BEYOND WATER, REST AND SHADE:

AN ATHLETIC APPROACH TO HEAT STRESS

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Scholars in the athletic field have studied heat related illnesses and their impact on athletes of all ages and levels. Their findings can be applied to industrial settings to aid safety professionals in preventing heat related illnesses in the workplace.

Heat related illnesses, injuries and death are entirely preventable in the workforce. OSHA's national heat stress campaign centers around prevention, water, rest and shade best practices, and has been very successful at raising awareness to the safety concern around heat stress. Yet heat-related deaths doubled from 2014 to 2015, and the number of non-fatal cases resulting from excessive heat exposure rose to 2,830 (Bureau of Labor Statistics, 2015). With weather patterns becoming increasingly unpredictable, it is more important than ever for safety professionals to be informed on the latest research to prevent future heat related illness and injuries. We will explore the science behind heat stress, how to recognize symptoms in the field, and how research from athletics can be used to prevent occupational heat illnesses, injuries, and most importantly, deaths.

// PERFORMANCE AND PHYSIOLOGY

THE SCIENCE BEHIND HEAT STRESS

Heat related illness (HRI) is an umbrella term used to describe a variety of health issues that result from prolonged exposure to environmental heat and humidity, including heat rash, cramps, heat syncope, heat exhaustion, and heat stroke. They are studied at length by professionals in various fields, including occupational health and athletics. To better understand how these illnesses and injuries occur, it is important to understand the underlying body processes that are taking place and how they contribute to the onset of symptoms.

Thermoregulation is the complex interaction of the body's central nervous system, the cardiovascular system, and the skin that helps maintain a core temperature of approximately 98.6° Fahrenheit. Thermoregulation operates like a home thermostat system in that the body (the hypothalamus) receives information from skin receptors and circulating blood and initiates heat transfer responses as needed. When core body temperature rises, the blood vessels near the surface of the skin widen, and sweating begins to occur in an attempt to dissipate heat (Casa et. al, 2012). As the thermoregulation system is overwhelmed by prolonged heat exposure, hyperthermia – a body temperature greater than normal – can occur. Moderate hyperthermia is normal and protective, but if it continues for a prolonged period of time and develops into an HRI, harmful long-term neurological effects can result. It is not necessarily the degree of hyperthermia that is important, but rather the duration of the increased body temperature – which is why it is critical to drop body temperature as soon as possible. Studies done by Dr. Doug Casa and the Korey Stringer Institute (2012) have shown that if a body is cooled within 30 minutes – the "golden half hour" – there is a 100 percent survival rate.

In general, the body gains or loses heat in one of four ways:

1. **Radiation:** Heat is transferred to or from an object or body via electromagnetic radiation from higher to lower energy surfaces (i.e., sunlight).

2. **Conduction:** Heat is transferred from warmer to cooler objects through direct physical contact (i.e., ice packs).

3. **Convection:** Heat is transferred to or from the body to surrounding fluid or air (i.e., fan or immersion in water).

4. **Evaporation:** Heat is transferred via vaporization of sweat.

Any of these heat loss methods can help overheating workers lower body temperature and prevent HRIs.

Ice packs and cooling towels are a good example of conduction, while a cold bath or misting system are examples of viable convection methods.

Evaporation is the most effective means of heat transfer. Efficient evaporation depends on water saturation of the surrounding air and velocity of the air, but its effectiveness is greatly reduced when humidity is high, as water cannot easily vaporize. In some cases, those experiencing severe heat exhaustion or heat stroke will stop sweating because their body can no longer react to an elevated internal temperature.

// MENTAL FUNCTION

Performance and physiology are key areas of study for exercise physiologists. The information obtained during athletic and military studies is valuable to those outside the aforementioned fields and can also be applied to those in the safety industry. Decreased mental performance may be linked to the discomfort of a high skin temperature, high skin wettedness, and strain to their cardiovascular system.

Military research has found that mental performance degrades most when a person is performing repetitive tasks (Department of Army and Air Force, 2003). This is often the case in industrial and construction settings, when routine tasks are completed more slowly when a worker is suffering from heat stress. Vigilant task performance worsens significantly after two to three hours of heat stress. Furthermore, heat stress can slow a worker's reaction time and decision-making ability, leading to errors.

Dehydration intensifies a worker's decreased mental function during heat exposure. Even simple tasks such as addition, response time, and recognition of words and phrases decrease as dehydration is prolonged.

// STAYING OFF THE INJURED LIST

Safety professionals can use research from athletics to help workers affected by heat stress return to work or to prevent heat stress from occurring in the first place.

KOREY STRINGER INSTITUTE

After professional football player Korey Stringer died from complications of heat stroke in August of 2001, his wife Kelci teamed with exertional heat stroke expert Douglas Casa, Ph.D., ATC to form the Korey Stringer Institute at the University of Connecticut in April, 2010. The institute has identified four "big ticket" items that, if followed, will almost certainly eliminate HRIs and fatalities.

1. Hydration

2. Heat Acclimatization

3. Work-to-Rest Ratios

4. Body Cooling Throughout the Session

Hydration is an obvious prevention method; however, it is only one piece of the HRI puzzle. All four items must be considered and implemented to prevent HRIs.

// HYDRATION

Water is an integral component of body processes as it carries nutrients and oxygen to cells, helps convert food to energy, and regulates body temperature. It accounts for 60 percent of body weight, 75 percent of muscles, and 80 percent of the brain. When an individual is adequately hydrated, called euhydration, body processes such as thermoregulation are able to occur. When an individual is dehydrated, however, these processes are unable to successfully happen. As discussed earlier, dehydration is a major contributing factor to HRIs. To prevent dehydration, and thus minimize the risk of contracting an HRI, workers should have free access to readily available fluids at all times. People should aim to prevent weight loss of more than two percent and keep urine light in color. One way to determine the amount of fluid an individual lost is to weigh themselves in the morning before their shift and immediately after. Every pound lost should be replaced with eight ounces of water (Casa et. al, 2012). Furthermore, electrolytes will be lost during the perspiration process and should be replaced accordingly.

// ACCLIMATIZATION

Acclimatization is a key prevention method to which states with existing heat illness standards refer. The California Heat Illness Prevention Standard, for example, defines acclimatization as a "temporary adaptation of the body to work in the heat that occurs gradually when a person is exposed to it. Acclimatization peaks in most people within four to fourteen days of regular work for at least two hours per day in the heat."

Military research agrees that optimal acclimatization requires specific and deliberate exposure to heat conditions. Though the effects of acclimatization to heat on mental performance have not been determined, acclimatization should lead to better mental performance for workers because their thermal comfort would be improved.

During the first few days of acclimatization, physiologic strain will be the highest and will be manifested by elevated core temperature and heart rate. This strain decreases with each subsequent day, and dramatically improves comfort and physical work capabilities as time goes on. Successful acclimatization increases stroke volume, which is the amount of blood pumped per heartbeat, and sweat rate, and decreases heart rate, core body temperature, skin temperature, and sweat salt loss.

It is important to note that dehydration negates many of the thermoregulatory advantages of acclimatization (Department of Army and Air Force, 2003). The military is one of the best organizations at helping their employees get accustomed to heat. Some of their heat acclimatization strategies that might apply to an industrial setting include:

- Mimic the work environment climate.
- Use work and rest to modify the heat strain.
- Ensure four to fourteen days of heat exposure.
- Maintain the daily duration of at least 100 minutes.
- Begin the acclimatization process up to one month before work in hot conditions begins.
- Upon arrival to the hot work environment, start slowly and reduce work intensity and duration and limit heat exposure.
- Acclimatize in the heat of the day, work in the coolest part of the day.

// WORK-TO-REST RATIO

Once temperatures reach 75 degrees Fahrenheit, begin adjusting work-to-rest ratios. There are many variables, including temperature, work intensity, and clothing/equipment that come into play, but the general idea is that as the heat increases so to should the frequency and length of breaks. OSHA has separate, temperature-dependent guidelines in place for workers doing light, moderate, and heavy work. For light work, the defined temperature is a Wet Bulb Globe Temperature (WBGT) of 86° Fahrenheit, 80° F for moderate work, and 77° F for heavy work. These guidelines suggest workers should not be subjected to the aforementioned temperature situations for more than two hours without a break (Minnesota Department of Labor and Industry, 2016).

// BODY COOLING

Preventing body temperatures from reaching dangerous levels while working in high-heat environments is key to heat related illness prevention. One way to combat rising temperatures is to utilize body cooling techniques throughout the workday or training session. These techniques include removing outer layers of clothing and/or equipment to allow the body to cool off and receive air flow. Place cooling towels, wet sheets, or ice packs over major arteries or areas with a conglomeration of blood vessels to facilitate cooling (Department of Army and Air Force, 2003). Wetting the skin surface via a hose, mist, or other means, and applying a fan can accelerate the evaporation process.

// PSYCHOLOGY OF TOUGHNESS

HRI is prevalent in athletes during the preseason and among new workers in industrial settings. In both populations, fighting the notion of "I don't need a break" is a challenge. The new worker may set out to prove their worth to an organization in the same way an athlete aims to impress their coach early in the season. This overzealousness may obviate a worker's training on HRI symptom recognition, causing them to bypass normal behavioral adaptations to heat and ignore the early warning signs of an HRI.

On the athletic field, recognition of early HRI symptoms is supplemented by the presence of an athletic trainer or team doctor who is well-versed in HRIs and takes prompt action when symptoms develop in an athlete. It is very unlikely to have such oversight in an industrial setting, leaving recognition of HRI symptoms to safety managers, supervisors, and the workers themselves. Often, those supervising athletes have incorrectly assumed that an HRI condition is not serious and that the athlete will recover on their own with rest (Casa et al, 2012). In the workplace, this attitude can be addressed in frequent training when workers will be exposed to hot working environments.

William M. Adams et. al, in conjunction with the Korey Stringer Institute, conducted a study of high school football coaches and their perceived confidence in dealing with heat stress. What they thought they knew versus what they actually knew was worlds apart. Despite being self-assured, most coaches were very deficient in their knowledge of the signs, symptoms, and emergency treatment of heat stroke (Adams et al, 2014). Studies show that if a heat stroke victim is not treated and cooled within a half hour of collapse, survival rate drastically decreases. So it is essential that authority figures recognize the signs of HRIs swiftly and address them properly.

// TREATMENT AND RETURN TO WORK

HRIs are cumulative in nature and can manifest themselves over the course of hours or days (Casa et. al, 2012). To counter the accumulation of heat stress, individuals should aim to incorporate some proactive measures into their daily routine while working in hot environments:

- Get at least seven hours of sleep per night.
- Eat a balanced diet.
- Hydrate properly every day, not just on work days.
- Rest in a cool environment and resist the urge to spend additional time in the heat.
- Decrease or eliminate the use of dietary supplements or substances that have a dehydrating effect, increase metabolism, or affect thermoregulation processes (i.e.: diuretics, coffee, and energy drinks).
- Be cognizant of any underlying health conditions that could affect the body's natural response to high heat exposure.

Treatments depend on the type of HRI the worker is experiencing (National Athletic Trainers' Association, 2002).

1. **Heat Rash:** Make sure skin is dry, move to a shaded area and rehydrate.
2. **Heat Cramps and Muscle Cramps:** Get rest and do some light, static stretching. A massage may help. Hydrate and replace electrolytes.
3. **Heat Syncope:** Move to a shaded area and elevate the legs above the heart, cool the skin, and rehydrate.

4. **Heat Exhaustion:** Use the same treatments as described for heat syncope and also remove excess clothing and equipment to facilitate evaporation. Fluid replacement via IV may be necessary and should be done in a healthcare facility.

5. **Heat Stroke:** The worker's core body temp should be lowered to under 102 degrees Fahrenheit within 30 minutes of collapse. This will return blood flow from the skin to the heart and lower the core body temperature by reducing the hypermetabolic state of the organs. The worker's trunk and extremities should be quickly immersed in a pool or tub of cold water (35° F-59° F) or wet towels placed over the entire body or cold water dousing. Consult a medical professional before submerging a person into a tub of water.

If a worker experiences any of the HRIs described above, returning to work on the same day is not recommended. According to the National Athletic Trainers' Association, the fastest way to decrease core body temperature is by immersing the trunk and extremities into a pool or tub filled with cold water (as described above). Other forms of cooling commonly used – including water spray, ice packs, or blowing air – decrease the body at a slower rate than cold-water immersion. If immersion is not possible, cooling with ice bags or cooling towels on as much of the body as possible, at major vessels in the armpit, groin, and neck regions as well as the hands and feet, and cold towels on the head and trunk can assure the most rapid heat loss.

// THE INDUSTRIAL ATHLETE

The Korey Stringer Institute's unofficial fifth big ticket item is education. The industrial athlete faces similar extreme environments, pressure, and exertion as a world-class athlete in their field of competition. Both can benefit from repeated HRI education on prevention, recognition, and treatment. HRIs can be prevented by adequate hydration, acclimatization, implementing work-to-rest ratios, and body cooling as temperatures soar. Having the ability to recognize and treat heat stress victims early can be the difference between life and death. By understanding an athletic approach to HRI prevention, the industrial worker can get a new, illuminating perspective on the matter.

// RESOURCES

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