Heat-Related Illnesses

The Role of the Occupational and Environmental Health Nurse

by Bonnie Rogers, DrPH, COHN-S, LNCC, FAAN, Kristin Stiehl, RN, BSN, CCM, Jennifer Borst, RN, BSN, COHN, Andrea Hess, RN, BSN, CEN, and Shauna Hutchins, RN, BSN, BA

ABSTRACT

Heat-related illnesses can occur in workplaces where hot environments pose a threat to at-risk workers. Operations involving high air temperatures and humidity, radiant heat sources, direct physical contact with hot objects, or strenuous physical activities have potential for inducing heat stress in employees engaged in job functions in specific industries. Exposure to high temperatures can lead to a progression of symptoms in the body, which can result in widespread tissue damage, organ damage, and even death if not treated in a timely and effective manner. Strategies to reduce the effects of heat in the workplace include engineering controls, administrative controls, and personal protective equipment. Occupational and environmental health nurses must be able to recognize and treat the broad range of symptoms that can result from exposure to high temperatures. They must work together with interdisciplinary teams to provide training and education to the work force so that workers are able to take appropriate measures to prevent the onset of a heat-related illness, recognize the early symptoms, and seek treatment. Interdisciplinary teams must ensure that appropriate controls in the work environment reduce the risk of heat exposure and related heat stress disorders. Education and early intervention are key to avoiding heat-induced illness and eliminating or minimizing the effects of high temperature environments.

Scientists are predicting that global temperatures may increase between 1.4° and 5.8° Celsius (C) or 2.5° to 10.5° Fahrenheit (F) (Global Warming, 2006). The increase in air temperature along with an increase in relative humidity has a direct influence on the incidence of heat disorders, especially in those individuals who are vulnerable (i.e., young children, the elderly, and those with certain chronic diseases). A heat wave in Chicago in 1995, one of the worst of the 20th century, resulted in hundreds of fatalities due to numerous days of excessive temperatures and lack of acclimatization to weather extremes. During the week of the heat wave, 1,072 (11%) more individuals were hospitalized than average (Semenza, 1999).

ABOUT THE AUTHORS

Dr. Rogers is Director, North Carolina Occupational Safety and Health Education and Research Center and Occupational Health Nursing Program, University of North Carolina, School of Public Health, Chapel Hill, NC. Ms. Stiehl is Medical Case Manager, Travelers Insurance, Dallas, TX; and graduate student, University of North Carolina, Chapel Hill, NC. Ms. Borst is graduate student, University of North Carolina, Chapel Hill, NC. Ms. Hess is staff nurse, Emergency Department, North Hawaii Community Hospital, Kamuela, HI; and graduate student, University of North Carolina, Chapel Hill, NC. Ms. Hutchins is Health Services Administrator, Division of Immigration Health Services, Florence, AZ; and graduate student, University of North Carolina, Chapel HIl, NC.

The heat index (Figure) shows the effect or "apparent temperatures" when heat and humidity are combined. The heat index is the cell where these two measures intersect and gives an idea of how combined heat and humidity in the air feels (Watts, 2006). For example, an air temperature of 90°F and a relative humidity of 60% intersect at a heat index of 100°F. Therefore, the temperature would feel more like 100°F with this humidity and temperature combination. The chart also indicates the range of outcomes (i.e., fatigue or sunstroke) depending on the apparent temperature reached. Symptoms of hyperthermia may range from mild fatigue, headache, or nausea to confusion and convulsions with eventual loss of consciousness and even death (Wexler, 2002). The various heat-related disorders are discussed in more detail later; however, the Sidebar (p. 281) contains heat-related terms and conditions used to describe the range of disorders.

Temperature	% Relative Humidity															
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
110	108	112	117	123	130											
105	102	105	108	113	117	122	130									
100	97	98	102	104	107	110	115	120	126	132						
95	91	93	95	96	98	100	104	106	109	113	119	124	130			
90	86	87	88	90	91	92	95	97	98	100	103	106	110	114	117	121
85	81	82	83	84	85	86	87	88	89	90	92	94	96	97	100	102
80	76	77	78	78	79	79	80	81	82	83	84	85	86	87	88	89

Legend	
80-89 degrees	Fatigue is possible with prolonged exposure and/or physical activity.
90-104 degrees	Sunstroke, heat cramps and heat exhaustion are possible with prolonged exposure and/or physical activity.
105-129 degrees	Sunstroke, heat cramps and heat exhaustion are likely. Heat stroke is possible with prolonged exposure and/or physical activity.
130+ degrees	Heatstroke/sunstroke is highly likely with continued exposure.

Figure. Heat index (or apparent temperature) chart showing various combinations of air temperature versus relative humidity. Air temperature measured in Fahrenheit (F). (Reprinted with permission from Watts, A. [2006]. ***Heat index chart.*** **Retrieved November 11, 2006, from www.tvweather.com/awpage/heat_index_chart.htm.)**

Individuals who work in hot and humid environments on a daily or seasonal basis may be affected by these heat-related conditions. Operations involving high air temperatures and humidity, radiant heat sources, direct physical contact with hot objects, or strenuous physical activities have potential for inducing heat stress in employees engaged in job functions in specific industries (U.S. Department of Labor, 2006). The Sidebar (p. 282) lists some of the most common occupations or industries in which workers may have an increased risk for heat-related disorders (National Institute for Occupational Safety and Health [NIOSH], 1986).

Occupational and environmental health nurses often serve as the sole clinician in the work setting and will assess for heat-related illnesses and refer for treatment. Some preexisting health problems (i.e., alcoholism, anorexia, dehydration, eating disorders, endocrine disorders, and high blood pressure) or extremes of aging may contribute to heat-related illness because the body's normal mechanism for dispersing heat may be impaired, resulting in an extremely high core body temperature (Wexler, 2002). In addition, medications such as alpha adrenergics, antihistamines, benzodiazepines, beta or calcium channel blockers, diuretics, and tricyclic antidepressants will also potentiate heat-related stress disorders because they interfere with the body's ability to dissipate heat produced by metabolic activity (Wexler, 2002). The occupational and environmental health nurse works with the interdisciplinary occupational safety and health team including the safety professional and industrial hygienist to assess workplace risk. The nurse is an essential member of the team, providing education and training to workers and management of workplace strategies to decrease heat-related risks.

EPIDEMIOLOGY

In general, analyses of the risk factors associated with heat-related deaths have been based on the underlying cause entered on death certificates (Luber, 2006). Consequently, the precise incidence of heat-related mortality is not known because cases are often unrecognized and underreported. Work is dangerous when the humidity reaches 60% and the air temperature is above 90°F creating heat-related stress conditions. It is estimated that six million workers in the United States are exposed to occupational heat stress (Wexler, 2002).

Excessive heat exposure in the United States caused 8,996 deaths from 1979 to 2002 (Centers for Disease Control and Prevention, 2004). According to the Bureau of Labor Statistics (2002), 24 workers died in 2001 due to extreme heat exposure, and a total of 3,135 lost time days away from work were secondary to occupational injuries and illnesses associated with heat exposure (Miles, 2003). The mortality rates due to extreme heat may be higher in certain industries (i.e., construction, agriculture, fishing, and manufacturing) (Wexler, 2002).

Another group of workers, firefighters, are at higher risk for heat-related illnesses because they are constantly exposed to extreme environmental temperatures while engaged in strenuous working conditions. To protect themselves from environmental hazards, firefighters are required to wear protective clothing and self-contained breathing apparatus. Because this equipment is heavy and consists of several layers, it interferes with the body's ability to dissipate heat when the core temperature rises. According to Selkirk, McLellan, and Wong (2004), ". . . it exacerbates the challenge of thermoregulation due to limited water permeability, increased metabolic load, and isolative properties" (p. 521). Studying this population, Selkirk et al. and others have determined that rest periods and active cooling methods such as forearm submersion in a temperature-controlled water tank can decrease the risk of heat-related illnesses and cardiovascular strain and are important control strategies in occupational settings where workers are exposed to increased temperatures while wearing protective clothing. Passive cooling methods, such as sitting in a climate-controlled atmosphere, have limited value.

A study was conducted on heat exposure of and interventions for mine rescue workers by researchers from NIOSH in collaboration with mine operators. This group of workers is exposed to extreme environmental temperatures in hot and poorly ventilated underground mines. Use of closed-circuit breathing apparatus, inability to drink fluids for prolonged periods of time, high activity level, decreased ventilation, and risk for fires further contribute to the problem of heat exposure (Varley, 2004). The physical condition of rescue workers should be monitored before and during a rescue operation, with those having abnormally elevated heart rates and temperatures excluded. Commercial cooling devices should not become a substitute for monitoring, and adequate training should be provided. Rest periods should be frequent and heart rate should be monitored. Hydration of rescue workers should become a standard practice before they put on closed-circuit breathing apparatus.

Long-term effects of chronic heat exposure have been noted (Canadian Centre for Occupational Health & Safety, 2001). Chronic heat exhaustion, sleep disturbances, and susceptibility to minor injuries and illnesses have been attributed to the possible effects of prolonged heat exposure. Glass blowers and furnace men have developed cataracts after many years of exposure to radiation from hot objects. Foundry workers, blacksmiths, and oven operators are also exposed to possible eye-damaging infrared radiation.

In men, repeatedly raising the testicular temperature 3° to 5°C decreases sperm counts. However, no conclusive evidence of reduced fertility among heat-exposed women exists. No adequate data exist from which conclusions can be drawn regarding the reproductive effects of occupational heat exposure at currently accepted exposure limits.

Laboratory study of warm-blooded animals has shown that hyperthermic exposure of pregnant females may result in a high incidence of embryo deaths and malformations of the head and central nervous system. However, no conclusive evidence of teratogenic effects of hyperthermia in humans exists. NIOSH (1986) recommends that a pregnant worker's body temperature not exceed 39° to 39.5°C during the first trimester of pregnancy.

Heat Terms*

Heat wave—prolonged period of excessive heat, often combined with excessive humidity.

Heat index—a number in degrees Fahrenheit (F) indicating how hot it feels when relative humidity is added to the air temperature. Exposure to full sunshine can increase the heat index by 15°.

Heat cramps—muscular pains and spasms due to heavy exertion. Although heat cramps are the least severe heat-related illness, they are often the first signal that the body is having difficulty with the heat.

Heat exhaustion—typically occurs when individuals exercise or work in a hot, humid place where body fluids are lost through sweating. Blood flow to the skin increases, causing blood to the vital organs to decrease, resulting in a form of mild shock. If not treated, the victim's condition worsens. Body temperature continues to rise and the victim may suffer heatstroke.

Heatstroke—a life-threatening condition in which the victim's temperature control system fails. Body temperature can rise so high that brain damage and death may result if the body is not cooled quickly.

Sunstroke—another term for heatstroke.

**From the Federal Emergency Management Administration. (2006).* Extreme heat: Know the terms. *Retrieved December 6, 2006, from www.fema.gov/hazard/heat/heat_terms.shtm.*

PATHOPHYSIOLOGY

Occupational heat exposure poses a threat to the health and safety of many workers. Exposure to heat from extreme environmental temperatures or heat generated by the body itself from overexertion during work activities can lead to serious health implications. Wexler (2002) indicates that when the body's natural ability to dissipate heat is impaired by varying internal and external factors, heat-related illnesses can occur. Exposure to high temperatures can lead to a progression of symptoms in the body, which can result in widespread tissue damage,

Common Industries or Occupations Susceptible to Extreme Heat*

- Surface mining
- Roofing
- Road repair
- Construction
- Dam building
- Farming/fishing
- Firefighting
- Iron, steel, and nonferrous foundries
- Brick-firing and ceramic operations
- Glass products manufacturing plants
- Rubber products manufacturing plants
- Electrical utilities (particularly boiler rooms)
- Bakeries
- Confectioneries
- Restaurant kitchens
- Laundries
- Food canneries
- Mines
- Smelters
- Steam tunnels
- Military (not on the National Institute for Occupational Safety and Health list)

**From the National Institute for Occupational Safety and Health. (1986, April).* Working in hot environments. *Retrieved December 6, 2006, from www.cdc.gov/niosh/hotenvt.html.*

organ damage, and even death if not treated in a timely and effective manner. According to Rosenberg (2005), blood flow to the brain, muscles, and internal organs is reduced, resulting in decreased oxygen and nutrients to these areas. Impaired strength, diminished alertness, and accelerated fatigue can occur as a result of this change in blood flow.

The hypothalamus is responsible for regulating the core temperature in the body within a narrow range of 36.4° to 37.3°C (97.5° to 99.1°F) (Nicoll, 2002). However, the body has a natural protective mechanism in place to rid itself of excess heat, preventing physiological damage caused by elevated temperatures. When the body becomes overheated and the temperature rises above the desired core temperature range, the body initiates a cooling response to reduce or minimize the temperature. According to Wexler (2002), the sympathetic nervous system regulates increases in skin blood flow and vasodilation, while the parasympathetic nervous system regulates sweating in an effort to dissipate heat. Increasing blood to the surface of the skin reduces blood flow to other vital organs in the body.

When the blood reaches the surface of the skin, heat is dissipated from the body through four mechanisms: conduction, convection, radiation, and evaporation (Glazer, 2005). Conduction occurs when heat is transferred from the body as it comes in direct contact with a cooler object. Convection is the dissipation of heat when cooler air passes over exposed skin. Radiation occurs when heat is released directly into the environment. Evaporation cools through perspiration on the skin. Certain environmental conditions can impair these heat-loss mechanisms. According to Barrow and Clark (1998), elevated humidity decreases the evaporation of sweat, and high ambient temperatures can cause heat gain through radiation. Also, the temperature has to be less than 20°C (68°F) for radiation and conduction to dissipate most of the heat.

During the cooling process, depending on the individual's size and hydration status, large amounts of fluid can be lost as water is drawn from the blood cells and evaporated through the skin as sweat. Although sweating can cool the body, it also depletes the body of water, plasma volume, and electrolytes (Sidebottom, 1992). Sidebottom further explains that the hypothalamus signals the pituitary gland to increase the production of antidiuretic hormone and modify thyroid and adrenal function in response to changes in fluid volume and electrolyte balance. As a result, the loss of sodium and water through the kidneys and the loss of sodium and potassium through sweat is diminished. The longer the worker sweats, the more blood volume is diminished and health risks increase (Rosenberg, 2005).

TYPES OF HEAT DISORDERS AND CLINICAL PRESENTATIONS

The Occupational Safety and Health Administration (OSHA) describes five types of heat disorders and their health effects, listed in descending order from lesser to greater effects (U.S. Department of Labor, 2006):

Heat fatigue impairs performance of skilled sensorimotor, mental, or vigilant jobs. Treatment for heat fatigue is to remove the individual from the heat source.

Heat rash, often called prickly heat, is the most common problem in hot work environments. Prickly heat is manifested as red papules on the skin and usually appears in areas where clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat. In most cases, heat rashes will disappear when the affected individual returns to a cooler environment. The primary objectives and treatment for an employee with heat rash are to encourage rest in a cool environment and keep the affected area cool and dry (Rogers, Randolph, & Mastroianni, 2003).

Heat cramps are sharp pains in the muscles that may occur alone or with one of the other heat stress disorders. In the workplace, heat cramps are usually caused by performing hard physical labor in a hot environment. For employees with heat cramps, temperature, pulse, and blood pressure must be checked. Fluids and electrolytes can be replaced by giving plain water or an electrolyte solution such as Gatorade (PepsiCo, Purchase, NY; 8 ounces every 15 minutes for 1 hour), or an intravenous solution of normal saline or lactated Ringer's solution per standing order if the employee is unable to tolerate oral fluids. Symptom relief can be provided by massaging affected muscles to relieve muscle spasms. Workers should be encouraged to rest in a cool environment. If an employee's vital signs are unstable or the employee experiences loss of consciousness, severe nausea, or vomiting, intervention is essential (Rogers et al., 2003).

Heat exhaustion occurs when the body's thermoregulatory system becomes overloaded and eventually fails. Heat exhaustion occurs when an individual performs strenuous activity in a hot environment for an extended period without consuming enough water, sodium, or both to replace what is lost to sweating. The signs and symptoms of heat exhaustion are tachycardia, headache, nausea, vertigo, weakness, thirst, giddiness, and fainting. Heat exhaustion should not be dismissed lightly. Fainting is associated with heat exhaustion and can be dangerous in the work environment because the victim may be operating machinery or controlling an operation. Rapid progression to heatstroke can occur. Fortunately, this condition responds readily to prompt treatment. The primary objectives and treatment for the worker suffering from heat exhaustion are to assess the employee's status by monitoring vital signs, check the skin, forehead, and axillae to determine the ability to sweat, and prevent the onset of shock by moving the individual to a cool place; however, care must be taken not to chill the employee. The occupational and environmental health nurse should position the employee lying down, elevate the feet 8 to 12 inches, and loosen the clothing. The worker's fluids and electrolytes must be replaced by giving plain water or an electrolyte solution such as Gatorade (8 ounces every 15 minutes for 1 hour), or an intravenous solution of normal saline or lactated Ringer's solution per standing order if the worker is unable to tolerate oral fluids. The nurse can provide symptom relief by applying cool, wet cloths and fanning the body. Referral to tertiary care must be considered if vital signs are unstable, severe nausea or vomiting is present, or progression to heatstroke occurs (Rogers et al., 2003).

Heatstroke occurs when the body's temperature regulation system fails and the temperature rises to critical levels above 104°F (40°C). This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict. Heatstroke is considered a health care emergency. The primary signs and symptoms of heatstroke include headache, visual disturbances, dizziness, nausea, vomiting, confusion, irrational behavior, loss of consciousness, convulsions, cessation of sweating (usually), hot, dry skin, an abnormally high body temperature (e.g., a rectal temperature of 41°C [105.8°F]), and an elevated heart rate. Typical laboratory findings in workers with heatstroke are elevated blood urea nitrogen, hematocrit, and creatinine phosphokinase and decreased serum electrolytes, particularly potassium, sodium, and calcium. Urinalysis may show red or white blood cells, protein, ketones, white blood cell casts, and hyaline casts. ST-segment and T wave changes may reflect myocardial ischemia or other cardiac problems (Stewart, 2002). If a worker shows signs of possible heatstroke, the occupational and environmental health nurse, a coworker, or a supervisor activates the local emergency medical system to immediately transport the employee to the hospital. The primary objectives and treatment while waiting for the emergency medical system to arrive are to assess the employee's status by monitoring vital signs every 5 to 10 minutes and urine output. Body temperature can be lowered by placing the individual in a cool environment, lying down with head elevated, removing clothing, and applying a hypothermia blanket or ice packs to the axillae and groin until core body temperature is below 103°F. The worker's blood circulation can be improved by massaging the extremities. Administering oxygen via nasal cannula per standing order and starting intravenous normal saline or lactated Ringer's solution per standing order may be needed. The nurse can also protect employees from injury caused by possible seizures. If seizures occur, employees should be turned on their side to prevent aspiration, maintain an open airway, and administer appropriate medications per standing order (Rogers et al., 2003).

OSHA REGULATIONS

Although OSHA does not have a specific regulation governing heat stress hazards, Section 5(a)(1) of the OSH act is referred to as the General Duty Clause and requires all employers to furnish to each employee work and a place of employment free from recognized hazards likely to cause death or serious physical harm. Section 5(a)(2) requires employers to comply with occupational health and safety standards promulgated under this act (U.S. Department of Labor, 1970, 2006). OSHA has previously cited employers based on the General Duty Clause for exposing employees to potential serious harm from excessive heat exposure (U.S. Department of Labor, 2001).

As guidance for employers, OSHA has included a section on heat stress in *The Occupational Safety and Health Administration Technical Manual* referencing many of the guidelines developed by NIOSH and the American Conference of Governmental Industrial Hygienists (Office of Radiation, Chemical and Biological Safety, 1999; U.S. Department of Labor, 2006). The American Conference of Governmental Industrial Hygienists has adopted threshold limit values for heat stress conditions designed to prevent the core temperature of workers from exceeding 100°F (38°C) (Adelakun, Schwartz, & Blias, 1999; American Conference of Governmental Industrial Hygienists, 2006) (Table). Threshold limit values for heat exposure establish work–rest regimens ranging from 25% to 75% rest during each hour based on wet-bulb globe temperature index, clothing, and workload (Adelakun et al., 1999). The wet-bulb temperature index is a heat stress indicator that measures the effects of temperature, humid-

Table

Permissible Heat Exposure Threshold Limit Values*,†

Work–Rest Regimen	*Light*	*Moderate*	*Heavy*
Continuous work	30.0°C (86°F)	26.7°C (80°F)	25.0°C (77°F)
75% Work, 25% rest, each hour	30.6°C (87°F)	28.0°C (82°F)	25.9°C (78°F)
50% Work, 50% rest, each hour	31.4°C (89°F)	29.4°C (85°F)	27.9°C (82°F)
25% Work, 75% rest, each hour	32.2°C (90°F)	31.1°C (88°F)	30.0°C (86°F)

**Temperatures are according to the wet-bulb globe temperature (WBGT) index. These threshold limit values are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should function effectively under the given working conditions without exceeding a core body temperature of 38°C (100.4°F). They are also based on the assumption that the WBGT of the resting place is the same as or close to that of the workplace. Where the WBGT of the work area is different from that of the rest area, a time-weighted average should be used (the American Conference of Governmental Industrial Hygienists* 1992–1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices *should be consulted).*

†From the U.S. Department of Labor. (2006). OSHA technical manual on heat stress. *Retrieved December 6, 2006, from www.osha.gov/dts/osta/otm/tm_ii/otm_iii_4.html.*

ity, and radiant energy using a wet-bulb globe temperature meter (Aerographer/Meteorology, 2006). Currently, the wet-bulb globe temperature index is the most common technique used to measure environmental factors that correlate with deep body temperature and other physiologic responses to heat (U.S. Department of Labor, 2006).

MODIFYING WORK AND THE ENVIRONMENT TO PREVENT HEAT-RELATED ILLNESS

Supervisors must determine the physical demands of all jobs, identify the hazards of heat stress including the health effects, and provide training for their employees about the signs and symptoms of heat-related illness. Strategies to reduce the effects of heat in the workplace include engineering controls, administrative controls, and personal protective equipment. Engineering controls should be instituted first to remove or reduce the source of heat in the environment. General ventilation is one type of engineering control using cooler air to dilute warm air. This dilution is achieved by bringing in cool air from the outside using a permanent ventilation system for a large building or a local exhaust system for a smaller area (U.S. Department of Labor, 2006). Ventilation and exhaust systems are useful to remove hot air and steam produced by industrial operations.

Another method is using air cooling to reduce both temperature and humidity. Local air cooling can be accomplished by enclosing workplaces near hot environments and using portable blowers with built-in air chillers. If the temperature is below 35°C, fans may also be installed to increase airflow or convection (Ontario Ministry of Labour, 2006). Air conditioning is one of the best methods for cooling air; however, it is expensive to install and operate. The use of insulating and reflective barriers (i.e., insulated furnace walls) limits heat from the source. Finally, mechanical assistance (i.e., hoists or lift tables) should be used to reduce the physical demands of job tasks in hot environments (Ontario Ministry of Labour, 2006).

After engineering controls have been incorporated, administrative controls must be implemented. Managers need to understand the physical demands of all jobs and heat stress and related health effects and provide training for employees about heat-related signs, symptoms, and illness. Workers should be acclimated through exposure to work in hot environments for progressively longer periods prior to performing jobs that involve heat extremes and allowed intermittent rest breaks in cool areas. The Ontario Ministry of Labour (2006) recommends that the regimen be 50% exposure on day 1, 60% on day 2, 80% on day 3, and 100% on day 4 for employees who have previously worked in jobs where heat levels can cause heat-related illnesses.

Work in hot environments should be scheduled during cooler parts of the day (e.g., baking should be done in the early morning). Other administrative controls can be used to reduce heat stress for workers including shift rotation, relief workers, and worker pacing (i.e., limiting work hours in extreme heat). Intermittent rest periods should be provided and cool liquids should be available close to the work area if possible. Workers should be encouraged to drink small amounts of water frequently (i.e., one cup approximately every 20 minutes) (U.S. Department of Labor, 2006).

Personal protective equipment may be used to prevent workers from absorbing radiant heat. Reflective clothing, available in aprons, jackets, or suits, should be worn loosely to allow heat from the body to evaporate (U.S. Department of Labor, 2002). Ice vests, accommodating as many as 72 ice packs, are available commercially and can cool the body for 2 to 4 hours. Wetted clothing, another cooling technique, can be worn under reflective or impermeable protective clothing.

Circulating air suits can be worn by workers for the purpose of cooling the body. Compressed air can be sent directly to an impermeable suit in three ways: by a single inlet, by a distribution tree, or by a perforated vest. This method of cooling involves evaporative or convective cooling of the body, and the warm air then escapes through openings in the suit. This type of personal protective equipment is effective but can be cumbersome and limit the mobility of the worker if attached to an air hose. Chemical protective suits (i.e., aprons, coveralls, or full suits intended to act as a barrier to prevent absorption of chemicals through the skin) and the weight of a respirator (self-contained breathing apparatus) can potentially add to the overall heat stress of a worker.

THE ROLE OF THE OCCUPATIONAL AND ENVIRONMENTAL HEALTH NURSE

The role of the occupational and environmental health nurse is to provide care to employees "with the goal to prevent work-related injury and illness, prevent disability, and help workers achieve and maintain the highest level of health throughout their lives" (Plog & Quinlan, 2002, p. 776). This can be accomplished through primary, secondary, and tertiary strategies. To achieve this goal, the occupational and environmental health nurse works in conjunction with other members of an interdisciplinary team to identify health and safety issues, develop interventions, create and implement programs, and monitor and evaluate the outcomes. The team consists of workers, management, nurses, physicians, safety professionals, ergonomists, industrial hygienists, and toxicologists (Wachs, 2005). Rogers (2003) points out that multidisciplinary collaboration is the key to development and implementation of a successful workplace hazard control program. Although other disciplines are involved in the development of health and safety programs, in most workplaces the occupational and environmental health nurse assumes most of the responsibility for planning, implementing, and evaluating these programs.

According to Rogers (2003), assessment, surveillance, management, prevention, and health promotion efforts are central to occupational and environmental health nursing practice. The emphasis on primary prevention focuses on the education of workers and management about how to prevent and identify heat-related illnesses, reducing the risk of serious injury from heat exposure. Workers should recognize the symptoms of heat-related illnesses and know to seek treatment. OSHA has developed a heat stress card (Sidebar, right) that employees will find useful. According to the U.S. Department of Labor (2006), "Training is the key to good work practices. Unless all employees understand the reasons for using new, or changing old, work practices, the chances of such a program succeeding are greatly reduced" (section III, chapter 4). An effective heat stress training program should include (NIOSH, 1986; U.S. Department of Labor, 2006):

- Knowledge of the hazards of heat stress, including descriptions for all jobs performed that place employees at risk for heat-related disorders.
- Recognition of predisposing factors, danger signs, and symptoms of heat stress and any factors that could potentiate a heat-related disorder (e.g., pregnancy).

Heat Stress Card*

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 heatstroke, can occur and 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 medications
- 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 Heatstroke

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

Preventing Heat Stress

- Know signs and symptoms of heat-related illnesses
- Monitor oneself and one's coworkers
- Block out direct sun or other heat sources
- Use cooling fans or air conditioning
- Rest regularly
- Drink lots of water (approximately 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 individual to a cool, shaded area
- Loosen or remove heavy clothing
- Provide cool drinking water
- Fan and mist the individual with water

**From the U.S. Department of Labor. (2002).* Heat stress: Hazards and possible solutions. *Retrieved November 15, 2006, from www.osha.gov/SLTC/heatstress/recognition.html.*

- Awareness of first-aid procedures for and the potential health effects of heatstroke, including methods to prevent serious sequelae from heat-induced illnesses, and first-aid training, provided by the employer, to determine when treatment and emergency procedures are indicated.
- Employee responsibilities in avoiding heat stress, including being knowledgeable about and following the policies related to the prevention of heat stress, informing management of working conditions that pose a heat-related hazard, and mutual accountability by the employer and employee to create an injury-free workplace (Geller, 2001).
- Identification of the dangers of using drugs, including therapeutic ones, and alcohol in hot work environments by discussing the potential effects with primary health care providers and making workplace accommodations as needed.
- Use of protective clothing and equipment to accommodate the worker and be suitable for the task. Clear guidelines need to be conveyed to employees and supervisors to ensure compliance. Cooled water and air should also be made available to all employees and they should be encouraged to consume water or electrolyte solutions (e.g., Gatorade) on a regular basis to prevent dehydration.
- Worker participation in environmental and health surveillance programs to protect workers and ensure success.

Secondary prevention efforts are aimed at early detection and adequate treatment to minimize disease or further injury. The assessment process begins when a job offer is made and a preplacement examination is conducted. This examination identifies preexisting health conditions and potential aggravation of preexisting conditions, and ensures that the worker is able to meet the demands of the job. This examination also provides baseline data for comparison with future evaluations. Periodic health assessments should be performed to evaluate changes in health status and hazard exposure. To perform an accurate assessment, the examining occupational health professional must be provided with current information on the worker's job description to have a complete understanding of job demands and potential exposure to workplace hazards (Rogers, 2003).

NIOSH (1986) and the U.S. Department of Labor (2006) recommend that the following information be included in preplacement and periodic health assessments for workers who are exposed to heat in the work environment:

- A comprehensive health history including evaluation of cardiac, vascular, respiratory, neurological, renal, hematologic, gastrointestinal, and reproductive systems as well as specific dermatologic, endocrine, connective tissue, and metabolic conditions that might affect heat acclimatization or the ability to dissipate heat.
- A complete occupational history to identify episodes of heat-related exposures and illness as well as evidence of successful adaptation to heat in previous jobs or non-occupational activities.
- A list of prescribed and over-the-counter medications used to assist in determining how medications could potentially impact cardiac output, electrolyte balance, renal function, sweating capacity, and autoimmune nervous system function.
- Information on personal habits including the use of alcohol and other social drugs to determine possible interactions with changes in body metabolism and core heat levels.
- Height, weight, gender, and age, which can also impact the incidence of heat-related illnesses. Workers should be encouraged to weigh themselves at the beginning and end of each shift. A drop of 5% in body weight indicates dehydration, and 7% calls for immediate rest and fluid replacement (Zal, 1984).

Employees should also be offered physical examinations, blood chemistry, blood pressure evaluation, and an assessment of their ability to understand the health and safety hazards of the job.

Ongoing health assessments should be scheduled to determine if any adverse health risks have occurred as a result of the work environment. Health surveillance data obtained from ongoing monitoring can be analyzed by the occupational and environmental health nurse to determine if repeated adverse effects are occurring as a result of a heat exposure. If a pattern of heat-related illnesses or injuries is observed in a specific group of workers, an industrial hygiene evaluation is recommended along with continued health surveillance (NIOSH, 1986; U.S. Department of Labor, 2006). The occupational and environmental health nurse is responsible for maintaining accurate and confidential health records. Those related to an exposure should include the number of employees monitored, types of potential exposures, other health screenings and diagnostic measures performed, written protocols and procedures for surveillance activities, data interpretation, and recommendations and actions for exposure abatement (Rogers, 2003).

Ongoing environmental surveillance with the industrial hygienist and other occupational health professionals can identify potential hazards in the workplace. By performing walk-throughs, the occupational and environmental health nurse can become familiar with the work environment and processes and observe employees' work practices and use of personal protective equipment (Rogers, 2003). When a hazard is identified, the nurse collaborates with other occupational health professionals to develop and implement control strategies and surveillance activities and then monitor their effectiveness.

Tertiary prevention strategies are designed to minimize further illness, implement rehabilitation programs, and optimize health (Rogers, 2003). As part of tertiary prevention strategies, some nurses act as case managers, assist with the implementation of transitional or modified duty programs, and recommend job restructuring and worker retraining. Tertiary prevention also includes chronic illness monitoring, and nurses can develop guidelines for employees with chronic diseases who are exposed to heat stress.

IN SUMMARY

Heat-Related Illnesses

The Role of the Occupational and Environmental Health Nurse

Rogers, B., Stiehl, K., Borst, J., Hess, A., & Hutchins, S.

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1 Heat exposures associated with working in select industries and occupations can be a serious problem resulting in life-threatening illness.

2 Strategies to minimize heat-related risk should begin with engineering controls to eliminate and mitigate the exposure. Administrative, work practice, and personal protection must be integral components of a comprehensive effort.

3 The occupational and environmental health nurse, part of a multidisciplinary team, must institute prevention measures including primary, secondary, and tertiary strategies to assist workers in preventing heat-related illness.

CONCLUSION

Heat poses a threat to the health and safety of many workers in a variety of occupations. The occupational and environmental health nurse must be able to recognize and treat the broad range of symptoms that can result from exposure to high temperatures. The nurse must work together with the interdisciplinary team to provide training and education to the work force. This is necessary so that workers can take appropriate measures to prevent the onset of a heat-related illness or recognize early symptoms and seek treatment. The interdisciplinary team must ensure that appropriate controls in the work environment reduce the risk of heat exposure and related heat stress disorders. Education and early intervention are key to avoiding heat-induced illness and eliminating or minimizing the effects of high temperature environments.

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