Heat and Hydration: What Every Rugby Player Should Know

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Overview.

Heat illness and heat 'exhaustion' / heat stroke in sports have made prominent news in the last few years with the deaths during training camp of Minnesota Vikings' offensive lineman Korey Stringer in 2001 and Baltimore Orioles' pitching prospect Steve Bechler in February 2003.

Although not something we immediately think of in Canadian Rugby with our climate, heat illness and de-hydration are still potentially serious problems in Canada.

In this article we will discuss the complete spectrum of heat related problems from simple exercise induced elevated temperature, through to the most serious, heat stroke as relevant to Rugby. We will discuss predisposing factors, treatment and most importantly, prevention for this condition.

Basics.

In scientific jargon, heat illness is defined as an elevation of the core body temperature to 38°C or more, where the cause is due to environmental conditions or internal heat production secondary to activity. Basically, this simply means the rise of a player's body temp above normal (36.7°C) due to the intensity of play or playing conditions (in the absence of a fever or febrile illness). Core temperature is measured via a rectal thermometer (skin and oral measurements are not as accurate or reliable).

Heat production during exercise results from continued muscle activity or contraction. Muscle action requires one of a number of energy cycles to occur (the conversion of fuel e.g. carbohydrates and fat, to molecules (ATP) used in muscle contraction). The major by-product of these cycles is heat energy. (Studies have shown that up to 75% of the energy produced by these cycles is wasted as heat.) Unless the body is able to dissipate or loose the heat to the environment as fast or faster than it is produced, sustained muscle activity will result in the accumulation of this heat causing body temperature to rise.

Heat loss to the environment occurs primarily through sweating (the evaporation uses heat) as well as conduction / convection (skin blood vessels dilate and transfer heat to the environment) and, to a lesser extent, breathing (heated moist air is expelled and cooler dry air inhaled). The body will normally adjust blood flow around the body to optimise flow to the working muscles and to the superficial vessels to optimise heat loss vs. muscle contractions. If heat loss (known as dissipation) is less than production, then the net effect is an increase in body temperature. The factors that affect this ability to dissipate heat (or accumulated energy) are discussed below.

Risk Factors.

We can divide the risk factors between environmental factors and player related factors.

Environmental Factors.

Temperature and Direct Sun.

If the ambient temperature is higher than the body's normal temp, there will be a net gain of heat from the environment to the player. In well conditioned, Acclimatized and hydrated athletes, and except in extremely hot conditions, this heat gain is controlled to within +/- 5°C through sweat. Even with this ability to control core temperature, many studies have still shown the significant adverse effect of ambient temperatures greater than 21°C on endurance, speed and power.

Direct sunlight will further compound the problem of heat gain through the obvious increase in convection heating.

Humidity.

It is not only high temperatures, but also the combination of heat and humidity that will affect the body's cooling ability. Conditions of high humidity seriously adversely affect the ability of sweat to evaporate and thus transfer heat away from the skin. Without this cooling mechanism, the rise in core temperature becomes exponential. Reports of heat stroke have occurred with a combination of Relative humidity of 40% and temperatures of only 26°C, conditions not uncommon during our summer.

Wind.

Wind will increase the rate of sweat evaporation and have a direct cooling effect on players.

From the above it is clear that the conditions with the highest risk for heat exhaustion or heat stroke are most common in the mid afternoon - sunny, hot humid and wind-still days. Organizers of sports events and training sessions should take all of these factors into consideration when planning the timing of a game or practice. A useful tool to use is the combination of 'wet' bulb and 'black' bulb temperatures when deciding whether conditions are too risky to hold a game. (These instruments take the effects of relative humidity, wind and direct sunlight into account for the readings but will not be discussed in any greater detail for this article.)

Player Factors.

Fitness and Acclimatization.

Although higher levels of fitness do not prevent heat stroke, all else being equal, the lack of fitness significantly increases the risk of it occurring. This is thought to be due to a number of factors, including the body's increased temperature regulation efficiency, increased exercise efficiency and decreased percentage body fat that occurs with training. Players that have had time to acclimatize to the hot humid conditions are at far less risk of heat stroke as their bodies adapt temperature regulation to the more difficult environment. Acclimatization is discussed in more detail below.

Hydration.

Apart from the deleterious effect of slight (< 2%) degrees of hydration on performance, the effect on temperature regulation is significant. This is due both to the inability of the body to sweat sufficiently and the changes that result in heart rate and blood flow.

Depending on size, level of effort and playing conditions, players can loose1-2 litres of sweat per hour or if this fluid is not replaced during the game, up to 4% dehydration of an 85kg (190lbs) player. This dehydration results in a 'viscous cycle' as dehydrated players are less efficient, heat up faster, are unable to get rid of the heat and, with-out appropriate intervention, progress ever more rapidly to heat exhaustion or heat stroke.

Other conditions that may cause a player to start out dehydrated include gastro-enteritis (vomiting and diarrhoea), fever and hangovers.

Equipment.

Traditional Rugby jerseys ability to reflect sun and to help wick sweat away form the skin is poor. A dark, thick cotton Rugby top over 'body armour' is not the most efficient for summer play or practice. If possible teams should use their lighter, short-sleeved strip when conditions are risky. Kit manufacturers are now using lighter weight modern wicking materials for Rugby uniforms.

Medications / Drugs.

A number of both commonly used 'over the counter' and prescription medications affect temperature regulation.

The two most common groups of 'risky' medications are the stimulants and diuretics. Common cold medications with a decongestant (pseudo ephedrine e.g. *Sudafed*, *Tylenol Cold and Sinus* etc) and appetite suppressants are stimulants, whilst diuretics are therapeutically to control high blood pressure and heart problems, but illicitly in sport to mask banned doping methods. Elite players should be aware that both the above groups of medications are in the IOC / IRB list of banned substances.

Other prescription medications that have been reported to play a role in heat stroke include antihistamines (for allergies), anti depressants and antispasmodics (for bowel cramps).

Supplements, herbal stimulants and weight loss formulas often contain stimulants (not always declared on the label) such as ephedra, 'mah huang', guarra etc or diuretics, all of which have a negative effect on temperature regulation (these have also been implicated in 'positive' doping tests).

An indication of the potential severe effects of these medications and stimulants (Ephedra and the 'Herbal equivalents' e.g. Chinese Orange Blossom) combined with heat is that they have been implicated in the deaths of both Korey Stringer and Steve Bechler. Ephedra is now banned in Canada but its derivatives and equivalents are still available.

Prevention.

Acclimatization.

It takes 5 – 10 days for a player to acclimatise to both heat and humidity. The body becomes more efficient in sweating (with an earlier onset and greater level), fluid absorption from drinking, and work levels. With Acclimatization, blood volume increases thus increasing the ability of the heart to pump blood (and oxygen) to where it is needed. The highest incidences of training camp heatstroke has occurred early on in camp (before the athletes have Acclimatized) and the day after a heavy work-out (usually during twice daily training sessions).

Training camps need to incorporate this Acclimatization period into their structure as does preparation and planning for tours / tournaments in hot humid climates. Players need to gradually increase their length and intensity of exercise in the heat prior to arriving at the camp. The most common (but costly) Acclimatization method for travelling teams is by arriving 10 days – 2 weeks before a competition or if this is not possible, to train at the hotter times of day when based in a milder climate. Simulated training in 'climate controlled' rooms is also used but will not be discussed further here due to the lack of these facilities in Canada.

Hydration.
As should be obvious from the preceding discussion, proper hydration is essential. There is no magic formula for X ml per hour that is appropriate for every player in all conditions, but a general guide is approximately 150 – 200 ml of cool fluid every 15 min for an 85kg player. Each player will loose fluids at a different rate and essentially fluid intake must match sweat loss. Players can monitor their hydration status and sweating rates through regular weighing before and after games or practices during the season. Fluid replacement must be a combination of water and electrolyte containing sports drinks to avoid developing a low blood sodium or electrolyte level.

Two water carriers may enter the playing area when there is a stoppage in play and when a try has been scored, but not when a penalty kick has been awarded. The water carriers must remain in the technical area at all times unless they enter the playing area to provide water. Water carriers must have some distinguishing mark e.g. arm bands. When weather conditions are exceptionally hot and/or humid, the referee is permitted to allow one water break (of one minute) in each half.

Environmental.
Ideally games and practices should be scheduled during the cooler, less humid times of the day (early morning and evening). Failing this, certain added precautions are possible.
Before the game players should avoid sitting in the sun and seek shade. Shady areas in the form of a tent or shelter should be provided for players on the bench and those waiting for their game to start (Some international and club teams have their subs stay in the dressing room during the game until needed or warming up).
Ice and ice water should be available to the players before, during and after games or practices and cooling fans should be considered.

Pre – Cooling.
One of the more visible technologies seen during the 2004 Athens Summer games was the increased use of pre-cooling by many countries including Canada, USA, Great Britain, Holland and Australia. Pre-cooling of the body's core temperature is achieved through Cooling Vests / hoods or suits worn up until the start of the event and again at half time. They are available in a wide range of technologies from simple ice vests to individual refrigeration units. The beneficial effect on performance in hot and humid environments has been well documented in numerous scientific studies but their use is limited by both expense and the logistics of supplying enough ice / power for the full team at remote venues.

Treatment.
The best form of treatment is obviously prevention through avoiding the risk factors discussed above. Players should be monitored by the coach, training staff and referee for developing signs of heat illness such as sluggishness, irritability, confusion, in- coordination, vomiting or dizziness. Once recognised, treatment speed is essential to prevent death.
The rule is to cool as quickly as possible. The most effective method is submersion of the player in an ice bath. If an ice bath is not available then cover the player with ice and wet towels in the shade near a fan or in cold water. Players must be encouraged to drink cold fluids and their temperature monitored regularly.
Once cooled, only then is transport to a medical facility for further treatment and monitoring appropriate. Do not delay cooling by transporting a player first as survival and full recovery is directly related to the speed of return of the core temperature to near normal.

Summary.
As with most conditions, prevention is far better than a cure for heat illness or heat stroke. The mainstays of prevention are education, Acclimatization, hydration, staying cool, awareness of the risk factors and continuous monitoring of players for early signs of susceptibility to heat and for signs of early heat illness.

Have a safe and cool season.

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