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Calving Difficulty and Calf Response to Stress

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Calving difficulty of the heifer can significantly depress some of her calf's physiological resources used to adjust to the stress of their new environment.

Summary

Calving difficulty altered the stress-related capabilities of the calf, placing the newborn in a compromised situation. Calves derived by severe mechanical pull or cesarean section exhibited depressed short-term defensive capabilities, lower cortisol and elevated neutrophil values, necessary for fighting infectious organisms. Of equal concern: when compared to calves born with little or no parturition difficulty, the stressed calves failed to develop effective adaptive mechanisms, having lower thyroid activity and lymphocyte values of principle importance for long-term survival. Neither the heifer's mothering ability nor her disposition tended to influence her calf's stress indicators.

Introduction

Parturition can be stressful for both the first calf heifer and her calf. Several physiological changes occur responding to the stress of parturition in an effort to maintain normal body function. For example, fetal cortisol is thought to be one of the primary changes in the calf's blood that initiate parturition in cattle. With respect to thermoregulation, T_3 has pronounced effects on brown adipose tissue utilization and subsequently the thermogenesis of the newborn.

Calf mortality represents a economic loss to the beef industry. Studies suggest the number of calves lost from calving difficulty (50.9%) exceeded losses from all other causes. Calf death due to calving difficulty also accounted for the single largest loss category through the first 96 hours of life. Therefore, calving difficulty, and the endocrine response to stress represents a major part of all economic loss in the cow herd. This study was designed to evaluate the relationship between the severity of calving difficulty and the hormone concentration and blood composition of the heifer and her calf.

Procedure

A total of 104 first-calf heifers were used in the experiment, over a two-year period. The heifers were from four university herds. The first two groups included; 36 MARC-MARC III and 10 purebred Angus first-calf heifers from the Agriculture Research and Development Center (ARD) near Mead, Nebraska. For these, the calving season began February 17 and ended March 12, 1995. During the second-year calving season, February 24 to April 4, 1996, 18 MARC II first-calf heifers from the West Central Research and Extension Center at North Platte, and 40 3/4 Angus X 1/4 Gelbvieh heifers from the ARD Center near Mead, Nebraska were sampled.

Pregnant heifers, kept in a calving pasture with free access to water and alfalfa hay, were checked at one hour intervals for oncoming signs of parturition. After exhibiting stage II labor for one hour (i.e. rupture of the fetal sac, fluid escape from the vulva and abdominal strain) the heifer was brought into the calving barn. An experienced herdsman assisted each heifer at parturition and assessed the level of calving difficulty (Table 1).

(Continued on next page)

Table 1. ARD calving score assigned to each parturition.

Calving Score	Assignment Criteria
1.	Unassisted delivery.
2.	Little difficulty. Assistance given by hand, but no calfjack or puller used. Assistance may not have been required.
3.	Moderate difficulty. Calfjack was used, typically pull duration was less than 10 minutes.
4.	Major difficulty. Calfjack used and major difficulty encountered. Duration of pull longer than 10 minutes.
5.	A cesarean section was preformed.

Immediately following birth, blood samples were obtained from the heifer and calf via jugular venipuncture. Calves were then bled in the same manner at 24, 48 and 72 hours of age. Dates, calving time and blood sampling were recorded. The dam's disposition and mothering ability were also assessed and the climatic conditions at the time of birth recorded. After ensuring proper postpartum care, heifer-calf pairs were placed in individual stalls for 24 hours, with fresh straw, feed and water. Upon completion of the 24 hour sampling of the calf, the pair was released into a post-calving pasture. The last two samples from the calves were taken in the pasture.

Blood samples were prepared and analyzed for; pack cell volume (PCV), differential white blood cell count (WBC), plasma cortisol and plasma triiodotyrosine (T_3). Statistical differences were determined by SAS analysis. All values are reported as means.

Results

Significant differences were not detected (P>.05) for breed of cattle or year of sampling. Thus, all heifer-calf pairs were grouped together for the statistical analysis.

Plasma cortisol concentrations, within birthing heifers, were significantly greater (P<.03) for those animals requiring severe mechanical pull or cesarean section, relative to heifers needing no assistance in the delivery of their calf (Figure 1). Statistical differences were also noted for heifers requiring modest mechanical assistance (less than 10 minutes) and those undergoing C-section (P<.05). It is important to note C-sections were preformed after failure to deliver the calf with mechanical assistance. Clearly those heifers requiring extensive mechanical assistance and/or surgical intervention were undergoing an acute stress, as is evident from the elevated cortisol values. Cortisol concentrations were not statistically different for heifers delivering bull versus heifer calves (Figure 1).

Cortisol, the stress indicator so identifiable in the heifer and clearly associated with the degree of calving difficulty,

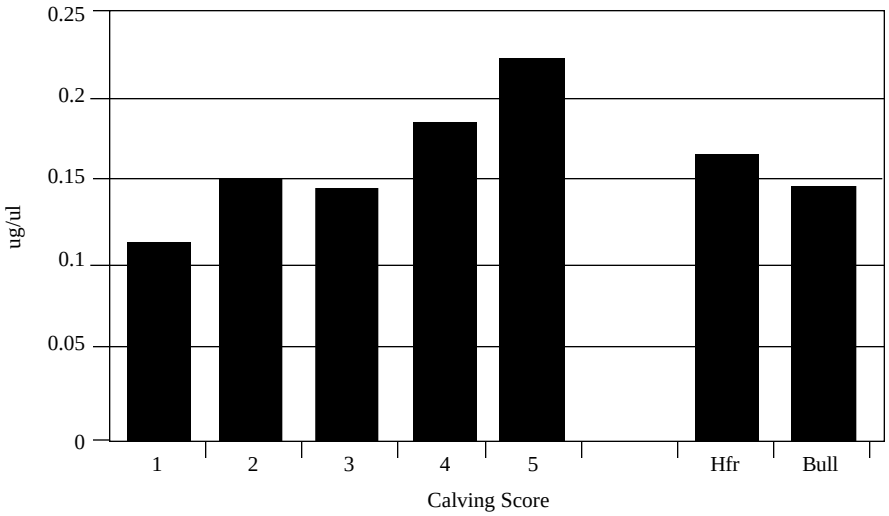

Figure 1. Concentration of cortisol in heifers at parturition as effected by the degree of calving difficulty and by calf sex. (P<.03; 1 vs. 4 & 5. P<.05; 2,3 vs. 5).

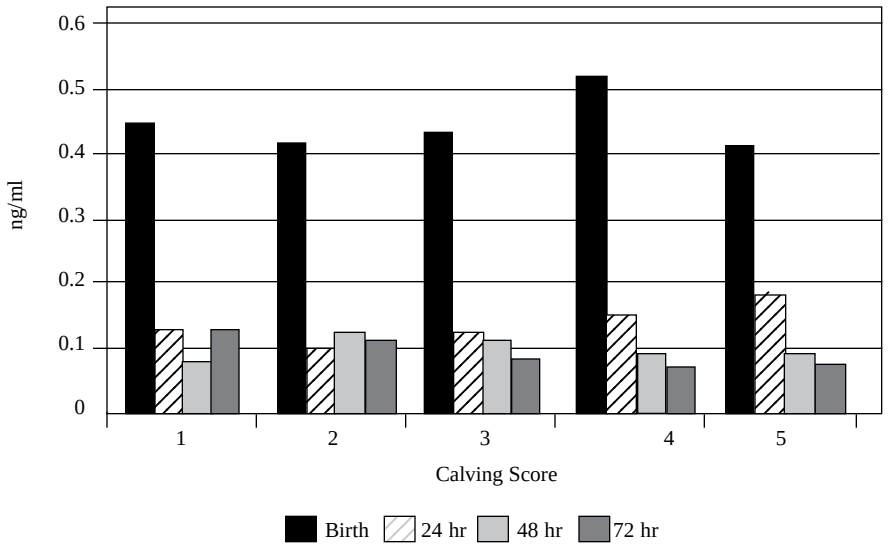

Figure 2. Concentration of cortisol in calves at birth and at 24, 48 and 72 hours of age as effected by the degree of calving difficulty. (Birth; P<.08; 1,2,3 vs. 4. 72 hrs; P<.07; 1 vs. 4,5).

was also in high concentrations within the calf population at the time of parturition (Figure 2). Cortisol values for the calf at parturition were higher (P<.08) in those calves delivered using more adverse procedures (i.e. severe mechanical pull versus hand or modest mechanical pull). It is important to note that high levels of cortisol are a favorable endocrine response for the newborn calf, considering the multiple rolls cortisol plays in the early survival of that calf. While cortisol's stress defense mechanisms are short-lived, and fall off rapidly within the first 24 hours of life (Figure 2), it does appear to maintain a slightly elevated concentration in those calves from difficult births. Calves requiring little or no assistance at birth maintained a reasonably constant plasma cortisol concentration during the three days following parturition. Calves requiring mechanical or surgical intervention, however, experienced a continual decline in cortisol values such that they were considerably less than unassisted calves at 72 hours postpartum (P<.07). The lower cortisol val-

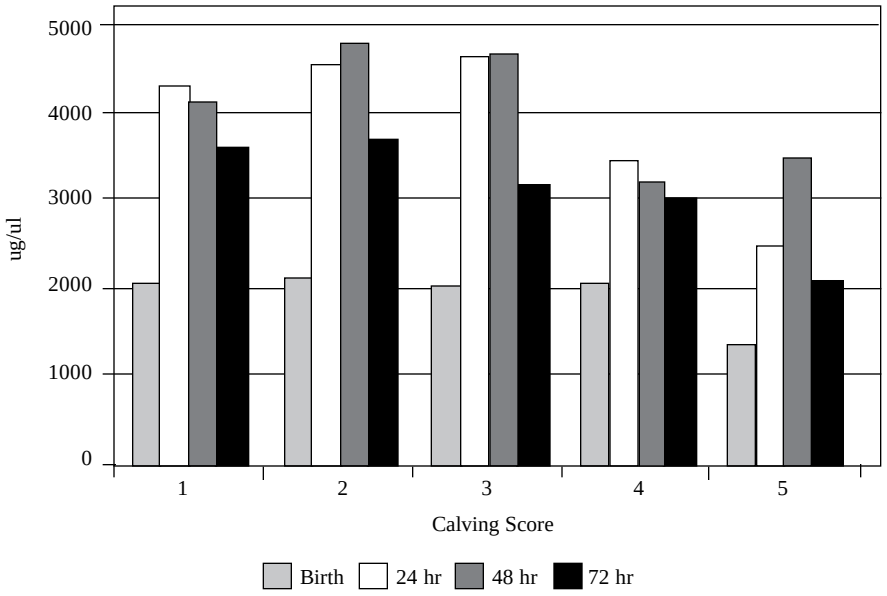

Figure 3. Concentration on T_3 in calves at birth and at 24, 48 and 72 hours of age as effected by the degree of calving difficulty. (Birth; P<.05, 1,2,3,4 vs. 5. 24 hrs; P<.02, 1,2,3 vs. 4,5. 48 hrs; P<.06, 1,2,3 vs. 4. 72 hrs; P<.08, 1,2 vs. 5).

Table 2. Neutrophil:lymphocyte ratio for calves at the time of birth, and at 24, 48 and 72 hours postpartum.

Hours Postpartum	Calving Score 1	2	3	4	5
Birth[a]	2.39	1.26	1.77	2.34	1.59
24 hrs	1.98	1.49	2.20	1.81	1.04
48 hrs	0.99	1.10	0.91	1.07	0.44
72 hrs[b]	1.48	0.79	1.38	1.82	2.08

[a]P<.05, 1 vs. 2.
[b]P<.08 1,2,3 vs. 4 and 5

ues are of concern, if, in fact, those first three to four days of life are the critical time in a calf's survival.

The calf's long-term survival skills might better be viewed via the study of plasma triiodotyrosine (T_3) during neonatal life. T_3 sets the metabolic state of the animal, responding to both external and internal stress factors (e.g. climatic changes, body size, brown fat thermogenesis and muscular, circulatory and respiratory activities of the body). There were no differences in T_3 among calving scores at the time of parturition (Figure 3), and presumably no difference in the metabolic state of calves derived with or without mechanical intervention. The exception to this was the cesarian born calves (P<.05). Physiologically, within the first 24 hours T_3 values should be increasing. However, calves born via severe mechanical pull or C-section exhibited a marked reduction in circulating thyroid hormone (P<.02), relative to unassisted delivery or modest assistance. The depressed T_3 is concerning when considering the January/February calving dates, the harsh environmental temperatures during this period and the critical need for body heat and muscular activity of the newborn calf.

Furthermore, knowledge of T_3 activity indicates the thyroid gland takes several days to respond to environmental stress. And T_3, unlike cortisol, is a long-term stress "adaptation mechanism", rather than an immediate defense response. Because of this, it is expected that on the third or fourth day of life, T_3 levels should be high. Once again, as with the cortisol values, calves delivered via severe mechanical pull or C-section exhibited a depressed endocrine response in association with the stress of parturition (Figure 3).

Like cortisol and T_3, the neutrophil:lymphocyte ratio (N:L) derived from the WBC count has been used extensively as an indicator of stress and morbidity. Neutrophils (phagocytic cells) increase in numbers during an acute stress, are short-lived and are considered stress defense cells. Conversely, lymphocytes (immune response cells) respond more slowly, exist in circulation longer, and are considered stress adaptation cells. While statistical differences were generally not noted during the early periods (Table 2), at 72 hours postpartum the N:L ratio was significantly higher (P<.08) for those calves derived via severe mechanical pull or C-section, relative to the unassisted or modest assistance calves. As with cortisol and T_3, the high N:L ratio clearly suggests calves of difficult birth are exhibiting a stress defense response (high neutrophils) and have yet to adapt to their new environment (low lymphocyte).

The significance of this research indicates the degree of calving difficulty has a pronounced effect upon that calf's ability to adapt to its new environment. Those calves requiring extensive mechanical assistance and/or surgical intervention express depressed cortisol and neutrophil values necessary for the immediate adjustment to their new environment. Their survival skills are further compromised via depressed metabolic adaptation capabilities (i.e. reduced T_3 and low lymphocyte concentrations) essential for that calf's first few days of life.

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