Sedative Administration to Horses Immediately After Maximal Exercise: Determination of Drug and Dose

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Horses recuperating from maximal exercise require increased doses of sedatives for effect. Authors’ address: Dept. of Veterinary Clinical Sciences, The College of Veterinary Medicine, The Ohio State University, 601 Tharp St., Columbus, OH 43210. © 1997 AAEP.

1. Introduction
Equine athletes suffer severe breakdown injuries during racing that, although infrequent, can have tragic results. A critical factor in treating horses immediately after a breakdown injury is the difficulty in calming an excited, stressed, exhausted, and potentially physically challenged (nonweight bearing on a limb or limbs) horse. This difficulty may prevent the safe removal of the horse from the racetrack and predispose the horse to further injury. An concomitant concern is the potential for prolonging the recuperative period from exercise in the injured horse. Recuperation in the horse is delayed if horses are made to stand stationary, as would be the case with injury. Cardiac output and mean right atrial pressure are higher and peripheral vascular resistance is lower in horses that walk compared with horses that stand stationary during recuperation from maximal exercise. These changes result in a delay in the return of blood lactate and venous bicarbonate concentrations to pre-exercise levels. Additional decreases in cardiac output, such as those that would be anticipated following the administration of sedatives and tranquilizers, might further retard the rate of recuperation. The behavioral, cardiovascular, and respiratory effects that result from the administration of sedatives and tranquilizers to horses at rest have been investigated. We could find no reports describing the effects of sedatives and tranquilizers administered during recuperation from maximal exercise. This project was designed to determine the intravenous dose of xylazine, detomidine, and a combination of xylazine and acepromazine that is required to produce effective sedation in horses immediately after maximal exercise.

2. Materials and Methods
Eight Thoroughbred horses were used. Before the horses entered the study, their left carotid arteries were elevated to a subcutaneous position. The horses were entered into an exercise program on a treadmill designed to establish and maintain a level of fitness similar to that maintained in Thorough-
bred horses in race training. At the end of 6 weeks the horses were tested to establish their individual maximum oxygen utilization (VO₂ max). The treadmill speed that caused the horses to exercise at 120% of VO₂ max was calculated and used during simulated races. At 14-day intervals, the horses were instrumented for collection of arterial and venous blood gases and measurement of cardiopulmonary and metabolic indices, including systolic, mean, and diastolic arterial blood pressure, heart rate, respiratory rate, and rectal temperature. The horses were exercised at 120% of their VO₂ max until fatigued or for a maximum of 2 min. Measurements were made prior to and 1, 5, 10, 15, 20, 30, and 60 min after exercise. Horses received one of three drugs or drug combinations: xylazine (1.1 mg/kg IV), detomidine (0.02 mg/kg IV) or a combination of xylazine (0.66 mg/kg IV) and acepromazine (0.02 mg/kg IV) 1 min after the end of the simulated race. The degree of sedation was evaluated 3–4 min after drug administration, and an additional dose of drug(s) was administered 5 min after the end of exercise (4 min after the initial dose) if sufficient sedation was not present. The degree of sedation was re-evaluated 3–4 min after drug administration, and an additional dose of drug(s) was administered 10 min after the end of exercise if sufficient sedation was not present. Sufficient sedation was defined as the horse attaining a head-down posture (nose within 1 m of the floor) and the lack of a response to visual and auditory stimuli. The goal was to produce a horse that was sedate enough to allow the induction of anesthesia with minimal resistance. Each drug or drug combination was given to a minimum of three horses.

3. Results
The administration of xylazine (1.1 mg/kg IV) 1 min after the end of exercise produced sufficient sedation in one horse but was ineffective in producing sedation in two other horses. An additional dose of xylazine administered 5 min after the end of exercise produced sufficient sedation in the other two horses. The administration of detomidine (0.02 mg/kg IV) 1 min after the end of exercise did not produce sufficient sedation in any horse. The additional dose of detomidine administered 5 min after the end of exercise produced sufficient sedation in all three horses. The administration of the combination of xylazine (0.66 mg/kg IV) and acepromazine (0.02 mg/kg IV) 1 min after the end of exercise did not produce sufficient sedation in any horse. The administration of an additional dose of the combination did not produce sufficient sedation. An additional dose of xylazine (no acepromazine) was administered 10 min after exercise in two horses and sufficient sedation was attained.

Selected cardiorespiratory and metabolic data are presented in Figs. 1–6. Results are reported for rectal temperature (Fig. 1), heart rate (Fig. 2), respiratory rate (Fig. 3), mean arterial blood pressure (Fig. 4), arterial partial pressure of carbon dioxide (Fig. 5), and arterial bicarbonate concentration (Fig. 6) prior to and 1, 5, 10, 15, 20, 30, and 60 min after exercise. Points in the figures indicate the mean and standard error of a minimum of three horses.

4. Discussion
Standard dosages of xylazine, detomidine, and a combination of acepromazine and xylazine were ineffective in producing sedation in Thoroughbred horses immediately after maximal exercise. The administration of a second dose of xylazine and detomidine produced sedation. The administration of a second dose of the acepromazine–xylazine combination did not produce sedation, but sedation was achieved when additional xylazine was administered after the combination. The cause of the increased dose requirement is not known but could
result from the level of excitement present postexercise or an atypical distribution of the administered drugs because of the increases in cardiac output that are present after exercise. Normally, sedative drugs are administered to horses at rest during sedentary levels of neuroexcitatory hormones and basal levels of cardiorespiratory function. During exercise, the concentrations of neuroexcitatory hormones increase, potentially increasing the concentration of sedative drug required to produce a given effect. Alternatively or in addition, the distribution of intravenously administered drugs may be altered in horses with high cardiac output. While brain blood flow remains relatively constant over a wide range of cardiac outputs, the percentage of cardiac output delivered to nervous tissue is greater in horses at rest compared with exercising horses. For a given intravenous dose of a drug, a smaller percentage of drug is delivered to the brain in a horse with high cardiac output compared with a horse with low cardiac output. If less drug is delivered to the brain, the tissue concentration of the drug will be decreased, reducing its efficacy.

In a previous study, the authors showed that heart rate remains significantly increased for 35 min after maximal exercise in Thoroughbred horses. The respiratory rate was significantly increased for 60 min when horses stood stationary or stood stationary with a splint on one front leg. Mean arterial blood pressure was increased for 15 min after exercise before returning to pre-exercise levels. Arterial bicarbonate concentrations fell with exercise and remained significantly decreased for 15 min. Arterial partial pressure of carbon dioxide decreased after exercise and remained significantly decreased for 35 min. Rectal temperature increased after

Fig. 3. Respiratory rate before (time 0) and after exercise and sedative administration. Drug(s) were administered 1, 5, and 10 min after exercise.

Fig. 4. Mean arterial blood pressure before (time 0) and after exercise and sedative administration. Drug(s) were administered 1, 5, and 10 min after exercise.

Fig. 5. Arterial partial pressure of carbon dioxide before (time 0) and after exercise and sedative administration. Drug(s) were administered 1, 5, and 10 min after exercise.

Fig. 6. Arterial bicarbonate before (time 0) and after exercise and sedative administration. Drug(s) were administered 1, 5, and 10 min after exercise.
maximal exercise and remained increased for 90 min.

Drugs administered in this study may alter the recuperative period from maximal exercise. Heart rate decreased to pre-exercise levels with the onset of sedation 10 min after exercise. Arterial blood pressure increased with exercise then decreased but remained above pre-exercise values for 60 min in all groups. Respiratory rate increased after exercise and remained increased for 30 min in all three groups. At 60 min after exercise, the respiratory rate appeared to return to normal after xylazine and acepromazine-xylazine but remained increased in the horses that received detomidine. The return of arterial partial pressure of carbon dioxide and arterial bicarbonate concentration to pre-exercise levels appears to be delayed. Of particular concern are the sustained increases in rectal temperature evident for 60 min when sedatives were administered after exercise.

This study was undertaken to determine the dose requirements for sedation of horses immediately after maximal exercise. Subsequent to this study, xylazine (2.2 mg/kg IV), detomidine (0.04 mg/kg IV), and a combination of acepromazine (0.04 mg/kg IV) and xylazine (2.2 mg/kg IV) are being studied in Thoroughbred horses immediately after maximal exercise on a treadmill. The results of this study and additional studies will be used to determine the optimal sedative and intravenous anesthetic technique for the induction of anesthesia in horses immediately after maximal exercise.

References