Exertional Heatstroke: Defending and Implementing Best Practice in the Field

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Central Michigan University

Thank you

Mr. Chris Schommer, Med, ATC

Funding Disclosure and Conflict of Interest

• 0 private companies have funded any of the studies discussed today
• The views in this presentation are my own and may not be the views of CMU or my colleagues.
• I hope to present unbiased information

Review: Evidence-Based Medicine Hierarchy

Review: PEDro Scale

Basics of PEDro:
• Used to grade RCTs
• 11 criteria (only 10 scored)
• The higher the PEDro score, the better the study

Current Practice/Thoughts on EHS Diagnosis
**EHS Epidemiology in American Football Athletes**

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Deaths</th>
</tr>
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<tbody>
<tr>
<td>1931-1978</td>
<td>68</td>
</tr>
<tr>
<td>1979-1998</td>
<td>31</td>
</tr>
<tr>
<td>1999-2015</td>
<td>47</td>
</tr>
</tbody>
</table>

**Total for Last 84 Years = 146**

**Last 50 Years = 119**

**Recognizing EHS**

- Two critical variables for identifying EHS:
  - Severe Hyperthermia (elevated core temp)
    - >40.5°C (105°F)
  - Obvious CNS impairment (e.g., altered consciousness, irritability)

**EHS Prognosis**

- The 2 MOST important factors influencing the prognosis of EHS are:
  1. Degree of Hyperthermia
  2. Length of Time the Individual is Hyperthermic

**Exertional Heat Stroke (EHS) Deaths**

Korey Stringer (1974-2001)

$T_{REC} = 42.67°C (109°F)$ @ 70 minutes after collapse

**Survivor... (literally!)**

Survivor, Kaoh Rong (Cambodia, 2016)

**Body Core Temperature Measurement Sites**

- Oral
- Tympanic
- Axillary
- Esophageal
- Intestinal (transmitter)
- Rectal
Which Devices do ATs Perceive as Most Valid?


Rectal & Ingestible perceived as most valid = Great!

But…

What Do the Data Show?


PEDro Score 3/10

EBM Tier 2

What Do the Data Show?


PEDro Score 7/10

EBM Tier 2

New Considerations for EHS Diagnosis

NATA Position Statement: Exertional Heat Illness (c. 2015)

Recommendation #22

But… How far should you insert the thermometer? Does it matter?
What do We Teach our Students?

So We Did a Study...

Step 1: Insert custom rectal probe (measure $T_{rec}$ at 4, 10, 15 cm) & esophageal probe

Step 2: Stand on treadmill for 10 min to acclimate to heat (40°C, 27% rH). Walk/run until esophageal temp reached 39.5°C.

Step 3 & 4: CWI until all 4 sites had temps <38°C. Then, recover in heat for 30 min.

So What?

• Rectal depth matters when measuring body core temperature.
• Inserting a rectal probe 6’’ provides the most accurate measure of body core temperature.

Current Practice/Thoughts on EHS Treatment

Treatment of EHS

• RAPID DIAGNOSIS ($T_{rec}$) & RAPID COOLING!
• Monitor vitals.
• Cool the athlete THEN ship to the ER!
• When rapid diagnosis and CWI performed, survival rates are 100%!!!
EHS Treatment

Can’t I just assume Heatstroke, avoid Rectal Temperature, & Start Immersion?

1. Confirms EHS diagnosis since S/S mimic other conditions
2. Tells you when to remove patient from CWI thereby preventing hypothermia
3. Allows you to develop RTP criteria

If you’re thinking “Naw, I’ll just put them in the tub and not do Trec…”

• Water immersion within 5 min of symptoms (Awesome!)
• EMS called (Great so far!)
• No Trec taken (uh oh…)
• EMS take Gavin out of the tub after 5 min (double uh oh…)
• 30 min later at hospital. Trec = 108°F (42.2°C) (this is not going to end well…)

Outcome of the Gavin Class Case

• Emergency liver transplant
• Almost dies

If you’re thinking “I’ll just cool them until they start to shiver, and then pull them out…”

If an athlete had a Trec of 42°C (108°F) and you pulled them out of the cooling tub after:

6 min = 40.86°C
9 min = 40.29°C

THAT’S STILL HEATSTROKE!!!
Reasons NOT TO Use Shivering as Your Guide for Stopping CWI

1. Not everyone shivers during CWI
2. EHS patients are often unconscious and can’t tell you if their shivering
3. Shivering can occur early during CWI (first 5 mins) which means the patient’s organs are still hot/stressed while they exhibit shivering
4. Skin temperature changes (in addition to core temperature changes) can trigger shivering

Current Practice/Thoughts on EHS in American Football Athletes

1. Practice starts in early August
2. Equipment-intensive sport
3. Intensity of sport
When are American Football Players Dying?


- 58% of deaths (known data) happen at Morning Practice!
- 86% of deaths (known data) happen in first 2 practices!
- 64% of deaths happen in August

NATA Position Statement: Exertional Heat Illness (c. 2002)

- Recommendation #22 (stated #3): "Lower the body core temperature as quickly as possible. The fastest way to decrease body temperature is to remove clothes and equipment and immerse the body (trunk and extremities) into a pool or tub of cold water (approximately 5°C to 15°C, [41°F to 59°F]). Aggressive cooling is the most critical factor in the treatment of exertional heat stroke. Circulation of the tub water may enhance cooling."

New Considerations for EHS Treatment: Necessity of Equipment Removal

So We Did 4 Different Studies...


General Methods for the 4 Studies

- Wear PADS or shorts during CWI (10°C) until \(T_{rec} < 38°C\).
- Exercise in PADS in the heat until \(T_{rec} > 38°C\).
- Pedo Score: 5/10
- EBM Tier: 2/10

Which American Football Players are Dying?


- 60% of fatalities (known data) weighed >110 kg (242.5 lb)
- 79% were considered obese.

PEDro Score: 2/10
EBM Tier: 3/5
Results from the 4 PADS studies

<table>
<thead>
<tr>
<th>Research Study</th>
<th>TREC Cooling Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miller et al, 2015 (Cold-water immersion for...)</td>
<td>0.28 ± 0.12°C/min</td>
</tr>
<tr>
<td>Miller et al, 2015 (Necessity of removing...)</td>
<td>0.23 ± 0.11°C/min</td>
</tr>
<tr>
<td>Miller et al, 2017 (Temperate water immersion...)</td>
<td>0.13 ± 0.05°C/min</td>
</tr>
<tr>
<td>Miller et al, In review JAT (Cooling rates of...)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- 0.28 ± 0.12°C/min
- 0.21 ± 0.11°C/min
- 0.28 ± 0.14°C/min
- 0.13 ± 0.05°C/min
- N/A

Why is CWI Effective with Equipment On?

1. A lot of BSA is still being treated
2. PADS do not interfere with water access to the body (i.e., conductive cooling still occurs)
3. PADS do not interfere much with convective cooling
4. Less shivering with PADS on

Study #4 (Cooling Rates of...) Results

Feeling better after a 30-minute wait... but their TREC were still near EHS temperatures!

So What?

1. PADS should be removed before CWI when:
   - individuals knowledgeable in equipment removal are present,
   - removal tools (e.g., scissors) are immediately available,
   - PADS can be easily removed,
   - PADS interfere with the ability to fully immerse the athlete.
2. If CWI has been delayed or the above are not met, immerse the football athlete with PADS on.
3. Don’t rely on patient perceptions of how hot they feel or the number of symptoms they present—especially if there’s been a delay in treatment! Use TREC to diagnose EHS!

NATA Position Statement (c. 2015) Now Recommends...

Current Thoughts/Practice for EHS Treatment: Water Bath Temperature
NATA Position Statement (c. 2015) Recommends...

To get a large water bath that cold, you need a lot of ice. What if you don’t have access to a lot of ice? Can temperate water reduce $T_{rec}$ effectively?

New Considerations for EHS Treatment: Temperate Water Immersion?

So We Did a... Critically-Appraised Topic (CAT)

PIQ Question = Are $T_{rec}$ cooling rates acceptable (≥0.08˚C/min) when severely hyperthermic humans are immersed in temperate water?

Studies included in CAT; $n = 3$

Studies excluded because of duplicate data reporting by the authors; $n = 1$

PEDro Score; 0/10

EBM Tier 1

CAT Methods and Interventions


Heated subjects to core temperature of 40˚C

Cooled subjects with 20-26˚C water (68-79˚F)

CAT Results


5A sec difference ($P<0.05$)

Control (NO PADS) cooling rate = 0.12 ± 0.05˚C/min

PADS cooling rate = 0.13 ± 0.05˚C/min

PEDro Score 5/10
Temperate Water Immersion VS. Cold-Water Immersion

**T WI PROS**
- Requires fewer resources (e.g., ice)
- Less effort to maintain water temperature
- Patient discomfort, shivering, and cold-shock responses decreased
- Less hypothermic afterdrop = less rewarming

**T WI CONS**
- Slower cooling rates
- Cell damage?
- Organ damage?
- Long-term damage?

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New Considerations for EHS Treatment: Effectiveness of Cooling Vests

ATs perceived effectiveness of cooling methods for EHS

1. Cold-water Immersion
2. Ice vests/blankets

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So What?

1. Use CWI if you can because it takes about 2x as long to cool people with TWI than CWI, but if CWI is not possible...
2. $T_{rec}$-cooling rates are still considered acceptable with TWI
   - EHS Victim with $T_{rec} 42°C$: If PADS left on = 14 mins with CWI; 26 min with TWI
3. Water immersion is more powerful than all other cooling strategies!

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So We Did another CAT

**PEDro Score**

<table>
<thead>
<tr>
<th>EBM Tier</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEDro Score</td>
<td>0/10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Research studies in English (2005-2015)
Examining Cooling Vests to Treat Hyperthermia (Core Temp >38°C)

**Studies Included in CAT**
- n = 8

**Studies excluded for not having PEDro score >6, Oxford EBM Category level 2 or higher, or core temp did not exceed 38°C**
- n = 4

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Table 2. Characteristics of included studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patients, n</th>
<th>Experimental Design &amp; Cooling</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>et al.</td>
<td>n=4</td>
<td>1. Temperate Water Immersion (TWI) with shade; 2. Cold-Water Immersion (CWI) with shade</td>
<td>No significant differences between both cooling vests.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PC17 vest cooling rate = 0.053±0.022°C/min (i.e., &gt;0.08°C/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No vest cooling rate = 0.042±0.015°C/min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gel vest cooling rate = 0.040±0.009°C/min</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Both cooling vests did not meet the acceptable (i.e., &gt;0.08°C/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differences between both cooling vests</td>
<td></td>
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<tr>
<td></td>
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<td>$T_{pre}$ pre-treatment</td>
<td></td>
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<td></td>
<td></td>
<td>$T_{post}$ post-treatment</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>No CI/CT differences after 60 mins</td>
<td></td>
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</tbody>
</table>

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Why are Cooling Vests Ineffective?

1. Don’t cover a lot of BSA
2. Require frequent changing of ice packs/water to optimize cooling
3. Rely only on conduction for cooling
4. Material between vest and skin

What Does This Mean for EHS Victims?

- If $T_{\text{core}}$ was 42°C and cooling vests were used, it would take 100 minutes to reduce $T_{\text{core}}$ to a safe level (i.e., 38°C)
- Goal is to reduce $T_{\text{core}}$ within 30 minutes of collapse

Current Thought on EHS Prevention: WBGT Guidelines

Current National WBGT Guidelines

<table>
<thead>
<tr>
<th>WBGT (°C)</th>
<th>20</th>
<th>21.1</th>
<th>22.2</th>
<th>23.3</th>
<th>24.4</th>
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<tr>
<td>WBGT reading</td>
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<td>22.2</td>
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<tr>
<td>Activity guide</td>
<td>Low intensity</td>
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<tr>
<td>32.3 - 33.5</td>
<td>30 minutes</td>
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<tr>
<td>31.0 - 32.2</td>
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</tr>
<tr>
<td>29.8 - 30.9</td>
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<td>1 hour</td>
<td>1 hour</td>
<td>1 hour</td>
<td>1 hour</td>
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<tr>
<td>28.5 - 29.7</td>
<td>1 hour</td>
<td>1 hour</td>
<td>1 hour</td>
<td>1 hour</td>
<td>1 hour</td>
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<tr>
<td>27.7 - 28.4</td>
<td>1 hour</td>
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Unacceptable cooling rates for EHS victims:

1. Dousing with water while running (~0.03°C/min)
2. Ice packs covering the body (~0.04°C/min)
3. Ice packs at major arteries and dousing with fanning (~0.05°C/min)
4. Fanning and compressed air (~0.04°C/min)

Cooling vests have similar cooling rates as:

- Dousing with water while running (~0.03°C/min)
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Chilled IVs (0.05°C/min)

Train chilled IVs (0.05°C/min)

Ice packs at major arteries

Material between vest and skin

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Material between vest and skin
New Considerations for EHS Prevention:
Using Regional WBGT Guidelines

Why Regional vs. National WBGT Guidelines?

"Revised" Georgia HS Standards for WBGT using Regional System

Different Standards within a State!

Policy Change Saves Lives!
Since 2011:
• 15 States Adopted Heat Acclimatization Policies
# Deaths During Preseason Practices from 1980-2015 = 22 deaths
Since Implementation & Following of EHS policies (50 preseasons): 0 deaths!
Cost = $0

New Considerations for EHS Prevention:
Using Precooling
General Methods for 2 Precooling Studies

Precool for 15 mins in 10°C (50°F) water or not CWI (10°C) until T_rec = 38°C

Put on Pads or No Pads Exercise in heat until T_rec = 39.5°C (103.1°F)


PEDro Score 5/10

EBM Tier No PADS Study With PADS Study

n=12 (6 males, 6 females) n=12 males

Δ=21.05 ± 10.94 min! Δ=17.6 ± 3.6 min!

No difference in cooling once hyperthermic!

Implementing This Information into Clinical Practice


• Scary stuff…
  • 77% of ATs said they read the position statement
  • 76.5% said they treated an EHS
  • <10% of Secondary School ATs use T_rec
  • 25% of College ATs use T_rec

PEDro Score 3/10

Addressing Concerns: COST

Data Therm II 4600 Thermometer Rubbermaid tub
Addressing Concerns: My School Won’t Let Me Do That!

Does your school have a policy on Diastat administration for seizures?

Addressing Concerns: Privacy

1. Privacy NEVER trumps patient care
   - Liability higher for not following best practice!
   - Are your administrators medically trained?
2. Exposure of patient lasts <30 seconds
3. If you have help, exposure can be minimized with towels or “wall of athletes”

How to take a Rectal Temperature and Maintain Privacy

Cooling an EHS victim (Tub Method)

Cooling an EHS Victim (TACo Method)
The “So What” Messages from Today

1. When taking \( T_{rec} \), insert a flexible thermometer 6" to get the most valid reading.
2. You don’t have to remove football gear before CWI or TWI to get acceptable to ideal cooling rates. Perform CWI ASAP and don’t ship until the patient is cooled \( T_{rec} < 102^\circ F \)!
3. Invest in a tub ($100-$300). Water immersion (temperate or cold) is the fastest way to lower \( T_{rec} \).
4. Don’t use cooling vests to treat EHS.
5. Develop regional WBGT guidelines.
6. Develop precooling strategies that are safe (consider anthropometrics, water bath temps, etc.)
7. Some percooling garments don’t prevent hyperthermia, dehydration, or affect how hot you feel

Unrecognized Hero

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Parole, VA 20132
Office: 540-251-2610
Fax: (540)-751-2601

Rectal Temperature Lab

• 3 stations:
  1. Butt model to practice rectal thermistor insertion
     • Try DataTherm 2
     • Try YSI 4600
  2. Cold-water immersion transport for unconscious victims
  3. TACO

Your Questions or Comments?
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