

# HEAT RELATED ILLNESS: PREVENTION AND MANAGEMENT

Christopher Lewis MSN APRN-FNP

Sports Medicine: Brunner Sanden Deitrick Wellness Center

# HEAT RELATED ILLNESS

- Hyperthermia occurs when the body's heat-regulating mechanisms don't work effectively. Older age, certain illnesses, and medications increase the risk of developing hyperthermia.
- The body maintains temperature homeostasis via four main mechanisms: (1) conduction (ex contact with hot or cold surface), (2) convection (ex a cool breeze or contact with water), (3) radiation (ex proximity to hot equipment), and (4) evaporation (ex sweating). When the body is unable to adequately regulate homeostasis using these methods, heat illness occurs.

# HEAT RELATED ILLNESS

- **Incidence of heat related illness-**
- According to the CDC every year on average in the US there are:
  - 702 heat related deaths
  - 67,512 ER visits
  - 9,235 hospitalizations
- According to the US Bureau of Labor in 2019 there were 43 work related deaths due to heat. This was lower than the high of 61 deaths in 2011 but higher than the number in all but one year from 2012 to 2018.

# HEAT RELATED ILLNESS

- Signs of heat illness-
  - HEAT EDEMA- Swelling of feet and ankles due to vasodilatation (widening of the blood vessels) and venous stasis (decreased return of venous blood). Treatment is removal to cool environment and elevation of the limbs
  - HEAT SYNCOPE- Simple transient loss of consciousness or collapse may occur suddenly after exertion in the heat. The patient's skin is cool and moist, the pulse is weak, and transient hypotension (low blood pressure) occurs. Treatment is rest in a recumbent (lying down) position, cooling, and oral rehydration.
  - HEAT CRAMPS- Spasms of the voluntary muscles of the abdomen and extremities. This is caused by electrolyte depletion (Sodium and Potassium). Treatment consists of fluid and salt replacement. (eg. Sports drinks, Salt tablets). Place the patient in a cool place, and massage/stretch muscles gently. The patient should avoid intense physical exertion for 1–3 days, depending on the severity.

# HEAT RELATED ILLNESS

- HEAT EXHAUSTION- A systemic reaction to prolonged heat exposure (hours to days) and is due to sodium depletion, dehydration, accumulation of metabolites, or a combination of these factors. It is a premonitory syndrome that rapidly evolves to heat stroke. Central nervous system symptoms are not present, and the core body temperature is usually less than 40°C (104°F) and can be normal.
  - Two types of heat exhaustion- Most cases a combination of both
  - Hypernatremic (primary water loss) Heat exhaustion from primary water loss occurs when an individual in a hot environment lacks appropriate hydration.
  - Hyponatremic (primary sodium loss). Heat exhaustion from primary salt loss occurs when an individual in a hot environment sweats excessive amounts and replaces fluid losses with water.

# HEAT RELATED ILLNESS

- HEAT EXHAUSTION (cont)- Signs and symptoms of heat exhaustion are nonspecific and include headache, nausea, vomiting, malaise, muscle cramps, and dizziness. Dehydration is manifested by tachycardia, hypotension, and diaphoresis.
  - Initial treatment includes placing the patient in a cool place and giving adequate oral hydration. If the patient is unable to drink fluids they should be taken to the hospital.

# HEAT RELATED ILLNESS

- HEAT STROKE- Characterized by dysfunction of the heat regulating mechanism, with altered mental status (ranging from confusion to coma) and elevated core body temperature in excess of 40°C (104°F).
  - Sweating is variable. The extremely high body temperature can rapidly cause widespread damage to body tissues, with significant rhabdomyolysis (rapid breakdown of muscle tissue) and multiorgan dysfunction.
  - Illness and death result from destruction of cerebral, cardiovascular, hepatic, and renal tissue. Heat stroke has the highest mortality of all heat-related illnesses, however, prompt cooling yields favorable survival rates (90–100%).

# HEAT RELATED ILLNESS

- Heat Stroke (cont)- Initial symptoms include headache, dizziness, nausea, diarrhea, and visual disturbances. Most patients have profound central nervous system dysfunction including seizures, delirium, ataxia, and coma. The skin is hot, flushed, and usually dry (although sweating may be present). Treatment should include placing the patient in a shady, cool place and remove his or her clothing. Sprinkle the patient's entire body with water, and cool by fanning, which will promote evaporative cooling and immersion in cool (not cold) water if possible. Emergency Services should be contacted ASAP.

# HEAT RELATED ILLNESS

- **Management of Heat Stress-** Implementation of controls to mitigate heat stress
- **Environmental Controls-**
  - Increase air velocity, use reflective or heat-absorbing shielding or barriers, reduce steam leaks, wet floors, or humidity.
- **Work Practice Controls-**
  - Limit time in the heat and/or increase recovery time spent in a cool area.
  - Reduce the metabolic (physically difficult) demands of the job (ex. by use of tools or increased workers per task).
  - Train supervisors and workers about heat stress.
  - Use a buddy system where workers observe each other for signs of heat-related illnesses.
  - Use a heat alert program whenever the weather service forecasts a heat wave
  - Institute a heat acclimatization plan and encourage increased physical fitness.

# HEAT RELATED ILLNESS

- **Training- for all workers and supervisors about the following:**
  - Recognition of the signs and symptoms of heat-related illnesses and administration of first aid.
  - Causes of heat-related illnesses and steps to reduce the risk. These include drinking enough water and monitoring the color and amount of urine output.
  - Proper care and use of heat-protective clothing and equipment and the added heat load caused by exertion, clothing, and personal protective equipment.
  - Effects of other factors (drugs, alcohol, obesity, etc.) on tolerance to occupational heat stress.
  - The importance of acclimatization.
  - The importance of immediately reporting any symptoms or signs of heat-related illness in themselves or in coworkers to the supervisor.
  - Procedures for responding to symptoms of possible heat-related illness and for contacting emergency medical services.

# HEAT RELATED ILLNESS

- **Supervisors should also be trained on the following:**
  - Implementing appropriate acclimatization.
  - What procedures to follow when a worker has symptoms of heat-related illness, including emergency response procedures.
  - Monitoring weather reports.
  - Responding to hot weather advisories.
  - Monitoring and encouraging adequate fluid intake and rest breaks.

# HEAT RELATED ILLNESS

- **Reducing heat burden-** Wearing PPE and certain clothing ensembles can often increase your risk for heat-related illnesses. PPE (e.g., waterproof aprons, surgical gowns, surgical caps, respirators, face shields, boots, and gloves)
  - Reduces the body's normal way of getting rid of heat by sweating and other means.
  - Holds excess heat and moisture inside, making the worker's body even hotter.
  - Increases the physical effort to perform duties while carrying the extra weight of the PPE and can lead to the worker getting hotter faster (e.g., working muscle increases body heat production).

# HEAT RELATED ILLNESS

- **Acclimatization-** Acclimatization is the result of beneficial physiological adaptations (e.g., increased sweating efficiency, etc.) that occur after gradual increased exposure to a hot environment. Employers should ensure that workers are acclimatized before they work in a hot environment.
  - Gradually increase workers' time in hot conditions over 7 to 14 days.
  - Closely supervise new employees for the first 14 days or until they are fully acclimatized.
  - Workers who are not physically fit need more time to fully acclimatize.
  - Acclimatization can be maintained for a few days of non-heat exposure.
  - Taking breaks in air conditioning will not affect acclimatization.

# HEAT RELATED ILLNESS

- **Hydration-** Workers should drink an appropriate amount to stay hydrated-
  - For moderate activities in the heat that last less than 2 hours, drink 1 cup (8 oz.) of water every 15–20 minutes.
  - If sweating lasts for several hours, drink sports drinks containing balanced electrolytes.
  - Avoid alcohol and drinks with high caffeine or sugar.
  - Generally, fluid intake should not exceed 6 cups per hour.
  - Properly hydrated worker should have urine that is a light yellow color

# HEAT RELATED ILLNESS

- **Rest Breaks-** Employers should ensure and encourage workers to take appropriate rest breaks to cool down and hydrate.
  - Permit rest and water breaks when a worker feels heat discomfort.
  - Modify work/rest periods to give the body a chance to get rid of excess heat.
  - Assign new and unacclimatized workers lighter work and longer, more frequent rest periods.
  - Shorten work periods and increase rest periods:
    - As temperature, humidity, and sunshine increase.
    - When there is no air movement.
    - If protective clothing or equipment is worn.
    - For heavier work.

# HEAT STRESS Acclimatization

New employees are at the highest risk for heat illness. Acclimatization is crucial to working in hot conditions.

## Things you need to know:

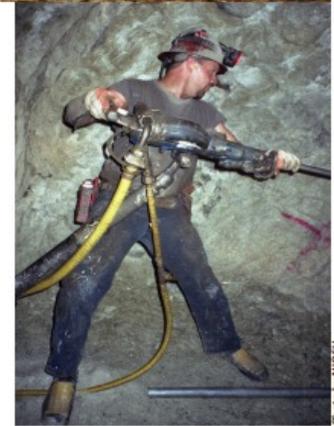
- Heat acclimatization is the improvement in heat tolerance that comes from gradually increasing the intensity or duration of work performed in a hot setting.
- The best way to acclimatize yourself to the heat is to increase the workload performed in a hot setting gradually over a period of 1–2 weeks.
- You begin to lose your acclimatization after about 1 week away from working in the heat.

## What are the benefits of heat acclimatization?

- Heat exposure causes less strain to the heart and other vital organs.
- Sweating improves (higher volume, earlier onset), which cools the body more quickly. Acclimatized workers need more water—not less—due to increased sweating.
- Workers increase their ability to comfortably perform physical tasks in the heat.

## Tips for acclimatization

- Best results will come from gradually increasing work time in hot conditions over a period of 7 to 14 days, and cooling off and fully rehydrating between shifts.
- **Pushing to the point of heat exhaustion will hurt, not help, your heat tolerance.**
- Typically, acclimatization requires at least two hours of heat exposure per day (which can be broken into two, 1-hour periods).
- The body will acclimatize to the level of work demanded of it. Simply being in a hot place is not sufficient. Doing light or brief physical work in the heat will acclimatize you **ONLY** to light, brief work. More strenuous or longer tasks require more acclimatization.
- Stay hydrated! Dehydration reduces the benefits of heat acclimatization.
- Eating regular meals aids acclimatization. Food replaces electrolytes lost in sweat, especially during the first few days of acclimatization, when you lose the most salt in sweat.
- Physical fitness aids acclimatization.



## Sample Acclimatization Schedule

### NIOSH Acclimatization Recommendations for New Workers

1st day	20% usual work duration
2nd day	40% usual work duration
3rd day	60% usual work duration
4th day	80% usual work duration
5th day	100% usual work duration

### NIOSH Acclimatization Recommendations for Workers with Previous Experience\* with the Same Job

1st day	50% usual work duration
2nd day	60% usual work duration
3rd day	80% usual work duration
4th day	100% usual work duration

\*Workers returning from an absence

- Managers should have a formal acclimatization plan for employees working in the heat. Starting new employees at full intensity is not safe.
- Adjustments to the acclimatization schedule may be needed depending on the worksite's situation and on individual factors.
- **Most workers should be able to safely handle a full workload after 4 days of gradual increase, even though they will usually not be fully acclimatized yet. Most people will continue to see beneficial improvements in heat tolerance for up to 2 weeks after exposure starts.**
- Sudden shifts in work intensity or sudden increases in environmental temperature can increase the risk for heat illness even for acclimatized workers.

## Case Study: Hazards of Not Acclimatizing Workers

A 41-year-old construction worker was sawing boards in 93 °F heat. At 5 p.m., the worker collapsed in the parking lot. He was found by another employee. His body temperature was recorded at 108 °F when he was admitted to the hospital. He died the next day. At the time of the incident, the employee had been working for the company for one day. The company had no formal heat stress policy or acclimatization plan.

### Lessons Learned

- Heat casualties often occur with new or less experienced employees.
- Deaths from heat stress often occur during the first few days on the job.
- Employers should have heat stress policies, and should implement acclimatization plans.



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## Urine Color Test

WELL HYDRATED

HYDRATED

DEHYDRATED  
Drink water!

SEVERELY DEHYDRATED  
Drink water immediately!

## HEAT STRESS

# Hydration

Drinking enough fluids is one of the most important things you can do to prevent heat illness. Water is generally sufficient for hydration.

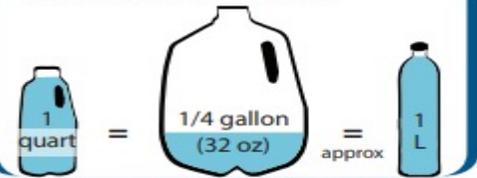
### Hydrate *Before* Work

- Being hydrated when you start work makes it easier to stay hydrated through the day.
- If you are dehydrated when you start work, you may not be able to drink enough to catch up with your body's need for water.

### Hydrate *During* Work

- Drink before feeling thirsty. **By the time you feel thirsty, you are already behind in fluid replacement.** Dehydration is a primary contributor to heat exhaustion.
- Your work performance may suffer when you are dehydrated, even if you don't notice.
- When working in the heat, drink 1 cup (8 ounces) of water every 15–20 minutes.
  - This translates to  $\frac{3}{4}$ –1 quart (24–32 ounces) per hour.
  - Drinking at shorter intervals is more effective than drinking large amounts infrequently.
- Do not drink more than 48 oz (1½ quarts) per hour! Drinking too much water or other fluids (sports drinks, energy drinks, etc.) can cause a medical emergency because the concentration of salt in the blood becomes too low.

#### How much water is that?



### Hydrate *After* Work

- Most people need several hours to drink enough fluids to replace what they have lost through sweat. The sooner you get started, the less strain you place on your body from dehydration.
- Hydrating after work is even more important if you work in the heat on a regular basis. Chronic dehydration increases the risk for a number of medical conditions, such as kidney stones.

## What to Drink

### Water

**Water will almost always maintain hydration during work in the heat, as long as you eat regular meals to replace salt lost in sweat.**

Photo by ©Thinkstock

## What to Avoid

### Energy Drinks

- Some energy drinks contain much more caffeine than standard servings of coffee, tea, or soft drinks.
- Drinking several energy drinks per day can raise your caffeine levels enough to affect your heart. High caffeine levels can be risky when added to the strain placed on your body by heat.
- Many energy drinks contain as much or more sugar as soft drinks, which adds hundreds of extra calories to your diet.

### Alcohol

- Alcohol can cause dehydration.
- Drinking alcohol within 24 hours of working in the heat can increase the risk of heat illness.

### What about salt tablets?

NIOSH does not recommend taking salt tablets. In most cases, salt can be replaced by eating normal meals and snacks throughout the day. Do not skip meals.

### What about caffeine?

The amount of caffeine in tea, coffee, and soft drinks probably will not have an effect on overall hydration.

### Do I need sports drinks?

In general, eating regular meals with adequate water intake is sufficient to maintain water and electrolyte balance.

For prolonged sweating lasting several hours, sports drinks with balanced electrolytes are another option to replace salt lost in sweat.

Heavy consumption of sports drinks will add unnecessary calories to your diet due to the added sugar.

## Case Study: Heat Stroke

A 44-year-old male worker died of heat stroke while working on a North Carolina farm. The man had been working in the fields for about a week. On August 1st, the heat index was between 100 °F and 110 °F. Around 3 p.m., the worker complained to the crew leader that he was feeling ill. He drank some water and was driven to the employee housing and left alone. He was found unconscious 45 minutes later. Emergency personnel took the worker to the hospital, where he was pronounced dead. His core body temperature was 108 °F.

## Lessons Learned

- Feeling ill while working in the heat is a serious warning sign. Any employee who reports feeling unwell during work in hot conditions could have heat exhaustion, which can quickly progress to heat stroke if not treated.
- Proper first aid for someone with suspected heat exhaustion or heat stroke involves **COOLING** the body as quickly as possible—not simply drinking water.
- People with severe heat illness do not always recognize the risks they face. If a worker shows signs of heat exhaustion or heat stroke, do not leave him or her alone until he or she receives medical attention.



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# Work/Rest Schedules

Using work/rest schedules can decrease the risk of heat illness

## Sample Work/Rest Schedule for Workers Wearing Normal Clothing\*

The NIOSH work/rest schedule is based on air temperature, with adjustments for direct sunlight and humidity. It may not be applicable to all worksites. Other work/rest schedules are available, some of which are based on Wet Bulb Globe Temperature.

See reverse for temperature adjustments for the NIOSH work/rest schedule and examples of light, moderate, and heavy work.

Temperature (°F)	Light Work Minutes Work/Rest	Moderate Work Minutes Work/Rest	Heavy Work Minutes Work/Rest
90	Normal	Normal	Normal
91	Normal	Normal	Normal
92	Normal	Normal	Normal
93	Normal	Normal	Normal
94	Normal	Normal	Normal
95	Normal	Normal	45/15
96	Normal	Normal	45/15
97	Normal	Normal	40/20
98	Normal	Normal	35/25
99	Normal	Normal	35/25
100	Normal	45/15	30/30
101	Normal	40/20	30/30
102	Normal	35/25	25/35
103	Normal	30/30	20/40
<b>104</b>	<b>Normal</b>	<b>30/30</b>	<b>20/40</b>
105	Normal	25/35	15/45
106	45/15	20/40	Caution
107	40/20	15/45	Caution
<b>108</b>	<b>35/25</b>	<b>Caution</b>	<b>Caution</b>
109	30/30	Caution	Caution
110	15/45	Caution	Caution
111	Caution	Caution	Caution
112	Caution	Caution	Caution

### Things you need to know:

- Continuous work in the heat is not advisable—you must take rest breaks periodically to allow your body to cool down.
- A variety of work/rest schedules are available that can be adapted to your worksite. Relying on self-pacing alone may not be sufficient.

### Example

A worker performing heavy work in 104 °F temperatures should work for 20 minutes and rest for 40 minutes.

### Example

A worker performing moderate work at 108 °F should use extreme caution! The risk for heat injury is high in this situation.

\* From NIOSH Criteria for a Recommended Standard, Occupational Exposure to Heat and Hot Environments, <https://www.cdc.gov/niosh/docs/2016-106/pdfs/2016-106.pdf>. Assumptions: workers are physically fit, well-rested, fully hydrated, under age 40, and environment has 30% humidity and perceptible air movement.

### Things you need to know:

- Heat illness can strike quickly—learn to recognize the symptoms.
- Workers with heat illness should stop working, get cool, and drink fluids.
- Altered mental state can be a sign of heat stroke and requires immediate attention.
- When treating severe heat illness, cooling is the first priority.

## HEAT STRESS

# First Aid for Heat Illness

Cooling is key. Know the symptoms and treatment of heat illness.

### Signs and Symptoms

Symptoms can occur in any order. For example, a person will not always experience heat cramps before they suffer from heat exhaustion.

### What to Do

Less Severe

#### Heat Rash/Prickly Heat

- Red cluster of pimples or small blisters, usually on neck, upper chest, groin, under breasts, and in elbow creases
- Extensive areas of skin that do not sweat on heat exposure, but present gooseflesh appearance that subsides with cool environments

- When possible, a cooler, less humid work environment is the best treatment
- Keep rash area dry
- Powder can be applied to increase comfort
- Do not use ointments or creams, as they may impair cooling—warm, moist skin can make the rash worse

#### Heat Cramps

- Muscle cramps, pain, or spasms in the abdomen, arms, or legs

- Drink fluids every 15 to 20 minutes and eat a snack or sports drink
- Avoid salt tablets
- Get medical help if the worker has heart problems, is on a low sodium diet, or if cramps do not subside within 1 hour

Severe

#### Heat Syncope (Fainting)

- Fainting, dizziness, or light-headedness after standing or suddenly rising from a sitting/lying position

- Sit or lie down in a cool place when beginning to feel faint or dizzy
- Slowly drink water or clear juice

#### Heat Exhaustion

- Headache
- Nausea
- Dizziness, weakness
- Irritability
- Thirst, heavy sweating
- Elevated body temperature
- Decreased urine output

- Call for medical help or take worker to a health facility for evaluation and treatment
- Stay with worker until help arrives
- Remove worker from hot area and give liquids to drink
- Remove unnecessary clothing, including shoes and socks
- Cool worker with water, cold compresses, an ice bath, or fans
- Encourage frequent sips of cool water

OFTEN FATAL

#### Heat Stroke

- Confusion, altered mental state, slurred speech, loss of consciousness
- Hot, dry skin or profuse sweating
- Seizures
- Very high body temperatures
- Fatal if treatment delayed

- This is an emergency! Call for emergency care immediately!
- Move worker to a cool area and remove outer clothing
- Cool worker with water, cold compresses, an ice bath, or fans
- Circulate air around worker to speed cooling
- Place cold, wet cloths or ice on head, neck, armpits, and groin
- Stay with worker until emergency medical services arrive

# REFERENCE

- Bowers R.C., & Vivolo J.C. (2017). Disorders due to physical & environmental agents. Stone C, & Humphries R.L. (Eds.), CURRENT Diagnosis & Treatment: Emergency Medicine, 8e. McGraw Hill.  
<https://accessemergencymedicine.mhmedical.com/content.aspx?bookid=2172&sectionid=165069554>
- Centers for Disease Control (2023). Heat & Health Tracker.  
<https://ephtracking.cdc.gov/Applications/heatTracker/>
- The National Institute for Occupational Safety and Health (NIOSH) (2018, June 6). Acclimatization. <https://www.cdc.gov/niosh/topics/heatstress/acclima.html>
- The National Institute for Occupational Safety and Health (NIOSH). (2018, June 6). Limiting Heat Burden While Wearing Personal Protective Equipment (PPE). [https://www.cdc.gov/niosh/topics/heatstress/heat\\_burden.html](https://www.cdc.gov/niosh/topics/heatstress/heat_burden.html)
- Bureau of Labor Statistics, U.S. Department of Labor, The Economics Daily, 43 work-related deaths due to environmental heat exposure in 2019 at <https://www.bls.gov/opub/ted/2021/43-work-related-deaths-due-to-environmental-heat-exposure-in-2019.htm> (visited May 30, 2023).