Injury Prevention: Just the Facts

Heat Illness

FACT SHEET 12-005-0316

What is Exertional Heat Illness?

Heat Illness associated with physical exertion is known as exertional heat illness (EHI). EHI is a spectrum of disorders ranging from dehydration to mild heat cramps, to heat exhaustion (when the cardiovascular system cannot maintain the high blood flow required for both movement and sweating), heat injury and heat stroke (when the body cannot regulate its temperature).[1-4] Hyponatremia, also a heat hazard, occurs when excessive water consumption causes an imbalance to the body chemistry.[1-2] **Table 1** summarizes these conditions.

Why is Heat Illness a concern to the Army?

Despite well documented effective techniques to prevent them, EHIs continue to be a threat to Soldiers in training and combat. On average, 2-3 Soldiers die annually from EHI, and more than 1,000 Soldiers develop an EHI requiring medical attention and/or lost duty time.[3] Even mild heat illness can significantly degrade performance. As a result, Army policy mandates all personnel receive annual heat illness prevention training before May of each year, and that all heat stroke and heat exhaustion cases are reported.[1-3,A]

What causes EHI and how can it be prevented?

EHI are caused by a combination of external conditions and indivual risk factors. Key external factors include **H**eat category within the past 3 days, **E**xertion level, **A**cclimation, and **T**ime of exposure and rest period ("**HEAT**") .

✚ *Heat category*

Most EHI occur between May and September, especially above 75°F.[1-7] However, military cases of EHI (including stroke) *occur year-round*, even in cooler temperatures.[4] In addition to the basic temperature, it is important to take into account the amount of sunlight, humidity, and windspeed. The Wet Bulb Globe Temperature (WBGT) index combines these 4 into one value. WBGT Risk Categories **(Table 2)** must be used to determine activity levels.[1,2] ***Prevention:*** *Avoid Risk Categories 4 and 5, especially repeated days; Conduct activities at night/ before sun up, in shade.*[A,B]

✚ *Lack of acclimation*

Higher rates of EHI are seen among trainees, especially recruits from northern locations.[5,6] This is often due to incomplete acclimation, when personnel are not used to sudden climate changes or increased frequency and duration of strenuous activities[6,7] ***Prevention:*** *Gradually increase exposure (e.g., 2 weeks or more) to warm climates and higher exertion levels with rest periods.*[C]

✚ *Exertion (duration, frequency, intensity)*

Strenuous physical training, sports, or job tasks increase EHI risk especially if activities extend over long time periods e.g., >60-90 minutes),[8] are repeated over days, and/or persons must wear protective equipment or carry heavy loads. Physically intense military activities such as Basic Combat Training, field training exercises, and road marches over 8 kilometers are examples of high risk activities. ***Prevention***: *Add 5°F to the WBGT for ruck sack/body armor and 10°F for full chemical protective gear to capture actual risk level. Minimize activity duration, frequency, level of exertion, and/or gear to reduce risk.*[1-4]

✚ *Dehydration*

Even in moderate weather conditions, heavy exertion causes fluid loss which can result in dehydration if not replaced. This increases EHI risk and can result in sub-optimal performance.[9] While 2% loss of body weight from dehydration has been suggested as a threshold for reduced aerobic performance, a specific measurement cannot be stated for everyone given the variability and fluctuation in individuals, other risk factors.[7,9] ***Prevention***: *Monitor hydration status during field training, follow Work/Rest and Water Consumption guidance* ***(Table 3)****, have personnel use knots or black beads on outer garment like in figure (1 per canteen/liter consumed) to monitor hydration status. In addition, first morning urine color charts are good tools to assess day-to-day fluid intake adequacy.*[1,2,A,B]

✚ *Personal risk factors*

- **Previous EHI**: increase risk of developing another EHI. Identify and monitor these Soldiers during training.[1,2]
- **Poor fitness**: 2-mile time >16 min, higher body fat
- **Illness**: fever, diarrhea, flu
- **Age and gender**: Though typical Army heat casualty is a Caucasion male <30 (between 18-25 years old),[5,6] Broader U.S. data suggests persons >40 years have higher risk of EHI and that males have higher risk of heat stroke), while females may have greater risk of mild EHI including heat exhaustion.[5,10]
- **High motivation:** these individuals push themselves harder and may ignore early EHI signs or symptoms.
- **Alcohol**: use in past 24 hours
- **Medication**: antihistamines, blood pressure medications, decongestants, antidepressants, some diuretics
- NOTE: typical consumption of caffeinated drinks has not been shown to lead to fluid loss or dehydration.[9]

Prevention*: Be aware of high risk persons; Identify and mark persons with prior EHI (e.g., use red beads); Use buddy system to monitor signs symptoms and hydration status.*[1]

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Table 1.
Heat Casualties: Signs, Symptom, Actions[1, 10, 11]

Heat cramps : *a first sign to catch*	
• Muscle pain or spasms (abdomen, arms, legs)	• Stop activity, move to shade • Drink juice/water with 1/2 pack salt or sports drink
Heat Exhaustion: *catch signs early & treat*	
• Dizziness • Headache • Nausea • Weakness • Clumsy/unsteady walk • Muscle cramps	• Rest in shade • Loosen uniform/remove head gear • Ensure excess water has not been consumed, have drink 2 quarts water over 1 hour • Evacuate if no improvement in 30 min, or if condition worsens
Heat Stroke: *a medical emergency*	
• Convulsions and chills • Vomiting • Confusion, mumbling • Possibly combative • Passing out (unconscious)	**COOL and CALL (asap)!** • Strip clothing • Rapid cool (ice sheets) • Call for ER evacuation • Continue cooling during transport • Keep same person to observe for mental change through transport
Hyponatremia: *a medical emergency*	
• History of large water consumption • Confusion • Vomiting (liquid, no food)/repeat vomiting • Clear urine • Convulsions	Water intoxication (overconsumption of water) requires medical treatment ASAP!
When in doubt – call 911 for emergency evacuation!	

Table 2.
Wet Bulb Globe Temperature Risk Categories

Category	WBGT, °F	WBGT, °C	Flag Color
1	< 82	< 27.8	White
2	82 - 84.9	27.8-29.3	Green
3	85 - 87.9	29.4 - 31.0	Yellow
4	88 - 89.9	31.1 - 32.1	Red
5 ≥90	≥ 32.2		Black

Figure 1. Wet Bulb Globe Temperature Index Calculator

Table 3. Work/Rest Times and Fluid Replacement Guide

Applies to average size, heat-acclimated Soldier wearing army combat uniform, hot weather (See TB MED 507 [1] for further guidance)

Heat Category	WBGT Index (°F)	Easy Work: Walking on hard surface, 2.5 mph, <30 lb. load; weapon maintenance, marksmanship training.		Moderate Work: Patrolling, walking in sand, 2.5 mph, no load; calisthenics.		Hard Work: Walking in sand, 2.5 mph, with load; field assaults.	
		Work/Rest (minutes)	*Fluid Intake (quarts/hour)*	*Work/Rest (minutes)*	*Fluid Intake (quarts/hour)*	*Work/Rest (minutes)*	*Fluid Intake (quarts/hour)*
1	78° - 81.9°	NL	½	NL	¾	40/20 (70)*	¾ (1)*
2 (GREEN)	82° - 84.9°	NL	½	50/10 (150)*	¾ (1)*	30/30 (65)*	1 (1¼)*
3 (YELLOW)	85° - 87.9°	NL	¾	40/20 (100)*	¾ (1)*	30/30 (55)*	1 (1¼)*
4 (RED)	88° - 89.9°	NL	¾	30/30 (80)*	¾ (1¼)*	20/40 (50)*	1 (1¼)*
5 (BLACK)	> 90°	50/10 (180)*	1	20/40 (70)*	1 (1¼)*	10/50 (45)*	1 (1½)*

NL = No limit to work time per hour.

*Use the amounts in parentheses for continuous work when rest breaks are not possible. Leaders should ensure several hours of rest and rehydration time after continuous work.

This guidance will sustain performance and hydration for at least 4 hours of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).

Rest means minimal physical activity (sitting or standing) in the shade if possible.

Body Armor - Add 5°F to WBGT index in humid climates.

NBC (MOPP 4) - Add 10°F (Easy Work) or 20°F (Moderate or Hard Work) to WBGT Index.

CAUTION: Hourly fluid intake should not exceed 1½ qts. Daily fluid intake should not exceed 12 qts.

1) Dept. of Army TB MED 507 – http://armypubs.army.mil/med/DR_pubs/dr_a/pdf/tbmed507.pdf
2) Dept. of Army TRADOC Regulation 350-29 Prevention of Heat and Cold Casualties (2012)
3) Dept. of Army (2015): OTSG Memorandum, *Heat Illness Program* **and** ALARACT Heat Illness Prevention (2015)
4) DeGroot, D. "Training in the Heat: Fact vs Fiction" *KNOWLEDGE*, 2016 https://safety.army.mil/MEDIA/Knowledge/TabId/97/ArtMID/478/ArticleID/441/Training-in-the-Heat-Fact-and-Fiction.aspx
5) Army Medical Surveillance Activity (AMSA), from Defense Medical Surveillance System (March Surveillance Rpts: Vol 07/No 03 –Vol 22 /No 03)
6) Carter et al., Epidemiology of Hospitalizations and Deaths from Heat Illness in Soldiers. *Med Sci Sports Exerc* 2005.1338-44.
7) Sawka et al., Integrated Physiological Mechanisms of Exercise Performance, Adaptation, and Maladaptation to Heat Stress. *Comp Physiol* 2011.
8) Wallace et al., The Effects of Continuous Hot Weather Training on Risk of Exertional Heat Illness. *Med Sci Sports Exerc*. 2005. Vol 37, 84-90.
9) Kenefick RW and Cheuvront SN, Hydration for recreational Sport and physical activity, *Nutrition Reviews*, 2012, Vol. 70 (Suppl.2):S137-142
10) CDC, Deaths attributed to Heat, Cold, and Other Weather Events in US 9 2006-2010), *National Health Statistics Reports,* No 76, 7/30/14

More: [A] APHC (Prov) Heat Illness Prevention page http://phc.amedd.army.mil/topics/discond/hipss/Pages/HeatInjuryPrevention.aspx
[B] APHC e-Catalog Heat Injury Products (cards, posters) https://usaphcapps.amedd.army.mil/HIOShoppingCart/searchResults.aspx?hotlist=8
[C] Dept. of Army (USARIEM) Acclimatization guidance: http://www.usariem.army.mil/assets/docs/partnering/HeatAcclimatizationGuide.pdf