



Review Article

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Heat Stress in (Sport) Horses: (I) Occurrence, Signs & Diagnosis, (II) Practical Management and Preventive Measures



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Introduction

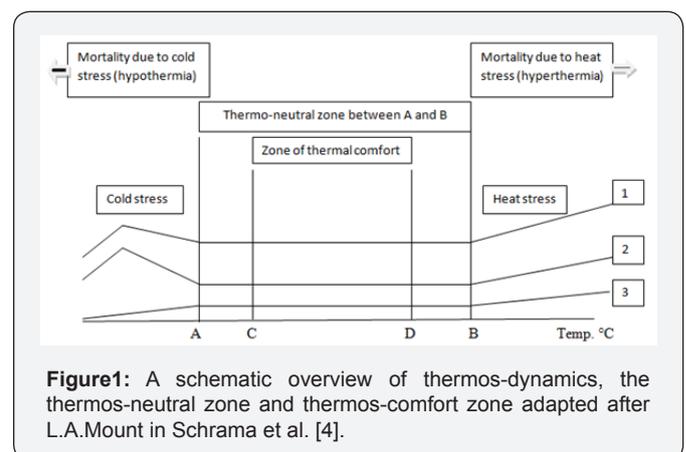
Heat stress in sporting horses is unfortunately a dramatically underestimated phenomenon. Unfortunately, because not only a loss of performance, welfare and health status occurs in horses which are affected by heat stress, but also the rider may suffer from the negative effects of this phenomenon [1,2]. The NASA has determined that the labor performance of human beings at environmental temperatures of 32 °C (90 °F) are 30% lower than under normal ambient temperatures, while the precision of work decreases with 300%. At temperatures of 37 °C (98 °F) this decrease is even higher: 50% and 700% respectively. Too often horse owners, riders and grooms think about this from a human point of view: "At this temperature I feel very warm; my horse will feel the same".

Horses, especially trained sport horses, do have a metabolism which is different from the human one. Their thermo-neutral zone is at a different level too. Despite the risks, people continue to use buckets or hoses with cold water to cool down the horse after a performance. To avoid the risks of heat stress (and even worse, heat stroke) or at least make those risks better manageable, there exist simple but effective measures, which do not need to be expensive. For horse competitions, especially in the hot outdoors season, the organizers should feel obliged to install appropriate cooling facilities and apply the appropriate cooling methods for the participants.

In this paper, we address,

- o The occurrence of heat stress, its negative effects on performance, welfare and health, and the most relevant signs of heat stress.
- o The management measures to reduce or better control the risks, and prevention.

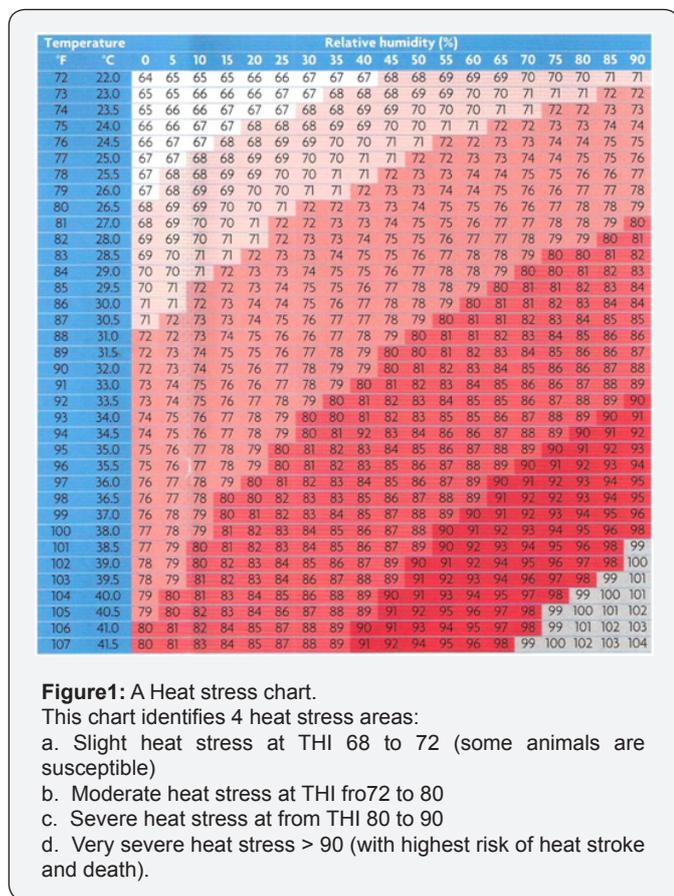
Occurrence, relevant signs and diagnosis of heat stress



The occurrence of heat stress: Horses have a thermo-neutral zone between 5 °C (41 °F) and 20 °C (70 °F) (Figure 1) there is some individual variation [3-5]. Thermo-neutral means that at these temperatures the horses can easily get rid of the heat that is produced in the body. At higher (but also at lower) temperatures changes do occur inside the body. The body tries to adapt itself to the new, undesired situation. At 20 °C (71 °F) and above we state that heat stress starts; it becomes more severe when temperature increases and/or relative air humidity increases. Under heat stress, the horses produce more heat in the body than they can get rid of. Most heat is lost through sweating and evaporation at the skin surface (65%); the rest mainly through the lungs and respiration (25%). The core problem in heat stress is the loss of water and electrolytes. In endurance, military or cross-country, this loss may increase up to 10 L. Horses feel best at temperatures between 10 °C and 18 °C (50 to 70 °F); this range is called the "thermo-comfort zone". The temperature

of 20 °C (70 °F) named above is the “upper critical temperature” (in recreation horses this upper limit might be slightly higher -22 to 24 °C (or 72 to 75 °F)- due to lower performance level and hence lower metabolism) as indicated by [6].

Horses produce the heat in their body during processes of body maintenance and several basic body functions, their metabolism and their performances (training and competition). More than 50% of the energy that is available in the muscles is converted into heat. This heat is normally lost through sweating, evaporation and convection, but is fully dependent on the ambient temperature and the air humidity. The normal rectal temperature of a horse is 38±0.5 °C (100±8.6 °F); this value is deduced from the muscle temperature which on its turn is deduced from the deep body temperature (metabolism). During heat stress situations, the rectal temperature increases.



acceptable threshold level for sport horses is around a THI of 68; above this value heat stress is present and risks occur. Around a THI of 80 or higher there is a mortality risk. Life-threatening situations occur when the rectal temperature reaches 40 °C (104 °F) or higher. Above 42 °C (110 °F) there is an oxygen deficiency, with damage to liver, heart, brains, and kidneys. Such a horse may show spasmodic movement, fall into coma and finally die. A horse that has been overheated under heat stress will a next time have become much more susceptible for heat stress effects.

The risks of heat stress for performance, welfare and health: At high temperature and air humidity the performance of a horse will always be less. High air humidity bears more risk than a high temperature alone. From 20 °C (70 °F) upwards, the horse will already loose water and electrolytes. It could be that a horse cannot get rid of its heat through sweating and evaporation because these processes do not function due to high air humidity. The skin surface of a horse is relatively smaller than that of a human being, due to biomass and body weight. Sweating and evaporation is therefore paramount for a horse. If a horse loses water, its blood circulation will be much less efficient: the blood volume has become smaller. This lower blood volume causes a lower blood flow to the skin (hence less sweating), to the muscles (hence lower energy flow and loss of performance) and less to the intestines (hence less energy, water and electrolyte absorption; higher risk of colic). When the heat stress is severe or of long duration, the recovery will be less well and of longer duration too [11,12]. Therefore, there is a 'golden rule': “The longer you wait with an intervention, the more severe will be the negative consequences for performance, health and welfare; during repeated heat stress, too. Hence, cooling should be done as soon as possible and in a correct way.”

Most relevant signs of heat stress: Most relevant signs of heat stress are: lower feed intake, lower activity level, decreased performance, stiff gaits, increased heart rate (>50 à 60 beats/min), panting (respiratory frequency >60 à 80/min; sometimes panting like a dog), diaphragm beats on the flanks during respiration, lung edema, ataxia (uncontrolled movements), diarrhea or colic [13-15]. Also inside the body there are several changes which already may occur from 20 °C (70 °F) upwards and which cannot be seen from the outside. Among these are: lower energy and nitrogen balance; loss of thyroid function; and different other metabolic deviations. When these deviating processes proceed, the immune system too can be affected negatively, rendering the horse more susceptible for (infectious) diseases. Sometimes horses do not sweat (anymore), especially when they have been exposed longtime to high ambient temperature and air humidity. The latter causes a high blood adrenaline level which lead to destruction of sweat glands in the skin. The heat stress problem is then further aggravated. There is a genetic component involved.

Horses are not all equally susceptible for heat stress and its consequences. Among risk factors playing a role are: breed

(thoroughbred versus traction horses), age (young versus older), performance and training-level, body condition (over-condition versus proper condition), housing (poor versus proper ventilation), level of feed intake, ration composition (protein and fat content; also salt supply and electrolytes), feed quality (especially digestibility), pasture conditions (like shadow, water, parcel surface), summer housing conditions (poor ventilation versus air-conditioning, cooling cycles), behavior (nervous versus calm), and motivation (high versus low adrenaline blood level). Heat stress may also occur during long transportation in a trailer or truck, which is exposed to the sun all the time.

Diagnosing heat stress: First thing to do is to determine whether the horse is indeed affected by heat stress.

Important signs are:

- o Panting like a dog (respiratory frequency >40/min)
- o Increased heart rate (>64/min)
- o Swollen parts of the body
- o Loss of performance; behavioral changes
- o Frequent neighing
- o Lowered elasticity of a skin fold in the neck; increased rectal temperature (> 38.5 °C, or >100 °F).

The Skin Fold Test is as follows: you pick up between thumb and index a skin fold on the neck, and loose it again. Normally that skin fold has disappeared within 3 to 4 sec; if that fold stands for 6 to 10 sec, you may be sure that the horse has lost water and electrolytes; you better call a vet right away. You also should call a vet when the rectal temperature is 40 °C or higher.

Another test is the Capillary Filling Test: press you thumb well on the gums, and let go again. Normally the pink-rose color is back within 2sec; if not, then there is dehydration. Furthermore, the urine could be very dark, which also may indicate dehydration. You may also check additional issues: increased pulse; sweating extensively or not at all; depression and dullness; severe muscle trembling; irregular heart beat and respiration; respiration frequency is higher than heart beat (this is called 'inversion'); intestinal sounds are dry and hard in case of dehydration.

Management measures for controlling heat stress & Prevention

Measures to take in case of heat stress

After a performance, a horse should be cooled down immediately, especially neck, brisket, shoulders, legs and back. This cooling should be done in the appropriate way (see further down). Cooling should not be done using wet sheets covering the horse's body, because due to the sheets the horse cannot get rid of the heat which is being caught under the sheet; hence, evaporation does not take place. Best is to use a hose

spraying cold water on the body during 5 or 10min, after which the (warm) water should be wiped off using a rubber drawer; then the cycle is repeated for several times until the skin feels cool again. Always check the rectal temperature while doing the cooling. You may interrupt the cooling cycles and let the horse walk for a couple of minutes quietly and maybe he would like to drink a little water. Heart beat and respiration frequency should have returned to normal values within 15 or 20min. (resp <60 beats/min and <40 beats/min). If after 30min the normal values have not been reached, you better call a veterinarian. An average normal recovery may take several hours [16,17].

In the stable one can install a regular house-fan in front of the box on horse shoulder height. When more performing fans are being used, make sure that the horse can escape a too strong airflow. Sprinklers cannot be installed in boxes for obvious reasons. Instead, one can use the shower area in the stable, installing sprinklers and fans; for large stables and many horses present this will be time-consuming and not be very labor-efficient. Air-conditioning in stables is possible and useful, but expensive. An intermediate approach is using mobile air-co units for different stable sections. Such a mobile air-co unit is very beneficial for competition conditions (e.g. Port-a-Cool).

At great, international competitions (e.g. Olympic Games in Atlanta and China) one can observe cooling facilities, composed of a series of metal porches provided with sprinklers and fans. After a performance, the horses pass through this "cooling lane". The true do-it-yourself people can make those porches themselves, getting more cheap sprinklers from a garden center, and install the facility next to the stable. Critical is the organization of effluent water. Sprinklers should be of rather low pressure and providing large droplets; this is elementary because the water should go down to the skin. Never use water-fog-equipment because these fog droplets are far too fine, the horse skin will never be reached; moreover, fog is very sensitive to wind! Remember that when many insects are present around the horse, they will cause irritation and further heat increases. You better spray insecticides but always on a dry skin!

For a horse in a truly highly severe heat stress (heat stroke) the following is valid: Hose the horse continuously with cool-cold water, especially neck, inside legs, shoulders, abdomen. After 10min hosing, eliminate the warm water with a rubber drawer, and start the cycle again. If available, install a fan in front of the horse at brisket height, let it turn continuously. Give the horse often small portions of cool water: one bucket without and another bucket with electrolytes; let the horse make its choice! After each 15min, take a slow walk with the horse; afterwards, repeat the cycles. If the stroke occurs outside, try to find a water stream to put the horse in and shadow. Again, a mobile air-conditioner may do miracles. Repeat all this until the veterinarian has arrived. The veterinarian, after having thoroughly examined the horse, may decide about the treatment to give. Potential options are for example: liquid transfusions

(bicarbonate; electrolytes; or 0.9% NaCl salt solution, sometimes up to 60L), painkillers, a sedative (for excited horses with nervous signs), and an anti-shock treatment, and most probably a short (3 to 5 days) or a longer (10 to 14 days) rest period.

Prevention of heat stress effects

Several preventive measures which may contribute to the prevention of the negative effects of heat stress on performance, welfare and health can be taken in practice. These measures are divided into three domains:

- o Feed and drinking water.
- o Stable climate and pasturing.
- o General management.
- o Feed and drinking water.

Increase the frequency of feedings per day, while you make the portions smaller. If you like to feed a larger volume, do so during the night. Avoid all possible stress factors, because stress will lower the feed intake of the horses. Check the vitamins and mineral status of the rations more often; you must be sure that no electrolytes (e.g. K, Na, Mg) or vitamins are lost in the ration. You can also adapt the ration to a “low heat ration” by lowering the protein content (never to exceed 14%), by adding fat into the ration, by not using citrus products in the ration, and maybe by adding a little water to the ration. For pastured horses, make sure that there are enough drinking places and that the water is fresh and cool (10 °C; about 50 °F); you could add electrolytes to the water. Clean the drinking spots more often on the day, both in the boxes and in the pasture, to avoid microbiological contamination. Let the water quality be checked in the laboratory an extra time; check for sulfates, chlorates and microorganisms.

Stable climate and pasturing: Create shadow on various places where horses eat in pasture; one could use medium maze nets at 400cm height. Install sprinklers and fans in a shower area of the stable, and/or fans in front of the boxes. Make sure that the sprinklers function at relatively low pressure and that they produce large droplets (fog machines, sprays and small droplets do not sufficiently reach the horse’s skin to cool). Apply appropriate cooling cycles (see text above). Never forget to get rid of the warmed-up water by using a drawer to wipe off the water. If applicable, reduce the walking distance from stable to pasture and vice versa. Reduce the duration of pasturing, especially during daytime between 11.00 and 15.00hr; you could pasture horses in the evening or at night, but then surveillance is indicated. If indicated, reduce the density of horses in a pasture plot. Eliminate the horse dung from the boxes more frequently (dung attracts flies and other insects which may irritate the horses, which on their turn produce more heat). Observe where horse stand and lay down in pasture; maybe you can adapt the pasture feeding -if any- to these places. Even after an early morning or an evening ride, always sponge the horse with cool water and eliminate the water after 10min.

General management measures: Avoid as much as possible the moving around of horses (from box to box; from box to paddock; from stable to stable) because this causes heat production. If necessary, do it during the early morning (e.g. 06.00 to 08.00hr). Avoid loading and unloading horses from a trailer or truck, and transportation of horses during daytime; if necessary, do it early in the morning or at night. When horses need to be treated (e.g. by the vet or the farrier), make sure that the horse does not stay longer than 30 min in the treatment facility. When a treatment facility is present, install large droplet sprinklers and fans there too; make sure that the water effluents is well organized. Eliminate wind breaking obstacles from pasture (e.g. bushes; hedges, tress with many leaves). Apply anti-insect or anti-fly (horse fly!) products when many insects are present, but do that on a dry skin only. Apply zinc ointment daily on the rose-white nose of horses against sunburn.

Conclusion

Horse owners, riders and grooms should be much more aware of the fact that horses are no human beings and that they have other metabolic demands than human beings. Horse owners must try to think from the point of view of the horse and not themselves. One also should realize that from 20-21 °C (about 70 °F) onwards, the first signs of heat stress already may occur, even when you cannot yet observe them from the outside, especially under humid weather conditions. Not all horses show all signs or all signs at the same time. Make a checklist for yourself with the most relevant signs and tests on it. In that way, you may be able to check rather quickly and well whether a horse is dehydrated due to heat stress or not.

Different cooling procedures are being applied, some are without optimal utility (foggers) while others are more adequate. Among the latter are the patented “horse cooling units” developed and produced by TESH-international.com. These open metal structure cooling units can be delivered as stand-alone units, or as cooling carousels and cooling alleys. The latter two are meant to cool down several horses simultaneously on large stables and at the finish of equine competitions. These horse cooling units provide the most adequate cooling procedure in heat stress conditions. Moreover, they can be equipped with Bluetooth electrocardiogram devices to follow the heart function before and during cooling after intensive training and competition [17,18]. Crucial is that any cooling intervention should be done immediately to limit the negative effects. A horse which has been affected once by heat stress has become more susceptible a next time, so horse owners should be prepared. Different simple and cheap measures can be taken to counteract the heat stress related problems. Electrolytes are highly important, but they are not a panacea.

Another misunderstanding is that heat stress can only occur among cross-country and endurance or military competition horses. Jumping horses and dressage horses too may be victim. Finally, during a performance the rider him/herself too may

become a victim; riders may lose easily 1 to 2L water per hour, show loss of concentration and accurateness. Prevention is always better than cure.

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