CONDITIONING THE ENDURANCE HORSE

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Endurance horses are trained and conditioned to perform over long distances at moderate speeds. When conditioning a horse for long distance competition, The training program must be designed and monitored to match the specific exercise type and intensity of competitive endurance riding.

The major physiological adaptations that can directly influence exercise capacity and stamina of endurance horses include:-

1. The efficiency of gas exchange, oxygen uptake, and delivery to the exercising muscles. Endurance horses rely almost entirely on aerobic metabolism of muscle energy (glycogen), fatty acids (blood lipids) and volatile fatty acids form hindgut fermentation.

2. The heart size and its capacity to deliver large volumes of blood to the working muscles. Although the exercise demand is not as high as for galloping horses, circulation of blood volume of 3-4 times per minute through the working muscles is common in endurance horses to deliver oxygen and take away the heat generated.

3. The type of training must be matched to condition mainly aerobic capacity for maximum efficiency of glycogen use. The aerobic pathway is used mainly during exercise, which is aided by the specificity of muscle fibre types to the highest aerobic capacity required.

4. The development and adaptation of skeletal structures to meet the requirements of a specific type of loading and stress imposed by concussion, 'wear and tear' and bone turnover of calcium during long distance exercise. This will help ensure the soundness of the animal and minimum downtime or layoff during long training programs.

5. The adaptation of the blood vascular system to maximize oxygen delivery to the working muscles by optimum red cell parameters and haemoglobin content to deliver oxygen to enable peak aerobic efficiency, regardless of speed or duration of exercise.

6. Endurance horses do not need to have the high red cell counts required by galloping horses, but they do require maximum aerobic (oxygen) delivery to the working muscles and must not be anaemic. The relative concentration of circulating red cells (called the packed cell volume, or PCV or haematocrit) also increases during endurance exercise due to reduction in circulating blood fluid as dehydration develops form sweat and respiratory loss. It is a disadvantage to have a high cell count.

7. Conditioning of the thermoregulatory function to efficiently remove heat produced during metabolism. This is an important function in endurance horses as the efficiency of sweating and fluid body reserves must be conditioned and maintained to ensure efficient cooling.

There is a difference in the specific requirements of aerobic and anaerobic exercise. The aerobic capacity must be conditioned by the training method to ensure it becomes the predominant metabolic pathway during all forms of exercise, especially endurance riding.

Studies indicate that even at maximum intensity, measured by V_{200}, for maximum aerobic power and VO_2 max. for peak aerobic capacity, a fit endurance horse still produces almost 100% of its muscle energy using aerobic pathways. Therefore, factors that directly or indirectly reduce oxygen uptake and delivery will reduce the efficiency and reliance on aerobic metabolism during maximum or prolonged exercise.

Anaerobic (no oxygen) capacity however, must be able to be conditioned as a reserve metabolic pathway for maximal exercise at faster speeds, such as a competitive finish to a ride. This is not a predominant pathway because of higher lactate accumulation and earlier onset of fatigue. Aerobic metabolism should be utilized as fully as possible at speed ranging from the trot to light canter, even when hill climbing or working under heavy trail conditions. Reduced aerobic efficiency or capacity due to respiratory and cardiovascular restraints increases the reliance on the less efficient anaerobic system and increases the risk of fatigue and risk of vetting out due to poor recovery.

Studies indicate that up to 63% of endurance horses that are otherwise sound and have normal blood parameters, when investigated for loss of peak performance, have underlying respiratory disease - the most common medical problem that affects performance potential. Up to 60% of chronic respiratory disease is caused by dust in the feed, bedding and working environment. The lung surface is also a vital area for exchange of heat and any reduction in function reduces heat exchange efficiency.

Integration of Aerobic and Anaerobic Pathways

The interrelationships and control of these two predominant metabolic pathways is dependent on a number of regulatory systems. These include the relative oxygen uptake and efficiency of delivery, the adaptation of muscle fibre types and specificity of metabolic enzymes, and the feedback mechanisms that facilitate or inhibit muscle mitochrondrial and enzyme activities. These all influence the relative proportion of the two metabolic pathways used during exercise, assuming there is adequate availability of muscle glycogen at peak or prolonged exercise intensity or duration.

The development of the cardiovascular and respiratory delivery systems and adaptation of muscle fibre types to utilize the enhanced oxygen delivery can be conditioned by incremental training. The specificity of the training program ensures that the maximum proportion of aerobic metabolism is used at the maximal exercise level and duration.

Although energy production is greatest at faster speeds, muscle glycogen concentration only decreases by approximately one-third during high intensity exercise such as thoroughbred racing and event competition. It is unlikely that in a properly fed and trained horse that glycogen storage or availability will limit exercise at maximum intensity. However, prolonged medium intensity exercise results in greatest glycogen depletion, as would be expected, with reductions of up to 56% during endurance competition over a 60km ride.

As exercise intensity and speed increases, there is an increased recruitment of faster contracting, more powerful Type IIb muscle fibres, with little glycogen depletion in Type I fibres. When exercise is continued at moderate speed or on extended duration to a fatigued state, all the Type I and 50% of the Type IIa fibres become significantly depleted in glycogen content. The Type IIa fibres retained a high level of glycogen. Progressive recruitment of Type I, then Type IIa, then Type IIb fibres occurs during prolonged exercise.

Therefore the training program must be designed to not only recruit specific fibre types, and adopt the most efficient aerobic (oxygen) energy use relative to speed, but limit the proportion of anaerobic metabolism and lactate production at higher speeds by conditioning maximum aerobic efficiency and oxygen uptake.

Oxygen Transfer

When the horse goes from rest to maximum exercise, oxygen consumption increases by 35 - 40 times. This is achieved by increase in respiration rate by up to 10 times at the gallop, and 3-4 times at fast trot endurance speeds. Inhaled volumes of up to 2250 litres of air into the lungs have been measured in racehorses and approximately 800-1000 litres of air per minute in endurance horses. A 450kg horse has about 3 million air sacs in its lungs with an expanded lung surface area of 8 - 10 tennis courts in size. To deliver oxygen efficiently from the lungs to the exercising muscles, cardiac output increases by five to six times at the gallop and 2-3 times at the trot and canter, with volumes of 120-150 litres of blood being circulated per minute, passing 2 to 3 times around the circulatory system per minute at endurance speeds.

An exercising horse takes only 30 seconds at high exercise intensity to reach maximum oxygen use, a human sprinter takes 4 - 5 minutes. The longer the race distance, the greater proportion of energy is produced by aerobic metabolism. Horses that have a better conditioned aerobic capacity are more likely to perform better, even over short distances, including a race lasting less than 60 seconds. (Rose 1995)

Training programs that focus on improving efficiency of uptake and delivery of oxygen to exercising muscles for both sprint and endurance exercise are critical to ensure speed and stamina of the horse. (Rose 1995)

The maximum oxygen uptake or consumption (VO_2max) measured during high intensity exercise to fatigue, where the horse can use no more oxygen, is a good measure of fitness in horses. This can only be measured accurately on a high speed treadmill equipped with ventilation masks.

The VO_2 max. for Thoroughbreds and Standardbreds is similar at around 164mLof Oxygen (O_2)/kg bodyweight/minute, although these horses are traditionally trained in different ways. Training programs designed for Standardbreds incorporate more aerobic condition exercise and much more total distance and amount of work performed than for a thoroughbred racehorse. In contrast VO_2 max. for human sprinters is 69 - 85mL O_2/kg/mm, and a greyhound 100mL O_2/kg/min.

Thermoregulation

Thermo regulation and heat loss must also be conditioned by training. The red blood cells perfusing through the working muscles deliver oxygen, and the blood fluid scavenges carbon dioxide produced during aerobic exercise. Red blood cells also transport large amounts of heat produced within the muscle into the blood. Up to 80% of the energy stored as glycogen is metabolized to heat during exercise. The red cells are the primary heat load carriers from the muscles to the body, and enable heat to be transferred to the skin to be lost by convection, radiation and sweat evaporation. Efficient heat exchange also occurs between the large amounts of inhaled air in contact with the highly vascular lung surface during exercise. Up to 30% of the heat load from metabolism is exchanged at the lung air interface during exercise, which is blown off in expired air, and 5% is evaporated as 85% saturated moist air passes over the lung alveolar surface in the expired air.

Specificity of Training

The training program designed for horses should be specific for the exercise type, intensity and duration for competition. Certain breeds of horses have higher percentages of muscle fibre types that make them more suited to a particular type of exercise. Thoroughbreds and Quarter Horses generally have higher proportion of high oxidative and anaerobic fast twitch fibres, whilst Arabians have more slow twitch, oxidative fibres suited to endurance competition.

In most training programs, an initial 6 - 8 weeks of long slow distance (LSD) type of conditioning exercise is a valuable basis for both prolonged endurance and high intensity sprint exercise. This type of conditioning exercise is not only required, to stimulate oxygen uptake capacity, but it is important to impose an initial stimulus for muscle-skeletal adaptation. A carefully planned incremental program will help progressively load joints, tendons and bone which may take 6 - 8 weeks to adapt to the extra stress imposed by high intensity work. This is a slower adaptation time than for cardiovascular and respiratory function. Joint cartilage thickens and becomes more resilient to ‘wear and tear’, tendon fibrils strengthen and the wall of bones remodel to improve structured rigidity and bone density to withstand increased load bearing at exercise.

For endurance competition, long slow distance work to increase strength and adaptation of the musculo-skeletal system, and attain optimum muscle fitness for endurance exercise at up to a prolonged trot of 400 metres/min may take 2 - 3 years of steady, specific training.

Training programs for endurance horses are usually divided into 3 phrases to provide a base for endurance and maximize aerobic capacity. Some faster exercise at the gallop should be included to stimulate anaerobic pathways and develop initial speed and acceleration.

Phase 1	Long slow distance exercise at speeds of less than 600 metres/min
Phase 2	Combined aerobic and anaerobic training at speeds of up to 750 - 850 metres per minute
Phase 3	Conditioning training over ride distances to ensure maximum stamina and endurance capacity, thermoregulatory efficiency and control of body fluid levels to avoid excessive dehydration.

Incremental Training

During the three training phases, the principal of incremental loading should be adopted to enable physiological responses as the cardiovascular, respiratory, musculoskeletal and nervous systems adapt to increasing exercise demand.

Both the intensity and distance of exercise should be planned in stepwise increments to enable gradual adaptation and effect of the training stimulus, and condition the recovery processes, without the risk of overload, resulting in metabolic problems such as tying up, and structural injuries to tendons, joints and bones.

It is important to plan increments in intensity every 2 - 3 weeks to provide the stimulus to respond and establish the fitness or strengthening effect. Incremental training also helps to maintain the appetite in horses in training, as sudden increases in speed or distance result in loss of appetite.

The principle of controlled overloading for short distances at a medium gallop can also be adopted to speed the adaptation processes, without causing damage and pathological changes.

Incremental training is also important to condition and adapt other body systems to withstand the duration and intensity of exercise performed and assist in helping the horse remain sound during prolonged training.

These include cardiovascular and skeletal adaptation, thermo-regulatory responses, appetite maintenance in horses in hard work, and psychological factors that reduce willingness and competitive attitude to training and competition.

In horses, increases in muscle enzyme levels in the blood, for example, are often found without clinical evidence of tying-up. Researchers postulate that this could result when a horse pulls up or decelerates quickly from sprint work, which uses other muscles not conditioned by acceleration and forward momentum. Muscle stress leads to minor strain and low-grade soreness, with elevation in muscle enzymes. Continued training at low intensities may help to reduce this effect.

Most types of training will improve fitness. Training should include principles of exercise adaptation, incremental challenge and loading and specificity to the type and duration of the exercise.

In any training program, it is important to schedule in rest and recuperation time, to not only allow body systems to recover and repair, but also to maintain the willingness of the equine athlete to perform at peak levels.