



STUDY OF HYPONATREMIA IN ICU SETTING IN TERTIARY CARE CENTER - A CROSS SECTIONAL STUDY

Medicine

Dr Parth Shah	Post Graduate Resident, Department of Medicine, PCMCs PGI YCMH, PIMPRI 411018
Dr. Manish Deshmukh	Senior Resident, Department of medicine, PCMCs PGI YCMH, PIMPRI 411018
Dr Seema Soni	Associate Professor, Department of Paediatrics, PCMCs PGI YCMH, PIMPRI 411018
Dr. Pravin Soni*	Professor and Head, Department of Medicine, PCMCs PGI YCMH, PIMPRI 411018 *Corresponding Author

ABSTRACT

Introduction—An abnormally low level of sodium in the blood is referred to as hyponatremia. Careful assessment and classification are important to direct diagnosis and treatment, reduce the risk of substantial morbidity and mortality in acute severe cases, and avoid the neurological complications associated with the overly rapid correction. In the ICU, hyponatremia is associated most frequently with chronic conditions such as congestive heart failure, advanced renal disease, and cirrhosis. **Aims & Objectives:** To study the prevalence of Hyponatremia in ICU Setting & to study the various etiological factors responsible for Hyponatremia. **Materials & Methods**—A cross-sectional observational study was conducted on 150 patients for 2 years from September 2019 to December 2021 at ICU at Tertiary Care center. All patients detail history, clinical examination and Laboratory Investigation were carried out. **Results**—Out of a total 150 patients, 27 patients did not have any Comorbid condition, 46 patients had one and 77 patients had more than one comorbidity. 113 (75.33%) had severe hyponatremia with serum sodium below 125 mEq/L, 26 (17.33%) patients were euvolemic, GCS Score of ≥ 13 was seen in 65 patients out of which 38 (25.33%) had severe hyponatremia. GCS Score between 8-12 seen 68 (45.33%) patients had severe hyponatremia. GCS Score of < 8 was seen in 7 (4.67%) patients with severe Hyponatremia. Correlation between GCS Score and Severity of Hyponatremia was found highly significant. ($p < 0.001$, HS). Those who had severe hyponatremia had low GCS score ($P < 0.0001$, HS) **Conclusion**—SIADH is the most typical cause of hyponatremia in ICU patients. In the presence of multiple comorbidities, a prolonged length of stay is seen. Shorter serum sodium and GCS at admission are linked to lower survival.

KEYWORDS

Hyponatremia, serum sodium, Syndrome of inappropriate antidiuretic hormone secretion (SIADH), urinary sodium levels & hypovolemia.

INTRODUCTION –

The heterogeneous disease states that lead to hyponatremia underline the fact that this syndrome is a secondary pathophysiologic process due to a disturbance in water homeostasis rather than a distinct disease entity.¹ Hyponatremia (serum sodium $[Na^+] < 135$ mmol/L) is the most common electrolyte disorder encountered in hospitalized patients (30-40%) and is present in 17.7% of patients admitted to the ICU.^{2,3} Hyponatremia can be classified based on serum osmolality, volume status, and urinary sodium into hypertonic, isotonic, and hypotonic types. Mild hyponatremia is generally asymptomatic, but where the decrease in serum sodium is marked (≤ 125 mmol/L) or acute (occurring over < 48 h), serious neurological complications can occur as a result of cerebral edema. The correction of hyponatremia should be carefully managed, because of its association with the osmotic demyelination syndrome (central pontine myelinolysis). Patients with chronic hyponatremia appear to be particularly vulnerable to this complication.⁴ The treatment approach to hyponatremia depends on the type of hyponatremia. Patients with hypovolemic hyponatremia are mainly treated by repleting the ECF volume with Normal Saline (NS). Water restriction and 3% saline are the mainstay of treatment of euvolemic and hypervolemic hyponatremia.⁵ The prevalence of hyponatremia in hospital admissions varies between 3.4% to 39.4%^{4,6,7} and even higher in ICU setup. The present study is designed to analyze etiology, clinical features, comorbid factors, the severity of hyponatremia, the rate of correction, and the impact of treatment on the outcome of these diverse groups of patients in ICU.

MATERIALS & METHODS –

A cross-sectional observational study was conducted on 150 patients for 2 years at our ICU Tertiary Care center.

Inclusion Criteria:-

Patients admitted in ICU having S. sodium level less than 135 or developed hyponatremia during Hospitalization.

Exclusion Criteria:-

Those who refused to give consent. All patients detail history, clinical examination and Laboratory Investigation including Serum Sodium, KFT, Serum Osmolality, Urine Osmolality, Urine Routine, Urine Sodium, Blood Sugar on Admission, LFT, Lipid Profile & CT Head (if necessary) were carried out. Various parameters assessed were serum sodium & glasgow coma scale.

RESULTS -

The mean age was 61.0 ± 15.38 . Out of the 150 patients, 89 were male accounting for 59.33 % and 61 were female making up 40.67 % of the study population. Amongst all the comorbidities hypertension was the most commonly encountered condition seen in 90 patients (60%), Diabetes mellitus was seen in 71 patients (47.33%), Chronic kidney disease was seen in 32 (21.33%), ischemic heart disease in 30 patients (20.13%), chronic liver disease in 9 patients (6 %) & congestive cardiac failure in 28 patients (18.67%). Out of a total 150 patients, 27 patients did not have any Comorbid condition, 46 patients had one and 77 patients had more than one co-morbidity. Out of a total 150 patients, 27 patients did not have any Comorbid condition, 46 patients had one and 77 patients had more than one comorbidity.

The most common predisposing factor was vomiting, 46.67% had vomiting. 34.67% had diuretic intake, 18.67% had poor intake, 4.67% had CNS infection, 7.33% had diarrhea and 2.67% of the patients had a history of sweating because of sun exposure in summer (Table 1 & Fig 1). Most common symptom in our study was nausea in 71 (47.33%) of patients, vomiting in 68 (45.33%) of patients, 60 (40%) of patients presented with drowsiness while 12 (8%) were delirious. Of the 150 patients with hyponatremia in this study, 113 (75.33%) had severe hyponatremia with serum sodium below 125 mEq/L. Minimum Sodium level is 106 mEq/L and Maximum being 132 mEq/L (Table 2 & Fig 2).

In the present study 26 (17.33%) patients were euvolemic, 72 (48%) patients were hypovolemic and 52 (34.67%) patients were hypervolemic (Table 3 & Fig 3). Out of 26 Euvolemic hyponatremic patients, SIADH was the most commonly encountered condition (24 patients). In the study of patients with hyponatremia, 2 patients had a Urine Osmolality of less than 100 mOsm/kg, 89 patients had between 100 - 500 mOsm/kg & 5 patients had between 500 - 800 mOsm/kg. In our study group, 34 patients had a urine sodium level of < 20 mEq/L indicating maximum sodium conservation by the kidneys. 76 patients had urinary sodium levels between 20 - 120 mEq/L. 11 patients had urinary sodium levels between > 120 mEq/L (Table 4 & Fig 4). There is no significant correlation between the presence of comorbidities and the severity of hyponatremia on admission except for the Ischemic Heart Disease (IHD) and Congestive Cardiac Failure (CCF) with a p value of 0.042 and 0.016 respectively (Table 5 & Fig 5). It has been observed that less is the s. sodium level more severe are the symptoms

(Table 6 & Fig 6). Out of 150 patients in the study group, 98 (65.33%) patients improved and discharged. But 52 (34.67%) expired.

Out of the 150 patients in the study, GCS Score of ≥ 13 was seen in 65 patients out of which 1 (0.6%) patient was with mild hyponatremia, 23 (15.33%) moderate hyponatremia, 38 (25.33%) had severe hyponatremia. GCS Score between 8-12 seen in 10 (6.67%) patients had moderate hyponatremia, 68 (45.33%) patients had severe hyponatremia. GCS Score of < 8 was seen in 7 (4.67%) patients with severe Hyponatremia. Correlation between GCS Score and Severity of Hyponatremia was found highly significant ($p < 0.001$, HS) (Table 7 & Fig 7). Those who had severe hyponatremia had low GCS score ($P < 0.0001$, HS) (Table 8 & Fig 8). In the present study, we have found that the presence of various comorbidities takes longer time for recovery (Table 9 & Fig 9). There is no significant correlation between Duration of ICU Stay and outcome in this study with a p value of 0.562 using the Chi-square test (Table 10 & Fig 10). In our study 26 patients with euvolemic hyponatremia,

24 patients had SIADH, and Commonest cause of SIADH was Bronchopneumonia (9 patients). 5 patients had CNS infection (Bacterial Meningitis, Tubercular meningitis, Cerebral Abscess). Other causes included GBS (2 patients), drugs induced like Carbamazepine, Oxcarbazepine, Valproate (3 patients), Stroke (1 patient) and idiopathic SIADH (4 patients) (Table 11 & Fig 11).

DISCUSSION-

The mean age in a study carried out by Rajesh Padhi et al⁷ was 60.4 ± 17.2 whereas in Patil et al⁸ the mean age of patients with hyponatremia was 58.23 ± 12.5 which was nearby to present study. Out of the total 150 patients, 89 males (59.66%) and 61 (40.67%) were females. This was comparable to studies done by Kanchana S Pillai et al,⁹ 46 (61.3 %) of the cases were males and by Patil et al,⁸ 41 (hyponatremic) were males and 59 were females in the study. In a study by Lokesh N K et al,¹⁰ most patients had chronic disease like Diabetes mellitus (50%), Hypertension (58%), Cardiac disease (31%), CKD (10%) and COPD (16%). And in other study by Shanmugasundaram Rajamani et al,¹¹ common comorbidities were, Diabetes mellitus (63%), Hypertension (44%), Cardiac disease (24%), CKD (9%), COPD (19%). In a study by Saeed et al,¹² hyponatremia was associated with diuretic use in 19 out of 57 patients (33.3%).¹³ Another study by Huda et al,¹⁴ 14 out of 22 (63.6%) patients of hyponatremia on diuretics were taking thiazide diuretics. Pneumonia is known to be associated with hyponatremia at the time of admission and it is associated with more severe illness, increased risk of mortality and prolonged hospital stays as reported by Nair et al.¹⁵ In our study, Pneumonia at the time of ICU admission, was the most common cause leading to SIADH. In a study done by Kanchana S Pillai et al,⁹ average Serum Sodium was 124.29 m eq/L. In a study by Hochman et al,¹⁶ 39% patients had mild hyponatremia and 61% had moderate to severe Hyponatremia which was similar to present study. Rajesh Padhi et al,⁷ the largest group of hyponatremic patients were euvolemic; 148 (58.96%) followed by hypervolemic; 66 (26.29%) and hypovolemic; 37 (14.74%). These results were contradictory to current study. In a study done by Kanchana S Pillai et al,⁹ number of patients with Urine sodium ≤ 20 was 9, and those with urine sodium > 20 were 66.

Average serum osmolality was 265. In this study we found correlation of GCS Score with Serum Sodium is highly significant ($P < 0.0001$, HS) Similar finding was reported in the study done by Kanchana S Pillai et al.⁹ Huda et al¹⁴ in their study found that there was 27% mortality among patients of severe Hyponatremia. In study by Nzerue et al¹⁷ mortality among patients with severe hyponatremia was 20.2%. These results were similar to present study.

CONCLUSION-

In critically ill patients, hyponatremia acquired in the ICU is not infrequent. For medical specialists, hyponatremia continues to be a key concern. In addition to being the most prevalent electrolyte problem, but it is also becoming understood to be a sign of disastrous outcomes in a number of circumstances. Early diagnosis, comprehensive examination of the fundamental processes underlying in its aetiology, evaluation of the severity and influence on the patient's course, and early notice of hyponatremia are all necessary for effective therapy.

List Of Tables & Figures

Table No.1 Predisposing factors of Hyponatremia in our study groups

Predisposing factors	No. of cases	Percentages
Diuretics	52	34.67
Sweating	4	2.67
CNS infections or surgery	7	4.67
Poor oral intake	28	18.67
Diarrhea	11	7.33
Vomiting	70	46.67

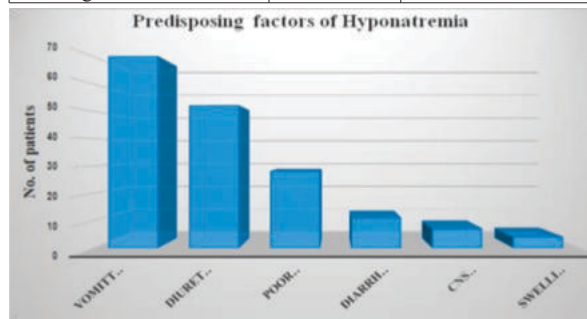


Figure 1. Predisposing factors of Hyponatremia

Table No.2. Grading of hyponatremia in the study population.

Sodium level	Number of Cases	Percentage
130 - 135 Mild	4	2.67
125 - 129 Moderate	33	22.0
<125 Severe	113	75.33
Total	150	100

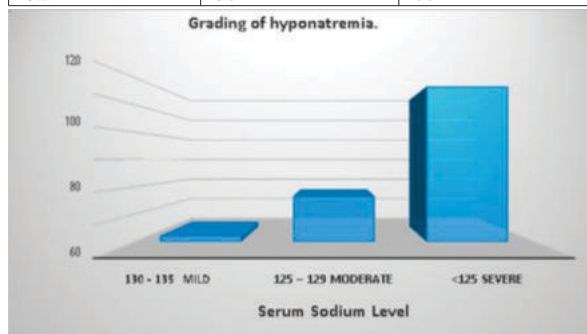


Figure 2. Grading of hyponatremia

Table No.3 Volume wise distribution of Hyponatremia

Volume status	Number of Cases	Percentage
Euvolemic	26	17.33
Hypovolemic	72	48.00
Hypervolemic	52	34.67

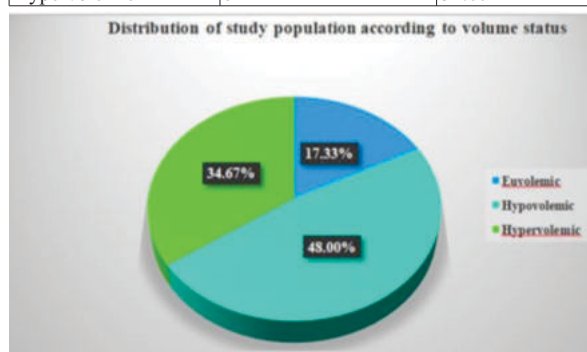


Figure3. Distribution of study population according to volume status

Table No. 4 Urine sodium level in study population

Urine Sodium	Number of Cases (N=121)	Percentage
<20	34	28.10
20 - 120	76	62.81
>120	11	9.09
Total	121	100
Mean SD (Range)	62.82 $\pm$ 59.66 (4 - 404)	



Figure 4. Urine sodium level in study population

Table No.5 Association of Co-morbidities and severity of Hyponatremia

Comorbidities	Severity of Hyponatremia			p-value
	Mild	Moderate	Severe	
Diabetes	0	20	58	0.076,NS
Hypertension	2	23	65	0.417,NS
IHD	0	2	28	0.042,S
CKD	0	6	26	0.480,NS
CLD	0	3	6	0.635,NS
CCF	0	1	27	0.016,S

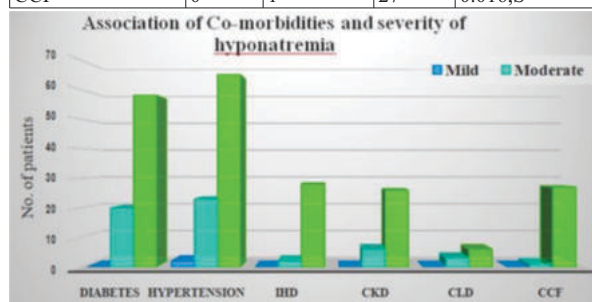


Figure 5. Association of Co-morbidities and severity of Hyponatremia

Table No.6 Association of severity of symptoms and severity of Hyponatremia

Severity of Symptoms	Severity of Hyponatremia			p-value
	Mild	Moderate	Severe	
Nausea	1	25	45	0.001,HS
vomiting	3	21	44	0.021,S
Drowsy	2	6	52	0.015,S
Delirium	0	3	9	0.818,NS
Convulsions	0	0	5	0.429,NS
Altered Sensorium	2	3	35	0.025,S
COMA	1	0	2	0.003,HS

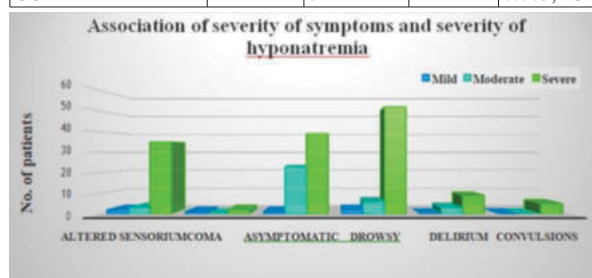


Figure 6 Association of severity of symptoms and severity of Hyponatremia

Table No.7 Association of GCS Score and severity of hyponatremia.

GCS Score	No. of Cases	Severity of Hyponatremia			p-value
		Mild	Moderate	Severe	
≥13	65	1(6.15)	23(35.38)	38(58.46)	Chi2=19.52 58
8 - 12	78	0	10(12.82)	68(87.18)	d.f.=4 p<0.001,HS

<8	7	0	0	7(100)	
Mean GCS	11.75 ± 2.5	13.42 ± 2.37	111.71 ± 3.81	<0.001,HS	

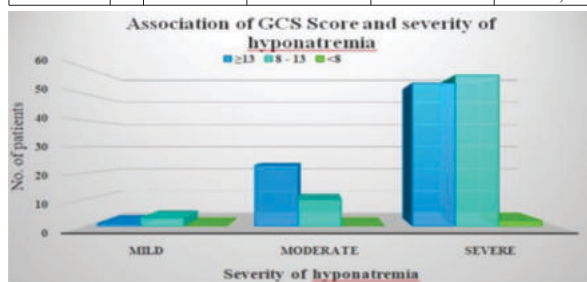


Figure 7 Association of GCS Score and severity of hyponatremia.

Table No. 8 Correlation of GCS Score with mean Serum Sodium level

GCS Score	Serum Sodium		p-value
	Mean	SD	
≥13	122.64	5.20	F=16.93
8-12	119.87	5.01	P<0.0001,HS
<8	111.71	3.81	
Correlation coefficient (r)	r=0.4127 , p<0.0001,HS		

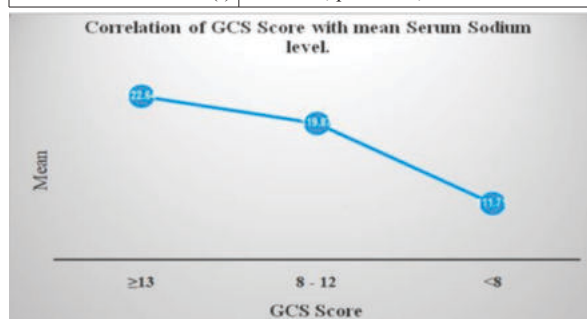


Figure 8 Correlation of GCS Score with mean Serum Sodium level

Table No.9 Association of comorbidities and ICU Stay in days

Comorbidities	ICU Stay in days				p-value
	<3	3-6	7-10	>10	
Diabetes	7(22.58)	48(61.54)	6(18.18)	1(12.50)	<0.001,HS
Hypertension	9(29.03)	43(55.13)	31(93.94)	7(87.50)	<0.001,HS
IHD	3(9.68)	9(11.69)	12(36.36)	6(75)	<0.001,HS
CKD	0	15(19.23)	13(39.39)	4(50)	<0.001,HS

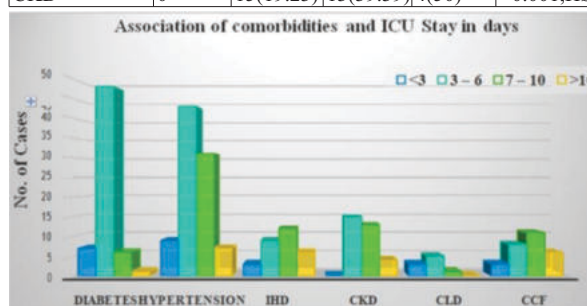


Figure 9. Association of comorbidities and ICU Stay in days

Table No.10 Association of Duration of ICU stays in study population and outcome

ICU Stay	Outcome		p-value
	Survivors	Non Survivors	
<3	19	12	
3-6	49	29	Chi2=2.052 8
7-10	25	8	d.f.=3
>10	5	3	p=0.562,NS

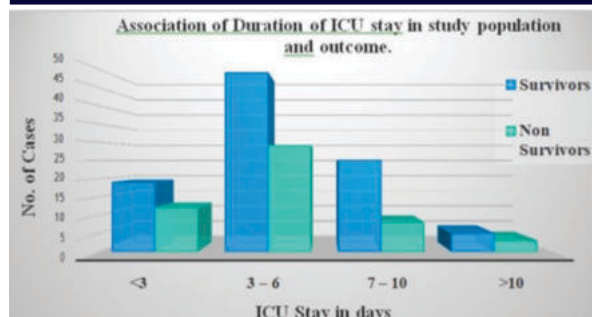


Figure 10 Association of Duration of ICU stays in study population and outcome

Table No. 11 Categorization of hyponatremia according to volume status

Cause of hyponatremia	No. of Cases	Volume status			p-value
		Euvolemic N=26	Hypovolemic N=72	Hypervolemic N=52	
Addison's disease	1	1	0	0	0.173,NS
Adrenal Insufficiency	2	1	1	0	0.436,NS
Diuretics	37	0	37	0	<0.001,H S
Extra renal losses	3	0	3	0	0.289,NS
Heart Failure	20	0	0	20	<0.001,H S
Liver disease	7	0	0	7	0.008,HS
Poor intake	8	0	8	0	0.012,S
Post-operative	2	0	1	1	1.000,NS
Renal disorder	24	0	0	24	<0.001,H S
SIADH	24	24	0	0	<0.001,H S
Sweating	2	0	2	0	0.665,NS
Vomiting	20	0	20	0	<0.001,H S

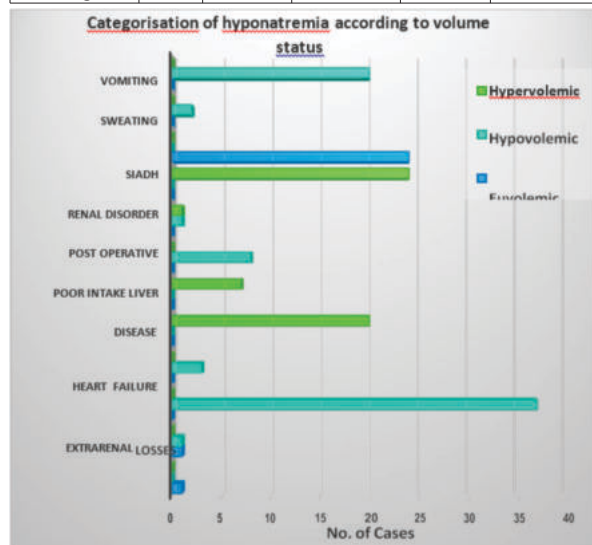


Figure 11. Categorization of hyponatremia according to volume status

Conflict of interest

The Authors have no conflicts of interest that are directly relevant to the content of this research.

Financial Resources

There are no financial resources to fund this study

Informed Consent

Informed Consent was obtained from the patient.

Author's Contribution

All the authors contributed equally to the research.

Data and materials availability

All data associated with this study done at PCMC'S PGI YCM hospital are present in the paper.

Acknowledgement

We thank all the participants who have contributed in this Study.

REFERENCES –

- Adrogué H, Madias N. Hyponatremia. N Engl J Med 2000;342:1581-9.
- Upadhyay A, et al. Incidence and prevalence of hyponatremia. Am J Med 2006;119: S30-S35.
- Funk GC, et al. Incidence and prognosis of dysnatremias present on ICU admission. Intensive Care Med 2010;36:304-311.
- Clayton JA, Le Jeune IR, Hall IP. Severe hyponatremia in medical in patients: etiology, assessment, and outcome. QJM 2006; 99:505-11.
- Koenig MA, Bryan M, Levin JL III, et al. Reversal of transtentorial herniation with hypertonic saline. Neurology 2008; 70:1023-1029.
- Chatterjee N, Sengupta N, Das C, et al. A descriptive study of hyponatremia in a tertiary care hospital of Eastern India. Indian J Endocrinol Metab 2012; 16:288–291.
- Padhi R., Panda B.N., Jagati S., Patra S.C. Hyponatremia in critically ill patients. Indian J Crit Care Med 2014; 18:83–87.
- Patil S, Mukherji A, Shetty A. Incidence of hyponatremia in critically ill patients in intensive care unit: observational study. International Journal of Dental and Medical Specialty. 2016;3(1and2):12-5.
- Pillai KS, Trivedi TH, Moulick ND. Hyponatremia in ICU. J Assoc Physicians India. 2018 May;66(5):48-52. PMID: 30477055.
- Lokesh, N. K., and S. D. Yamunraj. 'A Study on Incidence and Etiology of Hyponatremia in Hospitalized Elderly Patients Admitted in RIMS.'
- Shanmugasundaram Rajamani et al. Clinico-etiological profile of Hyponatremia in elderly. International Journal of Medical and Health Research:2017;3(7):25-30.
- Saeed B O, Beaumont D, Handley G H, Weaver J U. Severe hyponatremia: investigation and management in a district general hospital. J Clin Pathol 2002;55:893–896
- Regulation of Extracellular Fluid Osmolarity and Sodium Concentration; Text Book of Medical Physiology, Guyton C Arthur, Hall E John. 1994 9th edition 359-364. WB Saunders Company.
- Huda M S B, Boyd A, Skagen K, Wile D, Heyningen C van, Watson I, Wong S, Gill G Investigation and management of severe hyponatremia in a hospital setting Postgrad Med J 2006;82:216–219.
- Nair V, Niederman MS, Masani N, Fishbane S. Hyponatremia in community- acquired pneumonia. Am J Nephrol 2007;27:184-90.
- Hochman I, Cabili S, Peer G. Hyponatremia in internal medicine ward patients: cause, treatment and prognosis. Isr J Med Sci 1989; 25: 73 –6.
- Nzerue Chike M., Baffoe-Bonnie Henry, You Wei, Falana Babajide, and Dai Shifan. Predictors of Outcome in Hospitalized Patients with Severe Hyponatremia. Journal of the National Medical Association Vol. 95, No. 5, May 2003 335-343.