PHYSIOLOGICAL CONCERNS OF HEAT

Original idea from David Carlisle

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The mercury's rising, summer's promise is becoming a reality and you're looking forward to some relaxed flying in the lazy, hazy months.
In anticipation of summer, flight crews brush up on an assortment of operating concerns, but often ignored is how the human body performs in our thermal environment. High ambient temperatures and other performance factors affect it in much the same manner as an aircraft.

Heat can impair your ability to perform efficiently and can pose a serious threat to your health. During extreme circumstances it can be deadly.
Let's look at how your body manages and maintains its delicate heat balance and what happens during an overheat condition. You'll probably want a glass of cool water, but first, let's pour some summer survival truth.

YOUR BODY AND HEAT

Your body balances its temperature within an optimal range of 97.7°F to 101.3°F (36.5°C to 38.5°C) in much the same manner that an aircraft's air cycle machine controls its cabin temperature.
A human's thermostat is located in the hypothalamus region of the brain. It initiates temperature adjustments in response to inputs from thermal receptors in the skin and changes in blood temperature.
Your body's objective in high ambient temperatures is to maintain physiological efficiency and prevent a possible overheat and shutdown. If your body senses an abnormally high heat condition, it alerts you with cautionary warnings and by degrading your efficiency and performance. When pushed beyond its normal limits, varying degrees of *hyperthermia* (heat illness) follow.

Regulating internal temperature within narrow limits, your body conserves or sheds heat, taking into account numerous factors including the amount of sun and ambient temperature to which you're exposed, your fitness level, physical exertion, dehydration, obesity, poor circulation, diet and alcohol use.
Your body compensates for an increase in heat load - up to a point - by moving warm blood outward from the body's core via your cardiovascular and circulatory system to your skin, where it's lost to the atmosphere. Knowing your personal overheat warning signs, how to regulate them, and when your body will throw in the towel is imperative to preventing heat illness.

Two of the environmental means that provide over 85 percent of the body's heat loss are radiation cooling and evaporation. How well these work varies, depending on many factors such as ambient temperature and relative humidity. Other factors include your level of physical exertion, type of clothing, and salt and water intake.

The radiation of heat from your body (the transfer of heat from an object to another object of lower temperature) accounts for about 60 percent of your total heat loss. As ambient temperature increases, radiation cooling becomes less effective and there's more of a dependency on skin evaporation for heat dissipation.

Evaporation accounts for about 26 percent of your body's total heat loss. Since your body can give off water at a tremendous rate, it's essential to replace it in a timely manner.
An evaporation process that has the potential for danger is termed the *no sweat* condition. This can occur when you're undergoing light to moderate activity at 70°F to 75°F (21°C to 24°C) and there's about a 50-percent relative humidity. Under such circumstances, you can lose water rapidly even though you're not perspiring. This unnoticeable loss can possibly lead to varying degrees of heat illness.
When air temperature approaches and surpasses your skin temperature, the additional heat load interferes with the body's normal heat dissipation. Evaporation can't keep up with the necessary cooling requirements and your body's thermostat programs the skin to produce sweat.

Heat Index

The heat index combines the relative humidity with the actual air temperature to give an effective heat measure. Exposure to full sun can increase the heat index by 15°F.

- A heat index of 80°F to 90°F (27°C to 32°C): Fatigue is possible with prolonged exposure and/or physical activity.
- A heat index of 90°F to 105°F (32°C to 41°C): Sunstroke, heat cramps and heat exhaustion are possible with prolonged exposure and/or physical activity.
- A heat index of 105°F to 130°F (41°C to 54°C): Sunstroke, heat cramps or heat exhaustion are likely and heat stroke is possible with prolonged exposure and/or physical activity.
- A heat index of 130°F (54°C) and higher: Heat stroke is highly likely with continued exposure

A potentially dangerous situation could occur when evaporative heat loss is minimized. This can happen during periods of high relative humidity. If you're performing light to moderate work and the wind is light and air temperature is near your body temperature, the water on your skin won't evaporate efficiently and it acts as a heat block. You could experience a spiraling core temperature and varying degrees of heat illness within a short time.
In this situation make a conscious effort to remove the sweat from your body and replace your fluid loss. Relative to the rest of your body, your scalp, face and upper torso provide the most cooling, so get in front of a fan or under air conditioning, remove your shirt and hat and cool down.
In dry air, your body might delay the onset of heat illness for a while, but in either case you need to drink more water, replace your salt loss and get cool.

A contributing factor to heat stress is dehydration that can occur when your water intake doesn't replace the water loss. One of the latter symptoms is thirst, which occurs when your water deficit is about one to two percent of your total body weight. It's unfortunate that the thirst symptom is mild with regard to the amount of water lost since there may be a tendency not to drink enough to realign your deficit.
The lungs are responsible for about eight percent of the body's total heat loss. When you inhale, the air entering your lungs is warmed and saturated with water vapor, which is then transferred to the atmosphere upon exhaling. Since heat was required to vaporize the water, heat also is given off. The amount of water and heat loss is directly related to the depth and rate of respiration. Having healthy lungs helps aid in the transfer of body heat at all times and especially during periods that the body is experiencing a high thermal load.

Excess body fat is a liability when working in a hot environment. Because the specific heat of fat is greater than that of muscle tissue, fat increases the insulatory quantity of the body shell and retards the conduction of heat to the skin. An overweight person also has a small body-surface-area-to-body-mass ratio for the evaporation of sweat compared to a leaner, smaller person.
In addition to thwarting effective heat exchange in a hot, humid environment, the overweight person is at a distinct disadvantage in terms of temperature regulation. Exercise can increase the risk of heat stroke. Commonly prescribed drugs can inhibit the hypothalamus from allowing the vascular system to regulate the flow of blood from the body core to the skin, thus blocking the transfer and elimination of heat.
If these medications are combined with a strict adherence to a low salt diet your body can lose additional fluid and minerals. Coupled with other compromising factors such as high relative humidity, high OATS, and not being acclimatized to the heat, you could accelerate the onset of heat illness. Check with your flight surgeon before taking any medications and don't fly when you have the flu, as this illness will further dehydrate your body.

OVERHEAT COMPLICATIONS

If the early signs of heat stress - thirst, tiredness, grogginess and visual disturbances-are not heeded, cardiovascular compensation can begin to fail and a series of disabling complications can result.
The major forms of heat illness, in order of increasing severity, are heat cramps, heat exhaustion and heat stroke. There is often no clear-cut delineation between these maladies because symptoms often overlap.

When heat illness does occur, immediate action must be taken to reduce the heat stress and re-hydrate yourself or a fellow crewmember until medical help is available.
Heat cramps, or involuntary muscle spasms and their associated pain can occur during or after intense physical activity. They are usually observed in the specific muscles exercised, but can also occur in the muscles of the abdomen. Heat cramps don't necessarily mean the body's temperature is elevated to a dangerous level. Prevention can usually be ensured by drinking copious amounts of water and by increasing your daily intake of salt several days before a known period of heat stress. An easy way to do this is add a pinch of salt to your foods at mealtime.

Cool ,Clothing

- Clothing has a great effect on your body's ability to maintain and regulate heat. The ideal warm weather icing is lightweight and loose fitting, since that helps circulate the air near the body. A light color will help reflect the sun's rays. Even when wearing the right clothing; heat loss is retarded until the clothing becomes wet and evaporative cooling can proceed.
- Uniform coats can impose a significant barrier to heat dissipation by effectively sealing off the body's core surface from the benefits of evaporative cooling. Dry clothing, no matter how lightweight, retards heat exchange more than clothing that is damp or wet

Heat exhaustion is the body's response to excessive water and salt loss, both of which are found in sweat. It can develop in an individual who isn't acclimatized to the heat and often occurs during the first heat wave of the summer or during the first hard exercise session on a hot day.
Exercise-induced heat exhaustion is believed to be caused by ineffective circulatory adjustments compounded by a depletion of plasma volume. Blood usually pools in the dilated peripheral vessels of the cardiovascular system, drastically reducing the central blood volume necessary to maintain cardiac output.
Heat exhaustion is characterized by a weak, rapid pulse, low blood pressure in the upright position, headache, dizziness, general weakness, and possible vomiting and fainting. Normally the person will be sweating heavily from the exertion. His skin can be cool, moist, pale and clammy. A person experiencing these symptoms should stop working and move to a cooler environment. Fluids should be administered, usually via intravenous therapy.

FLIGHT DECK SUMMER SURVIVAL

You know it already but too much sun increases the risk of skin cancer. The ultraviolet (UV) rays in sunlight are responsible for damaging your skin and eyes. At altitude there is less atmosphere to screen the UV rays and consequently pilots need to take extra precautions.
The amount of skin damage is also dependent on your skin's pigmentation and tanning level. Individuals with fair skin need to exercise more caution. Be aware that certain drugs like tetra line and Retin-A can make you more susceptible to damage from sun exposure.

There are a variety of high quality products that can help protect you from harmful UV rays. Install cockpit sun visors that eliminate UV rays at altitude. Invest in a set of high quality sunglasses. Lens quality should be your first consideration, as a high quality glass lens will make a noticeable difference in how you feel at the end of the day. Your brain can adjust to minor distortions due to lens imperfections, but the extra workload will increase your fatigue. When fitted for prescription glasses, tell the eye doctor you're a pilot He'll help you avoid glasses that can block your peripheral vision. Look for 100-percent UV protection when making a final selection.

If you're considering using sunscreen on your face while flying, take some time to learn about the product and experiment with it on the ground. Read the SPF (sun protection factor) label. SPF ranges from eight to 15 to 30 and above. Number eight provides minimum protection (purportedly giving you protection such that eight hours of sun will only give you one hour of exposure) with the highest number providing maximum protection. UV rays have two known components: UVA and UVB. The difference is in their specific wavelength. Scientists initially thought only UVB was responsible for skin cancers and sunburn, but now UVA has been found to contribute as well, so make sure your sun block protects against both UVA and UVB.
Apply as directed on the label, including to your lips, scalp and ears. Be alert when sweating. Some sun blocks when accidentally rubbed in the eyes can cause so much pain and tearing that the victim becomes temporarily blinded. Rubbing your eyes further - the natural reaction to such a condition - only aggravates the problem and delays sight recovery.
If this happens to you in flight, immediately transfer control of the aircraft to the non-flying pilot. Use a clean absorbent napkin to dab your eyelids, then clear the area around your eyes starting above your brows and working outward, downward and inward below the eyes. When you've cleaned the area use a fresh napkin or linen that is moistened with fresh water and rescrub the area. Flush and re-flush your eyes with fresh bottled water as necessary. With extreme prejudice pitch that particular sun block product in the trash.

Always use a power cart or APU and pre-cool the cabin to a brisk temperature while accomplishing preflight duties.

Wear a hat while flying or when shade is at a premium. Temperatures on the ramp are often far in excess of those broadcast so cut back on the coffee and manufactured drinks that are loaded with sugar and/or caffeine since they can cause further dehydration. Water and sports drinks help replenish electrolytes and are better for you than sodas.

A body temperature of 103°F (39°C) or higher is considered dangerous.
The most serious and complex heat stress illness is heat stroke. It is a true medical emergency and requires immediate medical attention. Heat stroke occurs when the body's sweating mechanism fails and, unable to cool itself, the body's temperature rises rapidly to 106°F (41°C) or higher within 10 to 15 minutes. This can result in permanent disability, unconsciousness and death if swift treatment is not administered.
The symptoms vary but can include red, hot and dry skin; a rapid and strong pulse; headache; dizziness; nausea; and confusion. If the person was sweating, his skin may still be wet. The complexity of the problem is compounded because symptoms are often subtle.

When encountering a heat stroke victim, first call for medical help, and then move quickly to lower the individual's elevated core temperature before damage to the brain and other vital organs occurs. If there's no air-conditioned room nearby, move the person to a cool shady area.
Try to cool the person immediately using any means available including water from a garden hose, alcohol rubs, ice pack applications, or immersing the person completely in cold and/or ice water.

Monitor his temperature and continue the cooling efforts until the victim's body temperature drops below 101°F (38°C). If vomiting occurs, make sure his airway remains open by turning him on his side.

If you or another flight crewmember are feeling ill and you suspect heat is the culprit, seek out air conditioning or simply plop yourself in front of a fan. Toss a teaspoon of salt into a quart pitcher of water and drink some to compensate for salt loss. If that doesn't fix the problem and the symptoms persist, don't hesitate to take yourself or a crewmember off flight status and seek emergency medical help. Operating safely in any hostile environment depends on following rules and limitations, so regulate your exposure and work intensity. Meanwhile, keep plenty of bottled water and sports drinks in the ice bin. Stay cool. And have a great summer.

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