

Hydration in Athletes

Background

1. Dehydration
 - >2% body weight loss from water deficit
2. Hyponatremia
 - Lower than normal concentration of sodium in blood
3. Euhydration
 - Normal body water content
4. Overview of hydration during exercise/sports:
 - Fluid replacement before, during and after sporting events/exercise is important for sustaining exercise performance and preventing morbidity (SOR:A)
5. For more information:
 - Mayo Clinic-Dehydration: <http://www.mayoclinic.com/health/dehydration/ds00561>
 - Gatorade Sports Science Institute: <http://www.gssiweb.com/>

Pathophysiology

1. Pathology
 - Multiple factors influence sweat losses
 - Duration/intensity of exercise
 - Environment
 - Hot weather requires increased sweating: (SOR:A)
 - Dissipates metabolic energy
 - Avoids heat storage
 - Cooler environments:
 - Allow greater dry heat loss
 - Require lower sweating rates
 - Individual variation
 - Biochemistry of dehydration
 - Renin-angiotensin-aldosterone system regulates sodium retention
 - Vasopressin (anti-diuretic hormone ADH):
 - Regulates water retention in kidneys
 - Assists with thermoregulation
 - Atrial natriuretic peptide (ANP) secreted by the heart participates in water balance regulation
 - Daily water balance factors
 - Oral intake
 - Metabolic water produced 0.13 g/kcal
 - Respiratory water losses 0.12 g/kcal
 - Gastrointestinal tract losses 100-200 ml/day (excluding diarrhea)
 - Urine output:
 - Minimum 20 ml/hr
 - Maximum 1000 ml/hr
 - Total body water (TBW):
 - 60% of body mass (range 45-75%)
 - 70-kg person - approx 42 L of TBW

2. Incidence, prevalence

- Based on specific activity and individual metabolic variability
- Less incidence of dehydration:
 - Swimming, netball, water polo, female tennis
 - Intermediate incidence of dehydration
 - Male tennis, basketball
- Higher incidence of dehydration
 - Marathon/cross country running, ironman training/races, American football, soccer, rowing

3. Risk factors

- Dehydration
 - Poor oral hydration
 - Diuretic use
 - Alcohol consumption (SOR:B)
 - Vomiting/diarrhea
- Exercise associated hyponatremia
 - Over drinking of fluids relative to sweat rate
 - Inability to excrete relative fluid excess
 - During exercise
 - In initial recovery period
 - Fluid replacement with water or electrolyte-poor beverages
 - Leads to dilution of plasma sodium
 - Participation in endurance events
- Age Related Variability
 - Older adults
 - Have age related decreased thirst sensitivity when dehydrated making them slower to voluntarily reestablish euhydration (SOR:A)
 - Have age related slower renal responses to water and may be at greater risk for hyponatremia (SOR:A)
 - Children
 - Have lower sweating rates than adults (SOR:B)

4. Morbidity / mortality

- Dehydration-decrease in athletic performance (SOR:A)
 - Low blood volume
 - Reduced thermoregulation
 - Decreased cognitive function (SOR:B)
 - Reduced gastric emptying
 - Worse in hot weather (SOR:A)
- Heat stroke: (SOR:B)
 - Core body temp >104°F (40°C)
 - Hot dry skin
 - CNS abnormalities:
 - Delirium
 - Convulsions
 - Coma
 - Dehydration present in 17% of all heat stroke hospitalizations in U.S. Army

- Dehydration and vomiting may be associated with development of heat stroke (SOR:A)
- Skeletal muscle cramps (SOR:B)
- Rhabdomyolysis (SOR:B)
 - Release of skeletal muscle contents
 - Serum creatinine kinase >10 times normal
- Acute renal failure
- Exercise associated hyponatremia (SOR:A)
 - Sx occur with rapid plasma Na drop below 130 mmol/L
 - The lower plasma Na drops, the faster it continues to drop
 - Remains low longer
 - Increased risk for:
 - Dilutional encephalopathy
 - Pulmonary edema
 - Sx include:
 - Headache, vomiting, swollen hands and feet, restlessness, undue fatigue, confusion, disorientation, wheezing
 - Sx associated with plasma Na <120 include:
 - Seizure, coma, brainstem herniation, respiratory arrest, death

Diagnosics

1. History

- Symptoms
 - Fatigue, muscle cramps, hypotension
- Questions to ask
 - Fluid intake pre, during, post exercise
 - Fluid type: water, sports drink
 - Diuretic use
 - Alcohol consumption
 - Duration of exertion
 - Nausea/vomiting
 - Recent diarrhea
 - Recent bleeding/heavy menses

2. Physical exam

- Assess skin turgor
- Assess skin for presence of sweat
- Weight
- Mucous membranes-hydration assessment
- Vital signs
- Mental status

3. Diagnostic testing

- Hydration biomarkers (urine and body weight)
 - Urine Specific Gravity of =1.020
 - Indicates euhydration
 - Am I Hydrated? Urine Color Chart:
 - <http://www.rte.ie/tv/useitorloseit/hydration.pdf>
 - Urine osmolality
 - More variability
 - Values < 700 mOsmol/kg indicate euhydration

- Baseline body weight for euhydration
 - First morning, post void, nude, body weight, taken over three consecutive days (SOR:B)
- Laboratory evaluation
 - Electrolytes
 - Blood sugar
 - Urinalysis
 - BUN/Creatinine

Differential Diagnosis

1. Key DDx

- Fatigue
- Deconditioning
- Anemia
- Disruption of renin-angiotensin-aldosterone system
 - Kidney disease
 - Congestive Heart Failure
 - Previous MI
 - Medications
 - ACE inhibitors
 - AII receptor blockers
 - Aldosterone receptor blocker

2. Extensive DDx

- Gastroenteritis
- Diabetes

Therapeutics

1. Acute treatment:

- Fluid replacement
- Hydration before exercise
 - Prehydration with fluids should be initiated several hours before exercise
 - Enables fluid absorption
 - Ensures normal urine output
 - Consume beverages with sodium, salted snacks or small meals with fluids
 - Can help stimulate thirst and retain needed fluid.
 - 500-600 ml of water or sports drink 3 hrs before exercise
 - 200-300 ml of water or sports drink 10-20 mins before exercise
- Hydration during exercise
 - Drink 0.4-0.8 L/hr
 - Use higher rate for faster, heavier individuals competing in warm environments
 - Football players
 - Use lower rates for slower, lighter persons competing in cooler environments
 - Marathon runners

- If exercise lasts >4 hours:
 - Consumption of electrolytes may reduce the risk of developing hyponatremia
- Prevent excess dehydration
 - >2% loss of body weight from water deficit
- Prevent significant changes in electrolyte balance
- Hydration after exercise
 - Consumption of normal meals and beverages will restore euhydration if time permits between exertional events (SOR:A)
 - Rapid recovery from excessive dehydration may require 1.5 L of fluid for each kilogram of body weight lost
 - Consuming fluids and snacks with sodium will stimulate thirst and fluid retention
 - IV fluid replacement may be warranted in individuals with severe dehydration (>7% body wt loss) with nausea, vomiting, or diarrhea, or inability to ingest oral fluid
- 2. Further management (24 hrs)
 - Inadequate hydration-most common
 - Patient education
 - If dehydration was due to other cause-should have further work-up
- 3. Long-term care
 - Consider customized fluid replacement program
 - Should prevent >2% body weight reduction from baseline during exercise
 - Increased body weight during exercise from drinking may increase risk for hyponatremia

Follow-Up

1. Return to office
 - Return visit
 - 2-4 weeks if treated appropriately and Sx resolved in acute period
 - Earlier follow-up
 - If Sx were significantly recurrent or debilitation was prolonged
 - If associated with co morbid condition (cardiovascular or renal) dz
2. Refer to specialist
 - If associated with previously undiagnosed underlying medical condition
 - If significant dehydration occurred in spite of proper hydration before, during and after exercise
3. Admit to hospital
 - If dehydration is present with significant cardiovascular or renal disease
 - If significant dehydration is present in extremes of age
 - Infants or elderly without the means to hydrate themselves

Prognosis

1. Good if treated appropriately and no underlying medical conditions

Prevention

1. Prehydration
2. Educate patient
 - Performance can decrease with dehydration (SOR:A)

3. Meal consumption is critical to ensure full hydration on a day-to-day basis (SOR:A)
4. Sweat and electrolyte losses should be fully replaced to reestablish euhydration after exercise

Patient Education

1. Hydration and Performance:
http://www.gssiweb.com/Article_List.aspx?topicid=1&subtopicid=102
2. Dehydration: <http://www.mayoclinic.com/health/dehydration/DS00561>
3. Counsel patient on risk factors and strategies for hydration pre, during and post exercise

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