



Case report

Fatal hyponatremia due to drinking a large quantity of shoyu (Japanese soy sauce)

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ABSTRACT

We report a case of fatal salt poisoning in a 55-year-old woman who suffered from depression and drank a large quantity of shoyu (Japanese soy sauce). She presented with the highest ever documented serum sodium level of 187 mmol/L. This was associated with symptoms of cerebral damage which developed within hours after drinking the soy sauce. She died as a result of massive pulmonary edema, despite intensive medical treatment. Viewing the results of clinical and postmortem investigations together, her death could clearly be attributed to drinking a large quantity of soy sauce.

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1. Introduction

Hyponatremia is defined as a plasma sodium (Na^+) level of greater than 145 mmol/L and represents a state of hyperosmolarity. Hyponatremia may be caused by water deficit or a primary Na^+ gain. Hyponatremia due to water deficit accounts for the majority of cases of hyponatremia. Hyponatremia due to Na^+ gain occurs infrequently. This is most commonly seen in patients with diabetic ketoacidosis (DKA) and an osmotic diuresis treated with isotonic saline. Inadvertent administration of hypertonic NaCl can lead to hyponatremia.

It has been long-known that ingesting a great amount of salt is toxic. Saturated salt solutions are used as a traditional suicide method. We report a fatal case of severe hyponatremia (187 mmol/L) caused by drinking a large quantity of soy sauce.

2. Case report

A 55-year-old woman had a diagnosis of depression for 11 years. Her family doctor initiated antidepressive treatment. She was found lying on the floor with dark brown vomit around her mouth. A bottle of soy sauce was on a desk in her room (Fig. 1). She had consumed approximately 700 ml of soy sauce (approximately 75 g of salt or 1300 mEq of sodium). Her caretaker took her to the hospital. She was

deeply unconscious on arrival to the emergency department. She had a blood pressure of 100/40; respiratory rate, 40 breaths/min; heart rate, 128 beats/min; and temperature, 36.3 °C. The estimated Glasgow coma scale score was 6. Her breathing was shallow and rapid. Pulmonary, cardiac, and abdominal examinations were normal.

The only available biological laboratory data were obtained at the moment of admission. These data showed the following values: serum sodium level of 187 mmol/L; chloride level of greater than 150 mmol/L; potassium level, 4.5 mmol/L; blood pH, 7.101; pO_2 , 158.5 mmHg; pCO_2 , 21.8 mmHg; standard bicarbonate level, 6.6 mmol/L of plasma; and base excess, -21.2 mmol/L of blood. The complete blood count and the rest of the biochemistry results were within normal range. The clinical examination of the lung fields revealed massive pulmonary edema that was confirmed by X-ray. A head computed tomography (CT) scan revealed a subarachnoid hemorrhage (SAH).

Over the following hours, she suffered seizures and became more and more sleepy. She was intubated and admitted to the intensive care unit (ICU). Despite full intensive treatment and aggressive isotonic sodium chloride fluid resuscitation, the patient rapidly deteriorated and died 12 h after arrival.

3. Autopsy findings

She weighed 67.2 kg. The brain weighed 1320 g and brain edema was noted. Examination of the brain showed subarachnoid blood accumulation but did not show intracerebral blood accumulation. The

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Fig. 1. Japanese soy sauce (shoyu) was on the desk.

heart weighed 260 g and retained moderately dark-red blood. The left and right lungs weighed 640 g and 880 g, respectively. The lungs were moderately edematous and both lower lobes were intensely congested. The esophageal mucosa was red-brown. There were no remarkable changes in her other organs. Flurazepam hydrochloride was present in the urine; however, the drug was not detected in the gastric contents or the serum extract. The concentration of flurazepam hydrochloride in the urine was 1.88 µg/ml. Other drugs were not detected in the serum, gastric contents, or urine.

4. Discussion

It has been well documented that as little as two tablespoons of salt (30 g) can rapidly elevate the serum sodium concentration by as much as 30 mEq, depending on body weight.^{1,2} Our patient had been ordered to ingest large amounts of sodium. This resulted in the development of severe hypernatremia (187 mmol/L) and lead consequently to her death.

One thousand ml of shoyu contains 107 g of sodium chloride. A lethal dose of salt has been estimated to be 0.75–3.0 g/kg of body weight.^{3–5} Seven hundred ml of shoyu contains 75 g of salt. This would be 1.1 g/kg of body weight in our patient since her body weight was 67.2 kg. This value could be enough to be a lethal dose of salt, according to the reference values. Hypernatremia is easily determined from laboratory tests. A surprisingly small amount of salt intake can result in a fatal outcome. Coe showed that the serum sodium level begins to decrease with the passage of time after death.⁶ We found that the patient's serum sodium level decreased after death because of postmortem hemolysis. Her blood sodium concentration was 154 mmol/L at death and was 139 mmol/L at autopsy.

Intracellular dehydration is the most important clinical sign of salt intoxication. It results from a shift of water from the

intracellular to the extracellular space. The brain volume usually decreases rapidly and seizures may occur. Evidence of hemorrhagic encephalopathy is usually observed along with subdural, subarachnoid, intraventricular, or intracerebral hemorrhage.⁵ But in this case, subarachnoid hemorrhage (SAH) due to hyperosmolarity of the blood volume was not the direct cause of death. Other than fatal hypernatremia, the postmortem examination did not find any pathological factors that could explain the patient's presentation and eventual death. The death was attributed to massive pulmonary edema associated with high osmolarity of the serum. All of these observations, we believe, are related to drinking a large quantity of soy sauce.

Patients very rarely survive acute salt intoxication with blood sodium levels above 175 mmol/L.⁷ The prognosis appears to be particularly poor in cases where hypernatremia develops within a short period of time.⁸ Fatal cases occur in the typical psychiatric context of psychosis and intoxication generally results from voluntary ingestion.

5. Conclusion

In the present case, the patient's death is attributable to massive pulmonary edema due to drinking a large quantity of soy sauce. We report the surprisingly small amount of salt that can cause severe hypernatremia.

Conflict of interest

A 55-year-old woman who drank a large quantity of shoyu (Japanese soy sauce), presented with the highest ever documented serum sodium level of 187 mmol/L. She died as a result of massive pulmonary edema despite intensive medical treatment.

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Ethical approval.

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