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Is Admission Serum Sodium Concentration a Clinical Predictor for the Outcome of Therapy in Critically Ill Poisoned Patients?

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ABSTRACT

Background: Disorders of serum sodium concentration are some of the most electrolyte abnormalities in the intensive care unit (ICU) patients. These disorders adversely affect the function of vital organs and are associated with increased hospital mortality. **Purpose:** In the present study we aimed to evaluate the effects of serum sodium concentration abnormalities at the time of hospital admission on the clinical outcome of therapy in a cohort of critically ill poisoned patients. **Methods:** In this cross-sectional study, 184 critically ill poisoned patients aged >18 years and in the first 8 hours of their poisoning, hospitalized in the ICU of a tertiary care university hospital (Isfahan, Iran) between 2010-2012, were evaluated at the admission time and 24 hours later for serum sodium concentration abnormalities and its relationship with age, gender, consciousness status, ingested drugs and clinical outcome of therapy. The clinical outcome was considered as recovery and mortality. Logistic Regression analysis was performed for predictive variables including serum sodium concentration abnormalities in patients' clinical outcome. **Findings:** On admission, 152 patients (82.6%) were eunatremic, 21 patients (11.4%) were hyponatremic and 11 patients (6%) were hypernatremic. In the second day eunatremia, hyponatremia and hypernatremia was observed in 84.4%, 13% and 2.2% respectively. Age (OR=1.92; CI=1.18-3.12) and severity of toxicity (OR=1.32; CI=1.12-2.41) were predicting factors of mortality in ICU poisoning patients. **Conclusions:** Serum sodium concentration abnormalities are prevalent in critically ill poisoned patient but do not seem to have a predictive value for the clinical outcome of therapy.

Key words: hyponatremia, hypernatremia, poisoning, ICU.

1. INTRODUCTION

Disorders of serum sodium concentration are some of the most electrolyte abnormalities in critically ill poisoned patients (1). These disorders adversely affect the function of vital organs and are associated with increased hospital mortality (2).

Hyponatremia is caused by sodium loss or water retention (due to congestive heart failure, inadequate secretion of antidiuretic hormone, polydipsia, renal failure and liver failure) or both of them (3). Hyponatremia may present with decrease of blood osmolality, muscle cramp, fatigue, nausea, vomiting, and spasm and headache. Signs and symptoms related to brain edema include convulsion, delusion, loss of consciousness and coma (4). Hypernatremia is another electrolyte abnormality with less prev-

alence than hyponatremia (5). This disorder is caused by water loss from kidney or GI, thirst disturbance and inappropriate treatment with hypertonic liquids or diuretics (6, 7). This disorder occurs in 6-26% of patients in hospitalization period in ICU and associates with increased mortality (8, 9).

Both hypo and hypernatremia are also seen in poisoned patients (10). Toxicity with cathartics, lithium, sodium chloride, sodium bicarbonate and sodium valproate cause hypernatremia (11-13). Hypernatremia also has been reported on poisoning with chlorpropamide, ecstasy, phenothiazines and amitriptyline (12, 14, and 15). Consumption of drugs such trazodon and ecstasy are associated with hyponatremia with their effect on antidiuretic hormone (16, 17).

Studies about possible related factors with serum sodium concentration abnormalities in poisonings are limited. Rosenson and coworkers in evaluation of 1436 case of ecstasy poisoning found that hyponatremia is more common in females (16). Carbamazepine also can cause hyponatremia, although its effect is weak alone and factors such as age (more than 40 years), surgery and menstruation are related with increasing in its prevalence (18).

Some studies have been previously done on serum sodium concentration abnormalities in the intensive care unit (ICU) patients with other etiologies (1, 2, 19-22), but study of these abnormalities and their effect on prognosis in poisoned patients have not been done. Poisoned patients don't have underlying disease mostly. In addition to kind of ingested drugs, factors such as vomiting, gastric lavage and treatment (alkaline diuresis) are also important in occurrence of serum sodium concentration disorders. The aim of present study was evaluation of the effect of serum sodium concentration abnormalities at the time of hospital admission on the clinical outcome of therapy in a cohort of critically ill poisoned patients in a tertiary care referral university hospital in Iran.

2. MATERIALS AND METHODS

This cross-sectional study was done in the department of toxicological emergencies of Noor and Ali-Asghar [PBUH] University hospital affiliated to the Isfahan University of Medical Sciences, Isfahan from September 2010 to June 2012. This center which is the major referral medical center for toxicological emergencies for the central part of Iran, is facilitated, staffed and designed for the management of poisoned patients and approximately 400 poisoned patients are admitted to it monthly.

The study protocol was approved by the institutional board of human studies at Isfahan University of Medical Sciences. In addition, after the study was accurately explained to each patient, informed consent was taken from them for inclusion to this study. If the patient was not able or had not the capacity for decision making, informed consent for inclusion to this study were taken from the patients' first degree family.

All patients aged more than 18 years old admitted in the first 8 hour of poisoning during the time period of the study were recruited. Patients with SIADH or cancer and patients whom were referred from other hospitals to our center were not included in the study.

On ICU admission, venous blood sampling was taken for determining sodium level and also 24 hours later as well as other routine para-clinical tests. Vital signs and clinical manifestations were recorded for all patients. Age, ingested drugs, vomiting after poisoning, performing gastric lavage/ charcoal administration, alkaline diuresis, poisoning severity score (23), and consciousness status were investigated and recorded at the time of ICU admission as well. Outcome of patients were considered as recovery or death.

Patients were categorized in three groups based on their serum sodium level at the time of ICU admission (1) as: 1. hyponatremic: $\text{Na} < 135 \text{ meq/L}$ 2. eunatremic: $135 < \text{Na} < 145$ 3. hypernatremic: $\text{Na} > 145 \text{ meq/L}$.

Statistical analysis of data was performed by chi-square or fisher exact test for comparing of serum sodium concentration abnormalities based on age, sex, and vomiting after poisoning. Wilcoxon signed ranks was used to compare serum sodium level on admission day and 24 hours later.

Also logistic regression analysis was used for investigating role of different variables on patients' outcome. P value less than 0.05 was considered as statistically significant difference between groups. All analyses were performed by SPSS 16 (SPSS Inc., Chicago, IL, USA).

3. RESULTS

According to the inclusion criteria, 184 patients were completely evaluated. Patients aged from 18 to 90 years (mean SD: 33.514.3). 51.1% of the patients were male. The most common cause of poisoning was opiate toxicity (25%). (Table1).

Variable	Number (%)	
Age (year)	≤ 25	55 (29.9)
	26-34	76 (41.3)
	35-44	20 (10.9)
	≥ 45	33 (17.9)
Gender	Male	94 (51.1)
	Female	90 (48.9)
Serum sodium concentration status	Hyponatremia	21 (11.4)
	Eunatremia	152 (82.6)
	Hypernatremia	11 (6)

Table 1. Clinical and demographic characteristics of the studied patients at the time of admission (n=184)

Mean serum sodium level was 138.1 (SD=14.9) on admission. 82.6% patients were eunatremic, 11.4% hyponatremic and 6% hypernatremic. 24 hours after admission, mean serum sodium level was 135.2 (SD=14.3) with prevalence of eunatremia 84.4%, hypernatremia 2.2% and hyponatremia 13%. Although there was a statistically significant difference between mean sodium value on first and second admission day (P value<0.001) the frequency of sodium concentration status (hyponatremia, hypernatremia and eunatremia) were not significantly different on different days (p=0.47).

There were no statistically significant difference between the frequency of serum sodium concentration abnormalities on the first and second day between men and women (p>0.05). Patients were categorized in four age groups (25, 26-35, 36-45, >45 years) for sub analysis and there was no significant difference in the frequency of serum sodium concentration abnormalities on the first and second day in these age groups (p>0.05).

Table 2 has illustrated sodium concentration status based on the ingested drugs, severity of toxicity, level of consciousness, vomiting after toxicity, alkaline diuresis and gastric lavage. There was no statistically significant difference on the first and second measurements in these groups (p>0.05).

From 184 patients in poisoning ICU, 24 patients (13%) were died. In this population 5 (20.8%) were hyponatremic, 3 (12.5%) hypernatremic and 16 (66.7%) eunatremic.

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Variables	Na<135 meq/L	135<Na<145 meq/L	Na>145 meq/L	P value
Age (year)	≤ 25	4(19%)	47(31.1%)	0.17
	26-34	7(33.3%)	66(43.7%)	
	35-44	3(14.2%)	16(10.6%)	
	≥ 45	7(33.3%)	22(14.6%)	
gender	male	10(48%)	79(52%)	0.87
	female	11(52%)	73(48%)	
Ingested drugs	Opioids	6(28.6%)	38(25.2%)	0.82
	Psychiatric drugs	7(33.3%)	42(27.8%)	
	Anticonvulsant	1(4.8%)	12(7.9%)	
	insecticide and herbicide	4(19%)	21(13.9%)	
	Combination of drugs	3(14.3%)	38(25.2%)	
Poisoning severity score	mild	4(19%)	33(21.7%)	0.37
	moderate	7(33.3%)	54(35.5%)	
	severe	10(47.7%)	65(42.8%)	
Level of Consciousness	alert	5(23.8%)	17(11.2%)	0.12
	lethargic	5(23.8%)	34(22.4%)	
	stupor	0(0%)	26(17.1%)	
	coma	11(52.4%)	75(49.3%)	
Therapeutic measures	Without gastric lavage	7(33.3%)	38(25.2%)	0.98
	Gastric lavage	6(28.6%)	43(28.5%)	
	Gastric lavage+ charcoal	8(38.1%)	65(43%)	
	Charcoal only	0(0%)	0(0%)	
Vomiting	Yes	3(15%)	30(19.9%)	0.71
	No	17(85%)	121(80.1%)	
alkaline diuresis	Yes	8(38.1%)	43(28.3%)	0.68
	No	13(61.9%)	109(71.7%)	

Table 2. Serum Sodium (Na⁺) concentration status based on clinical and demographic characteristics of patients (n=184). Results are presented as frequency of patients (and percent).

There was a statically significant difference in mortality based on the ingested drugs (p=0.004).

Outcome was considered as recovery and death. In logistic regression analysis, age (OR=1.92 ; CI=1.18-3.12) and severity of toxicity (mild, moderate, and severe based on poisoning severity score) (OR=1.32 ; CI=1.12-2.41) were predictors of mortality. (Table 3)

Variables	OR	95% CI	P value
Age	1.92	1.18-3.12	0.008
Ingested drugs	0.93	0.79-1.06	0.276
Poisoning Severity	1.32	1.12-2.41	0.024
Gastric lavage	1.03	0.57-1.85	0.92
Level of Consciousness	1.54	0.25-1.15	0.11
Serum Sodium concentration status	1.03	0.92-1.51	0.57

Table 3. Predicting factors for patients' outcome (n=184)

4. DISCUSSION

In this study we have evaluated the effect of serum sodium concentration abnormalities on the outcome of therapy in critically ill poisoned patients in the first and second days of hospitalization. Frequency of hyponatremia and hypernatremia were 11.4% and 6% respectively on admission that hypernatremia decreases to 2.2% in the second day. Serum level of sodium in ICU patients has been reported differently in previous studies with different causes of hospitalization. Stelfox and his colleagues studied

sodium level in post cardiac surgery ICU patients. In their study prevalence of hyponatremia was 12% and hypernatremia was 4% (24). The frequency of occurrence of hypernatremia in ICU patients was also 5.7% in a study by Polderman (20). Aiyagari evaluated patients of neurologic ICU and the frequency of hypernatremia was 7.9% (25). In another research was done in France, hyponatremia has been seen in 14% of ICU patients (26%). However, in another study investigated ICU patients, frequency of hyponatremia and hypernatremia was 60.5% and 39.5% respectively (27). These differences may be due to the various etiology and clinical status of critically ill patients hospitalized in different types of ICUs. We studied only poisoning cases while the others determined serum sodium level abnormalities in all patients hospitalized in ICU with different reasons. Hyponatremia occurs due to water retention in dysfunction of organs such as kidney (3) and commonly may be seen in up to 30-40% of ICU patients (28). meanwhile underlying kidney and liver diseases are not common in critically ill poisoned ICU patients and altered electrolyte balance due to toxicity are usually transient. Hence the prevalence of serum sodium concentration abnormalities in this group of patients may be anticipated less than others.

In our study, there was not any statistical difference in the frequency of serum sodium concentration abnormalities based on age and gender or their subgroups. However, in an Austrian study on ICU patients for 10 years, it is reported that older age and male gender in patients with serum sodium concentration abnormalities were risk factors for increased mortality (2). We also found age as a predicting factor in mortality in ICU poisoning patients.

The highest mortality rates were in critically patients with herbicide and opiate toxicity. Herbicide toxicity has been associated with higher mortality rates in other studies as well (29, 30). Increased mortality in opiate toxicity may be due to the respiratory insufficiency which is previously been described elsewhere (31-35). This is while the statistical analysis of our results does not support that the type of the ingested drug is a predictive factor in mortality of our critically ill poisoned patients.

In our study age and severity of toxicity were predictors of mortality for the poisoned ICU patients which is consistent with a previous Turkish report in a quite similar medical setting (36).

Although many studies have confirmed increased mortality in critically ICU patients with hypernatremia (9, 37) in our study serum sodium concentration abnormalities were not related to increased mortality of the patients. It may be due to the differences in demographic and clinical characteristics of our cases. Usually most of the poisoning cases have not previous history of underlying diseases such as kidney and liver disease and the effects of toxin in these organs are temporary which could be managed successfully.

Our findings showed that serum sodium concentration abnormalities do not seem to be predictive factors for mortality and clinical outcome of therapy in our study and mortality was observed more in patients with eunatremia.

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Authors' contribution

AMS, NEM, FS and AY contributed in designing and conducting the study. HH collected the data. ZF, helped in data analysis. NEM and AMS rechecked the statistical analysis and prepared the manuscript. All authors have assisted in preparation of the manuscript and have read and approved the content of the manuscript and are accountable for all aspects of the work.

CONFLICT OF INTEREST: NONE DECLARED.

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