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Thermal regulation: The body's delicate balance against the odds

By: Kathryn Maxner

Managing heat stress in the workplace has become a "hot" topic in the 90s.

Out of 6,588 fatal work injuries reported in private industry in 1994, 28 workers—a 4% increase over 1993—died from exposure to "environmental heat." The majority of these deaths were classified under construction, manufacturing and agriculture. Fifty more deaths occurred because of "contact with temperature extremes," with an additional 24 fatalities listed under "other events of exposures," that included the subcategory "bodily reaction and exertion." Additionally, 2,199 people missed from one to five days of work because of the effects of heat and light, heat stroke, heat syncope (fainting) and heat fatigue.

These statistics were compiled from the Census for Occupational Injuries (CFOI), the U.S. Department of Labor's various state and federal sources, death certificates, workers' compensation reports and claims, regulatory agencies, medical examiner reports, police reports and news reports. But the true toll from heat-related causes is undoubtedly higher because the CFOI is not a complete census. Some state laws and regulations prohibit enumerators from contacting the next-of-kin, making it impossible to independently verify work relationships. For instance, 258 fatal injuries were not classified in the 1994 figures and 56 more fatalities were not included because their initiating source documents lacked sufficient information.

State and federal employees and

members of the armed forces are not included in this report, nor are the many small businesses that do not report accidents, injuries or fatalities. Many of these companies employ fewer than 20 employees. So there is virtually no data available to determine a true census of fatalities and work related injuries where the underlying factor preceding the accident or fatality may have been heat stress.

Thermal regulation

Thermal regulation is the process of managing one's "body vitals." That is the delicate balance of maintaining normal body temperature within a very narrow range, compelling the heat produced through normal metabolic activity and the heat lost by way of other bodily mechanisms to be continuously counterbalanced against prevailing environmental conditions.

The variables that define the level of heat stress one faces are personal characteristics such as age, weight, physical fitness, medical condition and acclimatization to the heat or cold. Four environmental factors directly affect our ability to withstand heat stress: temperature, humidity, radiant heat (from the sun or a furnace, for example) and air velocity. At temperatures above 92° F (skin temperature), the body gains heat through convection; that is, outside air molecules carry heat to the skin. When temperatures exceed 92° F, body heat is lost almost solely through evaporation, through insensible perspiration (drying of the skin tissues) and through sweating.

Sweating does not commence until the body triggers a need for cooling. When moderate climates prevail (temperatures less than 90° F), more means are available to dissipate body heat than under hot climatic conditions.

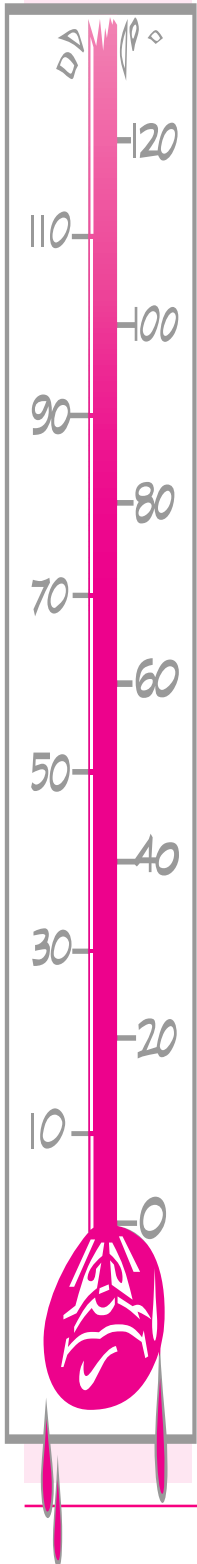
Diagnosis and prevention

The National Safety Council, NIOSH and OSHA and other authorities offer detailed diagnoses of heat stress, heat exhaustion, heat cramps and heat syncope. They advise seeking immediate emergency care for heat stroke victims.

OSHA Fact Sheet 92- 16, "Protecting Workers in Hot Environments," outlines ways to avoid all types of heat stress. The fact sheet lists these basic precautions:

- acclimatization to the heat
- engineering controls
- work practices
- training and education
- providing cooling devices
- appropriate protective clothing
- longer rest periods in cooler areas

While this [article] is addressed to workers in foundries, refineries, paper mills, [surface mines,] construction projects, and other locations where hot conditions can pose special hazards to personal safety and health, managing heat stress in the workplace is very much a concern for employers as well as employees. For employers, heat stress poses the threat of injuries, workers' compensation losses, costly downtime, lost workdays, and poor performance. For the employee, it can be the prelude to accidents,



cardiac stress, even death.

Heat stress can get the best of a healthy, physically fit individual no matter the time of year. It is no longer just a summer problem. Christopher Kearns, senior project officer for the U.S. Army's Dismounted Battlespace Battle Lab at Ft. Benning, GA, said the Army reports more incidents of heat stress during winter-like conditions, a problem attributed to the thermal burden of protective clothing and equipment while marching or exercising.

From January 1, 1994 to December 11, 1995, the U. S. Navy reported no heat stress fatalities. They did, however, report 17 heat stress casualties involving eight lost work days at a cost of \$3,364.

The body's trigger to react to the need for cooling or warming is the temperature of the blood as it reaches the hypothalamus in the brain. Reaction time to obtain thermal equilibrium is extremely quick. A similar process is our sympathetic nervous system's continuous fight with our parasympathetic nervous systems, keeping our pupils evenly dilated.

But, thermal regulation is difficult to achieve and maintain when working in hot conditions, particularly when the person is burdened by wearing protective clothing. The average individual doing light work burns approximately 3,000 calories daily. Sixty-five percent is lost through radiation, convection and conduction of the skin to the atmosphere, while 25% is lost through evaporation of water from the skin and lung surfaces. An individual performing heavy work, however, may burn as much as 425 calories per hour.

Humidity is one of the most important variables in the delicate balance of attaining thermal regulation. If the humidity is not excessive, the air velocity is sufficient to carry adequate amounts of heat away from the body, the body is properly and

continuously hydrated, and the body's organs can efficiently handle the level of metabolic activity and heat dissipation requirements, then thermal equilibrium can be maintained. But, when humidity is excessive, air molecules are unable to absorb additional moisture, making it extremely difficult for the body to dissipate heat.

Exertion in hot sun and high humidity, coupled with the conductive moisture created between your skin and protective clothing, makes it difficult for a worker's body to dissipate heat easily by evaporation through the skin. An individual in a situation as this will not attain thermal regulation without some form of relief—cooling, hydrating and rehabilitation. The six-man Palm Bay Police Dive Team, Palm Bay, FL, who worked the ValuJet crash site in the Florida Everglades, wore impermeable containment suits in a heat index environment approaching 111° F while combing the site for evidence. The thermal burden imposed on this team required short work periods, intermittent rehabilitation breaks and continuous, close monitoring by the EMTs until the team received body management cooling shirts donated by Exothermal Technology Corp. Wearing these cooling shirts beneath their specially designed dry dive suits afforded the team the ability to extend their work time and finish their work at the site without any signs of heat stress.

The effects of medication and drugs

The picture becomes more complicated if the employee is using over the counter headache, cold and flu remedies, tranquilizers or pain medication. Antihistamines, decongestants, and remedies containing alcohol act to dry up the mucous membranes and decrease sweat gland secretion, causing further dehydration.

"You're just asking for trouble,"

said Dr. John C. LoZito, a neurologist in Melbourne, FL. "You won't sense the onset of heat stress as quickly. Your senses, your reaction time and your motor skills are affected," according to Dr. LoZito.

Drugs and alcohol make people extremely susceptible to heat stress, while lack of sleep and improper nutrition, coupled with several cups of coffee and maybe a donut are terrific for triggering the quick onset of heat stress. The effects of a sleeping pill can linger for up to 24 hours within a person's system according to Dr. LoZito.

People who are diabetic, hypoglycemic or anemic are considered more susceptible. So are those with circulatory problems, atherosclerosis, previous head injuries or nerve damage, underactive thyroid or hypertension, as are individuals who are dieting, taking diuretics or smoke at least one pack of cigarettes daily.

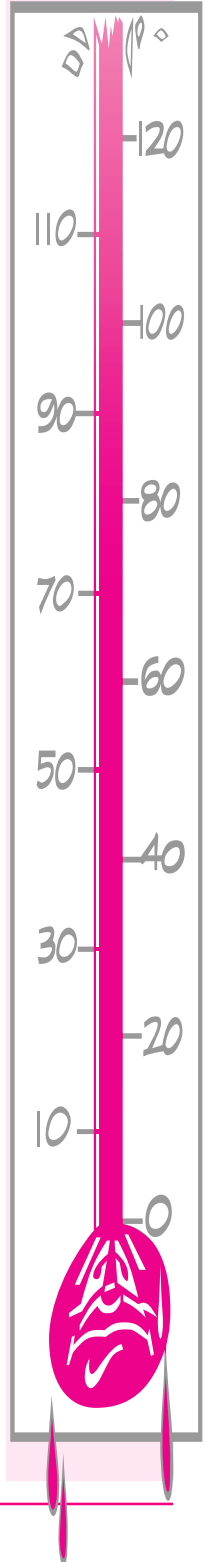
Sequelae—the name for recurrent complications—is frequent in individuals who recover from a severe heat illness. Such individuals are usually intolerant of heat and become extremely uncomfortable when exposed to heat stress conditions. Subtler physiologic changes may occur, such as emotional instability, clumsy articulation and lowered tolerance to alcohol.

Permanent anhidrosis (cessation of sweating) has been occasionally noted in some individuals who recovered from prolonged exposure to high heat and high humidity. For some individuals, irreparable damage to the body's heat-dissipating bodily mechanisms is noted. Muscle coordination is weak and affected in all quadrants of the body, and equilibrium and hand-eye coordination is off. Also, noted in some cases is the lack of nerve conductivity in the lower limbs.

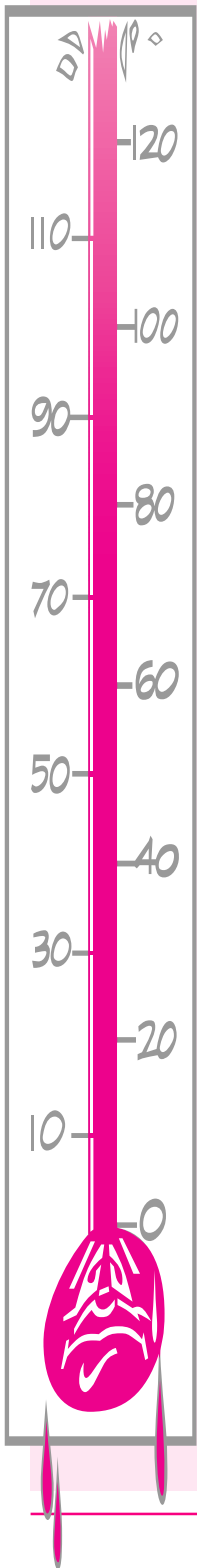
The morning after

So you thought last night's birthday party was a blast? You took a

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sleeping pill and finally got to sleep at 2:30 a.m.. You drank too much alcohol and now, upon waking, you feel so miserable that it's all you can do to gulp down some coffee and pop a few aspirin tablets before heading off to work. Physiologically, the alcohol already has you extremely dehydrated, your senses are dulled by the headache medication and the carry over effects of your sleeping aid have further dulled your senses. Sitting in the air-conditioned office, your motor skills, muscle coordination and equilibrium are affected, but you're feeling that caffeine boost. At least you didn't have to operate a hazardous piece of machinery in the hot sun or a hot warehouse today. Time performs its healing magic, but it will take several hours for your body to expel the toxins and medication, rehydrate itself and attain some metabolic balance. But what if you must work in a hot room or

wear protective clothing and you haven't had time to eat and properly hydrate with fruit juice or an electrolyte balanced beverage? And, the lunch break is still a few hours away. The scenario means that you are an excellent candidate for experiencing some form of heat stress. In reality, you could be classified as a safety hazard.

The keys to avoiding heat stress situations are awareness and prevention. People working in hot weather, especially those wearing burdensome protective clothing, should drink before they feel thirsty. If moderate to heavy work is performed, an electrolyte balanced drink is best for keeping the potassium levels up for proper muscle function, but a regular regimen of hydrating at least with water, continuously throughout the work day, assists the body in

continuing its natural process of thermal equilibrium—sweating.

If hydration becomes insufficient, where sweating becomes difficult, you have breached the stasis mechanism that keeps the balance of equilibrium intact. Once that occurs, the body reacts to the onset of a heat stress illness.

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Know your sunscreen

It's a case of don't be fooled by expensive imitations. The latest issue of Choice has found that cheaper sunscreens, which claim to be sun protection factor 15+ and broad spectrum, were just as effective as more expensive brands, because the claims were all tested before the products could be sold. The report also warned not to be fooled by sunscreens which boasted about screening out 'infra-red rays' and

'visible light' or were especially suitable for 'sun sensitive skin', because these features already apply to most products.

Source: Home Safety & Security, Summer 1997.

Speaking of skin, a safer sunblock is being formulated using nanoscale titanium powder developed by Nanophase Technologies of Burr Ridge, IL, with funding from National

Institute of Standards and Technology's Advanced Technology Program. The powder particles are smaller than the wavelengths of visible light measuring about 5 nanometers across, or less than a tenth the size of most bacteria. Spread on skin as an additive to cosmetics and sunblocks, they are transparent—leaving no white liquid—but block short ultraviolet rays almost completely.

Reprinted from the September 27, 1995 issue of the INDUSTRY.NET Report.

If you go out in the woods...

Just as every silver lining has its cloud, even the much-awaited coming of spring has drawbacks. Poison ivy, oak and sumac can affect two of every three people with anything from itch and irritation to allergic reactions requiring medical attention.

But a new product might be enough to send even the allergic

back to the woods. The U.S. Food and Drug Administration has approved a nonprescription lotion called IvyBlock to protect skin against the three poison sister plants.

Canadian Market Digest reports the lotion provides a protective layer on the skin that prevents contact with the plants' rash-raising oils. Like a

sunblock, the lotion would have to be applied about 15 minutes before possible contact, and reapplied every four hours.

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