6 AFC MEDICAL CONFERENCE CHENGDU 2019
4 - 8 March 2019

"Football & Sports Medicine - the Challenging Horizon"

Heat Illness and Heat Stroke "Best Practices"

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- Runner Marathon

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Objectives

- Incidence/trend in Sports/Soccer
- Definition , physiology and spectrum of Illness
- Who is at risk
- Prevention "Preventable Death"
- Management and "Best Practices"
- Together we build the culture of player safety

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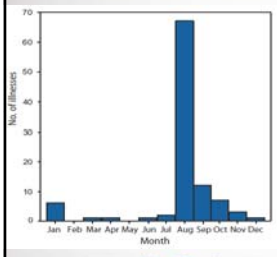
"Headlines"

- "Common sense indicated Stringer was susceptible to the reaction he had -- not to dying, but to heat stroke or heat exhaustion or an injury. He was prone to something that could develop into a serious situation."

Heat illness/Deaths in the USA from Heat Stroke



Heat deaths rising

Heat-related fatalities that occurred during sports have more than doubled since 1975

1975-79	8
1980-84	9
1985-89	5
1990-94	2
1995-99	13
2000-04	11
2005-09	18

Source: Korey Stringer Institute
By Veronica Salazar, USA TODAY

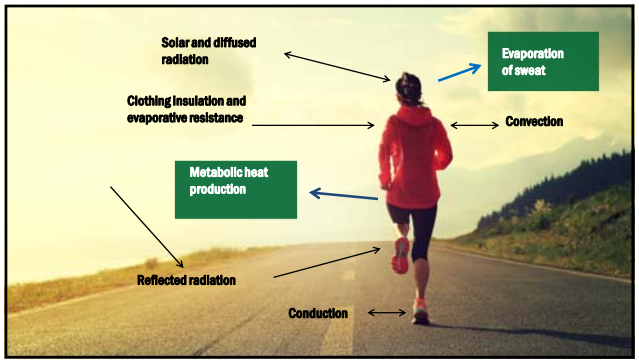
How are humans different? The ability to produce large volumes of sweat

Humans developed the ability to sweat profusely so that we could hunt the antelope during the hottest part of the day, as other mammals cannot regulate their core temperatures as effectively as we do because they cannot sweat

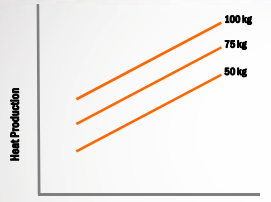
Heat "Gain or Loss"

- Radiation- "Sun"
- Convection-transfer layer of either air or water (water 40x greater)
- Evaporation- "Sweat" inhibited in humidity
- Conduction- between 2 objects

$$WBGT = 0.7T_{wb} + 0.2T_{bg} + 0.1T_{db}$$



Body Size



Dennis & Noakes *Eur J Appl Physiol*, 1999

Godek et al., *J Athl Train*, 2006
Sawka et al., *Med Sci Sports Exerc*, 2007
Godek et al., *J Athl Train*, 2008
Bakeret al., *J Sports Sci*, 2016

Sweating Rate by Sport

	Sweating Rate (L/h)	Δ Body Mass (%)
American Football (n=225/m=13)	**0.6-2.9**	-0.1 to -2.4
Basketball (n=230/m=9)	**0.7-2.7**	-0.6 to -1.6
Tennis (n=124/10)	**0.6-2.6**	-0.2 to -1.4
Soccer (n=497/m=21)	**0.3-2.5**	+0.4 to -3.5
Rugby (n=116/m=7)	**0.4-2.0**	-0.1 to -2.9
Ice Hockey (n=117/m=5)	**0.7-1.8**	-0.8 to -1.3
Cricket (n=68/m=3)	**0.1-1.4**	+0.1 to 4.3
Baseball (n=16/m=2)	**0.7-0.8**	-1.3

n = # athlete / m = # studies

Nuccio et al. *Sports Med*, 2017

Lack of Availability

Team Sport Factors That Influence Dehydration

Sport	Availability of Fluid		Environment		Intensity		Dehydration Risk	
	Training	Competition	Training	Competition	Training	Competition	Training	Competition
Basketball	High	High	Low	Low	Mod	Mod	Low	Low
Ice Hockey	High	High	Low	Low	Mod	High	Mod	Mod
Football	High	High	Mod	Mod	Mod	High	Mod	Mod
Baseball	High	High	Mod	Mod	Low	Low	Low	Low
Softball	High	High	Mod	Mod	Low	Low	Low	Low
Volleyball	High	High	Low	Low	Low	Low	Low	Low
Soccer	Mod	Low	Mod	Mod	Mod	High	Mod	High
Lacrosse	High	High	Mod	Mod	Mod	Mod	Mod	Mod
Rugby	High	Low	Mod	Mod	Mod	High	Mod	High

Belval et al.
J Athl Train

Heat Balance Equation

Heat Storage
Body Temperature

$$S = (M - W) \pm E \pm R \pm C \pm K$$

Conduction
- Ambient Temperature
- Skin Temperature
- Exposed Skin Surface Area

Metabolism
- Exercise Intensity (HR, Speed, Incline)
- Body Mass
- Body Composition
- Fitness

Evaporation
- Sweat Rate
- Relative Humidity
- Exposed Skin Surface Area
- Hydration Status
- Ambient Temperature

Radiation
- Sun Exposure
- Reflected Radiation
- Exposed Skin Surface Area

Convection
- Ambient Temperature
- Skin Temperature
- Wind Speed
- Exposed Skin Surface Area

Athletes at Risk

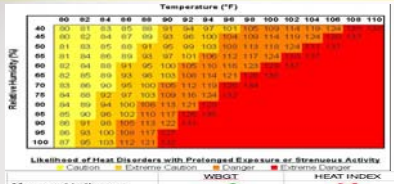
- Those at Risk
  - Overweight or high muscle mass to fat ratio
  - Sleep loss
  - Inadequately trained
  - Not acclimated
  - Run “too fast”
  - Ignore warning symptoms
  - Recent Illness
  - Genetic predisposition
  - Previous Heat Stroke
  - Medications (diuretics, antidepressants)
    - Stimulants

RISK FACTORS AND CONTRIBUTING FACTORS

Although hydration is very important, other factors to monitor that increases chances of heat illness include:

- Obese, out of shape athletes
- Athletes with fever or recent respiratory infections
- Athletes with sickle cell anemia
- Athletes with prior heat illness history
- Athletes who take illicit drugs such as ADD medication

Are there objective metrics that allow us to account for environmental conditions and the effects they have on athletes? WBGT



	WBGT	HEAT INDEX
Measured in the sun	✓	✗
Measured in the shade	✗	✓
Uses temperature	✓	✓
Uses relative humidity	✓	✓
Uses wind	✓	✗
Uses cloud cover	✓	✗
Uses sun angle	✓	✗

$$WBGT = 0.7T_{wb} + 0.2T_{bg} + 0.1T_{d}$$

Spectrum of Illness

CLASSIFICATION OF HEAT RELATED INJURIES

Injury	Symptoms	Signs	Treatment
Heat Fatigue (Mild)	Muscle cramps Fatigue Headaches Faintness	Muscle spasm Elevated heart rate Fainting	Cessation of exercise Removal from heat Re-hydration Cool bath/icing Rest
Heat Exhaustion (Moderate)	Headaches Weakness Nausea Vomiting Confusion Poor co-ordination	Decreased blood pressure Elevated heart rate Elevated body temp. Fainting Hot wet skin	Cessation of exercise Removal from heat Re-hydration Cool bath/icing Rest Consider I.V. fluids
Heat Stroke (Severe)	Inappropriate behavior Psychosis Coma	Severely elev. Body temp. Hot/dry or Cool/wet skin Elevated heart rate Decreased blood pressure Elevated breathing rate Electrolyte disturbances	*Medical Emergency* Potentially fatal Emergency transport Whole body cooling Laboratory monitoring I.V. fluid replacement

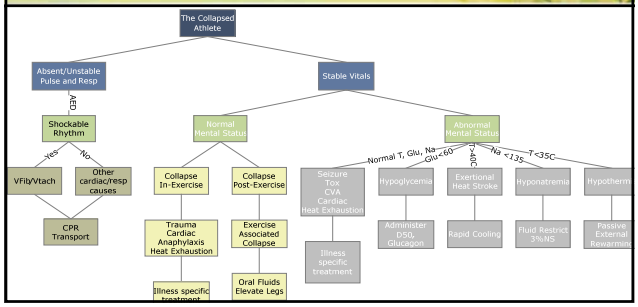
Recognition Heat Exhaustion

- Early Symptoms
  - Headache
  - Dizziness
  - Nausea
- If detected early and athletes temp allowed to be lowered avoid more serious issues
- NOT CONFUSED

Definition "Heat Stroke"

- Core Body Temp generally >40.5C or 104 F "with" associated organ system failure
- CNS dysfunction "Altered Mental Status"- Confused however may have lucid intervals

Algorithm for Athletic Collapse Non-Contact



Recognition

- Rectal temp is the only option to assess body temp
- Aural, oral, tympanic, axillary and forehead have ALL been shown to NOT be effective
- If no rectal probe available athlete with CNS dysfunction (suspected environment) is considered to be suffering exertional heat stroke

Can and does occur in our game

Heat Stroke "Altered Mental Status"

- **Cool First**

- Field treatment for heat stroke is fast cooling with ice water immersion. No faster way to cool exists than placing the athlete into an ice water tub.
- If necessary, the Marine Corps Method is an appropriate alternative, especially for those patients experiencing a cardiac event.
- **EMS transport should not be considered until after the athlete's temperature decreases to 102°F Treat On-Site**

Heat Stroke "Altered Mental Status"

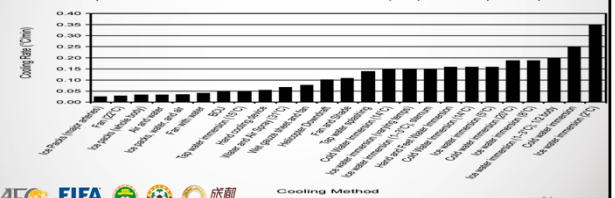
- **Treating Heat Stroke: Medical Emergency**
  - Number of minutes an athlete is over 105ºF will dictate if they live or die, and if they live, if they have long-term or permanent disability as a result of the condition.
  - When an athlete collapses, the best gauge of core temperature is rectal temperature. Oral, axillary, or tympanic temperature is not sufficient to diagnose or exclude heat illness.
  - Early features of heat stroke
    - Subtle central nervous system (CNS) changes, altered cognition or behavior, and core temperature over 104-105°F (40.0-40.6°C) at time of collapse.
  - Advanced features of heat stroke
    - Collapse with core temperature over 106-107°F (41.1- 41.7 °C) and striking CNS changes, including delirium, stupor, seizures, or coma.
  - A lucid interval may present, do not let this prevent necessary rapid cooling.

Treatment Cool First

- On-site, "within 5 minutes" no delay for transport to hospital
- Gold standard Cold Water Immersion CWI
- CWI cooling rates 0.16-.20 C/min
- Additional methods
  - Marine Corp
  - Alternating ice bags to axilla and groin
  - Soaked ice towels to head trunk and extremities

Heat Stroke "Altered Mental Status"

- **Why Ice Immersion?**
- In heat stroke, every minute counts. When core temperature is very high, body and brain cells begin to die, so fast cooling is vital. The ultimate goal is always to get the body temperature under 104ºF within 30 minutes of collapse (or faster if possible).



Heat Stroke "Altered Mental Status"

• Cooling Duration

- Continue cooling until the patient's rectal temperature lowers to 39ºC (102ºF).
- **If no rectal temperatures is available and ice water immersion indicated:**
  - Cool for 10-15 min and then transport to a medical facility.
  - If after 10-15 min the patient's symptoms have not improved, medical personnel should use their best clinical judgment as to whether additional cooling time is warranted.
  - If a less effective cooling method is utilized (i.e. MCM, tarp method, etc.) cooling time should be increased, 15-20+ min.
- An approximate estimate of cooling via cold water immersion is 1ºC every 5 min or 1ºF every 3 min (if the water is aggressively stirred).
  - Cooling rate will be slower initially, and increase the longer the person is in the tub.
  - Cooling for 15 min should bring temperatures down approximately 3ºC/5ºF.

Cooling Strategies/Opportunities in Football
Our Game is Different

- Training
  - Avoid warmest part of day
  - Access to ice tubs
  - Cooling between trainings
  - Adequate recovery time between trainings
- Matches
  - Post warm-up
  - Ice towels on sideline
  - Ice Slurry
  - Hydration break
  - Post- match

Acclimatization-Prevention

- Physiological adaptations with repeated exposures of exercise-heat stress
- Allows the body to better tolerate exercise in the heat
- Full acclimatization takes a period of 10-14 days

Table 4. Physiologic Responses After Heat Acclimatization Relative to Nonacclimatized State

Physiologic Variable	After Acclimatization (10–14 Days' Exposure)
Heart rate	Decreases[46,145]
Stroke volume	Increases[145,147]
Body-core temperature	Decreases[145]
Skin temperature	Decreases[152]
Sweat output/rate	Increases[46,47,149]
Onset of sweat	Earlier in training[46,145]
Evaporation of sweat	Increases[47,150]
Salt in sweat	Decreases[8,50]
Work output	Increases[46,50]
Subjective discomfort (rating of perceived exertion [RPE])	Decreases[50,145]

Mortality Risk Factors

- 21-63% mortality
- Prompt recognition is key
- Morbidity directly related to duration core temp >40.5C
- Mortality correlates with temp/time to cool and #organ systems (kidney, liver) affected
- Athletes presenting with anuria, coma and cardiovascular collapse=significant risk of death.

Effects of Aggressive Cooling

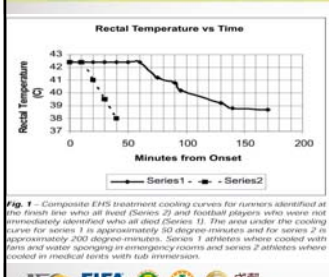


Fig. 1 – Composite EHS treatment cooling curves for runners identified at the finish line who all lived (Series 2) and football players who were not immediately identified who all died (Series 1). The area under the cooling curve for series 1 is approximately 50 degree-minutes and for series 2 is approximately 200 degree-minutes. Series 1 athletes where cooled with fans and water sponging in emergency rooms and series 2 athletes where cooled in medical tents with tub immersion.

"Best Practices" Preparing and Communicating the Risk

ALERT LEVEL	EVENT CONDITIONS	RECOMMENDED ACTIONS	TEMP
EXTREME	EVENT CANCELLED; EXTREME AND DANGEROUS CONDITIONS	PARTICIPATION STOPPED; FOLLOW EVENT OFFICIAL INSTRUCTION	WBGT > 82°F
HIGH	POTENTIALLY DANGEROUS CONDITIONS	SLOW DOWN; OBSERVE COURSE CHANGES; FOLLOW EVENT OFFICIAL INSTRUCTION; CONSIDER STOPPING	WBGT 77°- 82°F
MODERATE	LESS THAN IDEAL CONDITIONS	SLOW DOWN; BE PREPARED FOR WORSENING CONDITIONS	WBGT 65°- 77°F
LOW	GOOD CONDITIONS	ENJOY THE EVENT; BE ALERT	WBGT 41°-65°F

Heat Guidelines (MSSE)

- This document is intended to provide up-to-date recommendations regarding the optimization of exercise capacity during sporting activities in hot ambient conditions. Given that the performance of short-duration activities (e.g., jumping and sprinting) is at most marginally influenced, or can even be improved, in hot ambient conditions (Racinais & Oksa, **2010**), but that prolonged exercise capacity is significantly impaired (Nybo et al., **2014**), the recommendations provided in this consensus statement focus mainly on prolonged sporting events.
- Following the recent examples of the 2008 Olympics and the 2014 FIFA World Cup, sport governing bodies should consider allowing additional (or longer) recovery periods between and during events for hydration and body cooling opportunities when competitions are held in the heat.

"First FIFA Cooling Break June 29 2016

- History was made during the World Cup last-16 match between Holland and Mexico in Fortaleza on Sunday as the players left the field for the first official "cooling break" ever in the competition.
- In temperatures of up to 39C at the Estádio Castelão, Portuguese referee Pedro Proença opted to implement Fifa's new rules which allow a game to be stopped for three minutes to allow the players to rehydrate.
- A Fifa statement said: "Official and mandatory cooling breaks have not been established for the 64 games of the 2014 Fifa World Cup Brazil, but instead they will be considered on a match-by-match basis.
- "Climate conditions will be evaluated and should the temperature exceed 32 degrees, then the Fifa Venue Medical Office will recommend cooling breaks to the Fifa General Coordinator and Match Commissioner. The implementation of the cooling breaks will reside with the referee.
- "Cooling breaks last three minutes in duration are then implemented by the referee at approximately 30 minutes into the run-of-play in both halves of the match (i.e. around the 30th minute and 75th minute respectively). Three minutes will then be added to stoppage time at the end of each half."

FIFA "Best Practices"

- Prepare- MD-1 Match Commissioner meeting- discuss weather (heat conditions)
- 60 minutes prior to kick-off MC, Referee, VMD, and Team Doctors check WBGT
- Professional- >32 C
- U20 >28 C
- Mandates Hydration Breaks

FIFA 2016 World Cup

- Hydration Break
  - 30th and 75th minute
  - 3 minutes maximum in length
- Additional Substitution for Extra Time
- We need to Advocate for our players safety

Heat Guidelines (Developed Specific to Soccer) 2015

STEP 1

Temperature + Humidity= WBGT Temp.
https://weather.com/

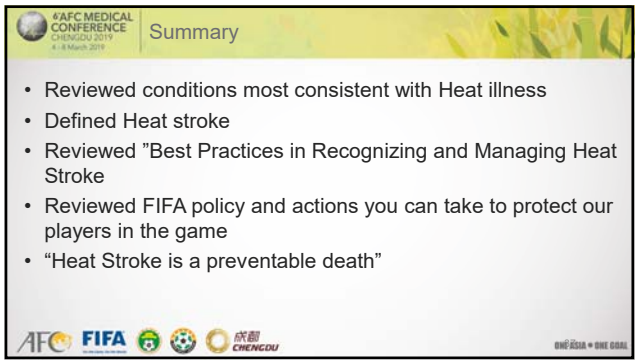
STEP 2

STEP 3 FIND YOUR ALERT LEVEL AND WORK TO REST RECOMMENDATIONS

Based on your WBGT and Regional Category determine your Alert Level and Work to Rest Recommendations using the table below.

ALERT LEVEL	WBGT BY REGION (°F) CAT 1	CAT 2	CAT 3	EVENT CONDITIONS	RECOMMENDED WORK TO REST RATIOS (ACTIONS & BREAKS)
BLACK	>86.2°	>89.8°	>92.0°	Extreme Conditions	No Outdoor Training, delay training until cooler, or Cancel Training.
RED	84.2-86.1°	87.8-89.7°	90.1-91.9°	High Risk for Heat Related Illness	Maximum of 1 hour of training with 4 by 4 minute breaks within the hour. No additional conditioning allowed.
ORANGE	81.1-84.1°	84.7-87.7°	87.1-90.0°	Moderate Risk for Heat Related Illness	Maximum of 2 hours of training with 4 by 4 minute breaks each hour, OR a 10 minute break every 30 minutes of training.
YELLOW	76.3-81.0°	78.9-84.6°	82.2-87.0°	Less than Ideal Conditions	3 Separate 4 minute breaks each hour, OR a 12 minute break every 40 minutes of training
GREEN	<76.1°	<78.8°	<82.1°	Good Conditions	Normal Activities. 3 Separate 3 minute breaks each hour of training, OR a 10 minute break every 40 minutes

Heat Guidelines USA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Summary
• Reviewed conditions most consistent with Heat illness
• Defined Heat stroke
• Reviewed ”Best Practices in Recognizing and Managing Heat Stroke
• Reviewed FIFA policy and actions you can take to protect our players in the game
• “Heat Stroke is a preventable death”
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