Praca oryginalna *Original paper*

Monitoring of some physiological parameters during the first 30 days of a foal's life

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Summary

The rectal temperature, heart rate and respiratory rate pattern during a foal's first month of life were studied. Twenty-four thoroughbred foals were divided in 2 groups: group A (Ga) consisted of 12 fully developed foals born within 340 days, while group B (Gb) consisted of 12 fully developed foals born between 341 and 355 days. Rectal temperature, heart rate and respiratory rate were recorded in each subject immediately after birth and for 30 consecutive days thereafter. Data were analyzed by means of a mixed-model factorial ANOVA with two factors: experimental days (1 to 30) and experimental group (born at term or born late). The groups were independent and the days were repeated measures. The results indicated a significant effect of time ($P<0.0001$) on heart rate and on respiratory rate in both groups, while no statistically significant difference was found in the thermoregulatory response, which was constant from birth. These results are important for the clinical evaluation of subjects born after the mean scheduled pregnancy term through the acquisition of the reference values of physiological parameters such as rectal temperature, heart rate and respiratory rate. These parameters are easy to record and represent valid indicators of the foal's homeostatic response during the neonatal period.

Keywords: physiological parameters, foal, neonatal period

During the neonatal period, homeostatic mechanisms complete their maturation, thereby allowing the foal's adaptation to extra-uterine life (9). The newborn is therefore in a metabolically instable condition that makes it particularly sensitive to perinatal period diseases resulting in a high mortality. Given that the foetal development depends on the intrauterine environment, which may heavily condition the expression of the foetal genoma, a high percentage of neonatal disorders is due to maternal disorders (3). In the mare, unlike other species, the foetal maturation that makes the passage to extra-uterine life possible begins only during the last 5 days of pregnancy, and ends within the first 7-10 days of life (2, 6). Therefore, when birth occurs before foetal maturation, loss of the foal's vitality may affect its survival possibilities; this risk is, however, also present in „full term" pregnancy (10).

According to the literature, the mare pregnancy duration ranges from 315 to 365 days, with a mean of 340 days (5). Knowledge of the possible implications of varying pregnancy duration on foetal maturation is important to understand, and thus prevent, the risk factors faced by both mare and foals during the neonatal period.

It is not known what the effects of the prolongation of the pregnancy beyond the mean pregnancy period of 340 days (considered to be the mean physiological period) to 365 days (considered to be the maximum physiological period) are, and whether any such effects involve significant changes in the homeostatic mechanism that guarantees the foal's fitness during the neonatal period.

With the aim of shedding light on the foal's neonatal physiology, whose knowledge is essential in neonatal care effectiveness, we studied the pattern of some physiological parameters (rectal temperature, heart rate and respiratory rate) required for the assessment of homeostatic responses in foals born after 340 days pregnancy, or later.

Material and methods

For our study, we used 24 thoroughbred foals born from mares covered naturally in the month of March.

During the pregnancy period, the mares were monitored by means of ultrasound on the 21st, 40th, and 60th days of pregnancy; the last ultrasound examination was performed in the 6th month of pregnancy.

The foals, born naturally, were divided in 2 groups: group A (Ga) consisted of 12 fully developed foals born within

340 days, while group B (Gb) consisted of 12 fully developed foals born between 341 and 355 days. The foals were clinically healthy, had a mean body weight of 45 ± 5 kg, had a mean time taken to stand of approximately 90 minutes, were kept with the mother, in a single, naturally lighted box.

In each foal, we recorded rectal temperature by means of a digital thermometer (HI92704, Hanna Instruments), with the probe inserted into the rectum to a depth of 9 cm, heart rate by means of a heart monitor (Equine Polar Vet. Check), and respiratory rate (counted visually with the help of a stopwatch over 5 min.). All these parameters were recorded at the same hour of the day (07.00) in both groups for 30 consecutive days from birth.

Statistical analysis of the results was performed on the mean values of the studied parameters since the intra-group variance was not significant. The data were analyzed with a mixed-model factorial ANOVA with two factors: experimental days, Time (1 to 30) and experimental group, Ga e Gb. The groups were independent and the days were repeated measures.

Results and discussion

The pattern of the mean values of the studied parameters (rectal temperature, heart rate and respiratory rate) in the 12 foals in groups A (Ga) and B (Gb) recorded during the 30 days considered are shown in figures 1 and 2. By applying a mixed-model factorial ANOVA, the following results were obtained: rectal temperature (group: $F_{(1,22)} = 0.11$, $P < 0.9$; time: $F_{(29,638)} = 0.12$, $P < 0.9$; interaction: $F_{(29,638)} = 1.20$, $P < 0.4$); heart rate (group: $F_{(1,22)} = 0.14$, $P < 0.7$; time: $F_{(29,638)} = 10.38$, $P < 0.0001$; interaction: $F_{(29,638)} = 0.94$, $P < 0.5$); respiratory rate (group: $F_{(1,22)} = 0.26$, $P < 0.6$; time: $F_{(29,638)} = 2.53$, $P < 0.0001$; interaction: $F_{(29,638)} = 1.08$, $P < 0.3$).

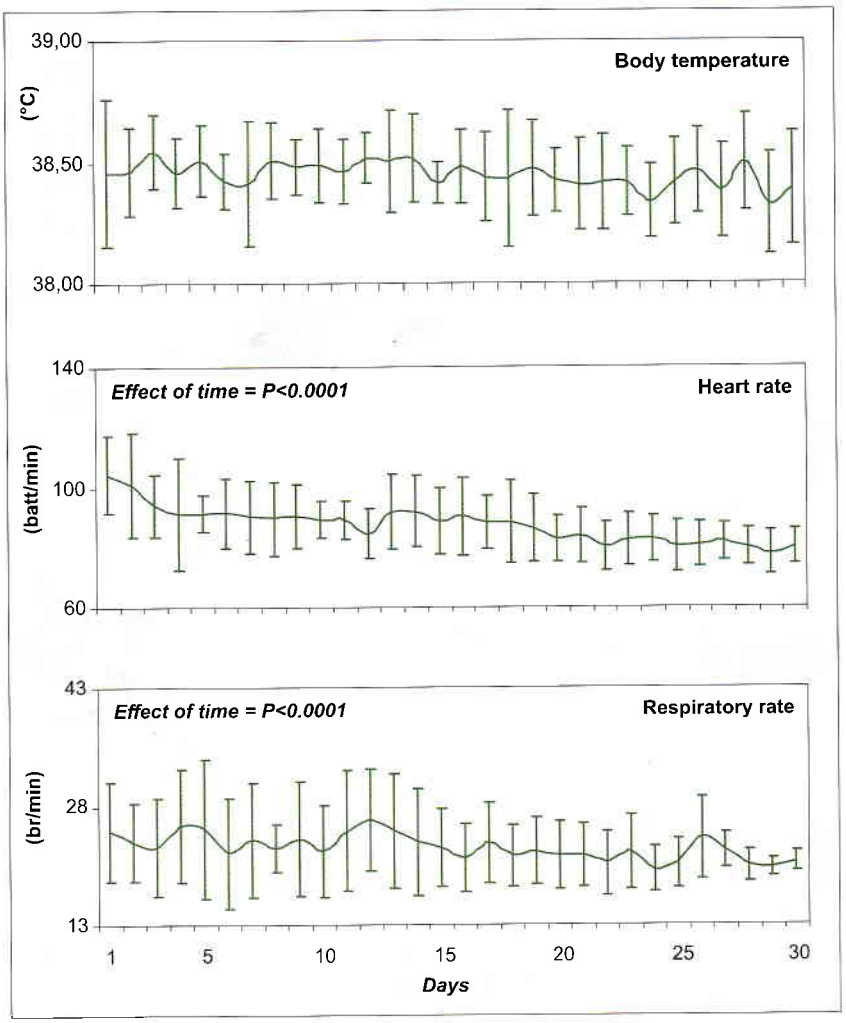

Fig. 1. Patterns of body temperature, heart rate and respiratory rate with their standard deviations and statistical significance in 12 foals in group A (Ga)

These results do not show any statistically significant variations of rectal temperature between the 2 groups, nor any interaction between the factors considered; furthermore, no significant effect of time or interaction was found in either groups. Heart rate and the respiratory rate showed the same pattern in both groups during the 30 days; a significant effect of time was found for both parameters, while no statistical significant variations nor experimental factor interaction were found between the groups.

The analysis of the data obtained show that, during the period considered, there was no statistically significant difference in rectal temperature either within groups A and B, or between these two groups.

At birth, a foal's ability to maintain thermal homeostasis is particularly limited and is subordinate to the degree of maturity of the organism at the time of birth, to its glycogen reserves and to its panniculus adiposus thickness. Foal rectal temperature during the first 4 days of life ranges between 37.2 and 38.9°C (5), thereafter settling at 37.5-38.5°C; these values are in agreement with the ones recorded in the present study. The lack of statistically significant differences for this parameter show that the thermal homeostasis mechanisms in the newborn foal are function perfectly from the very first weeks of life both in foals born within 340 days and those born later, thereby allowing them to keep body temperature constant during the first month of life. The efficiency of these thermal homeostasis mechanisms in the newborn is confirmed by the existence of a rhythmic pattern of body temperature that emerges within the first 10 days of birth, and matures fully during the first month of life (8).

The foal heart rate immediately after birth is around 40-80 bpm, and increases up to 130-150 bpm because of the physical activity due to its first attempts to stand; during the following days, heart rate settles at 70-100 bpm (5). The heart rate pattern recorded in the foal's first week of life depends on cardio-circulatory system modifications that occur in its first 12 hours of life: the foramen ovale and the arterial duct close, and the right-left cardiac shunt that persists in approximately

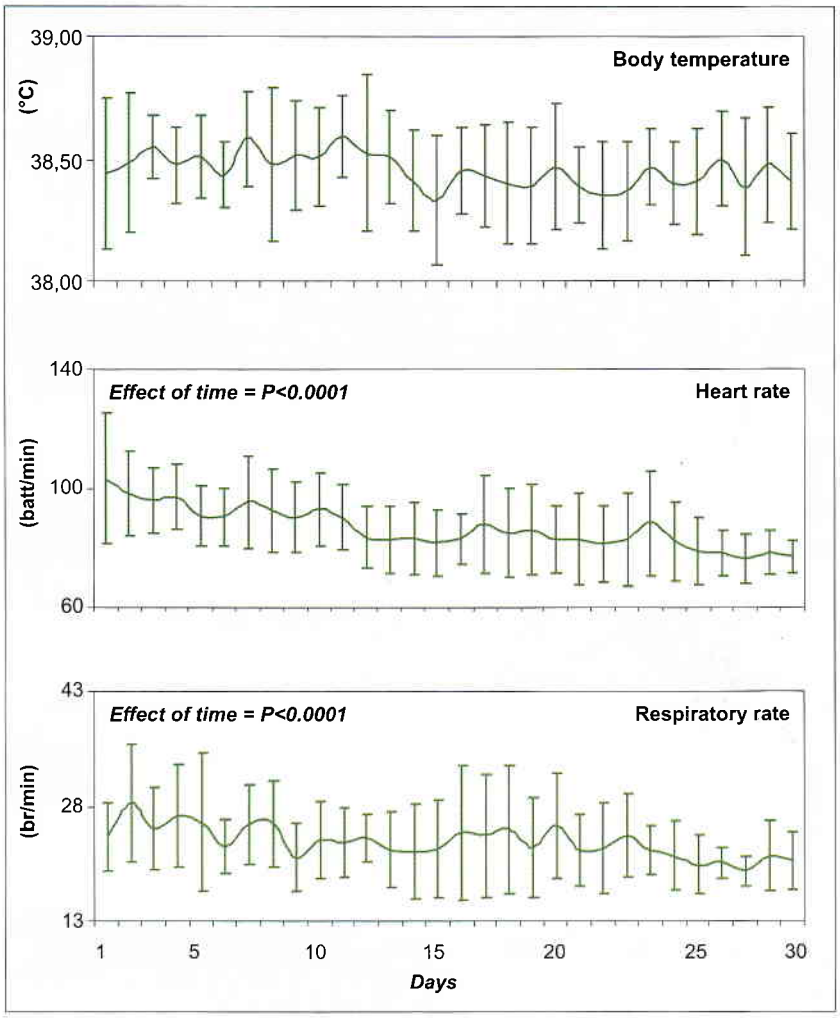

Fig. 2. Patterns of body temperature, heart rate and respiratory rate with their standard deviations and statistical significance in 12 foals in group B (Gb)

18% of cases (2) resolves spontaneously during the following weeks. In the newborn, the heart is forced to pump the blood through a vascular system that presents a strong elastic, peripheral resistance and, since the organism of the newborn is not yet able to vary cardiac output, it compensates the limited systolic volume by increasing the heart rate. This may explain the significant effect of time on the statistically significant decrease ($P < 0.0001$) in heart rate observed in both groups in the present study during the 30 days considered.

A significant effect of time ($P < 0.0001$) was also found in both groups for respiratory rate; this confirms the homeostatic physiological variability of this parameter during the neonatal period. It is known that in newborns there is a physiological respiratory immaturity due to an incomplete anatomical-functional development. Indeed, the physiological values of the respiratory rate are around 60-80 ram immediately after birth (5), though it drops significantly within 15 minutes (11); 12 hours later this value is 30-50 ram and by the end of the first week of life, it ranges between 20 and 40 ram (5).

In our study, the mean values of the studied parameters were within the physiological range for the neonatal period both in the subjects born within the scheduled term and in the foals born after this term.

No statistically significant differences were found between the two groups.

The mare pregnancy duration shows a marked variability depending on different environmental and biological factors: photoperiod (4, 7, 13); mare nutrition state, foetus genotype, neuroendocrine CNS mediated modulation (1, 12). This may explain why foals born naturally could paradoxically already be mature at 320 days, which is considered to be the minimum physiological period, and dysmature at 350 days (10).

Conclusions

Our results shed more light on the clinical evaluation of subjects born beyond the pregnancy scheduled term. The success of neonatal therapy resides in how promptly it is administered. For this therapy to be both prompt and effective, it is essential to have a sound knowledge of both the disease involved and of the reference values of the physiological parameters considered to be valid indicators of the homeostatic response of the organism during the passage from the uterine environment to the external one.

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