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Development of Salt Supplementation Guidelines during Hyponatremia in Hospitalized Patients

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Abstract

Salt, chemical name is sodium chloride is the main mineral responsible in maintaining the normal cell functioning and balance of electrolytes in the body from its electrolyte - sodium. The excess of sodium is known as hypernatremia which develops either by increase in sodium or by reduction in free water. Deficiency of sodium is called hyponatremia which indicates depletion in serum levels of sodium in the body. It is very prevalent electrolyte disorder in patients admitted in hospitals. Therefore in the present study, 50 hospitalized patients were studied on the basis of their diagnosis, length of hospital stay and electrolyte profile. Data collection included general profile, diagnosis, biochemical estimations and dietary Intake. Oral salt supplementation was applied as corrective approach to hyponatremia in the hospitalized patients. Regular monitoring of selected patients was done and dosage of salt was decided on the basis of severity of hyponatremia and subsequent diagnosis. It was concluded that ≤5g salt supplementation increases 5-6% serum sodium, 5-10g salt supplementation increases 5.6-8 % serum sodium, while 10-15g salt supplementation increases 9.6-11.2% serum sodium.

Keywords

Salt, hyponatremia, hypernatremia, sodium, electrolytes.

Introduction

Salt / sodium chloride / table salt is an ionic compound having the chemical formula NaCl, which is majorly consumed as a condiment or as a mode of preservation. Salt has prominent role in cookery as it enhances taste appeal of any recipe. It works as a preservative by decreasing water content of foodstuffs rendering it unavailable for the microorganisms and decreasing enzymatic activity (Inguglia *et al.*, 2019). Salt also improves flavor, texture, and mouth feel of many products especially processed foods (Durack *et al*., 2008).

In fact, salt consumption is very important for humans. It maintains plasma volume; regulate body fluid and electrolyte balance. Normal cell function and transmission of nerve impulses also depend on normal sodium levels in the body (Elias *et al*., 2019). Sodium is absorbed in the distal small intestine and colon (Strazzullo & Leclercq, 2014).

Eating habits have dramatically changed recently where consumption of salt has increased quite above the recommended allowances. The human body couldn't find it compatible to maintain good health (Agocs *et al*., 2020). Excess salt intake is associated with

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development of hypertension which subsequently poses risk for the development of cardio vascular diseases. Other health risks associated with high salt intake include kidney disease, stomach cancer, and aggravated asthma conditions (Durack *et al*., 2008).

Daily Salt Recommendations

World Health Organization in 2012 recommended consuming sodium in decreased amount (<2g/day) in order to prevent many degenerative diseases. For children, sodium recommendation is adjusted on the basis of energy requirements in relation to adults.

As per ICMR also, safe intake of sodium to decrease prevalence of hypertension was decided as 2000 mg/day that equals to 5 g salt per day (Indian Council of Medical Research & National Institute of Nutrition, 2020).

Sources of Sodium in our Diet

Sodium content of foodstuffs varies and depends on food source and on the degree of metabolism of that particular food in human body (Strazzullo & Leclercq, 2014). Low sodium foods that are include fruits, vegetables, oils, and cereals. Sodium content of whole milk is 50 mg per 100 ml. Processed foods vary highly in their sodium content because of added amount of salt during its preparation. Table salt and baking soda are the sources from which we get our majority of dietary sodium content.

Deficiency and Excess Symptoms

Hyponatremia (serum Sodium<136 mmol/L) is patho-physiologic process indicating disturbed water homeostasis (Hoorn & Zietse, 2017). Normally no deficiency signs are visible due to sodium deficiency. Depletion of sodium occurs in pathological situations like improper functioning of adrenal gland, chronic diarrhoea, extensive burns, heart failure, liver cirrhosis, uncontrollable vomiting, diabetic ketoacidosis, excessive intake of diuretics, extreme and prolonged sweating, or continuous gastric suction (Strazzullo & Leclercq, 2014). Common symptoms of low sodium include abdominal pain or cramping, bloating, body aches, dizziness, headache, impaired balance, malaise, muscle spasms & nausea.

Situation when serum sodium levels exceed 145mmol/L, the condition is termed as hypernatremia. This condition may arise due to increased sodium or loss of free water or both (Linder & Funk, 2013). General conditions causing dehydration include drinking less water, vomiting or diarrhoea, excessive sweating or use of diuretics. It typically causes thirst. Serious consequences like confusion, seizures, muscle twitching, coma, and death may also develop in the process of severity of untreated hypernatremia (Lewis, 2020).

Electrolyte Balance in our Body

Electrolytes are essential to maintain body's homeostasis as they are helpful in the regulation of fluid balance, myocardial and neurological functions, acid-base balance, oxygen delivery and many more important body processes. Electrolytes are vital in maintaining electrical impulses across the cell membranes. A condition of electrolyte imbalance is called dyselectrolytemia that may arise due to uncontrolled ingestion or

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excretion of any electrolyte. Renal failure is the major cause of electrolyte imbalance. The most common electrolyte imbalances occur due to increased or decreased levels of sodium, potassium or calcium.

Significance of the study

Many approaches and guidelines are applied for treatment and correction of hyponatremia. The severity of hyponatremia is classified as mild, moderate or severe. In 2014, hyponatremia was classified as normal 130-135 mEq/L, moderate as 125-129 mEq/L and severe as < 125 mEq/L by the European Society of Endocrinology, the European Society of Intensive Care Medicine and European Dialysis and Transplant Association (Henry, 2015). Present study focused on development and implementation of guidelines regarding salt supplementation during hyponatremia in hospitalized patients.

Aims & Objectives

- To assess level of hyponatremia in hospitalized patients
- To analyze the contributing factors in hyponatremia
- To determine the association of dietary salt intake in treatment of Hyponatremia
- To develop salt supplementation guidelines for hospitalized patients who are in the condition of Hyponatremia

Research Methodology

The present study was conducted for period of 6 months, i.e., from September 2020 to February 2021 to assess the electrolyte profile of hospitalized patients admitted in the Hospital and to assess the impact of salt supplementation in hyponatremic patients. The research procedure has been categorized along with relevant details under the following sections:

1. **Research design:** The proposed study was based on pre and post - test experimental design. The data pertaining to the study included patient's profile (age, sex, diagnosis and electrolyte profile). The step-wise illustration of the research project is shown in following figure:

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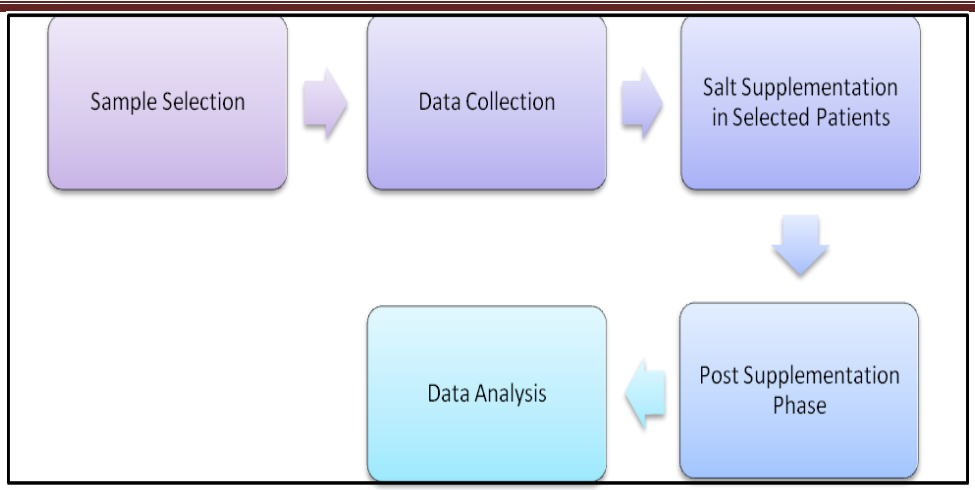

2. **Locale and sample of the study:** The study was conducted in Mahatma Gandhi Hospital, Jaipur

A total of 50 hospitalized patients were selected on the basis of their diagnosis, length of hospital stay and electrolyte profile. Purposive sampling technique was used for sample selection. This is a sampling method in which the samples are selected on the basis of their knowledge about the study.

Inclusion criteria: Critically ill patients/ patients with prolonged disease condition having longer length of stay in hospital with fluctuations in electrolyte profile.

Exclusion criteria: Patients having CKD, congestive heart failure, hypertensive & with shorter length of stay.

3. **Data collection and pre-supplementation phase**

- General Profile of the subject: Age, sex, Diagnosis, Severity of disease, length of hospital stay
- Anthropometric measurements
- Biochemical estimations, Electrolyte profile
- Dietary Intake

On the basis of above mentioned information and considering exclusion and inclusion criteria hyponatremic patients were selected.

Salt supplementation in hyponatremic hospitalized patients: Salt supplementation was selected as corrective approach for hyponatremia. Amount of salt supplemented is to be based on severity of hyponatremia in the particular individual.

4. **Post supplementation phase:** Patients undergone supplementations were evaluated and monitored on regular basis. Data regarding biochemical changes as well as other

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physiological changes (if any) were recorded to check the impact of salt supplementation.

5. **Data analysis:** Data was analyzed for all the selected hospitalized hyponatremic patients. The information obtained from the subjects was compiled systematically in an excel sheet and statistical analysis was done for the same. Tabulation of data was done as per requirement of the study. Percentage Difference and Standard Deviation were calculated to find out significant difference pre & post salt supplementation.

Results & Discussion

The results of the study have been presented under the following sections:

1. Data collection & pre-supplementation phase
2. Salt supplementation in hyponatremic hospitalized patients
3. Post supplementation phase and impact analysis

1. Data Collection and Pre-Supplementation phase

On the basis of the mentioned information and considering exclusion and inclusion criteria patients with prolonged disease / critically ill patient's condition having dyselectrolytemia with longer lengths of hospital stay were selected. General profiles of the patients are stated in Table 1:

Table - 1 General Profile of selected hospitalized patients

S.No.	Subject	Age	Sex	Height (Kg.)	Weight (Kg.)	Diagnosis	Diet
1	S1	61	F	160	80	Diabetes, Congestive heart failure	Ryle's tube feed 200 ml Diabetic
2	S2	52	F	155	50	Road traffic accident, covid negative	High protein normal diet
3	S3	54	F	175	95	Sub archanoid haemorrhage	Ryle's tube feed 250 ml Normal
4	S4	50	F	160	60	Coronary Artery Bypass Grafting	High protein normal diet
5	S5	25	M	165	75	Diabetes, Cellulitis,DCMP	Diabetic Diet
6	S6	45	M	170	70	Hydrocephalus	Normal diet
7	S7	7	M	120	21	Hydrocephalus	Ryle's tube feed 50 ml Normal
8	S8	72	F	165	65	Rheaumatoid Arthritis, RHD, Covid negative	Ryle's tube feed 200 ml Normal Oil X
9	S9	48	M	164	62	Aortic valve replacement	Cardiac normal diet GLVX
10	S10	45	F	160	60	Coronary artery disease	Cardiac normal diet
11	S11	62	M	150	45	Colon cancer	High protein soft diet

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12	S12	65	F	160	60	Ovarian cancer, pleural effusion	High protein normal diet
13	S13	41	M	175	80	Hepatic encephalopathy	High protein Low fat normal diet
14	S14	50	M	170	65	Intra cerebral hemorrhage	Ryle's tube feed 250 ml Normal
15	S15	42	M	160	60	Ulcer right leg	High protein normal diet
16	S16	29	M	152	43	Renal donor	Normal diet
17	S17	49	F	150	50	Road traffic accident, multiple fracture	Ryle's tube feed 250 ml Normal
18	S18	36	M	165	60	Chronic liver disease	High protein normal diet
19	S19	72	F	150	50	Koch's chest covid negative	High protein normal diet Curd x
20	S20	75	F	160	90	Diabetes, hypothyroidism	Diabetic Diet
21	S21	50	M	160	60	Vocal cord cancer	Ryle's tube feed 200 ml Normal
22	S22	25	F	155	65	Acute myeloid leukemia	High protein normal diet
23	S23	36	M	170	85	Meningioma	High protein normal diet
24	S24	35	M	170	70	Ganglio bleed	Ryle's tube feed 250 ml Normal
25	S25	23	M	160	55	Road traffic accident, head injury	Ryle's tube feed 250 ml Normal
26	S26	37	F	160	56	Celiac disease, jaundice	Gluten free normal diet
27	S27	20	M	170	65	Schizophrenia, covid negative	Ryle's tube feeding 200 ml normal
28	S28	40	F	160	70	covid positive 6 month pregnancy	Ryle's tube feeding 200 ml normal oil x
29	S29	40	M	160	55	Acute pancreatitis, diabetes	Ryle's tube feeding 200 ml Diabetic oil x
30	S30	38	M	157	70	Coronary Artery Bypass Grafting	Cardiac normal diet
31	S31	8	M	140	25	Fever with septic shock	High protein normal diet
32	S32	38	M	165	65	Chronic liver disease	High protein normal diet
33	S33	45	M	160	60	Post covid Peumonia	Ryle's tube feeding 200 ml normal
34	S34	40	M	160	60	Stomach cancer	Jenunal Feeding 150 ml normal oil x
35	S35	38	M	170	63	Cholangio carcinoma	High protein low fat soft + full normal diet
36	S36	65	M	165	60	Coronary Artery Disease	Cardiac Normal diet
37	S37	72	M	160	55	Prostate Cancer	High protein normal diet
38	S38	60	F	160	85	Sepsis, bed sores	Ryle's tube feeding 200 ml normal
39	S39	80	M	170	65	Post covid Peumonia	High protein soft + full normal diet
40	S40	70	M	170	75	Diabetes, hypothyroidism	Diabetic Diet

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41	S41	50	M	160	60	Scrubtyphis	High protein normal diet
42	S42	62	M	170	65	Mitral valve replacement	Cardiac normal diet GLVX
43	S43	12	F	150	45	Sub dural haemorrhage	Ryle's tube feeding 250 ml normal
44	S44	56	F	150	50	Breast cancer	High protein normal diet
45	S45	62	F	160	55	Reaumatic Heart disease	Cardiac nornal diet
46	S46	18	M	170	55	Poisioning	Ryle's tube feeding 100 ml normal
47	S47	52	M	160	45	Chronic obstructive pulmonary disease	Ryle's tube feeding 200 ml normal
48	S48	50	M	160	55	Chronic liver disease alcohol related cirrhosis	High protein low fat normal diet
49	S49	32	F	150	40	Retro viral disease-AIDS, Pulmonary TB	Ryle's tube feeding 200 ml normal Oil
50	S50	20	M	160	60	Acute lymphoblastic leukemia	High protein normal diet

From the above table it is evident that hyponatremia arise in patients suffering from neurosurgery, onco surgeries, cardio thoracic surgeries or patients having fluid overload in form of congestive heart failure, pleural effusion, renal or liver patients who have Ascitis. Similar type of observation was found in the study of Upadhyay *et al*., 2006; who stated that frequency of developing hyponatremia increases during special clinical condition such as pneumonia, congestive heart failure, AIDS, cirrhosis included marathon runners also.

Risk of developing hyponatremia is higher in post surgical patients as they have non osmotic stimuli for the release of antidiuretic hormone (Oh and Sutherland, 2006). Patients underwent neuro surgery also face problem of hyponatremia. As patients either suffer from inappropriate secretion of anti-diuretic hormone (SIADH) which is a volume expanded condition and cerebral salt wasting (CSW), which include renal sodium loss (Cole *et al*., 2004).

After cardiac surgery also, the problem of hyponatremia is very common that is a significant factor for length of hospital stay, post operative complications and higher mortality rate (Crestanello *et al*., 2013).

Renal Sodium losses occur with glycosuria, cerebral salt wasting, primary adrenal insufficiency and diuretics. Primary polydipsia is one of the causes of hyponatremia. Adrenal insufficiency leads to renal Sodium wasting with subsequent depletion of volume. Diuretics can be one of major causes of hyponatremia. However thiazides are more often associated with hyponatremia as they impair the ability to excrete dilute urine (Henry, 2015).

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2. Salt supplementation in hyponatremic hospitalized patients

The accurate identification and solution of hyponatremia in hospitalized patients is very crucial and need a very careful and experienced approach which can be achieved by normal saline or vasopressin receptor antagonist. Use of hypertonic saline is very important to treat hyponatremia to prevent cerebral edema (Lee *et al.*, 2014).

In a research work carried out by Mohmand *et al*., 2007 a retrospective review was conducted of 62 hyponatremic patients with a hypertonic saline. The infusion rate was 0.38 ml/ kg/ hour. It was concluded that hypertonic solutions should be infused at lower rates with a careful watch on serum sodium level and urinary output.

In the present study oral salt supplementation is selected and applied as a corrective approach for hyponatremia. Regular and close monitoring is crucial in such conditions as overcorrection may cause detrimental effects. Information regarding day-wise supplementation on subjects is presented in table 2.

Table 2- Salt Supplementation on Subjects day-wise

S. No.	Subject	Initial Na (i)	Salt supplementation day-wise (in g)				
			Day 1	Day 2	Day 3	Day 4	Final Na
1	S1	128	6	5	3	2	135
2	S2	125	12	8	6	6	137
3	S3	130	5	5	4	2	136
4	S4	130	5	5	4	2	135
5	S5	125	10	10	8	8	134
6	S6	131	4	2	0	0	137
7	S7	130	5	5	4	4	136
8	S8	128	8	6	6	4	137
9	S9	130	5	5	4	4	136
10	S10	130	5	5	4	4	136
11	S11	129	6	5	4	4	136
12	S12	127	8	6	6	4	137
13	S13	130	5	5	4	4	136
14	S14	125	12	8	6	6	137

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15	S15	130	5	5	4	4	136
16	S16	130	5	4	3	2	135
17	S17	122	15	10	8	6	138
18	S18	128	6	5	3	2	135
19	S19	131	4	4	2	0	137
20	S20	130	5	5	4	4	136
21	S21	130	5	5	4	4	136
22	S22	127	8	8	6	6	138
23	S23	128	6	5	3	2	135
24	S24	124	15	10	8	6	138
25	S25	125	10	8	6	6	137
26	S26	129	6	5	4	4	136
27	S27	128	6	5	3	2	135
28	S28	121	15	10	8	6	138
29	S29	130	5	4	3	2	136
30	S30	131	4	4	2	0	137
31	S31	129	6	5	4	4	136
32	S32	130	5	5	3	3	136
33	S33	128	6	5	3	2	135
34	S34	130	5	4	3	2	136
35	S35	130	5	4	4	2	137
36	S36	129	6	5	4	4	136
37	S37	130	5	4	4	2	137
38	S38	128	6	5	3	2	135
39	S39	130	5	4	4	2	137
40	S40	130	5	4	4	2	137
41	S41	131	4	4	3	2	137
42	S42	130	5	4	4	2	137

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43	S43	128	6	5	3	2	135
44	S44	130	5	4	4	2	137
45	S45	130	4	4	3	2	137
46	S46	127	8	8	6	6	138
47	S47	130	5	4	4	2	137
48	S48	130	4	4	3	2	137
49	S49	129	6	5	4	4	136
50	S50	128	6	5	5	4	138

Na = Sodium

Patients undergone salt supplementation along with pre and post supplementation values are presented in the above table. The details regarding percent difference and impact analysis is given in next section. In a study conducted by Munger, 2007 role of arginine vasopressin receptor was seen on free water excretion and normalizing serum sodium level.

In a study by Bajaj *et al*., 2018 albumin was used in treatment of hyponatremic patients with cirrhosis. It was documented that patients receiving intravenous albumin showed resolution of hyponatremia irrespective of kidney function and baseline sodium content.

Primary treatment to cure hyponatremia is fluid restriction. The fluid intake is restricted to <500 ml per day urine output. Fluid restriction is not applied –

If the urine osmolarity is >500mOsm/kg

If the sum of urine Na and K > serum Na

If fluid restriction causes delay in therapy

Other popular agents used in treatment of hyponatremia are urea and tolvaptan. Low amount of loop diuretic in combination to sodium tablets or normal saline are recommended in treatment of hyponatremia. In severe hyponatremia an IV filled with a salt based fluid of hypertonic saline (3% at 0.5 – 1.0 ml/ kg/ h or 1.8% at 1-2 ml/ kg/ h) is used for treatment of hyponatremia. Hypertonic saline solution infusion needs frequent monitoring nearly in each 4 – 6 hours (Alywin *et al*., 2015).

The study implied different treatment interventions for normalizing Sodium levels but there were no study regarding salt supplementation guidelines.

3 Post Supplementation Phase and Impact Analysis

Oral salt supplementation is applied as corrective approach of hyponatremia in hospitalized patients. Regular monitoring of selected patients was done and dosage of salt

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was decided on the basis of severity of hyponatremia in patients, diagnosis, route/type of diet and tolerance level. Data regarding percent increase in serum Sodium is presented in table 3

Table 3 - Impact Analysis

S.No.	Subject	Initial Na (i)	Final Na (f)	Standard deviation (S.D.)	Percent Increase (P in %)
1	S1	128	135	4.94	5.46
2	S2	125	137	8.48	9.60
3	S3	130	136	4.24	4.61
4	S4	130	135	3.53	3.84
5	S5	125	134	6.36	7.20
6	S6	131	137	4.24	4.58
7	S7	130	136	4.24	4.61
8	S8	128	137	6.36	7.031
9	S9	130	136	4.24	4.61
10	S10	130	136	4.24	4.61
11	S11	129	136	4.94	5.42
12	S12	127	137	7.07	7.87
13	S13	130	136	4.24	4.61
14	S14	125	137	8.48	9.60
15	S15	130	136	4.24	4.61
16	S16	130	135	3.53	3.84
17	S17	122	138	11.31	13.11
18	S18	128	135	4.94	5.46
19	S19	131	137	4.24	4.58
20	S20	130	136	4.24	4.61
21	S21	130	136	4.24	4.61
22	S22	127	138	7.77	8.66
23	S23	128	135	4.94	5.46
24	S24	124	138	9.89	11.29
25	S25	125	137	8.48	9.6
26	S26	129	136	4.94	5.42
27	S27	128	135	4.94	5.46

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28	S28	121	138	12.02	14.04
29	S29	130	136	4.24	4.61
30	S30	131	137	4.24	4.58
31	S31	129	136	4.94	5.42
32	S32	130	136	4.24	4.61
33	S33	128	135	4.94	5.46
34	S34	130	136	4.24	4.61
35	S35	130	137	4.94	5.38
36	S36	129	136	4.94	5.42
37	S37	130	137	4.94	5.38
38	S38	128	135	4.94	5.46
39	S39	130	137	4.94	5.38
40	S40	130	137	4.94	5.38
41	S41	131	137	4.24	4.58
42	S42	130	137	4.94	5.38
43	S43	128	135	4.94	5.46
44	S44	130	137	4.94	5.38
45	S45	130	137	4.94	5.38
46	S46	127	138	7.77	8.66
47	S47	130	137	4.94	5.38
48	S48	130	137	4.94	5.38
49	S49	129	136	4.94	5.42
50	S50	128	138	7.07	7.81

Standard deviation and percent increase was calculated on the basis of pre and post salt supplementation. The suggested guidelines / Ranges for salt supplementation are stated below in table 4.

Table 4 - Salt Supplementation ranges and it's Impact

Serum Sodium levels Range (Normal Na range of 135-137 mmol/L)	Amount of salt supplemented (in g)	% Increase
130-135	≤5	5-6
125-130	6-10	5.6-8
<125	10-15	9.6-11.2

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It was concluded that-

≤5g Salt supplementation increases 5-6% serum Sodium

5-10g Salt supplementation increases 5.6-8 % serum Sodium

10- 15g Salt supplementation increases 9.6- 11.2% serum Sodium

Conclusion

Salt maintains plasma fluid volume; it regulates water and electrolyte content of body, it is essential in convey nerve impulses and maintenance of normal cell functioning.

As consumption of salt has increased drastically over last few decades, therefore World Health Organization, 2012 has recommended <2g/day sodium intake to reduce risks of blood pressure, stroke and coronary artery diseases.

In present study, 50 hospitalized patients were selected by purposive sampling to assess degree of resolution of hyponatremia after salt supplementation at various levels. Dosage of salt was decided on the basis of severity of hyponatremia in patients, diagnosis, route/type of diet and tolerance level. It was concluded that ≤5g salt supplementation increased 5-6% serum sodium, 5-10g salt supplementation increased 5.6- 8 % serum sodium, 10- 15g salt supplementation increased 9.6- 11.2% serum sodium. Thus the present salt supplementation guidelines can be used to correct hyponatremia in hospitalized patients.

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