



Monitoring Fitness of Horses by Heart Rate

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Researchers studying the physiology of exercise of horses are continually refining methods to accurately monitor the fitness and health status of horses in physical training. Exercise creates a need for efficient use of all the physiological systems of the horse's body. Responses of the musculoskeletal, nervous, respiratory, and cardiovascular systems to exercise are studied to assist trainers and owners in designing programs that will promote maximal athletic efficiency of the horse. Cardiovascular fitness is of prime importance for the horse to efficiently utilize the other body systems. Function of the cardiovascular system can most practically and reliably define the fitness status of horses. The cardiovascular system is easily monitored by measurement of heart rate before, during, and following exercise.

This article identifies ways to monitor heart rate and how to interpret heart rate response at different times in the conditioning program.

Function of the Cardiovascular System

The cardiovascular system (CVS) is responsible for delivering blood to the muscles. Energy sources and oxygen are two important components of blood necessary for muscle activity. The CVS also must remove by-products of energy metabolism such as carbon dioxide and lactate from muscles. Without these functions, the horse's musculoskeletal system would not be able to function adequately.

The rate of blood flow to tissues is largely regulated by the number of times the heart beats per minute (heart rate). Heart rate is driven by oxygen and carbon dioxide levels in the blood. Exercising muscles need increased amounts of oxygen during and recovering from muscular activity. Also, elevated heart rates allow for the removal of large amounts of carbon dioxide that is produced during muscular activity. Other stimuli that can increase heart rate are those related to pain and excitement.

Heart Rate Parameters

The normal resting heart rate of a mature horse is between 30 to 40 beats per minute. This rate is difficult to obtain in some situations, as certain horses become excited by external stimuli, which elevates the resting heart rate. Simply apply-

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ing the monitor device may also elevate heart rate. Although resting heart rate in humans can decrease dramatically as a result of physical conditioning, the resting heart rate of horses does not appear to change appreciably with fitness.

The next benchmark to be defined is the heart rate at the anaerobic threshold. Heart rates below this threshold, 150 to 170 beats per minutes, characterize a large percentage of exercise being performed aerobically. Aerobic exercise uses energy pathways that are supported by the consumption of oxygen, and uses fatty acids and blood glucose as fuel sources. When exercise intensity or duration increase, the



requirements of the cardiovascular system increase, which in turn results in elevated heart rate.

Heart rates above the anaerobic threshold characterize rates of metabolism that exceed the abilities of the oxygen dependant pathways supplying energy. Heart rates of 170 beats per minute or greater characterize a large percentage of metabolism occurring anaerobically or without oxygen. Anaerobic metabolism is supported primarily with glucose and glycogen as the fuel source. The threshold heart rate, like resting heart rate, does not change dramatically with physical conditioning. The threshold for anaerobic exercise may be influenced by genetics.

Maximal heart rates in mature horses appear to be between 220 and 260 beats per minute. The maximal rates are variable between individuals, and do not appear to change with physical fitness. Maximal heart rates should not be used as a major part of a physical conditioning programs, rather, they should be monitored as a danger zone suggesting that fatigue may occur quickly.

Heart Rate Monitoring Methods

The technology of monitoring heart rates is rapidly progressing as more and more trainers and owners discover this valuable component of training programs. Several methods have been available for many years. A simple, low cost method is to feel the digital or mandibular pulse by placing a finger on the posterior digital or facial artery as it traverses underlying skeletal structures. However, it is very difficult to consistently count heart rates above resting values, and it is impractical for use during exercise.

The stethoscope can be more consistent in monitoring heart rates. A stethoscope placed along the heartgirth behind the left elbow of a horse's body can pick up the beating sounds of the heart. This method more accurately identifies heart rates in the resting to 100 beats per minute range than the finger pulse method. However, it is difficult to accurately determine the beats per minute at higher heart rates. ALSO, like the finger pulse method, it is impractical to use during exercise.

The most reliable method of determining heart rate during and while recovering from exercise is by electronic monitoring. Electronic monitoring systems measure electrical pulses of the heart and convert them into a digital number. Until recently, these systems were cost prohibitive for most trainers, but currently can be purchased for less than \$900. A popular model being used consists of stick-on type electrodes which are placed under the saddle pad and girth of the horse. A wrist watch designed mini-computer worn by the rider picks up the electronic signal of the heart from the transducer attached to the two electrodes, converts it to beats per minute and stores the data for later retrieval. With additional equipment, the information stored in the heart rate monitor can be downloaded to a larger computer for data analysis and storage. If a computer is not available, the data can be downloaded from the wrist watch manually.

Using Heart Rate as a Monitor of Physical Fitness

Initial response to onset of exercise

An understanding of the expected response of heart rate to different types and durations of work will assist in the design

of a conditioning program. Initially, heart rate will usually increase rapidly at the onset of exercise to highly elevated levels. This "overshoot" response is due to the excitation mediated release of epinephrine into the blood. Epinephrine is a very powerful hormone that causes several important physiological responses to exercise to occur. The increased heart rate usually lasts for one to two minutes before a steady state heart rate is obtained. Because of the overshoot response, heart rate in early exercise is not a good indication of work effort or fitness. One of the values of a proper "warm up" exercise is that it will assist the body in preparing for the onset of exercise. Monitoring heart rate after about two minutes of actual exercise, if exercise duration is that long, will provide an accurate indication of the type of workload being applied to the horse's body at that time.

Long, slow distance work during the "legging up" phase

Long, slow distance training is commonly called the backgrounding or legging up phase of a training program. During this phase, the horse is performing aerobic work. The cardiovascular system is conditioning itself to exercise and the musculoskeletal system is building up its tolerance to the stress of exercise. Initial conditioning at these levels will better prepare the horse to handle the later phases of exercise in the conditioning program. During this phase of training, the horse's speed and duration of exercise should allow for steady state heart rates below 150 to 170 beats per minute, which is the anaerobic threshold. The horse's speed increases at these heart rates as the horse becomes more fit. Also, recovery heart rates will occur faster as the horse becomes more fit. A horse in good aerobic condition will have recovery heart rate around 100 beats per minute at two minutes post exercise when exercising at rates to induce heart rates near the anaerobic threshold. Recovery heart rates at 10 minutes post exercise should be less than 60 beats per minute.

Speed work during the "breezing" phase

The sprint type exercise in this phase will be of shorter duration and at speeds much faster than the legging up phase. Horses are expected to work at heart rates between 170 to 190 beats per minute during the breezing or anaerobic phase of conditioning. The speed of exercise must be reduced if heart rates rise above 190 beats per minute. The speed at a given heart rate will increase as a horse becomes more fit. Recovery heart rate below 120 beats per minute at two minutes post exercise and below 70 beats per minute at 10 minutes post exercise suggest the horse is adequately conditioned to the level and intensity of exercise. "Warming up" and "warming down" exercises are mandatory at this phase and will greatly assist in reducing soreness and injury. The "warm down" at the walk or trot after a workout will also speed the establishment of the desired recovery heart rates.

Interval training during the sharpening phase

Several trainers are using interval training techniques, serial sprints interspersed with relief periods, following the breezing phase of training as a method of sharpening the horse's physiological response to exercise. Horses are worked at near maximum heart rates during this phase. As such it can be very dangerous because of the possibility of over stressing the horse's systems. Heart rate monitors are especially needed

when conducting this phase of a physical conditioning program. The horse's heart rate can be expected to be significantly above the 170 to 190 beats per minute range when sprinting. Heart rates during the relief interval between sprints should drop below 120 beats per minute before another sprint. The exercise bout should be discontinued if the heart rate does not come down within two minutes to 130 to 140 beats per minute. If this response happens, the horse should be warmed down and carefully monitored for signs of continued fatigue. As a horse becomes more fit, the speed of the sprints may increase and he will be able to handle more bouts or longer distances with the same heart rate response.

Monitoring Heart Rate to Detect Early Signs of Injury

One method of monitoring fitness is to graph the heart rate response to an exercise bout of constant speed through the exercise program. As a horse becomes more fit, heart rate at a constant speed decreases. It is probable that an injury has occurred if heart rate increases sharply during a specific exercise bout. Careful monitoring of heart rate may assist in early detection of injury much sooner than is otherwise possible. Another method is to graph the speed necessary to induce a constant heart rate as the horse progresses in the conditioning program, for example, the speed necessary to induce the anaerobic threshold heart rate of 150 to 170 beats per minute during the long, slow distance phase. The speed necessary to elicit a constant heart rate will increase as the horse becomes more fit. If an injury occurs, the speed at the heart rate would be less than expected.

It is important to reduce the level and intensity of the training program if early signs of injury are detected through an elevated heart rate response. Stopping the conditioning

program may not be necessary as the horse may be able to handle the injury, however trainers should carefully consider not racing or performing other types of work that induce maximal stress. Further injury detection techniques should be prioritized immediately. Injuries such as bowed tendons and bucked shins are common, as well as improper leg and hoof alignment caused by incorrect shoeing technique. It is advisable to consult with your veterinarian so further, possibly irreversible injury may be prevented.

Elevated heart rates may also be a sign of chronic fatigue, or overtraining as it is commonly termed in the industry. As with injury, the horse's conditioning program should be reduced in intensity. The training program may have to be completely stopped and the horse rested for 30 to 60 days if conditioning fatigue persists.

Record Keeping for Evaluation

Accurate record keeping is a must if heart rate monitoring is to be used as a fitness indicator. Much of the success of using heart rate is to observe changes in response over time. The rate these changes occur will assist in decisions to alter the intensity, duration or type of exercise to further the fitness level of the horse. It will allow for comparison of that individual to others over time as well as allowing comparison of an individual horse's progress on successive workouts.

Several possibilities are being explored by researchers and trainers utilizing heart rate monitors. One possibility is the use of efficiency indexes for selecting prospects. Indexes can be developed by comparing items such as speed or number of strides verses heart rate. Although not validated as of yet, several techniques show potential to greatly assist in the assessment of future potential of individuals selected for performance.

