EVALUATION OF THE VITALITY OF NELORE CALVES BORN OF NORMAL OR DYSTOCIC PARTURITIONS

(AVALIAÇÃO DA VITALIDADE DE BEZERROS NELORES NASCIDOS DE PARTOS NORMAIS OU DISTÓCICOS)[1]

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SUMMARY

Adaptation to extrauterine life is a critical period for the newborn. Numerous changes occur in different organ systems including respiratory function and acid-base equilibrium. Newborns may die due to hypoxia or trauma sustained during delivery. Thirty Nelore calves were used in this study, 18 born of normal and 12 of dystocic calving, to determine the influence of the type of parturition (normal or dystocic) on both neonatal Apgar score and blood gas analysis parameters of calves. The blood samples were collected by jugular venipuncture immediately after birth and 24 hours later. The blood pH, oxygen partial pressure (pO_2), carbon dioxide partial pressure (pCO_2), total carbon dioxide (TCO_2), bicarbonate concentration (HCO_3-), base excess (BE) and oxygen saturation (SO_2) were determined by using a portable blood gas analyzer. Significant differences were observed over time in the blood gas values of the calves during this study. The calves born from dystocic parturition had respiratory acidosis and lower vitality in the immediate post-partum period.

KEY-WORDS: Acidosis. Apgar. Blood gas analysis. Bovine. pH.

RESUMO

A adaptação à vida extra-uterina é um período crítico para o recém-nascido. Inúmeras alterações ocorrem em diferentes sistemas e órgãos, incluindo a função respiratória e o equilíbrio ácido-básico. Os neonatos podem morrer devido à hipóxia ou traumas sofridos durante a parturição. Visando avaliar a influência do tipo parturição (normal ou distócico) em relação ao escore Apgar de vitalidade neonatal e aos valores de hemogasometria de bezerros nascidos de partos eutócicos ou distócicos, foram utilizados 30 bezerros da raça Nelore, sendo 18 animais nascidos de partos eutócicos e 12 de partos laboriosos. As amostras sanguíneas foram colhidas por venopunção jugular, imediatamente após o nascimento e às 24 horas de vida. O pH, a pressão parcial de oxigênio (pO_2), a pressão parcial de dióxido de carbono (pCO_2), o dióxido de carbono total (TCO_2), a concentração de bicarbonato (HCO_3^-), o excesso de bases (BE), e a saturação de oxigênio (sO_2) foram determinados utilizando-se analisador portátil de gases sanguíneos. Observaram-se diferenças significativas entre os momentos nos valores hemogasométricos de bezerros. Os bezerros nascidos de partos distócicos apresentaram acidose respiratória e menor vitalidade no período pós-parto imediato.

PALAVRAS-CHAVE: Acidose. Apgar. Bovino. Hemogasometria. pH.

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INTRODUCTION

The moment of birth is, for newborns, stressful and associated with metabolic changes, considering that the newborn suddenly takes on vital functions hitherto performed by the placenta and survival depends on major changes in the respiratory and circulatory patterns (GRONGNET, 1982; WOOD, 1999).

These changes include activation of the hypothalamic-pituitary-adrenal axis of the calf, mediated mainly by cortisol, a potent stimulator of metabolism (WOOD, 1999). It has been observed in cattle (AURICH et al., 1993) and sheep (PADBURY et al., 1985) that during labor, and especially after the breaking of the umbilical cord, there is activation of the sympathetic adrenal system, with increased release of catecholamines in the first hour of life, which is considered an important factor in neonatal adaptation, increasing heart and respiratory rates, influencing functional lung capacity, surfactant production and decreasing lung fluid production.

Dystocia is a major cause for mortality of beef calves between birth and the first 96 hours after birth (PETTERSON et al., 1987). The incompatibility between the mother´s pelvis and the size of the fetus (IPF) is the most important cause of dystocia (ANDERSEN, 1993), that could be the result of either a large fetus or small pelvis or both. In cows, hormonal disorders caused by low estrogen concentration are also mentioned (OSINGA, 1978).

Dystocia and severe asphyxia at birth compromise the physiological transitions and increase the risk of neonatal mortality (VAALA & HOUSE, 2006). In animals with hypoxia, physical activity diminishes and the animals become lethargic, slow or unable to get up and feed themselves, presenting respiratory distress with tachypnea and cyanotic and/or pale mucosae (BENESI, 1993).

The evaluation of the calf immediately after birth allows prompt diagnosis of changes related to both stress and adaptation of the newborn. The method to evaluate the vitality of newborn calves is based on the system established for newborn babies by Virginia Apgar in 1953. Mülling (1976) adapted this system for the evaluation of spontaneous movements and muscular tone, irritability reflex, breathing and color of mucous membranes. In 1981, Born changed two of these criteria: muscle tone and movement, which began to be evaluated by the head reaction to cold water stimulus, while adding to these, the responses of the oculo-palpebral and interdigital reflexes.

It has been demonstrated that there is a correlation between the clinical status of dairy calves as evaluated by the modified Apgar and the parameters of blood acid-base equilibrium (BORN, 1981; KÖPPE, 1980; MAUER-SCHWEIZER et al., 1977). Therefore, blood gas analysis could be an additional method to evaluate calf vitality. However, for the two methods to be used correctly to assess beef calf vitality, the Apgar method modified by Born (1981) associated with blood gas analysis, it is important to determine the parameters for normal calving and dystocia, and to verify the relationship between the two methods.

The objective of this study was to asses the vitality of Nelore calves born of normal and dystocic calving by the Apgar method modified by Born (1981) and to determine the parameters of blood gas analysis in order to verify whether there is a correlation between calf vitality assessment and blood gas variables.

MATERIAL AND METHODS

A total of 30 calves born from Nelore embryos produced by *in vivo* (FV) and *in vitro* (FIV) fertilization techniques that were transferred (TE) to crossbred cows were evaluated. The calves were divided into two groups, normal (n = 18) and dystocic (n = 12) calving.

Calf vitality, immediately after birth, was evaluated by the Apgar method modified by Born (1981). The four parameters evaluated and their interpretation are shown in Table 1. The sum of these scores were interpreted as follows: 0-3, little vitality; 4-6, depressed and 7-8, good vitality.

Table 1 - Apgar scores modified by Born (1981) to evaluate newborn calf vitality

Evaluation criteria	Scores		
	0	1	2
Response to cold water, muscle strength (lifting the head, trying to stay of station)	Absent	decreased	Active, spontaneous movements
Interdigital and eyelid reflex	absent	Weak reaction/at least one reflex present	Immediate reaction/at least two reflexes present
Mucous color	white-blueish	blue	rose-red
Respiratory activity	Absent	Arrhythmic	Standard intensity and frequency

Table 2 - Means and standard deviations of the Apgar scores modified by Born (1981), respiratory rate (RR), heart rate (HR), pH, carbon dioxide partial pressure (pCO_2), oxygen partial pressure (pO_2), bicarbonate (HCO_3^-), total carbon dioxide (tCO_2) and oxygen saturation (sO_2) for 30 Nelore calves resulting from embryo transfer (ET) according to birth type and over time.

Variable	Birth type	time: 0 hour ($\bar{x} \pm s$)	time: 24 hours ($\bar{x} \pm s$)
Apgar	Normal	7.72 ± 0.75 a	Not conducted
	Dystocic	5.40 ± 1.17 b	Not conducted
pH	Normal	7.12 ± 0.12 aB	7.29 ± 0.11 aA
	Dystocic	7.10 ± 0.16 aB	7.25 ± 0.12 aA
RR (mpm)	Normal	44.28 ± 11.18 aA	38.33 ± 10.39 aA
	Dystocic	49.20 ± 22.65 aA	42.40 ± 13.17 aA
HR (bpm)	Normal	143.72 ± 21.45 aA	116.72 ± 17.68 bB
	Dystocic	152.00 ± 23.38 aA	132.20 ± 18.74 aB
pCO_2 (mmHg)	Normal	87.4 ± 19.44 aA	63.71 ± 13.94 aB
	Dystocic	84.59 ± 22.54 aA	64.71 ± 15.02 aB
pO_2 (mmHg)	Normal	44.44 ± 12.02 aA	42.33 ± 10.19 aA
	Dystocic	39.73 ± 19.54 aA	42.10 ± 13.73 aA
HCO_3^- (mmol/L)	Normal	28.02 ± 2.89 aB	30.27 ± 2.49 aA
	Dystocic	26.33 ± 2.91 aB	28.92 ± 3.40 aA
tCO_2 (mmol/L)	Normal	30.67 ± 2.87 aB	32.22 ± 2.32 aA
	Dystocic	29.18 ± 2.48 aB	30.90 ± 3.21 aA
sO_2 (%)	Normal	59.83 ± 10.65 aB	68.39 ± 9.69 aA
	Dystocic	47.73 ± 21.29 bB	59.70 ± 14.10 bA

Means followed by different letters, lowercase in the column and uppercase in the row, are significantly different ($p<0.05$).

Table 3 - Means and standard deviations of excess/deficit of bases (EB), in mmol/L, for 30 Nelore calves resulting from embryo transfer (ET) according to birth type and over time.

Birth type	Time: 0 hour ($\bar{x} \pm s$)	0 hour M	24 hours ($\bar{x} \pm s$)	24 hours M
Normal	-1.28 ± 4.28	0 aB	3.78 ± 7.32	4 aA
Dystocic	-2.64 ± 4.80	-2 aB	1.70 ± 5.62	2 aA

Means followed by different letters, lowercase in the column and uppercase in the row, are significantly different ($p<0.05$).

Additionally, we assessed respiratory rate (RR) and heart rate (HR). Blood samples were collected by jugular venipuncture at birth and 24 hours later using 5-mL tubes containing anticoagulant[4] to perform blood gas analysis within 15 minutes after collection. A handset analyzer[5] with specific cartridges[6], following manufacturer recommendations, was used to determine the following variables: pH, oxygen partial pressure (pO_2), partial pressure of carbon dioxide (pCO_2), total carbon dioxide (tCO_2), oxygen saturation (sO_2), bicarbonate (HCO_3^-) and excess/deficit of bases (EB). Before the processing of the samples, an electronic simulator[7] was used to check the correct functioning and after each reading, the equipment was calibrated. The values of pH, pO_2 and pCO_2, were adjusted according to rectal temperature of the animals, measured with a thermometer.

After tested for normality and homogeneity, the variables FR (mpm), FC (bpm), pH, pCO_2 (mmHg), pO_2 (mmHg), HCO_3^- (mmol/L), tCO_2 (mmol/L) and sO_2 (%) were submitted to analysis of variance and the means were compared by Tukey test for labor type and time. The variable EB (mmol/L) was submitted to Mann-Whitney to compare labor type and Wilcoxon test for comparison over time. Apgar assessment data were analyzed by Kruskal-Wallis test followed by Dunn test. Spearman correlation coefficients between Apgar results and the variables pH, pCO_2, pO_2, EB, HCO_3^-, tCO_2 and sO_2 were also calculated. Statistical analysis were performed by a software[8], at significance level $p<0.05$.

RESULTS AND DISCUSSION

The comparison of the Apgar scores, modified by Born (1981), showed that calves born after dystocic calving were depressed, since a significant difference was observed in the vitality scores of newborn calves after normal and dystocic births (Table 2).

Blood gas analysis (Table 2 and 3) results were not significantly different for the following variables pH, pCO_2, pO_2, HCO_3^-, tCO_2 and EB for the newborn calves after normal and dystocic births. Only sO_2 was significantly different between the two groups, either soon after birth or 24 hours later, lower values were observed for dystocic births. However, pO_2 and sO_2 measured in the venous blood do not provide information regarding lung ability to oxygenate the blood (HASKINS, 1977b), because these variables are influenced by other factors, such as the variation of oxygen consumption by various tissues, which by its turn is dependent on their activity.

The evaluation of blood gas parameters over time showed a significant increase of pH, HCO_3^-, tCO_2 and EB and significant decrease of pCO_2 (Tables 2 and 3) indicating respiratory acidosis soon after birth, which has been previously reported in calves by Bleul et al. (2007), Lisbôa et al. (2002), Uystepruyst et al. (2000), Varga et al. (1998), Varga et al. (1999), and Varga et al. (2001). However, this acidosis was not significantly different between calves born of normal or dystocic birth, and both groups tended to normalize the acid-base equilibrium 24 hours after birth by increasing pH and decreasing pCO_2, and increasing HCO_3^-, tCO_2 and EB as well.

In order to fight the acid-base imbalances, the body uses three main mechanisms: chemical buffering, mainly through bicarbonate, respiratory rate adjust by increasing respiratory frequency and, by excreting and retaining ions by the kidneys. The buffering and respiratory systems work within a few minutes, as opposed to the kidneys that respond slowly to excess acid or base (GUYTON & HALL 2002, HOUPT 2006).

In this trial, the prompt recognition of respiratory acidosis promoted the onset of compensatory response by increasing ventilation and chemical buffering concomitantly, thus reducing pCO_2, minimizing pH fall and stabilizing it, as reported by Carlson & Bruss (2008) and Lisboa et al. (2002).

Changes of the metabolic components are associated with the buffering response of acid pH, as the bicarbonate concentration increases; however, this response was mild in this experiment since, even over time, the HCO_3^- values remained within the reference range from 17 to 29 mmol/L (KANEKO et al., 2008), since the metabolic component is closely related to renal capacity to secrete hydrogen ions and retain bicarbonate ions. The bicarbonate ion did not increase possibly due to immaturity or lower capacity of renal reabsorption/secretion during the first hours of life and the short period during which the body was facing the acid-base imbalance. Such response may take several days to reach its peak even in adult animals (HOUPT 2006, CARLSON & BRUSS 2008).

The mean RR values found in the present study (Table 2) were slightly higher compared to standard values for newborn animals as reported by Vaala & House (2006), and were not significantly different between normal and dystocic birth or over time. Such an increase shows the role of this parameter in stabilizing the acid-base equilibrium over time in order to eliminate excess CO_2 produced. The increase of the respiratory rate coupled with the buffering capacity of the body fluids increases CO_2 removal rate, thus decreasing carbonic acid formation and increasing blood pH (VERLANDER 2004).

On the other hand, mean HR (heart rate) (Table 2) values were slightly higher than the values reported by Vaala & House (2006), however they were not significantly different with respect to birth type (Table 2). Decreasing HR between birth and the first 24 hours after birth is physiological, since the increased heart rate during birth results from the release of

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[4] BD Vacutainer® EDTA K2, Becton, Dickinson and Company, São Paulo, SP, Brazil.
[5] i-Stat® Portable Clinical Analyzer, Abbott Laboratories, Abbott Park, Illinois, USA.
[6] EG7+®, Abbott Laboratories, Abbott Park, Illinois, USA.
[7] i-Stat® Electronic Simulator, Abbott Laboratories, Abbott Park, Illinois, USA.
[8] SAS (Statistical Analysis System) version 9.1.3, SAS Institute Inc., Campus Drive, USA.

catecholamines due to labor stress and decreases gradually over time.

That said, the lethargy observed in the calves of dystocic birth was not accompanied by lower blood gas parameter values (Table 2) probably due to quick diagnosis of dystocia and appropriate obstetric intervention that minimized the effects of prolonged hypoxia during prolonged birth. According to Berger et al. (1992), the frequency of perinatal mortality is higher in assisted deliveries compared to non-assisted, which indicates dystocia as a major cause of morbidity and mortality during this period (LOMBARD et al., 2007).

Unlike the observations of Born (1981), Köppe (1980), Mauer-Schweizer et al. (1977), and Schuijt & Taverne (1994) for dairy calves, the present study did not display significant correlation between the blood gas parameters and the Apgar scores, modified by Born (1981), that would suggest to use the blood gas analysis as a laboratory method to evaluate the vitality of Nelore newborn calves (Table 4) .

For newborn babies, Steer (1987) concluded that measuring only the acid-base equilibrium is not enough to predict the outcome or make decisions regarding newborn treatment. The survival of babies without complications was reported even when blood samples from the umbilical artery had pH 6.6 (FYSH et al., 1982). According to Schuijt & Taverne (1994), although a significant relationship between the acid-base status and newborn calf vitality can be established, it should be kept in mind that pH values and excess base correlated moderately with the survival of the neonate.

Respiratory acidosis is described as a physiological process in newborn calves (VARGA et al., 1998; UYSTEPRUYST, 2006), due to anaerobic glycolysis in little perfused tissues, during the transition from placental supply of oxygen to the establishment of pulmonary function after the rupture of the umbilical cord (VAALA & HOUSE, 2006).

As described above, there are several methods to score the viability of newborn calves; however, the lack of a standard makes it difficult to validate them. Therefore, further studies under controlled conditions are necessary.

CONCLUSION

There is no correlation between the Apgar scores and the blood gas analysis parameters studied.

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Table 4 - Spearman correlation coefficients between the values of pH, partial pressure of carbon dioxide (pCO_2), oxygen partial pressure (pO_2), excess/deficit of bases (EB), bicarbonate (HCO_3^-), total carbon dioxide (tCO_2) and oxygen saturation (sO_2) and the Apgar scores modified by Born (1981) conducted soon after birth and 24 hours after, according to birth type.

Variable	Normal		Dystocic	
	0 hour	24 hours	0 hour	24 hours
pH	-0.144	-0.005	0.180	0.114
pCO_2 (mmHg)	0.173	0.004	-0.089	0.381
pO_2 (mmHg)	-0.209	0.002	0.653*	-0.331
EB (mmol/L)	-0.040	0.072	0.342	0.036
HCO_3^- (mmol/L)	0.110	0.114	0.408	0.096
tCO_2 (mmol/L)	0.152	0.080	0.409	0.081
sO_2 (%)	-0.172	0.053	0.665*	-0.032

* significant correlation ($p<0.05$).

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