

HEMATOLOGIC VALUES OF THOROUGHBRED FOALS FROM BIRTH TO SIX MONTHS OF AGE

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ABSTRACT

The common domestic equine species present various hematological differences within reference values as a result of age, breed, sex, physical activity, among others. Therefore, it is important that reference intervals should be established for these particularities. This work aimed to evaluate sequential changes in hematological parameters of healthy Thoroughbred foals from birth to six months of life. Blood samples were collected immediately after birth (before the intake of colostrum), at 24 h, 7 days, 1, 2, 3, 4, 5 and 6 months of age in order to measure packed cell volume (PCV), total plasma protein (TPP), fibrinogen and white blood cells (WBC). Descriptive statistics, analysis

of one-way AOV and comparison between means by LSD test were accomplished. Hematological values were assessed in 1426 samples. The curve variations in PCV, total plasma protein, fibrinogen and WBC values observed in healthy Thoroughbred foals from birth to 6 months were similar to those described for other breeds. However, we verified higher TPP values than mean reference values at all ages. The ranges of fibrinogen and WBC showed small intervals and maximum values below the hematologic reference values for all ages. These changes in hematologic values provide useful information for clinical evaluation of Thoroughbred foals.

KEYWORDS: equine neonatal, fibrinogen, hematologic profile, total plasma protein.

VALORES HEMATOLÓGICOS DE POTROS PURO SANGUE INGLÊS DO NASCIMENTO AOS SEIS MESES DE IDADE

RESUMO

As espécies domésticas de equídeos apresentam diferença nos valores hematológicos de referencia devido à idade, raça, sexo, atividade física, entre outros. Tendo em vista estas particularidades, é importante o estabelecimento de parâmetros de referência. O objetivo deste trabalho foi avaliar as mudanças sequenciais de parâmetros hematológicos de potros Puro Sangue Inglês, saudáveis, do nascimento aos seis meses de vida. Amostras sanguíneas foram coletadas imediatamente após o parto (antes da ingestão de colostro), as 24h, 7 dias, 1, 2, 3, 4, 5 e 6 meses de idade para mensuração de hematócrito, proteínas plasmáticas totais (PPT), fibrinogênio e leucócitos totais. Foi realizada estatística descritiva,

análise de variância simples (teste One-way AOV) e comparação entre as médias pelo teste de LSD. A avaliação hematológica foi realizada em 1426 amostras. A curva de variação do hematócrito, PPT, fibrinogênio e leucócitos totais observada nos potros do nascimento aos 6 meses de idade foram similares às descritas para outras raças. No entanto, valores médios de PPT foram mais elevados durante todo o período. As médias de fibrinogênio e leucócitos apresentaram pequenos intervalos e máximos valores abaixo dos valores de referencia em todos os momentos. As alterações em valores hematológicos têm importância na avaliação clínica de potros Puro Sangue Inglês.

PALAVRAS-CHAVE: fibrinogênio, neonatologia equina, perfil hematológico, proteína plasmática total.

INTRODUCTION

The common domestic equine species present various hematological differences within reference values as a result of age, breed, sex, physical activity, among others. However, it is important that reference intervals should be established for these particularities¹.

Hematological tests are an important tool for monitoring the overall health of the entire population of foals on equine farms, since certain parameters are early indicators of pathological processes. Foal hematological values change constantly during the gestational and neonatal periods and in the first months of life². Hematological profile is commonly performed in equine medicine for a variety of reasons: to screen clinically healthy animals, to identify conditions that might increase the risk during anesthesia or surgery, to diagnose a disease and to assess its severity and consequences, to formulate a prognosis and to monitor the response to therapy or the progression of the disease³. Hot-blooded horses (Arab and Thoroughbred) have been found to have higher RBC counts, hemoglobin concentration, packed cell volume, and blood volume compared to cold-blooded horses (draft horse and pony)¹.

Therefore, for adequate clinical evaluation of the foal it is indispensable to have accurate knowledge about hematological reference values according to individual age and breed. Previous studies of hematological changes in foals, while informative, were inadequate due to the following reasons: (1) small number of samples, (2) inadequate duration of sampling protocol, (3) inadequate frequency of sampling, especially during the early period of life, (4) use of ponies rather than full-size horses⁴. Even after almost two decades, these breed-related differences in foals have not been completely elucidated, and there are few articles providing data regarding hematological changes in healthy foals⁴. In this context, this work aimed to evaluate sequential changes in the hematological parameters of healthy Thoroughbred foals from birth to six months of life.

MATERIAL AND METHODS

During the years 2009 to 2011, 283 Thoroughbred foals were studied in a farm in

Acéguia, Rio Grande do Sul, Brazil. The study included 140 females and 143 males born from eutocic delivery and healthy during the period of attendance. Mares and foals were dewormed monthly and kept in a paddock of native grass and ryegrass (*Lolium multiflorum*) with access to shade and water *ad libitum*. This study used animals in the experimental model and had the approval of the Institutional Research Ethics Committee of the Universidade Federal de Pelotas (UFPel), registered under number 5810.

The partial hematologic values consisted of packed cell volume (PCV), total plasma protein (TPP), fibrinogen and total leukocytes (white blood count – WBC), which were measured on nine (9) occasions: immediately after birth (before the intake of colostrum), at 24h, 7 days, 1st, 2nd, 3rd, 4th, 5th and 6th month of age. On each occasion only one sample was collected from each animal. The blood samples were collected through puncture of the jugular vein with tubes containing EDTA. PCV was assessed by microhematocrit method. TPP concentration was measured by refractometry, and fibrinogen was evaluated by heat precipitation method. The total leukocyte count was done in an automatic cell counter (CELM CC-510). For white blood cell count a hemolyzing solution was used as diluent, consisting basically of surfactant and potassium cyanide 4mg/dl.

All data were evaluated by descriptive statistics, including an assessment of dispersion mean measure, standard deviation (SD) and coefficient of variation (CV). Then one-way analysis of variance (One-way AOV) and comparison between means by LSD test were carried out in a statistical program (Statistix 9[®], Analytical Software, Tallahassee, FL, USA). Significance was assigned to all values $p < 0.05$.

RESULTS AND DISCUSSION

Hematologic values were assessed in 1426 samples, from immediately after birth until the foal was six months old (Table 1). The hematologic values described are part of normal screening performed regularly on local farms, using resources that are available for routine control and prevention of infectious diseases.

Table 1 – Ranges* of packed cell volume (PCV), total plasma protein (TPP), fibrinogen and total leukocytes ($10^3/\mu\text{L}$) of Thoroughbred foals according to age

	PCV (%)	N**	TPP (g/dL)	N**	Fibrinogen (mg/dL)	N**	Leukocytes ($10^3/\mu\text{L}$)	N**
0 hour	44.8 – 45.8	283	6.4 – 6.6	283	302 - 327	280	5842 – 6264	271
24 hours	39.1 – 41.1	120	7.4 – 7.8	120	270 – 316	119	7771 – 8740	113
7 days	35.1 – 37	121	7.5 – 7.8	121	343 – 387	120	8220 – 9415	113
1 month	35.6 – 37.1	248	7.6 – 7.8	248	404 – 440	245	6863 – 7503	228
2 months	36.6 – 38	188	7.7 – 7.8	188	427 – 471	187	8406 – 9276	185
3 months	35.8 – 37	146	7.7 – 7.9	146	471 – 522	146	8875 – 9855	139
4 months	37.6 – 38.7	143	7.9 – 8	143	488 – 528	142	8461 – 9348	134
5 months	37.4 – 38.8	101	7.9 – 8	101	463 – 518	100	8065 – 8980	96
6 months	37.2 – 38.8	76	8 – 8.1	77	394 – 457	77	7568 – 8686	96

* Ranges determined by mean \pm 2 SD.

** Number of foals evaluated at each age.

Packed cell volume decreased significantly through the first week of the foal's life; between the first and the sixth month this value remained stable (Figure 1a). TPP values presented a rise ($p < 0.05$) during the first 24h of life and in the subsequent period rose gradually (Figure 1b). Fibrinogen demonstrated a gradual rise from birth to the fourth month of life, followed by a reduction in its values (Figure 1c). WBC increased ($p < 0.05$) during the first week of life, followed by a reduction in the first month, gradually rose between the first and the third months and decreased between the third and the sixth month of life (Figure 1d).

The hematological changes reported in this article provide information that is useful for clinical evaluation of foals from birth to six months of age. Poor data regarding hematological values have been provided in a special study about Thoroughbred foals. The ranges of partial hematologic values determined in Table 1 showed small changes between the minimum and maximum values. The high degree of homogeneity between results is characterized by small values of SD and CV. The largest CV observed was 16% for hematocrit, 11% for TPP, 42% for fibrinogen and 36% for leukocytes.

PCV values in our study were similar to the values reported in hematological reference values determined by a group of 43 Thoroughbred and quarter-horse foal^{4, 5}. Contrary to what was expected, the assessments at 0h and 24h for heavy draft horse foals⁶ showed higher PCV than that of the Thoroughbred foals in this study.

In this study a significant reduction was observed in PCV during the week following birth. The PCV rose transiently immediately upon delivery, and this is attributed mainly to blood flow through the umbilical cord. The subsequent decline in the red blood cells is considered physiologic,

being attributed to several factors, such as absorption of colostrum proteins with osmotic effect on the plasma⁷, reduced production of erythropoietin secondary to increased blood oxygenation performed via the lungs⁴, reduced lifespan of fetal erythrocytes, rapid development and growth of the foal resulting in hemodilution due to rapid expansion of plasma volume and reduced total mass of red blood cells⁸.

In humans, the rapid reduction in PCV levels during the neonatal period is attributed to changes in body fluids balance⁹, and this model is also proposed for equine neonates.

From the first to the sixth month of life, the mean PCV values of foals remained stable (Figure 1a). The PCV decreased over the next weeks of life to remain in the lower portion of the adult reference range⁴.

The TPP values found were higher in our study and above the mean reference values at all ages^{1, 4, 6}, also being similar to those described for Crioulo foals (8.15 g/dL)¹⁰. The lowest TPP was observed at birth, followed by an increase during the first 24 hours of life (Figure 1b), and this fact is related to intake of immunoglobulin present in the colostrum. This test is an indirect and nonspecific form of evaluating the transference of antibodies.

In this study we found that between 24h and three months of age TPP values remained stable. From the fourth month a significant increase was observed, reaching levels similar to adults (Figure 1b). The increase in TPP in foals up to one month of life may be related to dietary changes, by increased pasture intake, and the increase in muscular effort, by transference of mares and foals to larger paddocks³ and this management strategy was carried out on the farm of the present study.

Plasma fibrinogen concentrations were low in foals at birth, with a gradual increase until the

fourth month of life, then falling to values similar to adult horses (Figure 1c). This fluctuation curve is similar to that described by other authors^{2,4}.

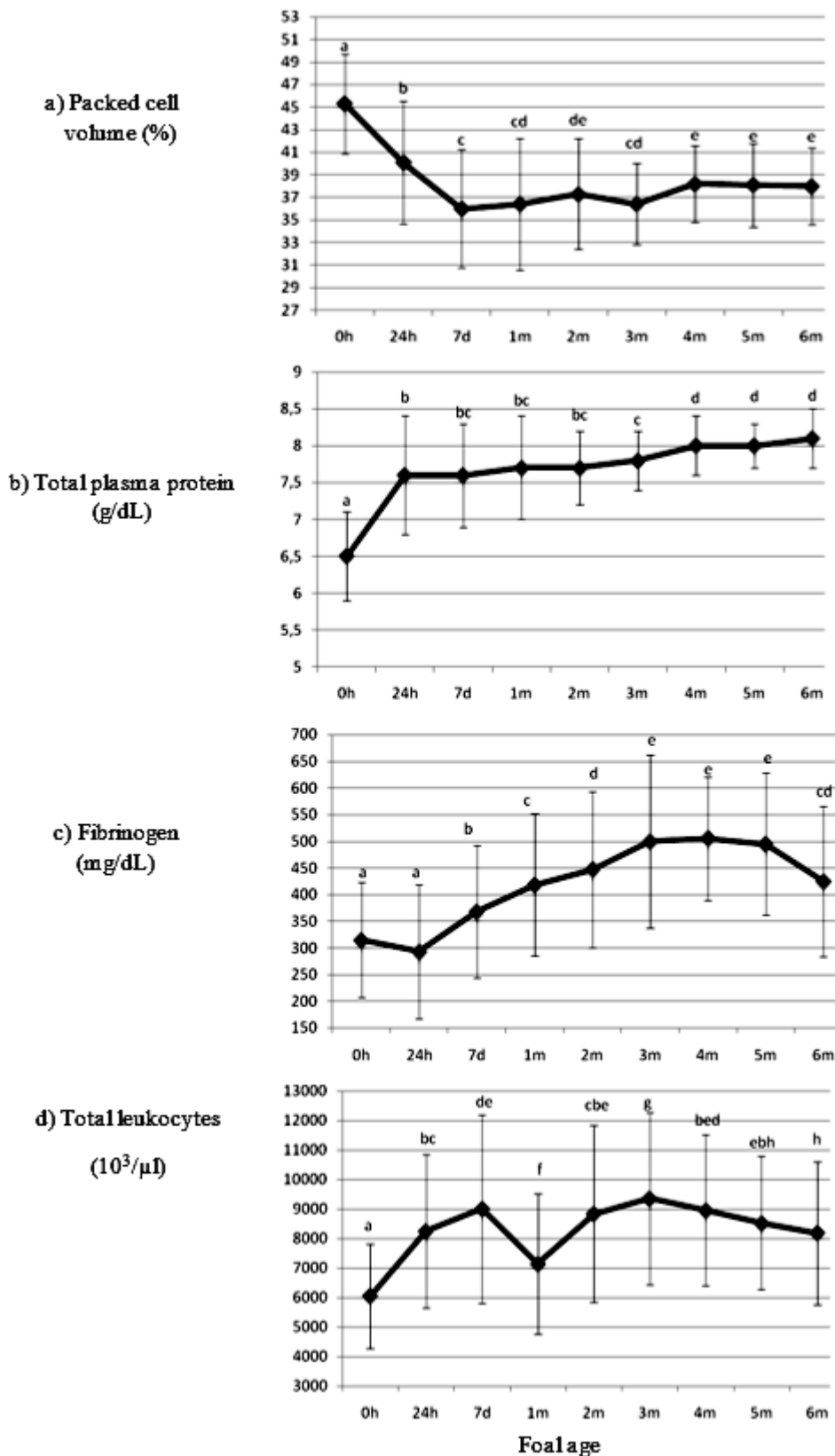


Figure 1 – Mean and standard deviation of a) Packed cell volume (%); b) Total plasma protein (g/dL); c) Fibrinogen (mg/dL); and d) Total leukocytes ($10^3/\mu\text{L}$) of Thoroughbred foals from birth to 6 months of age. Distinct letters indicate statistical difference ($p < 0.05$).

In the period between 7 days and the fourth month of age, a significant increase was observed in the fibrinogen value. The gradual rise was primarily attributable to the stimulation of the foals' immune system, due to contact with microorganisms and formation of commensal flora¹¹.

The ranges of amounts of fibrinogen and WBC (Table 1) showed all ages have smaller intervals when compared to the data reported as hematologic reference^{2, 4}; therefore, the maximum values of fibrinogen and WBC found were below the values reported by other authors^{1, 2, 4}. Fibrinogen concentrations increase in response to inflammation and infection, and a decline in concentration is used as an indication of successful therapy, in combination with WBC², thus, the low maximum values found in foals in this study are valuable insights for clinical routine and in convalescence evaluation for Thoroughbred foals.

At birth the average total leukocyte count was $6053 \times 10^3/\mu\text{L}$, but no reference values for neonatal foals before the first feeding were found in the literature. A significant increase in white blood cells was observed in the first 24 h of the foal's life. This increase is probably due to the large increase in circulating neutrophils in response to the peak level of cortisol in the fetal circulation that occurs in this phase^{2, 4, 11}. This only occurs in healthy foals, and it is directly related to endogenous steroid production, maturity of the adrenocortical system and consequently the foal's maturity at birth¹². Leukopenia is a common finding in septic and premature foals and an important parameter for early detection of at-risk foals¹³.

We observed that the leukocyte number was still rising during the first week of life. Between 7 days after birth and one month of age a reduction in WBC was verified. These variations are considered physiological and have been previously described in foals of other breeds^{4, 6, 11}. From the first to the third month of age a significant increase was observed in total leukocyte count, findings similar to those reported previously⁴, which attributed this fact to the increase in stimulation and maturation of the foal lymphoid system. Between the fourth and sixth months a decline was noted in total leukocyte values, approaching the reference parameters for adult horses.

Hematological evaluations in foals are important for the early detection of pathological manifestations, and they need to be carried out in association with a clinical examination. Implementing these tests and examinations routinely on equine farms aims to increase health monitoring of the herd and provide more individual attention to each foal.

CONCLUSIONS

The curve variation in the PCV, total plasma protein, fibrinogen and WBC values observed in healthy Thoroughbred foals from birth to six months were similar to those described for other breeds. However, higher TPP values than mean reference values were seen at all ages evaluated. The ranges of fibrinogen and WBC showed small intervals, characterized by maximum values below the hematologic reference values for all ages.

This study reports changes in hematologic values and provides useful information for clinical evaluation of Thoroughbred foals.

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