Prevention and Treatment of
Heat-Related Illness in
School –Aged Sports


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The views expressed in this presentation are the views of the presenter and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

I have no financial relationships or conflicts of interest to disclose.
Agenda

- Definitions of Exertional Heat Illness (EHI)
- Discuss Epidemiology of EHI
- Review ACSM and Military Flag Conditions Risk factors

Prevention: Manage Risk

Evaluation and Diagnosis

Treatment:
  - Field and Transport
  - Heat Deck

Return to Duty

Summary
Exertional Heat Injury (EHI)

- **Heat Cramps**
  - Exertional muscle cramps usually in hot environment
  - Large muscle groups

- **Heat Exhaustion**
  - Collapse occurring during or immediately following exercise
  - No organ damage or systemic inflammatory activation

- **Heat Stroke**
  - Collapse, hyperpyrexia and encephalopathy
  - Organ damage and/or systemic inflammatory activation
Myth of Youth: Are kids at higher risk of heat stroke than adults?

In the past, some said so. (review article)


Now, evidence says kids have same risk as adults.

American Football Related Heat Stroke Deaths

- 1931 to 1959: 5 heat stroke deaths reported
- 1960 to 2009: 123 heat stroke deaths
- 2009: 3 High School and 1 College heat stroke deaths
- 1995-2010: 42 football players died from heat stroke (31 high school, 8 college, 2 professional, and one sandlot).
- Since 1974 there has been a dramatic reduction in heat stroke deaths with the exception of 1978, 1995, 1998, when there were four each year, and 2000, 2006, and 2008 when there were five each year.

- Fatal Heat Stroke Rate: 0.20 per 100 000 player-seasons in US high school football
EHI Mortality / Morbidity: Time at Temperature

- **WWI**: British in Mesopotamia, 600 EHI (?deaths) until ice, water, and activity mods
- **WWII**: 200+ DEATHS at US training bases
- **Parris Island, SC USMC Training**
  - 1% - 5% HS mortality 1979-1990 Paris Is.
    - 1.5% (2/137) HS Cardiac Mortality
  - 0%: Since ice water rapid cooling adopted
- **Quantico, VA USMC Training**
  - 0%: Since ice water adopted (even T=110.5)
  - Many HS T>107F (Tmax=110.5F) with normal labs
Epidemiology of Hospitalizations and Deaths from Heat Illness in Soldiers

- Army data from 1980-2002
- 5,245 hospitalizations and 37 deaths
  - 60% reduction in hospitalization
  - 5x increase in heat stroke hospitalization
  - Caucasian > African or Hispanic Americans
  - Northern States > Southern States

Wet-bulb Globe Temperature Index

Factors considered:
- Air temperature
- **Humidity**
- Radiant heat
- Air Movement

Used to determine heat conditions
- Flag system
- ACSM vs. Military
# Heat Index

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<th>Relative Humidity (%)</th>
<th>°F</th>
<th>40</th>
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**Heat Index (Apparent Temperature)**

**With Prolonged Exposure and/or Physical Activity**

- **Extreme Danger**
  - Heat stroke or sunstroke highly likely

- **Danger**
  - Sunstroke, muscle cramps, and/or heat exhaustion likely

- **Extreme Caution**
  - Sunstroke, muscle cramps, and/or heat exhaustion possible

- **Caution**
  - Fatigue possible
ACSM vs. Military Flags

ACSM Recommendations:
- Introduced in Heat and Cold Illness During Distance Running, ACSM Position Stand, 1996
- Refined numerous times since

Military Recommendations:
- GREEN Flag (80F-84.9F) occurs in ACSM BLACK Flag (>82.4F) conditions!!!
<table>
<thead>
<tr>
<th>Flag Color</th>
<th>WBGT Index*</th>
<th>Intensity of Exercise</th>
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<tbody>
<tr>
<td></td>
<td><strong>&lt; 64.4</strong></td>
<td>Extremely intense physical output may precipitate heat injury. Caution should be taken</td>
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<td><strong>64.4 – 73.4</strong></td>
<td>Discretion required in heavy exercise for unseasoned personnel. Marginal heat stress limit for all personnel</td>
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<td><strong>73.4 – 82.4</strong></td>
<td>Strenuous exercise and activity should be curtailed for unseasoned personnel for first 3 weeks of heat exposure</td>
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<td><strong>&gt;82.4</strong></td>
<td>Strenuous exercise curtailed for all personnel with less than 12 weeks training in hot weather</td>
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<td>Physical training and strenuous exercise suspended for all personnel (excludes operational commitment not for training purposes)</td>
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*WET-BULB GLOBE THERMOMETER*
## Military Heat Stress Guidelines

<table>
<thead>
<tr>
<th>Flag Color</th>
<th>WBGT Index*</th>
<th>Intensity of Exercise</th>
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<tbody>
<tr>
<td>&lt; 80</td>
<td>Extremely intense physical output may precipitate heat injury. Caution should be taken</td>
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<tr>
<td>80 - 84.9</td>
<td>Discretion required in heavy exercise for unseasoned personnel. Marginal heat stress limit for all personnel</td>
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<tr>
<td>85 - 87.9</td>
<td>Strenuous exercise and activity should be curtailed for unseasoned personnel for first 3 weeks of heat exposure</td>
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<td>88 - 88.9</td>
<td>Strenuous exercise curtailed for all personnel with less than 12 weeks training in hot weather</td>
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<tr>
<td>90 and Above</td>
<td>Physical training and strenuous exercise suspended for all personnel (excludes operational commitment not for training purposes)</td>
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*WET-BULB GLOBE THERMOMETER*
Training in Black Flag Heat: Heat Injury Prevention
EHI Risk Factors: Environment

- Competitive or group activities “peer pressure”
  - 3 mi unit run, 6 mi unit hump, PFT, field ops

- Kevlar, Flak, Pack…add 10F (5.6C) to WBGT

- HUMID, sunny, hot (WBGT Flag system)
  - Most EHI occur at WBGT 70F – 85F (21.1C – 29.4C)
  - Military Heat Stress Flags:
    - Green 80F – 85F (26.7C -29.4C), Yellow 85F - 88F (26.7C – 31.1C), Red 88F – 90F (31.1C – 32.2C): Activity cautions
    - Black 90F+ (32.2C+): Activity suspended unless emergent

- NOTE: ACSM black flag starts at 82F (27.8C)

- Preceding day MAX heat stress
  - Most EHI had preceding day WBGT_{MAX} >85F (29.4C)
EHI Risk Factors: Personal

- Big (not just fat):
  - BMI 22-26 (OR 1.7 {1.3 – 2.4ci} )
  - BMI >26 (OR 3.6 {2.5 – 5.0 95% ci} )
- Slow: >8 min/mile runner (OR 5.6 {3.4 - 9.1 95%ci} )
  - Big and Slow OR=8.8
- Fatigue / Poor Sleep
- Overexertion / Competition (pushing beyond ability)
- Febrile: GI or Respiratory illness
- Poor Acclimatization
- Dehydration (recent heat strokes normal or over hydrated)
- Prior EHI?
- Drugs, Recent Alcohol, Supplements
A word about Supplements

- May Contribute to Heat Build-up and Death
- Individuals who use them may push beyond limits in heat.
- Anabolic steroids and stimulants (not on label) are associated with sudden cardiac death.
  - **Fat-Burners/Thermogenics** - Stimulants increase production of body heat!
  - **Creatine**
    1. Causes fluid shift out of blood into muscle (not cooling).
    2. Makes you bigger than stronger...BIG AND SLOW increases risk as much as 8.8 times!
  - **Excess Protein** - Requires additional fluid for digestion process.

- Use CAUTION when purchasing over the internet, the labels don’t necessarily reflect the real contents.
Prevention Tools

- Marine Corps Order 6200.1A
- Annual Training
- Area wide heat index monitoring/flag system
- Altered work/physical training hours
- Confidence in treatment excellence
- Tracking of injuries
**Prevention - Orders**

EHI Prevention is a LEADERSHIP issue:
- Commanding General discussion with COs and Force Order
- MUST follow directive May to Nov and when temperature exceeds 80 degrees
- Operational Risk Management
- Provide medical coverage with EHI equip. for risky events.
Prevention – Annual Training

- Train the trainers
  - Review the force order
  - Review the risk factors, signs and symptoms
  - Field management and required equipment
  - Heat deck management
  - Criteria for referral to ED
  - Return to duty
  - Plan to train the Marines
Personal Risk Reduction

- Maintain conditioning and ideal BMI
- Sleep 7+ hours (at least 4)
- Don’t over do it.
- Hydrate:
  - Urine pale / restore body wt night before.
  - 17oz 2 hour before event
  - 4oz per 15 min during event (max 3 gal. per day)
    - Sports drinks or carbohydrates if >1hr event.
- Protect from heat…cover and shade. Avoid sun burn.
Leadership Risk Reduction

- Leaders MUST KNOW their warriors (risk).
- Warriors must TRUST leaders in order to report changing risk and rest.
- No exertion if ill: Febrile, GI, Resp.
- Beware prior days WBGT and work load
- Closely monitor prior EHI warriors
- Minimize group paced / competitive events
- STOP!!! If dizzy or sick.
- Follow acclimatization/work:rest recommendations
- Wear PPE only when necessary for training
Prevention - Monitoring

Automated Heat Stress System
- Continuous, on-line measurement of WGBT
- Each base has monitoring equipment, monitored by Base Safety

Heat Flag Activity Limitations
- Updated hourly up to Red Flag
- Updated every 30 minutes above Red Flag
Prevention – Altered Routine

Acclimatize
- White t-shirts for new command PT
- PT early, step off 0500
- Recondition / Acclimatize: If off 2 to 4+ wks
  - Start back at 75% to 50% (increase 10%/wk)
  - Recondition 3 to 6 wks (acclimatize 2 to 3 wks)

Scheduled cooling breaks with rest
- Wet Head, Soak Arms / Hands, A/C, Shade

Minimize clothing and equipment
- Add 10F to WBGT Flag guide for kevlar, flak, pack and MOPP

Work / rest cycle per level of exertion
To Acclimatize

- Exercise 1 to 4 hours per session in heat.
- Moderate intensity (walk 3 mph with <40lb)
- Repeat daily for 7 to 21 days
  - 7 to 10 days for elite athletes
  - 21 days for Army units (MCO states 2-3 wks).
- Progressively increase workload as tolerated.
# Heat Index Guide

## (moderate work)

<table>
<thead>
<tr>
<th>Temp.</th>
<th>Work/Rest Ratio</th>
<th>Water Intake</th>
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</thead>
<tbody>
<tr>
<td>&lt;80º</td>
<td>Normal Activity</td>
<td>(\frac{3}{4}) Qt/hr</td>
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<tr>
<td>80-84.9º</td>
<td>50min work 10min rest</td>
<td>(\frac{3}{4}) Qt/hr</td>
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<td>85-87.9º</td>
<td>40min work 20min rest</td>
<td>(\frac{3}{4}) Qt/hr</td>
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<td>88-89.9º</td>
<td>30min work 30min rest</td>
<td>(\frac{3}{4}) Qt/hr</td>
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<td>&gt;90º</td>
<td>10min work 50min rest</td>
<td>1 Qt/hr</td>
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Training in Black Flag Heat: EHI Diagnosis and Treatment
EHI Symptoms: HE or HS

Nonspecific:
- Fatigue
- Cramps
- Confusion
- Faint
- Weak and Dizzy
- Nausea, Vomit
- Collapse, unable to continue
EHI Signs (think heat stroke)

T_{rect}: 103F to 110+F (39.4C to 43.3+C)
- If T<103F think water intox’ or heart problem

Mental Status Change: Coma, Combative, Gidy…

Collapse

Seizure

Note: Most or all are SWEATING. NOT DRY (as in classic heat stroke or is possible in the desert)
EHI Management: Equipment

**Field:**
- Coolers with ice water, 2 sheets, 2 towels
- Rectal thermometer, BP cuff
- Communication and vehicle
- 2 L NS and IV supplies (very rarely used)

**Heat Deck:**
- Pool with water, ice, mesh stretcher, buckets
- Rectal thermometer soft probe, BP cuff
- Lab and IV supplies (IVF rarely used in Okinawa)
EHI Management: Field / Transport

- ABCs
- Rectal Temp>103F (39.4C)
  - T<103: consider transport to ED for labs / studies (hyponatremia, cardiac, other dx…)
    - If not concerning, rest, cool, fluids, salty snacks and observe
- COOL transporting to better COOLING.
  - Ice water slurry sheets and towel serial wraps
    - Water Doused, Shade, Strip Clothes to Briefs, Move Air, Cool Packs
- Vitals q5min
- If time, (IV rarely done): 1L NS bolus
  - 2nd liter max at 250cc/hr…careful reassess.
EXERTIONAL HEAT INJURY ALGORITHM
FIELD PROTOCOL

COLLAPSE / EXERTIONAL INCAPACITY

Unconscious

- Verify Unresponsiveness
- Activate EMS
- Address "ABC's"
  - Rapid Cooling
  - Vitals (Rectal T)
  - IV Access only

Conscious

- Assess Mental Status for disorientation
- Vital Signs (BP, HR, RR, Temp)
  - Rectal Temp for all temps!
  - Repeat Vitals q5min. if vital signs or
    mental status abnormal or emesis > 1

If Unstable Vital Signs
If Severe Altered Mental Status

TRANSPORT TO ER

Normal Mental Status
and Temp < 103

Normal Mental Status
and Rectal Temp ≥ 103

Probable HEAT EXHAUSTION
Remove from Heat
Assess Hydration & Calorie depletion

Possible HEAT STROKE
Remove from Heat
Cooling Measures
Bolus IV Fluids

Possible Water Intoxication or MI
TRANSPORT TO ER

TRANSPORT to closest
HEAT Deck clinic or ER

TRANSPORT to closest
HEAT Deck clinic or ER

- DO NOT DELAY COOLING OR TRANSPORT FOR THESE ACTIONS.
- Cooled NS IV Fluid per provider guidance. If mucous membranes dry or "shock" present then bolus 1 L, then KVO. If mucous membranes wet, other signs
  of overhydration or CHF or ≤103 then NS @ KVO. Reassess ongoing IV fluids from clinical response, lung exam, urine output, and labs.
- Aggressive cooling while preparing transfer and while in route if Rectal T > 102. DON'T DELAY COOLING.
- Cooling: Ice water towels or sheets wrapped around body. Ice packs with pouring water over casualty. Cold IV fluids. Fanning, Vehicle air conditioning
  max OR windows open. Helicopter Rotor wash. Stop cooling when the rectal temperature drops below 102.
- Elevate legs, minimize clothing, rest in shade, oral rehydration & food or energy drink as indicated, reassess frequently.
EHI Management: Field / Transport
“Burrito”
EHI Management: Heat Deck

Cool to 102F (38.9C):
- Pool filled on deck, patient on mesh stretcher
- Ice packed on and around patient, water poured over
- Heat deck “code team” 3 to 6 people
  - Water atomizer fan not used
  - Don’t care about shivering except if can’t get T down…pneumonia?
- Rate: 0.4F/min (range 0.23F - 0.5F/min) [0.22C/min (range 0.12C - 0.28C/min)]

Rectal temp continuous monitor or q5min with vitals

IV fluids max 1L w/o reeval, 2L w/o labs
- IVF less important and MOST OFTEN NOT USED

Transport to ED if concerns, not improving, or after cooled to 102F (38.9C) if labs not obtainable at heat deck site.
- Labs obtained: CBC, Na, Cl, K, Cr, Glu, LFTs, CPK, UA
- Monitor, EKG, CXR, Labs (ABG, PT, PTT, FSP, PO4, Ca) as indicated.
Heat Deck Team: 3 to 6 people

- Leader / provider at head with bucket
  - ABCs, directs team, cools head
- Ice placers / bucket dippers / pourers (1-2*)
- Vitals*
- IV / labs*
- Recorder (if available)

* May combine jobs
EXERTIONAL COLLAPSE / INCAPACITATION
HEAT DECK PROTOCOL

Unconscious

 Assess responsiveness & Address ABC’s “AMPLE” Hx

Activate EMS & Address ABC’s
→ RAPID COOLING ⊗
→ O2 / IVF / EKG ⊗
→ Vitals & Rectal Temp q5min ⊗
→ Spot Glucose ⊗
→ Stat Labs ⊗ ⊗

Conscious

Mental Status & Cardiopulmonary Assessment
Vital Signs (BP, HR, RR, Rectal Temp q5min)
→ RAPID COOLING ⊗
→ IVF ⊗
→ Spot Glucose (Glucometer) → Treat if low
→ Stat Labs (Heat Panel) ⊗

If Unstable Vital Signs
Or Severe Altered Mental Status

TRANSPORT TO ER ASAP
Treat for heat stroke or hypoglycemia as appropriate

Altered Mental Status Current Temp > 102

HEAT STROKE
Rapid Cooling ⊗
O2 & IVF ⊗
Reassess Continually Temp q 5 minutes

Stop Cooling When Temp < 102
(Watch for Overshoot and Rebound)

Unstable Vital Signs
Persistent Altered Mental Status,
Extreme Muscle Pain/Tightness

If Vital Signs Stable and Mental Status normal or improving

Exertional Heat Illness (EHI)
Hx of T>103

Normal Mental Status Current Temp > 102

Possible HEAT STROKE
Rapid Cooling ⊗
O2 & IVF ⊗
Reassess Continually Temp q 5 minutes

Stop Cooling When Temp < 102

Normal Mental Status Current Temp < 102

Oral Rehydration
Reassess

Exertional Collapse
No Hx of T>103
(not EHI)

Review labs
Evaluate for Rhabdomyolysis & Organ damage ⊗

ALL TEMPERATURES ARE RECTAL!

• DO NOT DELAY COOLING OR TRANSPORT FOR THESE ACTIONS
• Cool NS IV Fluid per provider guidance. If mucous membranes dry or “shock” present then bolus 1 L then KVO. If mucous membranes wet, other signs of overhydration or CHF or T<103 then NS @ KVO; Reassess ongoing IVF need from clinical response, lung exam, urine output, and labs.
• IMMEDIATE: Na, Gluc, K if available, STAT Heat Panel: CK, Chm B, LFT’s, Uric Acid, UA + Micro, CBC w/diff, Consider PO, Mg, PT, PTT, FSP, ABG, CXR and EKG & myoglobin if severe. CHCS ORDER SET “Heat Panel”. Studies should be done at a MTX capable of performing studies.
• Rapid Cooling Measures: Ice water / nood. Ice Shoots. Cold IV Fluids. Ice packs while rewarming water. Hose waterain. Fans. Stay coolin when temperature
EHI Management: Heat Deck
EHI Management: Heat Deck “Taco” (no pool method)
EHI Management: Other Cooling

- Cool Packs to Axilla, Neck, and Groin
  - Equal to ambient cooling? (helpful if water used)

- Evaporative: In the desert (Hot and Dry)
  - Fast and slow cooling rates reported
  - 20% mortality (Classic Heat Stroke)
    - Helo rotor, windows down driving…

- Water mist / fan: U.S. Emergency Dept. Standard:
  - 0.1F/min (0.06C/min)…10%-20% Mortality

- Cold IVF (0.1F/min)
EHI Management: Stable

- Vitals q15min until cleared
- Review Labs and Studies
- Consider Hospitalization (Table 1)
- SIQ 1 day
<table>
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<tr>
<th>CATEGORY</th>
<th>CARDIOVASCULAR STATUS</th>
<th>CNS STATUS</th>
<th>CREATININE</th>
<th>CK</th>
<th>MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Orthostatic Sx –Tilt Test</td>
<td>Normal</td>
<td>≤1.4</td>
<td>&lt;1000</td>
<td>Follow-up not necessary</td>
</tr>
<tr>
<td>2</td>
<td>Syncope other than Parade syncope</td>
<td>Lethargy, Confusion and/or Slow mentation</td>
<td>1.5 – 1.9</td>
<td>1000 - 2999</td>
<td>Clinical/Lab follow-up in 24 hours</td>
</tr>
<tr>
<td>3</td>
<td>Orthostatic Hypotension +Tilt Test</td>
<td>Combativeness, Delirium and/or Persistent Ataxia/Vertigo</td>
<td>2.0 – 2.9</td>
<td>3000 – 10,000</td>
<td>To Emergency Department for Clinical and Lab Follow-up in 4-8 hours (consider Admission)</td>
</tr>
<tr>
<td>4</td>
<td>Shock</td>
<td>Seizure, Obtundation and/or Coma</td>
<td>&gt;3.0</td>
<td>&gt;10,000</td>
<td>To ED for stabilization &amp; Hospitalization</td>
</tr>
</tbody>
</table>
EHI Management: Follow up

- Reeval next day, repeat labs and follow labs until “good”.

- Return to full duty (2 days to weeks):
  - CPK decreasing near 1000 (to 3000) “good”
  - All other labs normal (LFTs often limit)
  - Exam normal
  - Warrior athlete Sx free, motivated to return

- Administrative separation considered if 2 HS or biopsy proven genetic predisposition.
COOL!...U.S. Marine in Fallujah gets Girl Scout Cookies!
EHI Prevention Summary

- This is a Leadership Issue
  - Develop a plan
  - Teach the plan
    - Know the Risk Factors and work to minimize them.
  - Follow the plan
EHI Treatment Summary

- ABCs
- Rectal Temp
- Rapid, Aggressive Cooling – ICE and WATER!
- Reevaluation
- Return to Duty Multifactorial
QUESTIONS?
REFERENCES:

REFERENCES:

46. Personal Communications: Dr. Jim Cotter, Exercise and Environmental Physiology, University of Otago, Duedin, New Zealand with Dr Steve Blivin OCT 08.
47. Personal Communications: Dr. Fabian Lim, Military Physiology Laboratory Defence Medical and Environmental Research Institute, DSO National Laboratories, Singapore, with Dr Steve Blivin OCT 08
48. Personal Communications: Dr Yoram Epstein, Heller Institute of Medical Research, Tel-Hashomen, Israel with Dr Steve Blivin NOV 2006 and JUN 2008.
49. Exertional Heat Illness Guidelines. USMC Officer Candidate School, Quantico, VA. 2006.