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Seasonal and maternal effects on acid-base, L-lactate, electrolyte, and hematological status of 205 dairy calves born to eutocic dams

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ABSTRACT

In this study, we used linear mixed models to determine the effects of season, time of sampling relative to birth (factors), duration of the delivery process, duration of maternal grooming, calf body weight (BW) at birth, and time of day (covariates) on values of venous blood gas, acid-base and electrolyte parameters, and L-lactate concentrations in dairy calves born to eutocic dams in summer (SUM, n = 101) and winter (WIN, n = 104). Neonatal vitality was assessed at 0, 1, and 24 h after delivery in a linear scoring system using muscle tone, erection of the head, muscle reflexes, heart rate, and sucking drive as criteria. Simultaneously with vitality scoring, venous blood samples were collected by jugular venipuncture. Blood was tested for pH, partial pressure of CO_2 (pCO_2; mmHg) and oxygen (pO_2; mmHg), L-lactate (mmol/L), hemoglobin (Hb; g/L), ionized calcium (Ca^{2+}; mmol/L), sodium (Na^+; mmol/L), potassium (K^+; mmol/L) and chloride (Cl^-; mmol/L). Bicarbonate (HCO_3^-; mmol/L), base excess (BE; mmol/L), total carbon dioxide (TCO_2; mmol/L), and anion gap (mmol/L) were calculated. Electrolyte parameters were affected by none of the factors or covariates. Time of day at birth did not affect any of the parameters of interest. Vitality score tended to increase over time and it showed higher values in WIN calves than in SUM calves. Concentrations of HCO_3^-, BE, and L-lactate indicated a higher degree of metabolic acidosis in SUM calves; however, pH was not affected by season. Concentrations of Hb were higher in SUM calves than in WIN calves; however, covariates did not affect Hb concentrations. Blood pH, concentrations of pO_2, HCO_3^-, and BE decreased, whereas L-lactate concentrations and values of pCO_2, TCO_2, and anion gap increased with longer duration of delivery. A shift in acid-base balance was also linked to BW of the calf at birth, with lower values of blood pH, HCO_3^-, and BE in calves with higher BW compared with those with lower BW at birth, whereas TCO_2 and L-lactate concentrations increased with higher calf BW at birth. Values of pO_2 increased and pCO_2 decreased with longer duration of maternal grooming. Blood pH, HCO_3^-, and BE increased, whereas L-lactate concentrations and anion gap decreased with longer duration of licking the calf. Our results indicate that prolonged delivery can impair acid-base status and can cause slight lactic acidosis, even in calves born from spontaneous or eutocic calvings, and that high BW at birth predisposes calves to acidosis. The positive effect of maternal grooming on neonatal acid-base status should be considered in parturition management. Season, duration of the delivery process, calf BW at birth, and duration of maternal grooming are recommended for consideration in future studies on blood gas and acid-base parameters in dairy calves in the immediate neonatal period.

Key words: vitality, acid-base balance, season, duration of calving, maternal grooming

INTRODUCTION

The physiological adaptation of newborn calves to extrauterine life has great importance in terms of neonatal vitality because of the great number of rapid physiological changes during the transition from fetal to neonatal life. In large dairy units, the lack of vitality may go unnoticed, resulting in short- or long-term implications for the health and performance of young animals. About half of all perinatal losses occur during the first 2 d of life (Vermorel et al., 1983; Schuijt, 1990); therefore, extensive research has explored neonatal calf vitality and several blood parameters related to various obstetrical conditions (Szenci, 2003).

Detailed research on the acid-base status of newborn calves was started in 1977, and studies of this type have

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been initiated in an increasing number of countries (Szenci, 2003). So far, it has been demonstrated that difficult (Szenci et al., 1988; Lombard et al., 2007) and prolonged deliveries (Herfen and Bostedt, 1999) are related to the disturbance of acid-base parameters in newborn calves. Murray et al. (2015) showed that dystocia could also impair the efficiency of IgG absorption and weight gain. However, the definition of dystocia is subject to varying interpretations, which can cause difficulties in field data collection and in the comparison of different studies. The effect of forced extraction on the acid-base balance of newborn calves was presented in the early 1980s (Szenci, 1983). Recent works have shown that mild or severe obstetric assistance affects the adaptation of calves to extrauterine life, especially through compromising the acid-base balance and electrolyte homeostasis of newborn calves (Bleul and Götz, 2013; Vannucchi et al., 2015).

As alternatives for expensive and inconvenient laboratory-intensive, blood-based measurements, several vitality measures based on clinical observations have been developed (Lorenz et al., 2011). These scoring systems are commonly based on the original Apgar scores (e.g., Mülling, 1977) or on the direct observation of lying, walking, or sucking behaviors (Barrier et al., 2012). Other researchers have introduced more practical systems for field conditions (Szenci, 1982; Schuijt and Taverne, 1994). However, it is still debatable whether vitality scores accurately reflect the acid-base status and the proper vitality of the offspring (Murray and Leslie, 2013). In a recent study, Homerosky et al. (2017) showed that traditional Apgar parameters such as heart rate, respiratory rate, and mucous membrane color are not useful for the identification of calves with acidemia. Another problem with the assessment of assistance-related differences in clinical parameters is that the results may have been confounded by decisions made by the stockperson as to when assistance was necessary. The majority of long-standing studies on neonatal vitality have focused on the physiological concerns of difficult calvings; however, severe and life-threatening acidosis (Bleul et al., 2008) and hypoxia (Bleul, 2009) can occur even after spontaneous deliveries.

Therefore, the objective of the present study was to characterize the acid-base and electrolyte status of newborn calves born to eutocic dams. The respiratory and metabolic components of acidosis (short-term well-being) as well as parameters suitable for assessing potential life-threatening neonatal asphyxia by reflecting long-term changes in blood gas exchange were investigated. We attempted to identify seasonal, maternal, and calf-related variables that have not previously been considered and might have potential effects on blood parameters of primary acid-base disturbances in the first 24 h of life of bovine neonates. We presumed impaired vitality, acid-base status, and higher L-lactate concentrations in calves born in summer than those born in winter.

MATERIALS AND METHODS

Experimental Design

The experiment was carried out on a large-scale dairy farm in Hungary with around 900 lactating Holstein-Friesian cows. Two hundred and five neonatal calves born in summer [**SUM**, n = 101; between June 15 and August 20, 2013; average temperature (range) = 24.6°C (14.7–38.7°C)] and winter [**WIN**, n = 104; between November 25, 2013, and February 15, 2014; average temperature (range) = 4.3°C (1.7–11.2°C)] from eutocic calvings were included in the study.

Eutocic calving was considered as a combination of "no assistance" and "slight assistance" (where assistance or traction was brief and slight, and the cow may otherwise have calved unassisted) by one person (Mee et al., 2011). The BCS of the dam was scored using the 5-point scoring system (Hady et al., 1994) immediately after calving. Assistance rates and other characteristics of calvings are presented in Table 1. Calves born from prolonged spontaneous calvings (>2 h from appearance of hooves to delivery) and calvings needing assistance by 2 or more people with considerable force (using obstetrical ropes) or using a calf jack during delivery were considered dystocic and were excluded from the investigation.

Table 1. Characteristics of calvings involved in this study (means ± SD)

Season of calving	BCS of dam[1]	Age of dam at calving (yr)	Calf BW at birth (kg)	Sex of the calf		Duration of delivery[2] (min)	Assistance rate[3] (%)
				Male (no.)	Female (no.)		
Summer (n = 101)	3.0 ± 0.1	4.7 ± 0.5	35.5 ± 0.9	48	53	178.4 ± 24.5	13.5
Winter (n = 104)	3.1 ± 0.1	4.6 ± 0.4	36.2 ± 1.0	47	57	169.7 ± 26.8	12.3

[1]BCS of the dam was scored using the 5-point USA scoring system (Hady et al., 1994) following calving.

[2]Between the onset of calving restlessness and delivery.

[3]Calves born with slight assistance were involved in the study and considered as eutocic [where assistance (traction) was brief and slight and the cow may otherwise have calved unassisted].

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