Heat-relatedIllnesses--

All modelers beware.

Too much exposure to a hot sun and high humidity, combined with excessive physical exertion can give modelers big trouble. But heat-related illnesses, ranging from muscle cramps to fatal heat stroke can be guarded against with a little awareness of the causes and use of preventive measures. There are four distinct heat-related illnesses that may seem to overlap as you read the descriptions below. Despite having many factors in common, the clinical pictures differ.

1. Heat cramps are painful contractions of muscles that follow exercise, such as after repeated long retrieval chases on foot. Most sufferers of cramps are in good physical condition but have noted excessive sweating and usually have normal body temperatures. Excessive sun exposure may not be involved and the environmental temperature may even be cold and lower than body temperature. Loss of body water and salt in the sweat leads to dehydration and lowered sodium levels in the blood, with similar abnormalities probably occurring within muscle cells. Oral replacement of water and sodium chloride usually results in cessation of the cramps.

2. Heat exhaustion or heat collapse is all too common, especially in non-acclimatized older persons who take diuretics. It is important to note that heat exhaustion may occur in inactive persons exposed to adverse environmental conditions as well as those who are physically active. The illness represents a failure of the cardiovascular system to respond adequately to high external temperatures. It is most often but not invariably precipitated by unrecognized lack of fluid intake and depletion of water and salt in sweat. The onset is often sudden and unexpected, but may be preceded by weakness, nausea and faintness followed by a worrisome collapse. The blood pressure may be low and the pulse increased. Sweating may be absent and the skin cool. The body temperature may be normal or subnormal since exposure to heat has usually not been severe or prolonged. Most instances of mild heat exhaustion resolve with rest in a recumbent position and oral fluid replacement in a cool environment. Usually only severe prostration requires intravenous fluid replacement.

3. Exertional heat injury occurs most commonly in runners and involves injury to muscles and other organ systems. Excessive exercise in high temperatures and humidity with inadequate conditioning and acclimatization may lead to exertional heat injury. Maximal sustained use of muscles may cause energy consumption of muscle to increase as much as 20-times basal levels. Because the metabolic efficiency is only about 25%, the released excess energy is quickly transferred from muscles to blood as heat, raising the body core temperature dramatically. Profuse sweating results and persists as long as hydration remains adequate. If extreme body temperatures develop, a host of gastrointestinal, cardiovascular or neurological symptoms and signs may result, including low blood pressure and loss of consciousness. Severe elevation of muscle and liver enzymes may be observed in laboratory tests. Multiple organ failure may occur in severe cases. Prompt body cooling and appropriate intravenous fluid replacement are vital to survival and recovery. Exertional heat injury can be prevented by avoidance of exercise in extreme heat and humidity, and by drinking large volumes of water before, during and after exertion.

4. Heat stroke or sun stroke may follow excessive and prolonged exertion at any age, but actually occurs more commonly as a non-exertional entity in elderly persons with underlying chronic diseases and who receive diuretics. Other drugs incriminated as precipitating or contributing to heat stroke by affecting heat transfer or re-setting the body thermostat to an abnormally high level include anti-histamines, anti-Parkinson and psychotropic medications. The cause of heat stroke is unknown but direct exposure to the sun, although commonly involved, is not required. Sweating is often absent in the ill person because constriction of vessels in the skin and extremities have shunted blood internally, preventing dissipation of heat from the body core. Rectal temperatures higher than 106º F and body core temperatures as high as 112º F are observed. The onset may be preceded with nausea, headache or faintness but the individual may suddenly become stuporous or comatose. Shock usually intervenes. Severe laboratory abnormalities appear. Death may occur in hours associated with cardiac and multi-organ failure.

Heat stroke is an extreme emergency and was responsible for 6,615 recorded deaths in the U.S. during 1979-1995. In heat stroke, the heat regulating body mechanisms have failed, with no means to dissipate core heat. Immediate treatment is necessary, regardless of the setting. The patient's clothes should be removed and the individual immersed in an ice water bath or packed in ice, a treatment of proved merit. For example, the U. S. Marine Corps have achieved highly successful outcomes for ice-water bath treatment of heat stroke in new recruits. Massage to increase skin circulation and heat dissipation, vigorous re-hydration and other life support measures may also be required.

Rare and unusual forms of hyperthermia, resembling heat stroke, may be associated with use of amphetamines, monoamine oxidase inhibitors, cocaine, tri-cyclic anti-depressants and LSD. These illnesses may require specialized forms of drug treatment and support.

Acclimatization allows adaptation to adverse environmental conditions and protects against heat-related illnesses. It is a poorly understood but important means by which we tolerate high temperatures. Integral to the process is our ability to transfer body heat to the environment through evaporation of sweat. But the water and salt expended in sweat must be regularly replaced to maintain the cooling process. Otherwise, the body temperature may eventually rise precipitously. The pituitary gland and kidneys are stimulated to produce hormones that help retain body water and sodium, but potassium may be lost in the process. After full acclimatization, the cardiac output, pulse rate and respiratory rate may all be somewhat increased. The process takes four to seven days. Does this remind you of feeling stronger the final days of the AMA Nationals?

Hydration is normally maintained by homeostasis mechanisms that balance fluid intake and output (urine, sweat and exhaled moisture). Maintenance of hydration is important in the prevention of heat-related illnesses. But that water-conserving mechanism may be bypassed by the need to dissipate body heat through sweating, resulting in depletion of body water and electrolytes. In those circumstances, the first warning sign of impending dehydration is prolonged excessive sweating, which may be followed quickly by reduced urine flow and lowered body weight. The total blood volume may also contract as water is extracted from intra-vascular compartments.

The approach of attempting over-hydration before exposure to hot, humid conditions as a means of preventing heat-related illnesses has theoretical merit but is limited by the homeostasis mechanisms that automatically adjusts body fluid balance. Nonetheless, an early start on hydration is strongly recommended since once an individual falls behind on fluid intake, catch-up is very difficult if not impossible during competition.

Electrolyte replacement is ordinarily not critical in treatment of mild dehydration and less severe heat-related illnesses. Several commercially available "sports fluids" do contain measured amounts of sodium and potassium (plus carbohydrates) that normal body mechanisms can sort out after ingestion and retain or excrete as needed. In severe and life-threatening heat-illnesses, major abnormalities of blood electrolytes require expert monitoring and replacement because of the potential for affecting heart function and rhythm, especially in the presence of impaired kidney function or other organ failure.

Caution flags should be obvious. Be aware of and alert to the following factors that can predispose to heat-related problems on the flying field:

- Environmental temperatures near to or higher than body temperatures (>90ºF)—inhibits normal transfer of excess body heat to the environment.
- High humidity (>60%)—impedes evaporation of sweat and the related cooling effect.
- Poor conditioning and acclimatization—a setup for illness.
- Occlusive clothing—insulates the body and impedes evaporation of sweat.
- Pre-existing dehydration—due to low fluid intake, illness or medications.
- Prior use of diuretics leading to intended reduction of free body water--(this does not imply that diuretics should be discontinued).
- Use of other drugs known to be associated with heat-related illnesses.
- Overly strenuous physical activity—most persons are aware of this but push on.
- Known low urine output despite fluid intake—indicating possible early dehydration.

In summary, use of common sense and good judgement are the keys to prevention of heat-related illnesses. Remember to consider the following on and off the flying field:

- Heat-related illnesses usually occur on the first day or two of a heat wave or an extended outing--before acclimatization has occurred.
- Know your physical limits—function within those limits.
- Drink adequate fluids regularly throughout the day—enough to result in voiding significant urine volumes at least every 2-3 hours.
- Long retrieval chases should always be motorized—don't go on foot or alone, if possible.
- Ingest fluids freely on chases—go to the trouble to do this.
- Maintain two-way communications—your location on a chase should be known to others.
- Stay out of the sun and in the shade—whenever possible.
- If you become aware of possible heat-related symptoms—always seek fluids and assistance.

Reference.

1. Harrison's Principles of Internal Medicine. Fauci, Anthony S., et al, Editors; 14th Edition, pp. 88-90. Magraw-Hill Companies, Inc., Pub., N.Y. 1998.

(Bob Perkins is Emeritus Professor of Internal Medicine and former Director, Division of Infectious Diseases, The Ohio state University, Columbus, Ohio).