HYDRATION IN THE PEDIATRIC ATHLETE

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GOALS FOR TODAY

• UNDERSTAND THE VARIABLES THAT MAKE HYDRATION RECOMMENDATIONS INDIVIDUALIZED
• DIFFERENTIATE THE TWO MAJOR TYPES OF MUSCLE CRAMPS AND HOW TO TREAT
• PRE, DURING, AND POST HYDRATION REQUIREMENTS
“JUST MAKE SURE YOU STAY HYDRATED.”
WHAT DOES THAT EVEN MEAN!?
CHILDREN VS ADULTS

• OLD THEORY..
  • CHILDREN ARE LESS EFFECTIVE IN REGULATING BODY TEMPERATURE
  • CHILDREN HAVE LOWER EXERCISE HEAT TOLERANCE

• LATEST DATA..
  • YOUTH ATHLETES ARE NOT AT A CARDIOVASCULAR OR THERMOREGULATORY DISADVANTAGE
  • CHILDREN HAVE HIGHER LEVELS OF EVAPORATIVE COOLING AND SWEATING EFFICACY
SWEATING RATE VARIABILITY

- CONSIDERABLE DIFFERENCES BETWEEN INDIVIDUALS
- 9-12 YEAR OLD BOYS AND GIRLS
  - 300ML TO 700ML/H
- OLDER MALE ADOLESCENTS
  - 2.5L/H OR MORE WITH STRENUOUS ATHLETIC/SPORT ACTIVITY
  - EVEN WITH AMPLE FLUID AVAILABILITY, OPPORTUNITIES TO REHYDRATE, AND REGULAR FLUID CONSUMPTION, POST EXERCISE BODY WATER DEFICITS CAN BE 2-4L OR MORE.
CALCULATING SWEAT RATE

- Ensure athlete is hydrated (light colored urine)
- Pre exercise body weight with minimal clothing
- Exercise for one hour (type and intensity similar to conditions)
- Post exercise body weight with minimal clothing
  - If water is consumed during exercise, subtract the water weight from the post exercise weight
- Every 2.2 pounds lost equates to 1 liter of sweat loss
  - For 5 pounds lost in 1 hour, sweat rate is $5/2.2 = 2.27$ liters/hour
## FLUID LOSS IMPACT

<table>
<thead>
<tr>
<th>Percent (%)/Body Weight Lost to Sweating</th>
<th>Outcome</th>
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<tbody>
<tr>
<td>1</td>
<td>Core body temperature increases</td>
</tr>
<tr>
<td>1-2</td>
<td>Aerobic exercise performance decreases</td>
</tr>
<tr>
<td>3+</td>
<td>Increased risk for heat illness</td>
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</table>
SWEAT SODIUM LOSS VARIABILITY
SWEAT SODIUM LOSS VARIABILITY

• PRIMARY ELECTROLYTES IN SWEAT
  • **NA⁺** (20-70MMOL/L)
  • **K⁺** (5MMOL/L⁻¹)
  • **CA²⁺** (1MMOL/L⁻¹)
  • **MG²⁺** (0.8MMOL/L⁻¹)

• SODIUM CONTENT IS WIDELY VARIABLE

• AS SWEAT RATE INCREASES, RATE OF ELECTROLYTE/SODIUM LOSS INCREASES
MUSCLE CRAMPS

• A HOT ENVIRONMENT IS NOT A PREREQUISITE
• ATHLETES ARE NOT NECESSARILY OVERHEATED
• TWO DISTINCT AND DISSIMILAR CATEGORIES OF EXERCISE-ASSOCIATED MUSCLE CRAMPS
  • SKELETAL MUSCLE OVERLOAD AND FATIGUE
  • WHOLE-BODY EXCHANGEABLE SODIUM DEFICIT (EXERTIONAL HEAT CRAMPS)
OVERSTIMULATION OF THE SENSORY NEURON RESULTS IN DISINHIBITION OF THE ALPHA MOTOR NEURON
MUSCLE FATIGUE HYPOTHESIS

- Repeated or extended loading on skeletal muscles results in:
  - Increased afferent activity of the muscle spindle
  - Decrease in Golgi tendon inhibition of alpha motor neuron control
  - Sustained alpha motor neuron activity
  - Intense, sustained, involuntary, focal muscle contraction that is unopposed by Golgi tendon organ control
PREDISPOSING RISK FACTORS

- OLDER AGE
- POOR FLEXIBILITY
- IMPROPER MECHANICS
- INSUFFICIENT CONDITIONING
- CRAMPING HISTORY
- EXCESSIVE EXERCISE AND INTENSITY
- RELATED METABOLIC DISTURBANCES
EXERTIONAL HEAT CRAMPS

• ESTIMATE SWEAT INDUCED LOSS OF 20%-30% OF THE EXCHANGEABLE $\text{Na}^+$ POOL
• CONTINUOUS PHYSICAL ACTIVITY OVER AN EXTENDED PERIOD OF TIME
• SUSTAINED HIGH SWEAT SODIUM CONCENTRATION (SALTY SWEATERS)
• CONSISTENT SWEATING RATE
2014 NBA FINALS
TO MAINTAIN PLASMA VOLUME, WATER SHIFTS FROM THE INTERSTITIAL FLUID COMPARTMENT TO THE INTRAVASCULAR SPACE
A CONTRACTED INTERSTITIAL SPACE EXCITES NEUROMUSCULAR JUNCTIONS, CAUSES WIDESPREAD MUSCLE CRAMPING.
## FATIGUE OR SODIUM DEFICIT?

<table>
<thead>
<tr>
<th>Muscle Overload and Fatigue</th>
<th>Sodium Deficit</th>
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<tbody>
<tr>
<td>Acute onset</td>
<td>Typically begins with lower extremity fasciculation's</td>
</tr>
<tr>
<td>Focal contractions (Quadriceps, calf)</td>
<td>Widespread contractions</td>
</tr>
<tr>
<td>Acute resolution (stretching, massaging, icing)</td>
<td>Needs further management</td>
</tr>
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</table>
TREATING ELECTROLYTE DEFICIT

• AT THE ONSET OF MUSCLES TWITCHES
  • ORAL BOLUS SOLUTION
    • 16OZ SPORTS DRINK WITH 3.0 GRAMS ADDED SALT (TABLETS)
    • CONSUMED OVER 5-10 MINUTES
    • MASSAGING AND ICING MUSCLES CAN STILL BE APPLIED TO RELAX THE MUSCLES
    • ATHLETE CAN USUALLY RESUME TRAINING/COMPETITION WITHOUT SYMPTOMS FOR ANOTHER HOUR OR MORE
  • CONTINUE TO CONSUME ADDITIONAL LOWER-SODIUM FLUIDS AT REGULAR INTERVALS
  • REPLACE ANY REMAINING FLUID DEFICITS AS YOU NORMALLY WOULD AFTERWARDS
  • IV HYDRATION WITH NORMAL OR HYPERTONIC SALINE MAY BE NEEDED IF CRAMPING PERSISTS
ELECTROLYTE DEFICITS

POTASSIUM RICH SUPPLEMENTS OR FOODS ARE NOT INDICATED AND TYPICALLY WILL NOT PROVIDE ANY RELIEF (K+ (5MMOL/L-1))
ELECTROLYTE DEFICITS

• SODIUM DEFICIT IS USUALLY NOT DETECTABLE BY MEASURING SERUM ELECTROLYTES
  • SIGNIFICANT SWEATING WILL RESULT IN SOMEWHAT NORMAL TO ELEVATED LEVELS
  • POST EXERCISE ELECTROLYTE LEVELS ARE MORE REPRESENTATIVE OF FLUID COMPARTMENT SHIFTS
OTHER CONSIDERATIONS FOR EXERTIONAL LEG PAIN OR CRAMPS IN THE ATHLETE

- Medial Tibial Stress Syndrome (MTSS/Shin Splints)
- Stress Fracture
- Chronic Exertional Compartment Syndrome
- Rhabdomyolysis
- Foot Strike Hemolysis / Iron Deficiency +/- Anemia
- Use of Ergogenic Supplements and Caffeine
- Sickle Cell Disease or Trait
- Popliteal Artery Entrapment
PREVENTING DEHYDRATION

• DIETARY SODIUM
• PRE, DURING, AND POST HYDRATION GUIDELINES
• 14 DAY HEAT ACCLIMATIZATION PERIOD
ATHLETES NEED SODIUM!
DIETARY SODIUM

• PREPUBESCENT AND EARLY PUBESCENT ATHLETES TYPICALLY ARE NOT SIGNIFICANTLY EFFECTED OVER A SINGLE PRACTICE OR COMPETITION.
  • NORMAL DIET SURROUNDING BOUTS OF ACTIVITY IS OFTEN SUFFICIENT, EVEN IF ONLY WATER IS CONSUMED DURING AND AFTER EACH TRAINING SESSION/GAME.
• TYPICAL DIETARY INTAKE OF SCHOOL AGED CHILDREN WELL EXCEEDS THE RECOMMENDED AMOUNT.
• BARRIERS TO OFFSETTING NUTRIENT LOSSES BETWEEN MULTIPLE SAME-DAY OR DAY-TO-DAY SESSIONS:
  • SALTY SWEATERS (2,000 – 5,000 MG/HOUR)
  • LIMITED TIME BETWEEN EVENTS OR GAMES TO RECOVER
  • MEALS ARE OFTEN IMPRactical
POPULAR FOODS HIGHER IN SODIUM
LEAST POPULAR ITEM
SPICY THEORY
PRE-EXERCISE HYDRATION

• Assuming there has been adequate caloric intake and athlete is healthy
  • Weigh-in prior to training session/game
  • 16 oz water 2 hours prior
  • Another 8-16 oz 15 minutes prior
HYDRATION DURING EXERCISE

• UNRESTRICTED ACCESS TO WATER OR SPORTS DRINK SHOULD ALWAYS BE PROVIDED
  • LEADS TO ROUGHLY 4-8OZ FLUID EVERY 20 MINUTES FOR YOUNG ADOLESCENTS
  • NO MORE THAN 32OZ PER HOUR FOR OLDER ADOLESCENTS
  • THIRST SHOULD NOT BE RELIED UPON AS A MOTIVATOR TO DRINK (TOO LATE)
SALTY SWEATERS DURING EXERCISE

• COMMERCIAL SPORTS DRINK WITH ADDED SALT (1.5 TO 3.0 GRAMS OF SALT TO 32OZ FLUID) DURING EXERCISE
## Indications for the use of Sports Drinks

<table>
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<th>Indication</th>
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<tr>
<td>Prolonged continuous activity &gt; 45 minutes</td>
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<tr>
<td>Extremely intense activity with risk of heat illness</td>
</tr>
<tr>
<td>Hot and humid conditions</td>
</tr>
<tr>
<td>Individuals who are poorly hydrated prior to participation</td>
</tr>
<tr>
<td>Individuals with high sweat rate</td>
</tr>
<tr>
<td>Poor caloric intake prior to participation</td>
</tr>
<tr>
<td>Poor acclimatization to heat and humidity</td>
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<td></td>
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<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
</tr>
<tr>
<td>Energy (kJ/100 mL)</td>
</tr>
<tr>
<td>Sodium (mg/100 mL)</td>
</tr>
<tr>
<td>Sodium (mmol/L)</td>
</tr>
<tr>
<td>Potassium (mg/100 mL)</td>
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POST EXERCISE HYDRATION

• POST EXERCISE WEIGHT LOSS MEASURED ON EVERY ATHLETE

• CONSUME 16 OZ. PER POUND LOST WITHIN 2 HOURS, BUT DO NOT EXCEED 32 OUNCES PER HOUR.

• FOR ADOLESCENTS WHO SWEAT EXTENSIVELY, AN ADEQUATE DIET AND 32OZ / HOUR FLUIDS WILL NOT BE ENOUGH TO OFFSET FLUID AND ELECTROLYTE DEFICITS
  • IF PLAIN WATER OR LOW-SODIUM FLUID IS CONSUMED ALONE…
    • PLASMA VOLUME IS RESTORED BEFORE COMPLETE RESTORATION OF THE INTERSTITIAL SPACES
    • THIRST HAS DISSIPATED AND URINE PRODUCTION HAS INCREASED, BUT WHOLE BODY WATER RECOVERY HAS NOT OCCURRED

• COMPLETE POST EXERCISE REHYDRATION INVOLVES MORE THAN JUST WATER
INADEQUATE REHYDRATION

• If an athlete loses 3% or more between practices or competitions, they should be withdrawn from participation until rehydration can be completed in a safe and timely manner, and their % weight loss is acceptable.
• SERUM SODIUM < 135 MMOL/L

• PRIMARY CAUSE IN SPORTS IS OVERCONSUMPTION OF LOW- OR NO-SODIUM FLUIDS IN EXCESS OF SWEAT, URINARY, AND OTHER COLLECTIVE BODY LOSSES.
  • STOMACH ONLY ABSORBS 1.2L PER HOUR

• PRE-TO POST-SESSION GAIN IN BODY WEIGHT.

• MOST COMMON IN LONG DISTANCE RUNNERS ALONG COURSES WITH FREQUENT WATER STATIONS

• EARLY SIGNS AND SYMPTOMS
  • HEADACHE
  • NAUSEA
  • SEVERELY LOW SODIUM CAN RESULT IN SEIZURES, COMA AND DEATH.
PRESEASON HEAT ACCLIMATIZATION

• PHYSIOLOGIC FUNCTION, EXERCISE HEAT TOLERANCE, AND EXERCISE PERFORMANCE ARE ALL ENHANCED WITH A PROPER HEAT ACCLIMATIZATION PROGRAM.
  • THE INTER-ASSOCIATION TASK FORCE FOR PRESEASON SECONDARY SCHOOL ATHLETICS
  • THE NATIONAL ATHLETIC TRAINER’S ASSOCIATION’S SECONDARY SCHOOL ATHLETIC TRAINERS’ COMMITTEE
14 DAY HEAT ACCLIMATIZATION PROTOCOL

• DAYS 1-5
  • NO MORE THAN 1 PRACTICE PER DAY
  • TOTAL PRACTICE TIME SHOULD NOT EXCEED 3 HOURS IN ANY 1 DAY
  • A 1 HOUR MAXIMUM WALK-THROUGH IS PERMITTED
    • 3 HOUR RECOVERY PERIOD BETWEEN THE PRACTICE AND WALK-THROUGH
  • DAYS 1-2 HELMET ONLY
    • GOALIES SHOULD NOT WEAR FULL PROTECTIVE GEAR OR PERFORM ACTIVITIES THAT WOULD REQUIRE SUCH.
  • DAYS 3-5 HELMET AND SHOULDER PADS ONLY
    • FOOTBALL ONLY: CONTACT WITH BLOCKING SLEDS AND TACKLING DUMMIES ONLY
14 DAY HEAT ACCLIMATIZATION PERIOD

• DAY 6
  • ALL PROTECTIVE EQUIPMENT MAY BE WORN.
  • FULL CONTACT SPORTS:
    • 100% LIVE CONTACT DRILLS SHOULD BEGIN NO EARLIER THAN DAY 6

• DAY 6-14
  • DOUBLE PRACTICE DAYS MUST BE FOLLOWED BY A SINGLE PRACTICE DAY.
  • ON SINGLE PRACTICE DAYS, 1 WALK-THROUGH IS PERMITTED.
    • 3 HOUR BREAK BETWEEN PRACTICE AND WALK-THROUGH.
  • IF A DOUBLE PRACTICE DAY IS FOLLOWED BY A REST DAY, ANOTHER DOUBLE PRACTICE DAY IS PERMITTED AFTER THE REST DAY.
  • ON A DOUBLE PRACTICE DAY, NEITHER PRACTICE SHOULD EXCEED 3 HOURS, AND ATHLETES SHOULD NOT PRACTICE FOR MORE THAN 5 HOURS TOTAL, AND PRACTICES SHOULD BE SEPARATED BY AT LEAST 3 CONTINUOUS HOURS.
# Medications with Thermoregulatory Effects

<table>
<thead>
<tr>
<th>Medication</th>
<th>Physiologic Effect</th>
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<tbody>
<tr>
<td>Beta Blockers</td>
<td>Reduce Cardiac Output</td>
</tr>
<tr>
<td>Anticholinergics</td>
<td>Reduce Sweating</td>
</tr>
<tr>
<td>Antihistamines</td>
<td>Reduce Sweating</td>
</tr>
<tr>
<td>Tricyclic Antidepressants</td>
<td>Reduce Sweating</td>
</tr>
<tr>
<td>Sympathomimetic (OTC Decongestants)</td>
<td>Reduce Peripheral Vasodilation</td>
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CLOSING POINTS

• ALL YOUTH ATHLETES HAVE THE RESPONSIBILITY TO BE WELL HYDRATED AND WELL NOURISHED, AND CLINICIANS SHOULD ENCOURAGE THESE PRACTICES.

• A SMALL PRE AND POST SESSION WEIGHT LOSS IS OKAY, WHILE WEIGHT GAIN SHOWS TOO MUCH FLUID WAS CONSUMED.

• CONDITIONED ATHLETES WITH A HISTORY OF MUSCLE CRAMPING MAY NEED TO ADD SALT TO THEIR DIET AND SPORTS DRINK TO OFFSET THE SWEAT SODIUM LOSS.

• KEEP OTHER MEDICAL CONDITIONS IN MIND
REFERENCES

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THANK YOU