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# Preventing Heat Stress

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by Thomas D. Landis

It's that time of the year when nursery workers are exposed to long hours in the sun, and are therefore at risk to a number of heat-related illnesses. Heat stress is a function of both environmental conditions and personal conditioning. Four environmental factors contribute to heat stress: air temperature, humidity, wind velocity, and radiant heat. People vary in susceptibility to heat with age, gender, weight, physical condition, medical history, and degree of acclimation.

**How the Body Handles Heat.** The human body, being warm blooded, maintains a fairly constant internal temperature, even though it is being exposed to varying environmental temperatures. To keep internal body temperatures within safe limits, the body must get rid of its excess heat, primarily through varying the rate and amount of blood circulation through the skin and the release of fluid onto the skin by the sweat glands. These automatic responses usually occur when the temperature of the blood exceeds 98.6 °F (37 °C) and are kept in balance and controlled by the brain. In this process of lowering internal body temperature, the heart begins to pump more blood, blood vessels expand to accommodate the increased flow, and the microscopic capillaries dissipate heat to the environment. If heat loss from increased blood circulation through the skin is not adequate, the brain senses overheating and signals the sweat glands to emit sweat onto the skin surface. Evaporation of sweat cools the skin, eliminating large quantities of heat from the body (NIOSH 1986).

The effectiveness of sweating greatly depends on atmospheric conditions, especially humidity and wind speed. As atmospheric humidity increases or wind speed decreases, evaporation of sweat from the skin slows until at very high humidities, the body sweats profusely with little beneficial cooling. With so much blood going to the external surface of the body, relatively less goes to the active muscles and the brain, resulting in fatigue and loss of mental acuity. In extreme cases, fainting can result from overheating. Workers who perform precise or detailed work may find their accuracy suffering, and their comprehension and retention of information may diminish.

## Diagnosing Illnesses Caused by Exposure to Heat

Excessive heat exposure can cause a variety of illnesses, which can vary greatly between individuals. The major illnesses are listed by their order of severity (Table 1).

**Heat fatigue** is the least serious heat-related condition, and common symptoms include impaired performance of skilled sensory, mental, or vigilance jobs, and is often due to a lack of acclimatization. Therefore, developing of a program of acclimatization and training for work in hot environments is advisable. There is no treatment for heat fatigue except to get away from the heat stress before a more serious condition develops.

**Heat rashes** are the most common problem in hot work environments. Prickly heat is manifested as red papules and usually appears in areas where the clothing is restrictive or where body parts rub. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

**Heat cramps** are usually caused by performing hard physical labor in a hot environment. Cramps are thought to be triggered by an electrolyte imbalance due to excess sweating, but they can be caused by either too much or too little salt. Instead, heat cramps appear to be caused by the lack of water replenishment; excess salt can build up in the body if the water lost through sweating is not replaced. Under extreme conditions, such as working in heavy protective gear, a loss of sodium may occur. Recent studies have shown that drinking carbohydrate-electrolyte replacement liquids is effective in preventing or treating heat cramps.

**Heat exhaustion** is characterized by symptoms such as headache, nausea, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment. Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous under many work conditions. Of greater concern is that the signs and symptoms of heat exhaus-

Type of Illness	Signs and Symptoms	Treatment
<b>Mild Heat Stress</b>	<ul style="list-style-type: none"> <li>• Dizziness, fatigue, or irritability with decreased concentration and impaired judgement</li> </ul>	<ul style="list-style-type: none"> <li>• Loosen clothing</li> <li>• Rest in shade</li> <li>• Drink water</li> </ul>
<b>Heat Rash</b> ("Prickly Heat")	<ul style="list-style-type: none"> <li>• Tiny, blister-like red spots on the skin with prickling or itching.</li> <li>*Common on clothed areas of body</li> </ul>	<ul style="list-style-type: none"> <li>• Wash skin and apply lotion or corn starch</li> <li>• See physician if rash persists</li> </ul>
<b>Heat Cramps</b>	<ul style="list-style-type: none"> <li>• Heavy sweating; painful spasms of legs, arms, or abdominal muscles; can occur after strenuous work</li> </ul>	<ul style="list-style-type: none"> <li>• Loosen clothing</li> <li>• Drink lightly salted liquids or sports drinks</li> <li>• Massage affected muscles</li> </ul>
<b>Heat Exhaustion</b>	<ul style="list-style-type: none"> <li>• Profuse sweating, fatigue, headache, dizziness, nausea, chills, fainting</li> <li>• Pale, cool skin; excessive thirst, dry mouth; dark yellow urine</li> <li>• Fast pulse, with body temperature from 99.5 to 101.3°F (38 to 39°C)</li> </ul>	<ul style="list-style-type: none"> <li>• Move patient to shade and make them recline and rest</li> <li>• Loosen and moisten clothing, and fan to cool body</li> <li>• Encourage patient to drink water, <i>but do not give salt</i></li> <li>• <i>If patient becomes unconscious, treat for heat stroke</i></li> </ul>
<b>Heat Stroke</b> ** Life-threatening Emergency **	<ul style="list-style-type: none"> <li>• Often develops suddenly</li> <li>• Headache, dizziness, confusion, incoherent speech, irrational or aggressive behavior</li> <li>• Sweating may decrease or even stop</li> <li>• Body temperature of more than 104°F (40°C)</li> </ul>	<ul style="list-style-type: none"> <li>• Move patient to shade and wrap body with wet cloth and fan to cool</li> <li>• Treat for shock by elevating legs</li> <li>• Transport immediately to medical treatment facility</li> <li>• Encourage patient to drink water, <i>but do not give salt</i></li> </ul>

Table 1 - Heat Stress can be expressed in a variety of different illnesses that can be distinguished by specific signs, symptoms, and treatments.

tion are similar to those of heat stroke, a medical emergency. Workers suffering from heat exhaustion should be removed from the hot environment and given fluid replacement, and encouraged to get adequate rest.

**Heat stroke** is the most serious condition, which occurs when the body's system of temperature regulation fails and body temperature rises to critical levels. Heat stroke is caused by a combination of highly variable factors, and its occurrence varies greatly between individuals. Heat stroke is a medical emergency, so if a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The primary symptoms of heat stroke are confusion, irrational behavior, loss of consciousness, convulsions, and a hot, dry skin. The most diagnostic symptom is an abnormally high body temperature — a rectal temperature of 106 °F (41°C). In such extreme cases, death can

result. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment. Regardless of their protests, no employee suspected of being ill from heat stroke should be left unattended or sent home until examined by a physician.

## Managing Heat-Related Problems

Avoiding heat stress is the common responsibility of the nursery manager and the workers, so regular training is essential. A comprehensive heat safety program should consist of six steps:

**Assign responsibility** - Make sure that someone takes the lead in the program. Ideally, one field worker should be appointed a safety coordinator and receive special training, but everyone should be taught to look out for each other.

**Hold seasonal training** - All new workers, and especially supervisors, should be trained in the recognition, prevention, and treatment of heat-related problems. Refresher courses should be given at the beginning of each season and work crews should be reminded with periodic tail-gate sessions and posters. A wide variety of training aids and posters are available from the Occupational Health and Safety Administration (OSHA) of the US Department of Labor (Figure 1). Many other training aids are available on the internet in both English and Spanish. One particularly good resource for tailgate training is Heat Hazards in Agriculture (Teran 2008).

**Acclimatize workers** - The human body needs time to adapt to working in the sun and heat, and this is particularly important for new employees. Acclimatization is a physiological process where the body adapts to the type of work and ambient heat levels, improving the circulation system and salt balance. It usually takes about two weeks, although individuals acclimatize at different rates. Everyone, regardless of their age or physical condition needs time to acclimate to heat, so don't assume that someone in good physical shape will naturally be more heat tolerant.

**Adjust for weather conditions and type of work** - Work assignments should take into account weather, workload, the physical condition of the worker, and if special protective clothing will be worn. Watch weather forecasts and monitor conditions at the work site, and then adjust the job accordingly. Assign tasks based on ability, acclimatization, and general health. Schedule work during cooler hours of the morning and evening, and postpone strenuous jobs during unseasonably hot weather. Because pesticide application requires protective clothing that can rapidly create heat stress, schedule this work for early in the morning or late in the evening. Schedule frequent water and rest breaks and provide shade.

## OSHA QUICK CARD™

### Protect Yourself Heat Stress



When the body is unable to cool itself by sweating, several heat-induced illnesses such as heat stress or heat exhaustion and the more severe heat stroke can occur, and can result in death.

#### Factors Leading to Heat Stress

High temperature and humidity; direct sun or heat; limited air movement; physical exertion; poor physical condition; some medicines; and inadequate tolerance for hot workplaces.

#### Symptoms of Heat Exhaustion

- Headaches, dizziness, lightheadedness or fainting.
- Weakness and moist skin.
- Mood changes such as irritability or confusion.
- Upset stomach or vomiting.

#### Symptoms of Heat Stroke

- Dry, hot skin with no sweating.
- Mental confusion or losing consciousness.
- Seizures or fits.

#### Preventing Heat Stress

- Know signs/symptoms of heat-related illnesses; monitor yourself and coworkers.
- Block out direct sun or other heat sources.
- Use cooling fans/air-conditioning; rest regularly.
- Drink lots of water; about 1 cup every 15 minutes.
- Wear lightweight, light colored, loose-fitting clothes.
- Avoid alcohol, caffeinated drinks, or heavy meals.

#### What to Do for Heat-Related Illness

- Call 911 (or local emergency number) at once.

While waiting for help to arrive:

- Move the worker to a cool, shaded area.
- Loosen or remove heavy clothing.
- Provide cool drinking water.
- Fan and mist the person with water.

For more complete information:

**OSHA** Occupational Safety and Health Administration  
U.S. Department of Labor  
[www.osha.gov](http://www.osha.gov) (800) 321-OSHA

OSHA 3154-07R-05

Figure 1 - A wide variety of training aids and posters are available from the Occupational Health and Safety Administration (OSHA) of the US Department of Labor.

**Establish a drinking water program** - Dehydration is the primary cause of heat-related illnesses, so replacing water loss through sweating is the single most important factor of a heat safety program. The human body contains about 5 quarts (4.7 l) of blood (mostly water), which helps cool the body by conducting heat produced by the muscles to the skin surface. The amount of water that is needed to prevent dehydration varies between individuals, and is affected by temperature, humidity, and the type of work. An average person requires 6 to 10 quarts (5.7 to 9.5 l) of water on a hot summer day. Because the feeling of being thirsty always lags behind actual dehydration, workers should be trained to drink some water before starting the job, and then drink more “by the clock”. That’s at least one cup (about 0.25 l) of water every 30 minutes under average conditions, and more when temperatures increase (Figure 2). Chugging water to quench an intense thirst makes no more sense than pouring water on an already wilted plant. Water temperature should be cool but not cold, and plain water is generally preferable to other types of liquid, including sports drinks.

Salt tablets should not be taken with water. The average American diet contains sufficient salt for acclimatized workers even when sweat production is high. If, for some reason, salt replacement is required, the best way to compensate for the loss is to add a little extra salt during meals (NIOSH 1986)

**Make proper clothing a condition of employment** - Heavy clothes trap heat near the body and dark colors absorb the most sunlight so encourage workers to wear light-colored, loose-weave cotton garments. Hats or visors should be required when working outdoors.

## References and Sources of Additional Information

National Institute for Safety and Occupational Health. 1986. Working in hot environments NIOSH Publication No. 86-112. 6 p. Available at: <http://www.cdc.gov/niosh/hotenvt.html> (accessed 29 Jul 2010).

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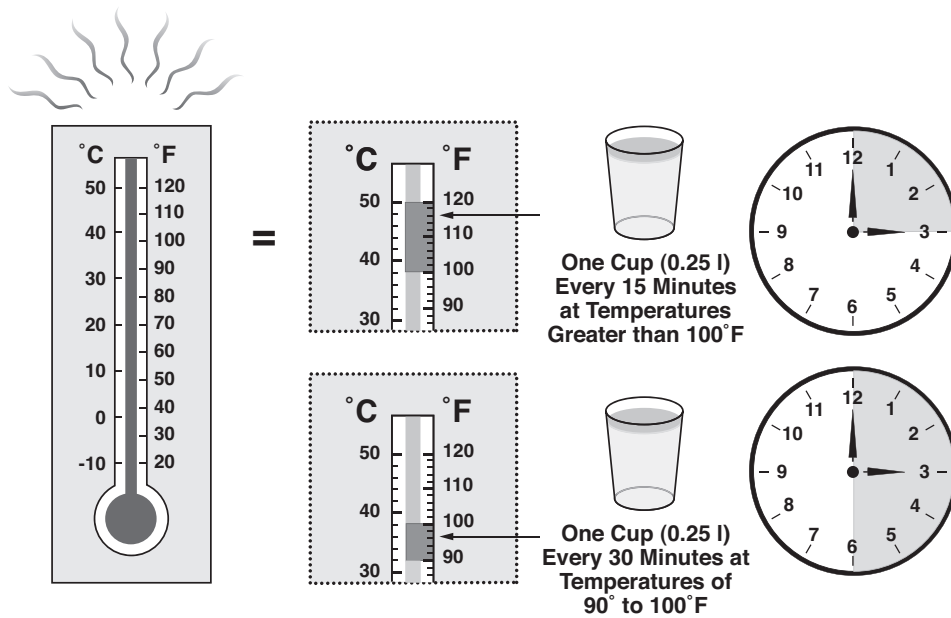


Figure 2 - Workers should be trained to drink some water before starting the job, and then drink more “by the clock”. That’s at least one cup (0.25 l) of water every 30 minutes under average conditions, and more when temperatures increase.