Hyponatremia Among the Institutionalized Elderly in 2 Long-Term Care Facilities in Taipei

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Background: Hyponatremia is common in the institutionalized elderly, and syndrome of inappropriate antidiuretic hormone secretion was deemed the most important etiologic factor. The purpose of this study was to evaluate the prevalence and etiologic factors of hyponatremia among institutionalized elderly and to explore its association with nutritional status.

Methods: Subjects in 2 private long-term care facilities (LTCFs) participated in this study. Periodic nutritional evaluations, including anthropometric measurements and serial laboratory examinations, were performed every 6 months. When hyponatremia was identified, serum osmolality, serum levels of cortisol, thyrotropin, antidiuretic hormone, urine osmolality, and electrolyte profile were done instantly. Water loading tests were performed for subjects with euvolemic, hypo-osmolar hyponatremia. Nutritional status (i.e. hemoglobin, serum albumin, serum total cholesterol, body mass index [BMI], and mean body weight loss within 6 months) was compared between hyponatremic and normonatremic subjects during hyponatremic episodes and at follow-up (6 months later).

Results: In total, 67 (mean age = 77.2 ± 8.8 years, M/F = 45/22) LTCF residents were enrolled. The prevalence of hyponatremia was 31.3% (21/67) during the 6-month period, and 62.5% of these cases were related to reset osmostat. In addition, BMI was similar between hyponatremic and normonatremic subjects during hyponatremic episodes (19.1 ± 3.2 vs 20.5 ± 4.0 kg/m^2, p = 0.16), but became significantly lower in hyponatremic subjects 6 months later (18.5 ± 3.2 vs 20.8 ± 4.2 kg/m^2, p = 0.027). However, the mean body weight loss during the 6-month follow-up was similar (3.0% vs 0.8%, p = 0.25). Furthermore, hemoglobin and serum levels of albumin were similar between groups during hyponatremic episodes and at follow-ups, but serum levels of total cholesterol were significantly lower in hyponatremic subjects on both occasions (166.9 ± 30.5 vs 190.2 ± 38.2 mg/dL, p = 0.016 during hyponatremic episodes and 153.6 ± 29.4 vs 182.8 ± 35.5 mg/dL, p = 0.003 at follow-up).

Conclusion: About a third of LTC-dwelling elderly would experience hyponatremia during the 6-month period, and 62.5% of them were due to reset osmostat. The relationship between hyponatremia and undernutrition deserves further investigation. [*J Chin Med Assoc* 2006;69(3):115–119]

Key Words: elderly, geriatrics, hyponatremia, nursing home, syndrome of inappropriate antidiuretic hormone secretion

Introduction

The homeostatic system regulating water and electrolyte balance undergoes various changes with age. The confluence of aging, comorbid medical conditions, polypharmacy, and altered oral intake results in fluid and electrolyte imbalance in the elderly. Hyponatremia, the most common electrolyte disorder in the elderly, has been deemed part of normal aging due to the progressive decline of maximal renal concentrating capacity.[1–5] The complex interrelationship between aging and antidiuretic hormone (ADH) has brought more complexity to this phenomenon.[6–10] Compared with healthy community-dwelling elderly, frail elderly contracting acute illness and residents of long-term care facilities (LTCFs) were more susceptible to hyponatremia.[11–14]

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The prevalence of hyponatremia among elderly nursing home residents was between 18% and 22.5% in a 12-month period, and 78.3% resulted from syndrome of inappropriate antidiuretic hormone secretion (SIADH).[13,15–17] Clinically, hyponatremia among the institutionalized elderly is usually asymptomatic, and severe complications secondary to hyponatremia are relatively rare. In Taiwan, studies of hyponatremia among the institutionalized elderly are lacking; therefore, we conducted this prospective observational study to explore the period prevalence of hyponatremia among residents of LTCFs to evaluate underlying etiologies and to explore the relationship of hyponatremia with nutritional status.

Methods

From July 2002 to June 2003, we prospectively recruited subjects older than 65 years of age in 2 private LTCFs near Taipei Veterans General Hospital. Taipei Veterans General Hospital also aided these 2 LTCFs with medical services and domiciliary nursing care. Physicians visited these subjects once every month, and the domiciliary care nurses visited them once every 2 weeks. Informed consents signed by families were obtained for each subject before the study. Nutritional status was evaluated every 6 months, which included anthropometric measurements (body height, body weight, triceps skinfold thickness, mid-arm circumferences, presence of edema) and laboratory examinations (hemoglobin and serum albumin, blood urea nitrogen, creatinine, total cholesterol, sodium, and potassium). Hyponatremia was defined as having a serum sodium level of less than 135 mEq/mL. Subjects with hyponatremia would immediately undergo further laboratory tests such as serum osmolality, thyrotropin, cortisol, ADH, urine osmolality, and electrolytes. Subjects with abnormal thyroid function or cortisol levels were excluded from the study and were treated accordingly. Moreover, subjects with dehydration, overhydration, decompensated congestive heart failure, liver cirrhosis, or renal failure were also excluded and were referred for further treatment. Subjects who were currently taking diuretics, steroids, or antidepressants were excluded as well. Subjects without hyponatremia during the study period were followed with exactly the same protocol as the control subjects.

SIADH was primarily defined as serum osmolality of less than 275 mOsm/kg H_2O with inappropriate urinary response to hypo-osmolality (urine osmolality > 100 mOsm/kg H_2O).[18] To differentiate SIADH from reset osmostat, the water loading test was performed in every euvolemic hyponatremic episode after excluding subjects who were medically unsuitable for fluid loading. The water loading test was done by loading a certain amount of water (20 mL/kg body weight) orally within 10–15 minutes after a 10-hour overnight fast, and placing the patients in a recumbent position for 5 hours.[19,20] Meanwhile, voided urine was collected every hour for 5 hours for further biochemistry examinations, including osmolality and electrolyte profile. The water loading test would be considered normal if (1) the voided urine amount exceeded 65% of the loading amount at the fourth hour or 80% at the fifth hour and (2) urine osmolality was less than 100 mmol/kg H_2O among samples of voided urine.

Data in the text and tables are expressed as means ± standard deviation (SD). Results were compared between groups depending on the type of data analyzed using the Chi-square test, Student *t* test, or Mann-Whitney *U* test (SPSS 13.0; SPSS Inc, Chicago, IL, USA) where appropriate. The Wilcoxon signed-rank test was used for comparisons of pre-load and after-load serum ADH levels among hyponatremic subjects. For all tests, results with p values of less than 0.05 (2-tailed) were considered statistically significant.

Results

Prevalence

In total, 67 (mean age = 77.2 ± 8.8 years, M/F = 45/22) subjects were enrolled in the study. Six (9.0%) subjects had hyponatremia at screening, and 19 (28.4%) became hyponatremic in the follow-up period (4 of them were hyponatremic at both surveys). Altogether, the period prevalence of hyponatremia was 31.3% (21/67) within 6 months. The control group consisted of 46 subjects (mean age = 76.7 ± 8.9 years, M/F = 28/18) with regular follow-up for 6 months.

Comparisons of nutritional status between hyponatremic and normonatremic subjects

Compared with normonatremic subjects, hyponatremic subjects had similar body mass index (BMI) during hyponatremic episodes (19.1 ± 3.2 vs 20.5 ± 4.0 kg/m^2, p = 0.16). However, BMI became significantly lower in hyponatremic subjects 6 months later (18.5 ± 3.2 vs 20.8 ± 4.2 kg/m^2, p = 0.027), but the mean body weight loss during the follow-up period did not reach statistical significance (3.0% vs 0.8%, p = 0.25). Hemoglobin and serum levels of albumin were similar between hyponatremic and normonatremic groups on both occasions; however, serum levels of total cholesterol were significantly lower in hyponatremic subjects on both occasions (Table 1).

Results of water loading tests

After careful exclusions, 16 of 21 hyponatremic subjects were eligible for water loading tests. Among those who undertook water loading tests, 75% had central nervous system (CNS) disorders (50% having cerebral arterial accidents), 50% had hypertension, 37.5% had dementia, and 25% had diabetes mellitus. Six subjects excreted less than 35% of loaded water and there were 13 subjects with urine osmolality greater than 100 mmol/kg H_2O in collected urine samples. Therefore, SIADH accounted for 37.5% (6/16) of all hyponatremic episodes in this study (Table 2). Serum levels of ADH among these subjects remained unchanged before and after water loading tests (pre-load: 3.6 ± 1.3 ng/L and post-load: 3.4 ± 0.9 ng/L, normal reference range: 2.5–8 ng/L) (Table 3).

Discussion

Hyponatremia is the most common electrolyte disorder in the elderly, especially in institutionalized elderly.[1–5] The etiology of hyponatremia among the elderly is complex and the unclear relationship between ADH secretion and advancing age makes this phenomenon even more complicated.[6–10] Miller et al[13] reported that 78.3% of hyponatremia cases among nursing home residents were caused by SIADH. However, only 37.5% of hyponatremia cases in this study were attributed to SIADH. Clinically, SIADH is primarily diagnosed by the presence of the hypo-osmolar state (serum osmolality < 275 mmol/kg H_2O) with inappropriate urine response (urine osmolality > 100 mmol/kg/H_2O), but reset osmostat shares similar presentations.

Table 1. Comparisons of elderly residents with and without hyponatremia among 2 private long-term care facilities

	Hyponatremic (n = 16)	Normonatremic (n = 46)	p value
Age, yr	76.2 ± 8.2	76.7 ± 8.9	0.84
Male, %	75.0	60.9	0.30
Hemoglobin at hyponatremia, g/dL	12.7 ± 1.7	12.8 ± 1.5	0.89
Hemoglobin 6 months after hyponatremic episodes, g/dL	12.3 ± 2.1	12.9 ± 1.7	0.32
Serum albumin at hyponatremia, mg/dL	3.8 ± 0.4	3.8 ± 0.3	0.66
Serum albumin 6 months after hyponatremic episodes, mg/dL	3.7 ± 0.4	3.8 ± 0.3	0.58
Serum total cholesterol at hyponatremia, mg/dL	166.9 ± 30.5	190.2 ± 38.2	0.016
Serum total cholesterol 6 months after hyponatremic episodes, mg/dL	153.6 ± 29.4	182.8 ± 35.5	0.003
Body mass index (BMI) at hyponatremia, kg/m^2	19.1 ± 3.2	20.5 ± 4.0	0.16
BMI 6 months after hyponatremic episodes, kg/m^2	18.5 ± 3.2	20.8 ± 4.2	0.027
Body weight loss, %/6 months	3.0	0.8	0.25

Table 2. Results of water loading tests among 16 nursing home residents with euvolemic hyponatremia

Case no.	Body weight (kg)	Urine Na (mEq/L)	Urine K (mEq/L)	Urine Cl (mEq/L)	Urine excretion rate (mL/h)	Urine osmolality < 100 mmol/kg H_2O	Water excretion >65 % at 4th hour	Results
1	62.6	10	15	37	112.5	+	–	SIADH
2	76.4	62	21	73	347.8	–	–	SIADH
3	64.8	33	7	21	138.0	+	–	SIADH
4	48.8	76	39	108	277.5	–	–	SIADH
5	51.4	95	30	92	272.5	–	+	Reset
6	45.3	31	18	37	157.0	–	+	Reset
7	47.5	54	13	41	206.8	–	+	Reset
8	40.2	67	17	76	200.3	–	+	Reset
9	42.0	67	12	79	181.0	–	+	Reset
10	50.9	29	14	32	145.3	–	+	Reset
11	52.4	51	24	70	177.0	–	+	Reset
12	50.4	50	11	49	119.0	–	+	Reset
13	47.3	37	11	10	155.8	–	+	Reset
14	47.0	68	19	57	230.5	–	–	SIADH
15	43.5	20	16	10	108.5	+	+	Reset
16	58.3	75	25	85	245.3	–	–	SIADH

Reset = reset osmostat; SIADH = syndrome of inappropriate antidiuretic hormone secretion.

Table 3. Comparisons of serum sodium and antidiuretic hormone (ADH) among hyponatremic subjects before and after water loading tests

Case no.	Pre-load serum sodium (mEq/mL)	Post-load serum sodium (mEq/mL)	Pre-load serum ADH (ng/L)	Post-load serum ADH (ng/L)	Results
1	131	134	2.5	3.0	SIADH
2	131	132	2.8	4.2	SIADH
3	134	131	8.0	4.4	SIADH
4	132	132	3.6	3.2	SIADH
5	133	124	3.2	3.7	Reset
6	129	127	4.9	3.3	Reset
7	129	128	3.3	5.4	Reset
8	129	128	3.5	3.8	Reset
9	123	127	3.3	3.5	Reset
10	131	130	2.7	2.7	Reset
11	121	124	3.8	3.6	Reset
12	128	132	3.1	3.4	Reset
13	123	138	3.7	2.1	Reset
14	134	130	3.5	2.0	SIADH
15	124	131	2.9	3.5	Reset
16	132	126	3.5	2.2	SIADH

Reset = reset osmostat; SIADH = syndrome of inappropriate antidiuretic hormone secretion.

The critical difference between them is that reset osmostat preserves the ability of water excretion, which can be documented by the water loading test. Preservation of water excretion is the vital feature of reset osmostat, therefore, subjects who did not excrete more than 65% loaded water in 4 hours were considered SIADH with or without the presence of inappropriate urine response to water loading. Serum sodium levels among subjects with reset osmostat fluctuates in a lower-than-normal range, so the fluctuating prevalence of hyponatremia (15.0–28.4%) in this study just reflects the nature of reset osmostat.

Both SIADH and reset osmostat are common complications in patients with CNS disorders, and they share some similar clinical characteristics. In spite of these similarities, the treatment of SIADH and reset osmostat is completely different. As indicated, SIADH plays a critical role in hyponatremia among residents in LTCFs, and water restriction should be performed extensively across institutes. However, to our knowledge, reports confirming the success of water restriction in LTCFs are lacking. We have several reasons to believe reset osmostat to be the major etiology of hyponatremia among the institutionalized elderly. First, none of the study subjects demonstrated symptoms of hyponatremia, which is a vital feature of reset osmostat. Second, without particular intervention like fluid restriction or sodium supplementation, only 4 individuals (all were diagnosed as having SIADH by water loading tests) maintained persistent hyponatremia during the 6-month follow-up period. Third, serum sodium levels fluctuating from normal to mildly subnormal levels is a feature of reset osmostat. Finally, no significant changes in serum ADH levels were noted despite a large amount of water loaded.

Hyponatremia was found to be related to lower BMI among the institutionalized elderly, implying a possible association between hyponatremia and undernutrition.[21] However, the relationship between hyponatremia and nutritional status is far more complex than it appears. The mutual presence of lower BMI and hyponatremia can result from inappropriate fluid intake, instead of undernutrition. In this study, after exclusion of clinically dehydrated or overhydrated states, we found no consistent association between hyponatremia and undernutrition. BMI, a common nutritional marker, was significantly lower in hyponatremic subjects 6 months following the episodes, while it was similar between groups during hyponatremic episodes. Moreover, serum levels of total cholesterol, another nutritional marker, were significantly lower during hyponatremic episodes than 6 months later. On the contrary, another 2 commonly used nutritional markers in LTC, hemoglobin and serum albumin, showed no difference between hyponatremic and normonatremic subjects during hyponatremic episodes and during the follow-up period. The association of hyponatremia with undernutrition was not universally seen in this study, and further investigations are needed to provide conclusive information.

In conclusion, hyponatremia among the institutionalized elderly in Taiwan was as common as in previous reports from western countries. Unlike previous reports, reset osmostat instead of SIADH explained most of the euvolemic hyponatremia among the institutionalized elderly. Hyponatremia as a nutritional marker deserves further investigation.

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