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# Optimal active recovery intensity in Standardbreds after submaximal work

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## Summary

***Reason for performing study*: A retrospective study concerning spontaneous active recovery intensity, i.e. at a freely chosen speed, after a submaximal exercise in trotters showed that the mean intensity demanded by trainers corresponds to 40–50% of maximal heart rate (max HR; unpublished data). However, in human athletes, optimal active recovery intensity was found to be about 60–70% of max HR. Is the spontaneous recovery optimal after a submaximal exercise in trotters?**

***Objectives*: To compare different recovery intensities and define the most efficient one.**

***Methods*: Thirty-seven trotters performed a standardised exercise test on the track. Horses were randomly divided into 4 groups of recovery: passive recovery (n = 10), 10 min walk recovery (n = 10, 100 m/min), 10 min slow trot recovery (n = 9, 250 m/min) and 10 min fast trot recovery (n = 8, 420 m/min). Before, during and 1 h after exercise, speed, heart rate, blood lactate concentration were measured as well as respiratory frequency and rectal temperature. Creatine kinase (CK) was measured 1, 3 and 5 h after exercise.**

***Results*: Walk, slow trot and fast trot recovery corresponded respectively to 45–50%, 55–60% and 65–70% of max HR. Heart rate and blood lactate concentration were significantly lower after the 10 mins recovery with increasing intensity of recovery.**

***Conclusion*: The most efficient intensity of recovery was the 10 min fast trot recovery (65–70% max HR) as this type of recovery allows the optimal blood lactate disappearance.**

***Potential relevance*: Considering the usual habits of trainers or drivers, recovery intensity after trot races should be increased in intensity to optimise its efficiency.**

## Introduction

Influence of post exercise activity has been widely described in humans athletes (Evans and Cureton 1983; Fairchild *et al*. 2003, Spierer *et al*. 2004) but also in horses (Marlin *et al*. 1987; Rainger *et al*. 1994; Lovell and Rose 1995; Hubbell *et al*. 1997). In both species, the authors described that blood blood lactate disappearance was related to treadmill speed and that warm down periods enhance utilisation of lactates as susbtrate by muscle. In human athletes, Hermansen and Stensvold (1974) showed that the optimal intensity of active recovery was about 60–70% $VO_{2max}$. In horses, 3 recovery activities of various durations have been compared on the treadmill: standing, walking (100 m/min) and trotting (190–240 m/min) (Marlin *et al*. 1987; Lovell and Rose 1995). Those intensities are quite low compared to the intensity needed for optimal recovery described in human athletes. On the track, most Standardbreds spontanously recover by walking or trotting at about 250 m/min (unpublished data). In fit horses of age, this intensity corresponds to heart rate (HR) of 100–120 beats/min, i.e. 40–50% max HR. Our hypothesis was that a faster speed during recovery would optimise blood lactate disappearance as seen in human athletes. The aim of that study was to compare 4 different recovery intensities and to verify if, as in human athletes, an intensity of approximatively 60–70% max HR is the most efficient one.

## Materials and methods

### *Horses*

Thirty-seven Standardbred Trotters, aged 3–10 years old, were involved in this experiment. They were all in full training and clinically sound. They were divided into 4 groups of equivalent age and athletic capacity. All horses were exercised employing a traditional training schedule: two high-intensity training sessions per week (2 bouts of 2500 or 3000 m at medium speed ending with 500 m at maximal speed) completed by two low-intensity training sessions (30–45 mins at an average speed of 500 m/min).

### *Standardised exercise test*

All horses performed a standardised exercise test on the same day on the track as described by Demonceau and Auvinet (1992). The external conditions were optimal with a dry and firm track, a sunny but cool weather with no wind. After a 10 min warm-up at about 350 m/min, they performed three 3 min stages at increasing speeds. The exercising speeds were: 500, 570 and 640 m/min. Immediately after the third stage, horses trotted at maximal speed on the distance of 500 m order to reach a high intensity exercise.

### *Recovery*

Following this work, the 4 groups of horses were randomly defined as:

- *Rest group:* 10 horses were stopped just after physical exercise and placed in their box. These horses composed the passive recovery group.

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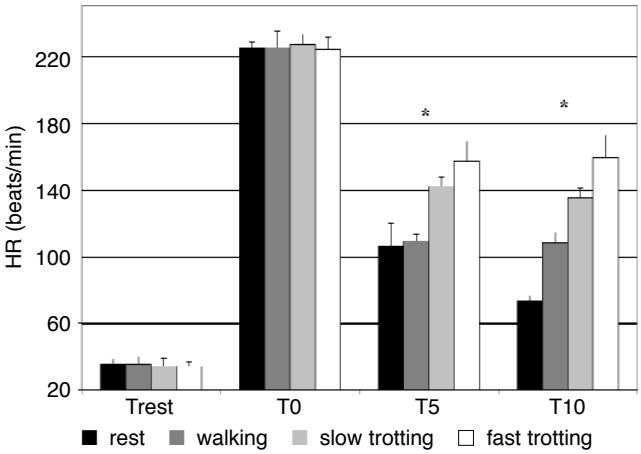


*Fig 1: Heart rate in the four recovery groups from T0 to T10. *Slow trotting and fast trotting significantly different from rest and walking groups (P<0.05).*

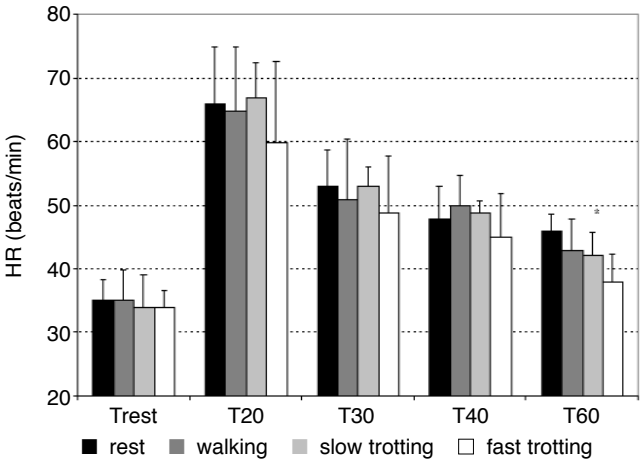


*Fig 2: Heart rate in the four recovery groups from T20 to T60. *Rest group significantly different from fast trotting group (P<0.05).*

- *Walking group:* 10 horses were walked at approximately 100 m/min during 10 mins just after the test and were then placed in their box. This was the low active recovery group.
- *Slowing trotting group:* 9 horses were trotted during 10 mins at a velocity of 250 m/min and were then placed in their box. They constituted a medium active recovery group.
- *Fast trotting group:* 8 horses were trotted during 10 mins at a velocity of 420 m/min and were then placed in their box. These horses were included in the high active recovery group.

*Physiological parameters*

During exercise and recovery, the following parameters were recorded:

- Heart rate (HR) was monitored by a heart rate-meter[1] at rest, continuously during the test and up to 1 h of recovery. For each horse, the maximal heart rate was estimated on the basis of the maximal heart rate measured during the accelerations.
- Jugular venous blood samples were collected into tubes containing fluoride and oxalate for the determination of whole blood lactate concentration (La) by enzymatic method of Boeringher. Blood were collected before the test (Trest), at the end of the exercise (T0), and then after 5, 10, 20, 30, 40, 50 and 60 mins of recovery (respectively T5, T10, T20, T30, T40, T50 and T60).
- Respiratory frequency (RF), expressed in breaths/min, and rectal temperature (T) in °C were measured at rest, T10 and T60.

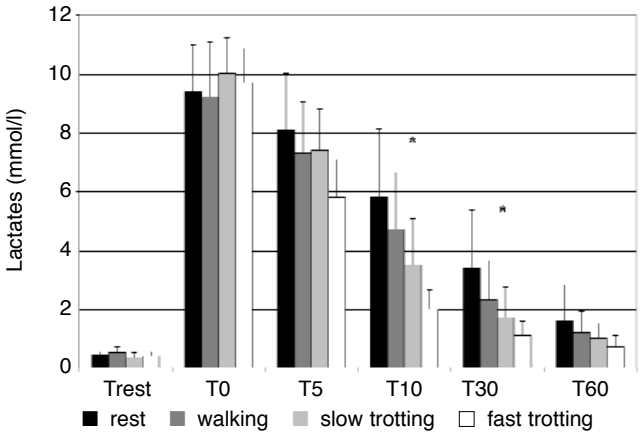


*Fig 3: Blood lactate concentration in the four recovery groups. *Rest group significantly different fast trotting group (P<0.05).*

- Muscular enzymes (CK) were measured at rest, 1, 3 and 5 h after exercise.

*Statistical analysis*

Physiological variables calculated were studied using statistical software[2]. Data are presented as mean ± s.d. An analysis of variance (ANOVA) was calculated to study the relationships between recovery types and physiological variables. Duncan's *post hoc* tests were performed if there were differences. A level of significance of P<0.05 was used throughout this study for all the tests.

## Results

The speeds measured in the walking, slow trotting and fast trotting groups were respectively of 104 ± 10 m/min, 262 ± 7 m/min and 442 ± 20 m/min.

Changes in heart rate (HR) during early recovery (T0–T10) are presented in Figure 1. Heart rate was related to intensity of exercise and HR was significantly higher in slow and fast trotting than in standing and walking groups in the 10 mins of active recovery. But, on a second occasion, horses with higher intensity of recovery had lower HR than those having low intensity recovery. At T60, HR of the rest group was significantly higher that of the fast trotting group (Fig 2).

During maximal exercise, mean maximal HR of 225 ± 9 beats/min, 227 ± 6 beats/min and 224 ± 8 beats/min were measured in the walking, slow trotting and fast trotting groups, respectively. When comparing mean HR during the 10 min recovery to mean maximal HR in each group, the walking, slow trotting and fast trotting groups recovered at intensities of 48, 60, 70% of max HR, respectively.

Changes in blood lactate concentration in the 4 recovery groups are presented in Fig 3. Mean blood lactate concentration on T0 were the same in the 4 groups. Significant changes in blood lactate concentration appeared on T10 and T30, with the fast trotting group having lower blood lactate than the standing and walking groups. More intense recovery leads to lower blood lactate concentration.

Mean respiratory frequency and rectal temperature in the 4 groups are shown in Table 1. There was no significant difference between the 3 active recovery groups in respiratory frequency and rectal temperature at T10 and T60. We noticed only higher respiratory frequency and rectal temperature in the standing group at T10 compared to active recovery groups. A significant increase in CK was observed at T60 compared to Trest (322 ± 42 vs. 176 ± 15 iu/l). No significant changes in CK activities in the 4 groups were observed.

## Discussion

*Methodological considerations*

In contrast with the other studies on recovery in horses, this experiment was realised under track conditions. This particularity allows the measurement of a large number of horses in training (37 instead of 5 or 6) and a real reproduction of training conditions. However, it does not allow the realisation of more subtle physiological measurements such as muscle metabolites, muscle temperature or arterial blood gas. Concerning the intensity of exercise, most studies used a maximal exercise, such 2 mins at 720 m/min and 5° incline (Marlin *et al.* 1987), 2 mins at 120% $VO_{2max}$ and 4° incline (Hubbell *et al.* 1997), and 2 mins at 750 m/min and 10° incline (Lovell and Rose 1995) resulting in mean blood lactate concentrations of 15, 11 and approximately 25 mmol/l, respectively. Most of our horses were involved in competition and in order to avoid disturbance in the competition programmes, we chose to reproduce a training session including an anaerobic exercise instead of a real maximal exercise. Finally, in all previous studies, recovery protocols were lengthy (about 30 mins) and therefore not practical in real training conditions. The choice of a 10 min duration for active recovery was made taking into consideration the possibility for trainers to include it in training.

*Changes in heart rate*

Concerning changes in HR in standing groups, our results are similar to those described by Hubbell *et al.* (1997) who found mean heart rate in standing group at T5, T30 and T60 respectively of 86, 62 and 51 beats/min. However, our mean HR at T5, T20 and T30 (106, 66 and 53 beats/min) are quite different from the ones described by Lovell and Rose (1995) which were respectively of 137, 116 and 110 beats/min, in spite of max HR of 225 and 218 beats/min in each study. This difference is possibly due to the fact that horses in the study by Lovell and Rose (1995) were untrained. The influence of training level on heart rate during recovery has been previously described (Bayly *et al.* 1983; Foreman *et al.* 1990). With increasing training duration, the cardiac adaptation leads a faster return to baseline HR after exercise.

In active recovery groups, our results of mean HR cannot be compared to those of previous studies as recovery duration was only 10 mins and there was no 10° treadmill incline as in the study by Lovell and Rose (1995). These authors also observed that the decrease in HR was significantly faster with standing recovery compared to a recovery of 30 mins walking or another of 15 mins trotting plus 15 mins walking. However, they noticed no significant difference in HR in the 3 recovery groups on T20. Hubbell *et al.* (1997) compared 3 recoveries during 90 mins: walking 30 mins plus 60 standing, 90 mins standing or 90 mins standing with a leg splint (to simulate injury during exercise). When comparing HR in the 3 recovery groups, these authors observed that on T30, the walking group had higher HR than the other two groups.

*Blood lactate disappearance*

Blood lactate disappearance is the main objective of active recovery and has been well described both in man and horses. After a maximal exercise, Marlin *et al.* (1987) compared 3 types of recovery: 70 mins standing, 70 mins walking and 30 mins trotting plus 40 mins walking. Mean peak post exercise blood lactate was the same in all trials, between 20 and 22 mmol/l. The half times for blood lactate disappearance were significantly different between the 3 types of recovery, higher intensity producing shorter half time. They were respectively of about 27 mins, 17 mins and 12 mins for standing, walking and trotting. Rate constants for blood lactate disappearance were correlated to post exercise work rate expressed in treadmill speed. In our study, with post exercise blood lactate concentration of about 10 mmol/l, we found half times for blood lactate disappearance of 17, 11, 7 and 5 mins for standing, walking, slow trotting and fast trotting groups. As in the study by Marlin *et al.* (1987), slow trot provided approximately a half time divided by 2 compared to standing. Hubbell *et al.* (1997) also found a significant lower blood lactate concentration in walking group compared in standing after 30 mins recovery. Because of a technical problem, Lovell and Rose (1995) could only compare standing vs. trotting plus walking conditions in term of blood lactate disappearance. They also found that the rate of disappearance was directly correlated to the intensity of post exercise activity.

**TABLE 1: Respiratory frequency and rectal temperature during recovery in the four recovery groups (mean ± s.d.)**

| | Respiratory frequency (resp/min) | | | Rectal temperature (°C) | | |
|---|---|---|---|---|---|---|
| Time | Rest | T10 | T60 | Rest | T10 | T60 |
| Rest | 14 ± 3 | 57 ± 25* | 22 ± 9 | 37.4 ± 0.4 | 39.5 ± 0.6* | 38.2 ± 0.6 |
| Walking | 13 ± 3 | 27 ± 12 | 16 ± 6 | 37.5 ± 0.3 | 38.6 ± 0.2 | 37.8 ± 0.3 |
| Slow trotting | 13 ± 4 | 37 ± 17 | 18 ± 5 | 37.4 ± 0.3 | 38.8 ± 0.5 | 38.2 ± 0.2 |
| Fast trotting | 14 ± 6 | 32 ± 16 | 18 ± 4 | 37.5 ± 0.3 | 38.6 ± 0.3 | 37.8 ± 0.4 |

*significant difference between rest group and other recovery groups. ($P<0.05$).

*Other variables*

As regards respiratory frequency (RF) and rectal temperature (RT), Lovell and Rose (1995) and Hubbell *et al.* (1997) did not observe any difference between their different group of recovery. In our study, we noticed that the rest group had higher RF and RT at T10. This might be due to a methodological bias as standing horses immediately entered and were covered in their box. Their thermoregulation might have been less efficient than for other horses kept moving at a lower ambient temperature on the track. Another explanation for the higher RF in the rest group could be the metabolic acidosis caused by high lactate concentration in blood.

*Conclusion*

The results show that recovery effect, i.e. shorter metabolic acidosis, could be optimised by trotting faster than spontaneous intensity. As in human athletes, an intensity of 60–70% max HR allows a faster blood lactate disappearance than lower intensity exercises. Ideally, the systematic control of heart rate during, and after, exercise could lead to a better individualisation of training but also of recovery. Futher research is needed to define other means of optimisation of recovery in race horses. As in human athletes, studies on rehydration, timing and quality of post race renutrition or physiotherapy should be carried out as the ability to recover quickly after a race becomes more and more crucial.

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## Manufacturers' addresses

[1]Schoberer Rad Meßtechnik, Jülich, Germany.
[2]NCSS, Kaysville, Utah, USA.

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