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

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- 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

Percent (%)Body Weight Lost to Sweating	Outcome
1	Core body temperature increases
1-2	Aerobic exercise performance decreases
3+	Increased risk for heat illness

SWEAT SODIUM LOSS VARIABILITY

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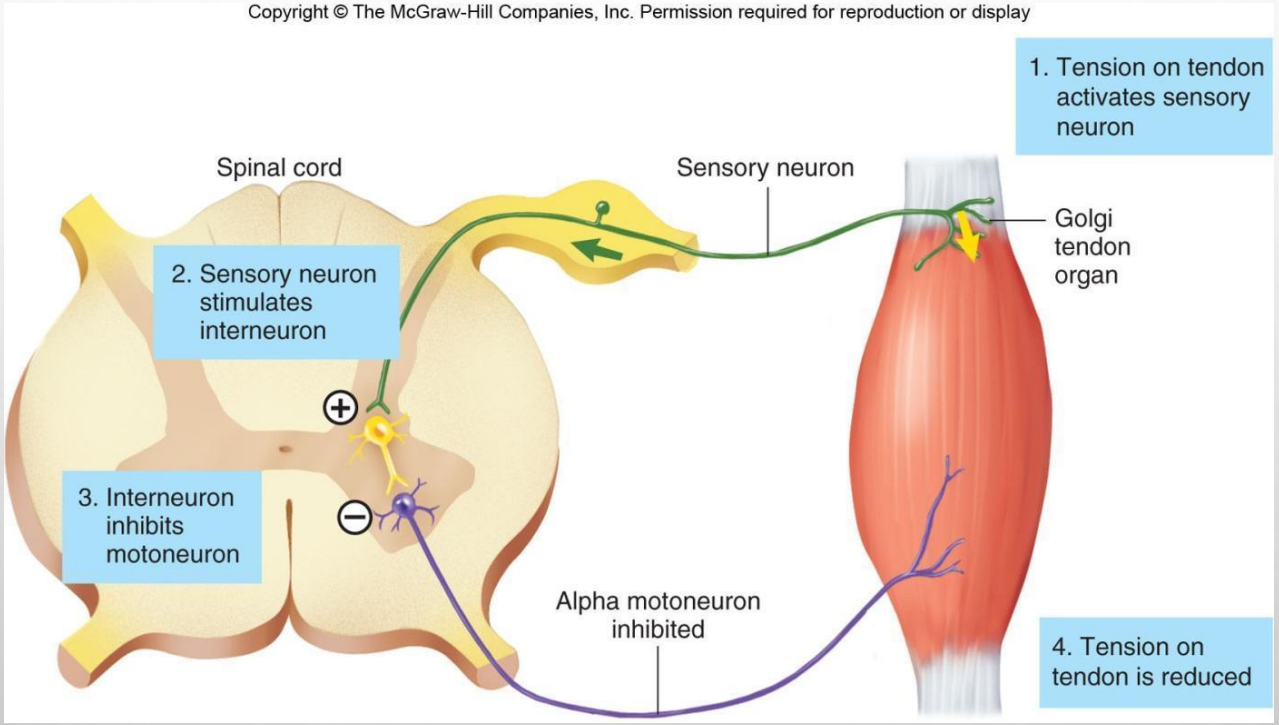
- PRIMARY ELECTROLYTES IN SWEAT
  - **NA+ (20-70MMOL/L)**
  - K^{+} (5MMOL/L^{-1})
  - CA^{2+} (1MMOL/L^{-1})
  - MG^{2+} (0.8MMOL/L^{-1})
- SODIUM CONTENT IS WIDELY VARIABLE
- AS SWEAT RATE INCREASES, RATE OF ELECTROLYTE/SODIUM LOSS INCREASES

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

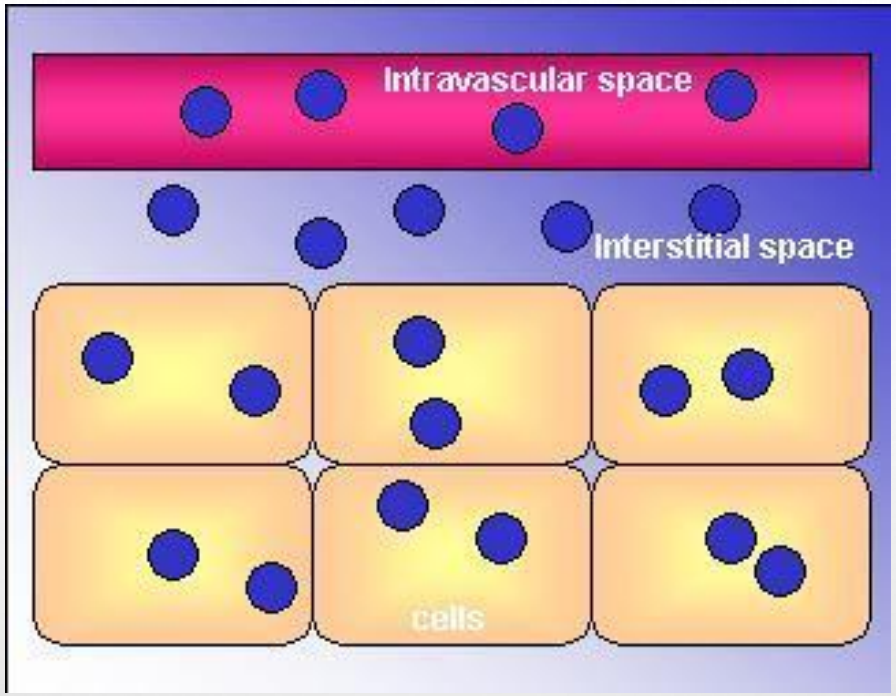
PREDISPOSING RISK FACTORS

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

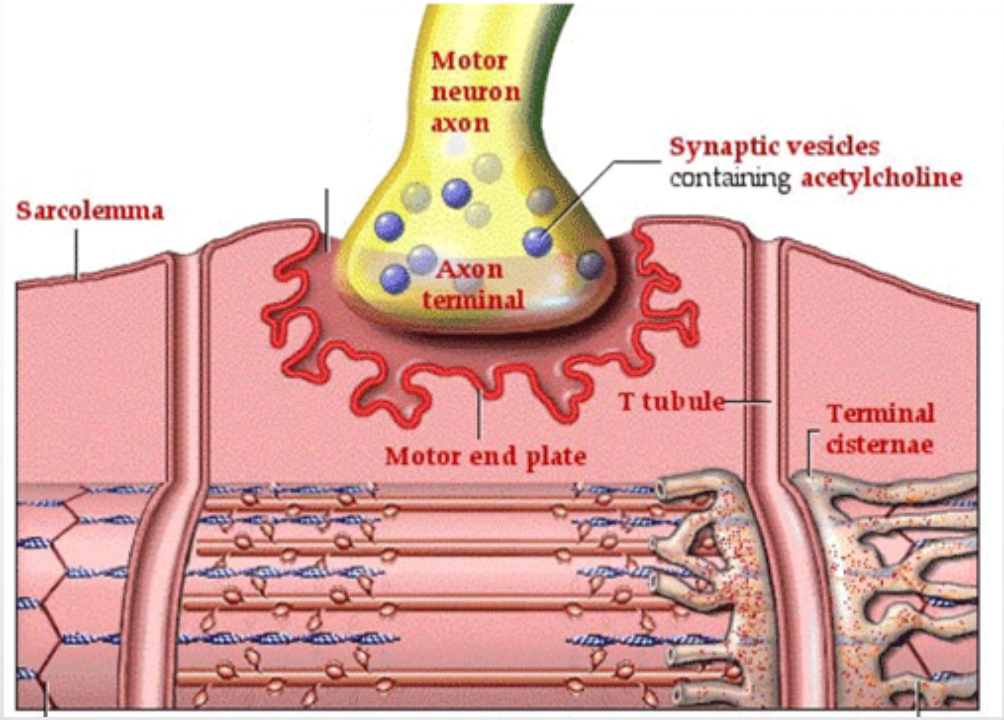
EXERTIONAL HEAT CRAMPS

- ESTIMATE SWEAT INDUCED LOSS OF 20%-30% OF THE EXCHANGEABLE 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?

Muscle Overload and Fatigue	Sodium Deficit
Acute onset	Typically begins with lower extremity fasciculation's
Focal contractions (Quadriceps, calf)	Widespread contractions
Acute resolution (stretching, massaging, icing)	Needs further management

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 8-16OZ 15 MINUTES PRIOR

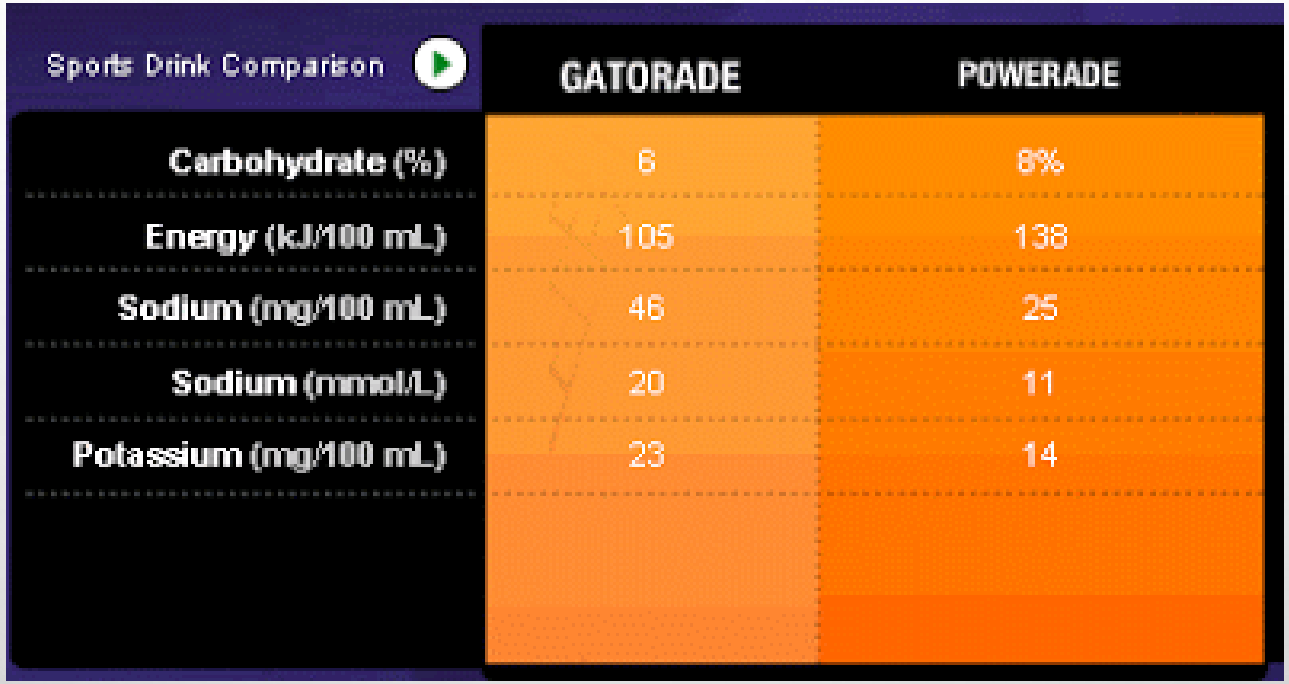
HYDRATION DURING EXERCISE

- 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
Prolonged continuous activity > 45 minutes
Extremely intense activity with risk of heat illness
Hot and humid conditions
Individuals who are poorly hydrated prior to participation
Individuals with high sweat rate
Poor caloric intake prior to participation
Poor acclimatization to heat and humidity


Sports Drink Comparison
GATORADE
POWERADE
Carbohydrate (%)
6
8%
Energy (kJ/100 mL)
105
138
Sodium (mg/100 mL)
46
25
Sodium (mmol/L)
20
11
Potassium (mg/100 mL)
23
14

POST EXERCISE HYDRATION

- POST EXERCISE WEIGHT LOSS MEASURED ON EVERY ATHLETE
- **CONSUME 16 OZ. PER POUND LOST WITHIN 2 HOURS, BUT DO NOT 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.

HYPONATREMIA

- 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

Medication	Physiologic Effect
Beta Blockers	Reduce Cardiac Output
Anticholinergics	Reduce Sweating
Antihistamines	Reduce Sweating
Tricyclic Antidepressants	Reduce Sweating
Sympathomimetic (OTC Decongestants)	Reduce Peripheral Vasodilation

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

- HYDRATION IN THE PEDIATRIC ATHLETE – HOW TO GUIDE YOUR PATIENTS, MICHAEL F BERGERON, PHD, FACSM. AMERICAN COLLEGE OF SPORTS MEDICINE 2015. VOLUME 14 NUMBER 4, PAGES 288-293
- MUSCLE CRAMPS DURING EXERCISE – IS IT FATIGUE OR ELECTROLYTE DEFICIT? MICHAEL F BERGERON, PHD, FACSM. AMERICAN COLLEGE OF SPORTS MEDICINE 2008. VOLUME 7 NUMBER 4, PAGES S51-S55
- POSITION STATEMENT AND RECOMMENDATIONS FOR HYDRATION TO MINIMIZE THE RISK FOR DEHYDRATION AND HEAT ILLNESS, CASA DJ, ARMSTRONG ET AL. OCTOBER 2011.
- NATIONAL FEDERATION OF STATE HIGH SCHOOL ASSOCIATONS SPORTS MEDICINE HANDBOOK, 4TH EDITION, MAY 2011. FLUID REPLACEMENT AND DEHYDRATION, PAGES 64-66.
- HYDRATION, KOREY STRINGER INSTITUTE.COM
- PRESEASON HEAT-ACCLIMATIZATION GUIDELINES FOR SECONDARY SCHOOL ATHLETICS, DOUGLAS J CASA, PHD, ATC, FNATA, FACSM AND DAVID CSILLAN, MS, LAT, ATC. JOURNAL OF ATHLETIC TRAINING, VOLUME 44 NUMBER 3, 2009.

THANK YOU