**Hydration: From Lab Bench to Sideline Bench**

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**Outline**

- Physiology of water balance  
- Hydration and body temperature  
- Hydration assessment  
- Individualized hydration  
- Conclusions

**Body Fluid Balance**

**Terminology**

Hyperhydration  
Euvhydration  
Dehydration  
Hypohydration  
Rehydration

**Involuntary Dehydration**

![Graph showing the relationship between voluntary dehydration and sweating](image)

- Figure 11—Relation between gross sweating rates and voluntary dehydration in six groups of men (20–25 years) at heat (40°C and 70% RH), moderate (38°C, 50% RH), and high (40°C, 50% RH) sweating rates. The solid line indicates the fluid intake; 4-axial indicates fluid intake equals sweat loss.
Hypohydration and Body Temperature

- Peripheral/Skin blood flow decreases
- Sweat rate decreases
- Less evaporative cooling
- Temperature increases 0.15 – 0.20°C per % body mass loss

Field Study

Four 7.5 mile trials-randomized counter-balanced (ie. ½ DHY ½ HY):
- Trial 1: Race
- Trial 2: Sub-maximal
- Trial 3: Sub-maximal (pace feedback)
- Trial 4: Race

400ml of water given at 2.5 and 5 mile marks for HY group

• “...[Sports Medicine professionals] should be aware that core temperature is not necessarily associated with either percentage of dehydration or sweat rate”
“If athletes choose to consume caffeinated beverages, they need to balance this with equal amounts of non-caffeinated fluid.”

Ergogenicity of Caffeine

- Performance increased when 3-6mg/kg ingested prior to and every 30min during exercise
- Tested up to 9 mg/kg (That’s 630mg for me)
- Practice with this stuff

Caffeine

- Replacing caffeinated fluids post-practice
- Caffeine before and during exercise
- No differences in urine output
- Resting urine output (what’s in your bladder)

Hydration Assessment
What does that spot check mean?


Competitive Athletes

- Sweat rate assessment
  - Determine individual needs
  - Sweat rate varies from 0.5 – 3.9 L/hr
  - Dependent on a number of factors
- Sweat-electrolyte assessment

Individualized Hydration

- Consume fluids and electrolytes based on individual losses
- Should lose <2% body mass during exercise
  - Drink according to individual sweat rate
- Replace 125-150% of losses following exercise
  - For the novice: drink according to thirst
    - Avoids hyponatremia

Physically active are not so good

- On average, about 65-85% of athletes report to game or practice activities inadequately hydrated
  - NBA Study (78% dehydrated); Osterberg KL et al, JAT, 2009
  - Ice hockey players (>50% dehydrated); Palmer MS et al, Appl Physiol Nutr Metab, 2010
  - Youth football campers (>70% dehydrated); McDermott BP et al, JER, 2009
  - High School football players (65-85% dehydrated); Yeargin SW et al, JAT, 2010
- Replace ~66% of sweat losses during activity
Hydration & Performance

- What happens if athletes are pushed beyond and not allowed to tank it?
  - Overbearing coach, military, end of distance event, parents, teammates
- Decreased endurance exercise performance
- Decreased anaerobic performance

Hydration Assessment

- Urine color
- Urine specific gravity
- Urinary frequency
- Body mass changes

Urine Color

- Must be done in clear container or stream assessment
- Urine is always delayed
  - Indicative of 2 hours ago

Body Mass Changes

- 3-day euhydrated weight as baseline
- Can detect subtle changes in hydration
- Cannot use 1-day body mass as baseline


Conclusions

- Many student-athletes are dehydrated
- They are decent during activity, but not good outside of activity
- Hydration assessment is not difficult. Use multiple measures.

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How do measure hydration status?

- Stable isotope dilution
- Neutron activation analysis
- Bioelectrical impedance spectroscopy
- Body mass change
- Plasma/Serum osmolality
- ADH level
- Urine osmolality
- Urine specific gravity
- Urine conductivity
- Urine color
- 24-hour urine volume
- Salivary flow rate
- Rating of thirst

Classifying Hydration Status

(290 data points, 59 male test subjects) Data fit to normal curve

Delayed Thirst

- Weight
- Urine (color/frequency)
- Thirst


Classifying Hydration Status

<table>
<thead>
<tr>
<th>Extremly dehydrated</th>
<th>Slightly dehydrated</th>
<th>Well hydrated</th>
<th>Euhydrated</th>
<th>Slightly hypo</th>
<th>High hypo</th>
<th>Normal</th>
<th>Slightly hypo</th>
<th>Very hypo</th>
<th>Extremly hypo</th>
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### Methods of assessing hydration

Nude Body weight pre- and post

- 70 kg baseline
- 68 kg after exercise

\[ \frac{2}{70} \times 100 = 2.86\% \]

dehydrated