%) had hyponatremia and 277 (2.5%) hypernatremia at admission to the ICU. In our study 97 (77.42%) Patients out of the 124 patients with dysnatremia we found to have hyponatremia and remaining 27(22.58%) patients were having hypernatremia. The incidence of Hyponatremia (24%) was more common in our study compared to 11.2% in the above study. Hypernatremia was present among 7% of all the patients admitted to the ICU.

Among the 97 patients with hyponatremia, 58 (59.37%) patients were females and remaining 39 (40.63%) patients were males giving a slight female predominance. But hypernatremia was more common in males 57.14% (n=15) and in females 42.86% (n=12).The peak incidence of dysnatremia is in the age group between 61 to 80 yrs. with 46 patients (37.10%), 41 to 60yrs. 33 patients (26.61%), 20-40 yrs. 14 patients (11.29%), followed by 31patients (25.00%) in age group above 81yrs.

The peak incidence of hyponatremia is in the age group between 61 to 80 yrs. with 37 patients (38.54%), the age group of 41 to 60yrs. 27 patients (28.12%), 20 patients (20.83%) in age group above 81yrs. Incidence in the age group of 20-40 yrs. was only 12 patients (12.5%).Unlike hyponatremia, the peak incidence of Hypernatremia is in the age group between above 81yrs. with 11 patients (39.29%), 61 to 80 yrs. 9 patients (32.14%), 6 patients (21.43%) in age group of 41 to 60 yrs. and 2 patients in the age group of 20-40 yrs. The serum Sodium at time of admission was between 130-135 mEq/L in 42 patients (43.75%), between 121-135mEq/L in 26patients (27.08%) and between 111 -120 mEq/L in 14 (14.58%) patients. The serum sodium level between 101-111 mEq/L in 10patients (10.41%) and in 4 patients (4.16%) it was below 100mEq/L.[(6)]

Severe hyponatremia in patients with decompensated heart failure may require extracorporeal ultrafiltration, which has been consistently shown to improve congestion, lower diuretic requirements, and correct hyponatremias.[(7)]

Dietary sodium restriction with a low-sodium diet (2g daily) is useful to restore or maintain euvolemia and fluid restriction (2 liters/day) is recommended for cardiac failure patients with moderate hyponatremia (Na <130 mEq/L) and may be useful in facilitating fluid overload in other patients.[(8)]

A recent study involving 151,486 adult patients from 77 intensive care units over a period of 10 years in Austria has demonstrated that many cases of dysnatremia are acquired in the intensive care unit, and that the severity of dysnatremia is associated with poor outcome in a graded fashion. Most patients (114,170, 75.4%) had normal sodium levels on ICU admission. The frequencies of borderline (130 - 135 mmol/L), mild (125 - 130 mmol/L), and severe hyponatremia (Na < 125 mmol/L) were 13.8%, 2.7%, and 1.2%, respectively. The frequencies of borderline (145 - 150 mmol/L), mild (150 - 155 mmol/L), and severe hypernatremia (Na > 155 mmol/L) were 5.1%, 1.2%, and 0.6%, respectively. All types and grades of dysnatremia were associated with increased raw and risk-adjusted hospital mortality ratios.[(9)]

Another study on the ICU patients with dysnatremias corroborated these findings, reporting that ICU-acquired hyponatremia and ICU-acquired hypernatremia were associated with increased mortality. Dysnatremia at ICU admission has higher risk of death compared with ICU-acquired dysnatremia. ICU-acquired hyponatremia and hypernatremia are very common in critically ill patients following cardiac surgery. ICU-acquired hypernatremia is seen associated with negative fluid and positive solute balance. [(10,11,12,13)]

Dysnatremia was common in neurosurgical ICU patients. Patients with primary dysnatremia had higher mortality rates. Hypernatremia was independently associated with higher risk of in-hospital mortality irrespective of the time of acquisition in the ICU. A retrospective analysis of prospectively collected data of 1,751 neurosurgical patients (57.9% male, 42.1% female, SAPS2 score 33.9 ± 18.6) with a mean age of 85.1 ± 16.6 years admitted to a 50 bed surgical ICU between January 2004 and January 2009.

All patients admitted to the ICU between January 2004 and January 2009 included retrospectively in this study. Of the 10,923 surgical ICU patients included in the study, 1,215 (11.2%) had hyponatremia and 277 (2.5%) hypernatremia at admission to the ICU. Among patients with normonatremia at admission to the ICU (n = 9,431), the incidence of ICU-acquired dysnatremia was 31.3%. Dysnatremia present at ICU admission (OR = 2.53; 95% CI: 2.06 to 3.12, P < 0.001) and ICU-acquired dysnatremia (OR = 2.06; 95% CI: 1.71 to 2.48, P < 0.001) were independently associated with an increased risk of in-hospital death. Dysnatremia at ICU admission (OR = 1.23; 95% CI: 1.01 to 1.50) was associated with a higher risk of in-hospital death, compared to ICU-acquired dysnatremia. Fluctuation in serum sodium concentration was also independently associated with an increased risk of in-hospital mortality; both in patients who remained normonatremic (>6 mmol/l/ICU stay) and those with dysnatremia (>12 mmol/l/24 hours or >12 mmol/l/ICU stay).[(14)]

Observational study performed on a prospective database fed by 13 intensive care units. Unselected patients with ICU stay longer than 24hs were enrolled over a 14-year period. 11125 patients were included in this study. Among these patients, 3047 (27.4%) had mild to severe hyponatremia at ICU admission, 2258 (20.3%) had borderline hyponatremia at ICU admission, 1078 (9.7%) had borderline hypernatremia and 877 (7.9%) had mild to severe hypernatremia. After adjustment for confounder, both moderate and severe hyponatremia were associated with day-28 mortality.[(15)]

A retrospective cohort study performed at a surgical ICU of a university hospital in Vienna, patients were admitted to the ICU after major cardiothoracic surgery between May 1999 and October 2007. Data on serum sodium in the ICU, ICU mortality, hospital mortality, and length of ICU stay were collected prospectively. 2,699 patients underwent surgery during the study period, and 2,314 patients were included in the study. Two hundred twenty-one (10%) patients acquired hypernatremia during their ICU stay. Median onset of hypernatremia was on day 4 (2–7). Patients with ICU-acquired hypernatremia had a higher ICU mortality (19%) compared to patients without hypernatremia (8%; $p < 0.01$). Length of ICU stay was increased in patients with hypernatremia (17 vs. 3 days; $p < 0.01$).[16]

Prospective, Multicenter case control study including seven short- and long-term geriatric care facilities of 150 patients with hypernatremia matched to 300 controls. Clinical assessment of hydration status at bedside, such as abnormal skin turgor or dry oral mucosa was done. Secondary outcome measures: 30-day mortality rate and clinical indicators associated with mortality. Patients and controls were comparable in terms of drugs and underlying diseases, except for history of dementia, which was more frequent in patients than in controls. Patients were significantly more likely than controls to have low blood pressure, tachycardia, dry oral mucosa, abnormal skin turgor, and recent change of consciousness. Only three clinical findings were found in at least 60% of patients with hypernatremia: orthostatic blood pressure and abnormal subclavicular and forearm skin turgor. The latter two signs were significantly more frequent in patients with hypernatremia. Four other signs (tachycardia, abnormal subclavicular skin turgor, dry oral mucosa, and recent change of consciousness) had a specificity of greater than 79%. Using logistic regression, four signs were significantly and independently associated with hypernatremia: abnormal subclavicular and thigh skin turgor, dry oral mucosa, and recent change of consciousness. The mortality rate was 41.5% and was significantly higher in patients with hypernatremia.[17]

Prevalence of hyponatremia was significantly higher in the elderly group (17.0%) than in the adult group (5.7%, $p < 0.001$). Similarly, the prevalence of severe hyponatremia was significantly higher in the elderly group (1.9%) than in the adult group (0.3%, $p < 0.001$). [18]

In elderly patients, the prevalence of hyponatremia was higher in patients without Chronic Kidney Disease than in patients with Chronic Kidney Disease. Special attention should be paid to elderly patients without Chronic Kidney Disease in order to prevent severe hyponatremia.[19]

In a study done in a tertiary care centre in subhimalayan region, 106 patients of hyponatremia admitted in medicine wards were included in study. In this study, the hospital-based incidence of hyponatremia during the study period was 1.17% among the patients admitted in the department of medicine wards. The patients' age ranged from 20 to 95 years with a mean age of 62.25 ± 17.77 years. Sixty patients (57%) aged more than 60 years and 46 (43%) patients' age was below 60 years. There were more males than females in the present study. The male to female ratio was 1.25:1. Forty-nine (46%) patients had co-morbidities of diabetes or hypertension, 25 (24%) patients had hypertension and 12 (11%) patients had diabetes. Twelve (11%) patients had both diabetes and hypertension. Serum sodium levels were <125 in 8 patients of the 11 expired patients.[20]

V. Conclusion

In this study we found out that the incidence of Dysnatremia is high in Medical ICU admissions, ie 31%. Predominantly females were more affected with hyponatremia but hypernatremia was more common in males. The incidence of Hyponatremia (24%) was more common than hypernatremia (7%) among all the patients admitted to the ICU.

The peak incidence of hyponatremia was in age group between 60 to 80 yrs. This may be because of higher incidence of comorbid illness and increased incidence of ICU admissions in this age group. More over this age group is also prone for geriatric problems and mismanagement at home. They are also at high risk of developing complications due to multiple ailments and poly pharmacy. Dementia and stress may aggravate the disease severity as they loss the control of fluid intake compared to normal subjects.

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