

# **Exercise Associated Hyponatremia (EAH)**

## **Background**

1. 2007 Second International Exercise-Associated Hyponatremia Consensus

Development Conference defines EAH as:

- Serum or plasma sodium below normal reference range of laboratory occurring during or up to 24 hours after prolonged physical activity

## **Pathophysiology**

1. EAH -dilutional hyponatremia

- Increase in total body water relative to amount of total body exchangeable Na
- Major risk factor:
  - High rate of fluid consumption during/after exercise
- Hyponatremia significantly associated with weight gain during Boston marathon
  - Correlated with excessive fluid intake
- Arginine vasopressin (AVP) secretion is exacerbating factor in most cases
- During exercise, plasma AVP levels not maximally suppressed
  - Suggests non-osmotically stimulated AVP secretion
  - With hyponatremia and/or hypervolemia, plasma AVP levels within "normal ranges" are physiologically inappropriate
  - Under these conditions, AVP should be maximally suppressed
- Pathophysiology similar to SIADH

2. Incidence, prevalence

- 2002 Boston Marathon
  - 13% had hyponatremia (defined as a serum sodium concentration  $\leq 135$  mEq/L)
  - 3 runners (0.6%) had critical hyponatremia (serum sodium concentration  $\leq 120$  mEq/L) <sup>2</sup>
- Incidence of hyponatremia is variable in other studies:
  - 0-2% and 7-18% in ultra distance triathlon

3. Risk factors:

- Low body weight
- Female sex
  - Due to lower body mass
- Exercise duration  $>4$  hr
- Slow running or performance pace
- Race inexperience
- Excessive drinking behavior
- High availability of drinking fluids
- Impairment by drugs
  - NSAIDs
  - SSRIs
  - Thiazides
- Extreme hot or cold environment

- Medical factors
  - History of SIADH
  - Intrinsic renal disease
- 4. Mortality:
  - Exact incidence not known-likely low

## **Diagnostics**

### 1. History

- Endurance athlete finishing athletic event with a wide range of symptoms
- Nonspecific complaints:
  - Fatigue, headache, dizziness, bloating and nausea and/or vomiting
  - Many of these symptoms can also be present after prolonged exercise in absence of EAH
- Severe manifestations:
  - Altered mental status, seizures, coma, respiratory distress, death
    - Death usually related to cerebral edema

### 2. Physical exam

- Due to nonspecific clinical symptoms and potential for life-threatening consequences, it is recommended that medical facilities at endurance events have capability for onsite analysis of serum or plasma sodium <sup>3</sup>
- Physical exam should be directed at signs and symptoms of EAH
  - Focused neurological and pulmonary exam is indicated
- Lower serum sodium usually associated with more neurological signs and symptoms

### 3. Diagnostic testing

- Laboratory evaluation
  - Symptomatic athletes should have a serum sodium measured
  - Pre and post weights should be compared
- Diagnostic imaging
  - Patients with neurological impairment need emergent brain imaging for cerebral edema
    - Head CT: initial test for cerebral edema

### 4. Diagnostic criteria

- Signs and symptoms develop when sodium falls below 135 mEq/L
  - Typically symptoms more severe with lower sodium
- Serum sodium not always a reliable predictor of clinical severity
  - Due to individual variability
- Sodium 130-134 mEq/L relatively asymptomatic
- Symptomatic hyponatremia usually occurs when rate of sodium decreases 7-10 % within 24 hr

## **Differential Diagnosis**

### 1. If athlete is unresponsive:

- Exercise-related disorder
- Heat Stroke
- Severe hypoglycemia

- Non-exercise related disorders:
  - Cardiac arrest
  - Grand mal epilepsy
  - Subarachnoid hemorrhage
  - Diabetic coma
- 2. If athlete is asymptomatic:
  - Heat exhaustion
  - Hypoglycemia
  - Fatigue
  - Infection
  - Deconditioning

## **Therapeutics**

### 1. Acute treatment

- Athletes with low serum sodium and mild-moderate symptoms (SOR:C)<sup>3</sup>
  - Fluid restriction
  - Observation until onset of spontaneous diuresis
- Athletes with hyponatremic encephalopathy-seizures, confusion, coma or other neurologic symptoms
  - Arrange for EMS transport
  - Establish IV access
  - If plasma or serum sodium cannot be measured immediately treat with 100 mL of 3% saline bolus
  - Administer high-flow oxygen
  - If neurologic symptoms persist or worsen prior to arrival at the hospital:
    - 100 mL bolus of 3% saline can be repeated for up to two additional bolus infusions at 10 minute intervals

### 2. Further management (24 hrs)

- Symptomatic patients should be transported to medical center where serum sodium and neurologic status can be closely monitored
- Do not delay treatment of hyponatremia while waiting for results of diagnostic imaging tests
- Avoid isotonic or hypotonic fluids (except if indicated in ACLS protocols)
  - May worsen hyponatremia and fluid overload
- If symptomatic EAH persists or worsens despite appropriate treatment
  - Treat with current acute symptomatic hyponatremia guidelines
  - ICU setting
  - Appropriate specialist consultation
- Hypertonic saline should be discontinued as soon as neurologic symptoms resolve
- There are no reported cases of osmotic demyelination in EAH<sup>5</sup>

### 3. Long-term care

- Hospitalize athlete until symptoms have resolved
- Educate athlete on how to prevent future episodes of EAH

## **Follow-Up**

1. Return to play
  - In mild cases, activity can resume few days after completing educational session on preventing EAH
2. Admit to hospital
  - For symptomatic EAH
  - For mild EAH symptoms that do not resolve with spontaneous diuresis

## **Prognosis**

1. In case reports all patients who received hypertonic saline survived
2. Deaths reported in literature were athletes who failed to receive hypertonic saline

## **Prevention**

1. Endurance athletes should drink according to thirst during the race (SOR:C)<sup>3</sup>
2. Onsite analysis of serum or plasma sodium should be available at endurance events
  - Can use portable device: i-STAT
  - Should have hypertonic saline available
3. Limit excessive water intake with fewer water stations
  - Every 5 km in marathons
  - In triathlons every 2.5 km while running, every 20 km while cycling
4. Insufficient evidence that ingestion of sodium prevents or decreases risk of EAH
5. Consumption of carbohydrate/electrolyte containing sports drink does not provide much protection
6. Pre-race weights should be recorded by race staff
  - Should be easily accessed by medical personnel
7. Race and medical directors should be educated on dangers of EAH

## **Patient Education**

1. Endurance athletes should be educated about:
  - Dangers of over hydration
    - Goal should be weight loss of up to 2% during exercise-not more
  - Risk factors for EAH
  - Signs and symptoms of EAH
  - Need to seek immediate medical attention if have any signs and symptoms of EAH

## **References**

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