

Difference of Clinical Characteristics between Hospital-acquired Hyponatremia and Hyponatremia on Admission

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Hyponatremia in adults is a common problem that has been associated with mortality rates ranging from 40% to 60%. Clinical characteristics of hospital-acquired hyponatremia have not been well defined. To evaluate the difference between hyponatremia on admission and hospital-acquired hyponatremia, we reviewed 50 patients with hyponatremia at Hanyang University Guri Hospital for 51-month period from 1 March 2001 to 31 May 2005. We defined hyponatremia as serum sodium concentration more than or equal to 150 mEq/L. Hospital-acquired hyponatremia was more frequently (62%) observed than hyponatremia on admission (38%). Patients with hyponatremia on admission (73.1±11.7 years) were older than those with hospital-acquired hyponatremia (59.3±13.7 years). Only 30% of patients was alert in mental status. Fifty six percent of all patients (n=50) had neurologic problem such as head injury, cerebral infarction or hemorrhage. Admission hyponatremia was caused by severe dehydration due to no access to water. Seventy seven percent of hospital-acquired hyponatremic patients were associated with diuretics and solute diuresis. Treatments of hospital-acquired hyponatremia were also delayed and inadequate. Rate of correction in 6, 12, 24 hours after peak sodium level was not different between hyponatremia on admission and hospital-acquired hyponatremia. More rapid correction during 6 hours in hyponatremia on admission was associated with higher mortality (survival 2.1±0.7 mEq/L, death 7.1±4.9 mEq/L, p<0.05). Higher mortality was observed in patients with more severe renal insufficiency. In conclusion, hospital-acquired hyponatremia is largely avoidable by clinical attention and appropriate therapy. Patients with cerebrovascular events or renal insufficiency, patients treated with diuretics or hypertonic solute need careful fluid management and the close monitoring of blood sodium level. Particularly, the rate of correction during the first 6 hours should be also managed very cautiously in hyponatremia on admission.

Key Words : Hyponatremia, Hospital-acquired, Rate of correction

Introduction

Hyponatremia in adults is a common problem that has been associated with mortality rates ranging from 40% to 60%¹⁻⁴. Most studies of this condition have focused on its occurrence in the geriatric population. An increased incidence of hyponatremia in

mentally handicapped patients has also been reported⁵.

However, the epidemiologic factors and pathogenesis of hyponatremia in the general hospitalized population have not been well defined. We did a study to determine differences in clinical characteristics between patients who presented with hyponatremia on admission with those who developed it during the hospital course. Particular attention was paid to look for the influence on prognosis by the rate of correction.

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Materials and Methods

We retrospectively studied all adults (≥ 16 years of age) with hypernatremia at Hanyang University Guri Hospital for 51-month period from 1 March 2001 to 31 May 2005. The definition of hypernatremia is arbitrary but Ross and Christie⁶⁾ suggested that most authors define hypernatremia as serum sodium concentration of ≥ 150 mmol/L and this has been used in this study. The duration and resolution of hypernatremia were determined on the basis of an upper limit of normal of 145 mmol/L.

Patients with hypernatremia were identified from the records of the clinical pathology laboratory, and subsequently their case notes were examined for clinical details, i.e., diagnosis, etiology, duration of hospitalization, treatment and outcome.

Table 1. Demographic Characteristics of Patients

	Hypernatremia on admission (n=19)	Hypernatremia during hospital stay (n=31)
Number of patients (%)	19 (38%)	31 (62%)*
Male : Female	12:7	17 : 14
Mean age (years)	73.1 \pm 11.7	59.3 \pm 13.7*
Peak serum sodium (mEq/L)	165.2 \pm 9.7	160.8 \pm 7.8
Duration of hypernatremia (days)	4.0 \pm 3.0	4.8 \pm 3.6
Hypertension (%)	10 (52%)	15 (48%)
Diabetes mellitus (%)	12 (63%)	18 (58%)

Data are presented as mean \pm SD

*p<0.05

Particular attention was paid to the physical examination for signs and symptoms of dehydration. Details of the neurological examination and mental status of each patient were also record. The amount and type of parenteral fluids prescribed as well as details of all medications were examined.

Data were analyzed by either a two tailed independent Student t-test or a Chi-square test using SPSS 11.0. A p value of less than 0.05 was considered statistically significant.

Results

A serum sodium concentration greater than or equal to 150 mmol/L was reported in 50 patients during the 51-month period of 1 March 2001 through 31 May 2005. Demographic data for the patients are shown in Table 1. Hospital-acquired hypernatremia (62%, n=31) was observed more frequently than hypernatremia on admission (38%, n=19). Patients who developed hypernatremia before admission were significantly older than those during hospital stay (mean age \pm SD, 73.1 \pm 11.7 years compared with 59.3 \pm 13.7 years; p<0.05).

The underlying conditions that were associated with hypernatremia are shown in Table 2. Twenty nine (58%) of patients had neurologic problem. Mental status of patients was recorded in Fig. 1. Only fifteen (30%) of patients were alert. Department on admission revealed that twenty six (52%) of all pa-

Table 2. Underlying Conditions of Hypernatremic Patients (n=50)

	Hypernatremia on admission (n=19)	Hypernatremia during hospital stay (n=31)	Total (%)
Cerebrovascular event	8	21	29 (58)
Infection	4	1	5 (10)
Hepatic failure	0	4	4 (8)
Pulmonary disease	2	1	3 (6)
Hyperosmolar coma	3	0	3 (6)
Gastrointestinal disease	1	2	3 (6)
Cardiovascular disease	0	1	1 (2)
Others*	1	1	2 (4)

*Drug intoxication 1, Depression 1

tients were admitted to neurosurgery and neurology department (Fig. 2).

Various factors in admission hypernatremia and hypernatremia during hospital stay were compared (Table 3). Duration of hypernatremia, peak sodium level and the rate of correction in 6, 12, 24 hours, mortality were not significantly different between hospital-acquired hypernatremia and hypernatremia on admission. But serum creatinine and osmolality were higher in patients with hypernatremia on admission compared to hospital-acquired hypernatremia. However, all patients (n=19) of hypernatremia on admission were due to dehydration. Etiologies of hypernatremia were classified. Hospital-acquired hypernatremia

(22%), solute diuresis in eight (25%) and both in nine (29%) of patients (Fig. 3).

Association with prognosis of correction rate and renal insufficiency was recorded (Table 4). More rapid correction within 6 hours in hypernatremia on admission was associated with higher mortality. Renal insufficiency was also associated with higher mortality in both groups.

Discussion

Unlike hypernatremia on admission, hospital-acquired hypernatremia affects patients of all ages. Hypernatremia on admission is more frequently observed in the elderly in most reports⁷. In our study,

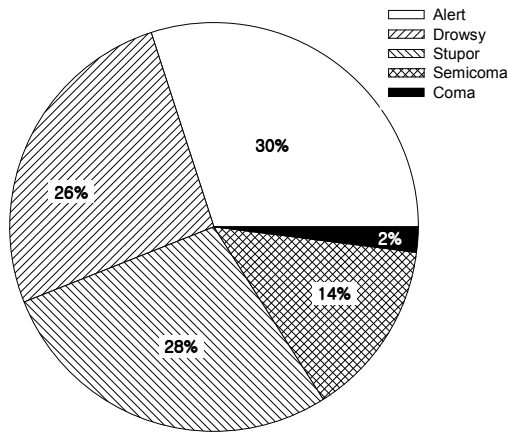


Fig. 1. Mental status of hypernatremic patients (n = 50).
mia was associated with diuretic therapy in seven

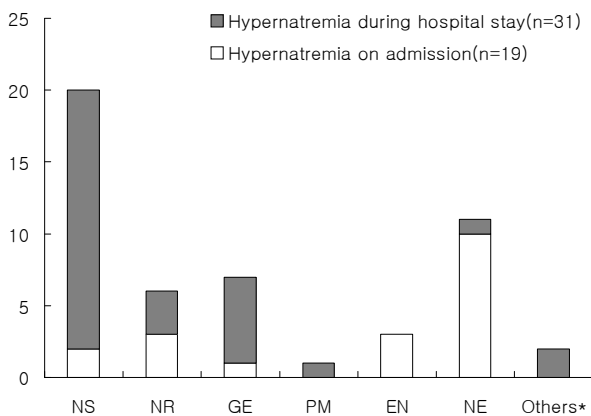


Fig. 2. Admission department of hypernatremic patients. NS: neurosurgery, NR: neurology, GE: gastroenterology PM: pulmonology, EN: endocrinology, NE: nephrology *Neuropsychiatry I, Thoracic surgery I

Table 3. Various Factors of Hypernatremic Patients (n=50)

	Hypernatremia on admission (n=19)	Hypernatremia during hospital stay (n=31)
Correction Rate (mEq/L)		
6 hours	5.0±4.4	4.7±3.6
12 hours	8.5±4.5	7.2±6.1
24 hours	11.6±4.9	7.8±7.6
Duration from onset to peak sodium level (days)	0	1.0±1.3*
Serum creatinine (mg/dL)	2.9±2.6	1.5±1.3*
Osmolality (mosm/L)		
Urine	572±144	533±171
Serum	370±30	350±31*

*p<0.05

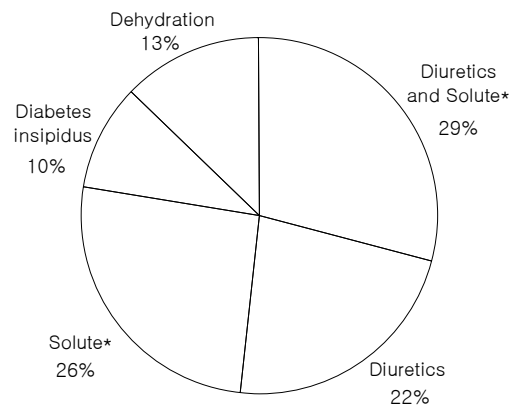


Fig. 3. Etiology of hospital acquired hypernatremia (n=31). *High glucose solution, mannitol.

Table 4. Patient Survival according to Correction Rate or Renal Insufficiency

	Survival (number)	Death (number)	p value
On admission (mEq/L)			
6 hours (n=14)	2.1±0.7 (6)	7.1±4.9 (8)	<0.05
12 hours (n=14)	7.0±3.9 (7)	10.0±4.9 (7)	N
24 hours (n=15)	9.2±4.0 (7)	13.6±4.9 (8)	N
Serum creatinine (n=19) (mg/dL)	1.6±0.8 (9)	4.1±3.2 (10)	<0.05
Hospital-acquired			
6 hours (n=12)	5.6±2.0 (6)	3.8±4.8 (6)	N
12 hours (n=15)	7.7±4.1 (8)	6.7±8.2 (7)	N
24 hours (n=29)	10.3±8.2 (12)	6.1±6.8 (17)	N
Serum creatinine (n=31) (mg/dL)	1.3±0.9 (13)	1.6±1.5 (18)	<0.05

patients with hypernatremia on admission were older than those during hospital stay. Although hypernatremia on admission was a geriatric disease, hospital-acquired hypernatremia was not in our study.

The clinical manifestations are even more elusive in hospitalized patients because they often have pre-existing neurologic dysfunction⁷⁾. In our study 56% (n=26) of all patients had neurologic dysfunction and 70% (n=35) were drowsy mentality or below. Only 30% (n=15) of patients was alert on admission.

Ninety two percent (n=46) of all patients were admitted through emergency room. Hypernatremia itself was primary cause of admission in only 26% (n=5) of patients with hypernatremia on admission. Multiple main diseases as infection, liver failure, cerebrovascular event and hyperosmolar coma were combined with hypernatremia. The main underlying disease of patients with hospital-acquired hypernatremia was cerebrovascular event (65%) such as head injury, brain infarction and intracranial hemorrhage.

In patients with hypernatremia developed over a period of hours, rapid correction improves the prognosis without increasing the risk of cerebral edema, because accumulated electrolytes are rapidly extruded from brain cells^{8,9)}. In such patients, reducing the serum sodium concentration by 1 mmol per liter per hour is appropriate⁸⁾. A slower pace of correction is prudent in patients with hypernatremia of longer or unknown duration, because the full dissipation of accumulated brain solutes occurs over a period of several days^{9,10)}. In such patients, reducing the serum

sodium concentration at a maximal rate of 0.5 mmol per liter per hour^{11,12)}. In our study, more rapid correction during 6 hours only in patients with hypernatremia on admission showed higher mortality. The rate of correction during 12 or 24 hours statistically was not associated with prognosis in both groups.

The mortality of 56% we observed is similar to that reported in other studies of hypernatremia¹⁻⁴⁾. As stressed in these studies, however, much of the excess mortality cannot be directly attributed to the hypernatremia itself. Based on careful review of the medical records, our study suggest that hypernatremia partially contributed to mortality in less than 10% of patients.

The standard recommendation for the treatment of hypernatremia is that, in addition to replacement of ongoing water losses, approximately half of the water deficit be replaced during the first 24 hours and that the remainder of the deficit be replenished during the subsequent two to three days¹³⁻¹⁵⁾. In our study, sodium level was peak on development in all patients with hypernatremia on admission, but after 1-4 days in 15 patients with hospital-acquired hypernatremia. This fact suggested that despite frequent measurement of the serum concentration, treatment of hypernatremia was frequently inadequate or delayed in hospital-acquired hypernatremia.

The major factors contributed to the hypernatremia were severe dehydration due to poor oral intake in patients with hypernatremia on admission, but diuretics or solute diuresis in those during hospital stay.

Hospital-acquired hypernatremia results primarily from inadequate and inappropriate prescription of fluids to patients with predictably increased water losses and impaired thirst or restricted free water intake or both.

Higher mortality was observed in patients with more severe renal insufficiency in both groups. This fact suggested that renal tubular defects partially contributed to hypernatremia although renal insufficiency could be associated with the severity of underlying disease. Increased free-water losses could be caused by impaired renal concentrating capacity due to renal tubular defects.

As this was a retrospective study, there were several limitations which could have influenced our results. Amongst these were inaccurate estimate of fluid intake due to poor charting, insufficient data on osmolalities and standardized examination. Despite these limitations we believe that hypernatremia during hospital stay is largely avoidable by prompt clinical attention and appropriate therapy. Attention should be given towards improving physician education about fluid management in high risk patients.

Patients with cerebrovascular events or renal insufficiency and patients treated with diuretics or hypertonic solute need careful fluid management and the close monitoring of blood sodium level.

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