EFFECTS OF SEVERITY OF DYSTOCIA ON COLD TOLERANCE AND SERUM CONCENTRATIONS OF GLUCOSE AND CORTISOL IN NEONATAL BEEF CALVES

R.A. Bellows* and M.A. Lammoglia

*Fort Keogh Livestock and Range Research Laboratory, ARS, USDA, Miles City, MT

**BovaGen, San Antonio, TX

Received for publication: May 26, 1999
Accepted: August 24, 1999

ABSTRACT

Effects of dystocia on rectal temperature and serum cortisol and glucose concentrations, were studied in neonatal calves exposed to 0°C. Primiparous dams were observed continuously during parturition and if Stage II (labor) was not completed within 2 h after appearance of the allantochorion, delivery was completed with obstetrical assistance. Parturitions were scored (CDS) for difficulty and obstetric assistance required: CDS 1, no assistance (n=8); CDS 2, minor manual assistance (n=7); CDS 3, use of a mechanical calf puller (n=5); CDS 4, cesarean section (n=6). A blood sample, rectal temperature, and body weight were obtained within 30 min after birth. Calves were then fed 38°C pooled colostrum, muzzled to prevent suckling, and placed back with their dam in a heated (22°C) barn. At 4 h of age an indwelling jugular catheter was inserted. At 5 h of age calves were placed in a 0°C room for 140 min and blood samples and rectal temperatures were obtained every 10 or 20 min. A shivering score (1 = no shivering; 2 = moderate shivering; 3 = intense shivering) was assigned at each sampling time. Rectal temperatures were higher (P<0.01) in CDS 1, 2 and 4 calves (39.0, 39.3, and 39.0 ± 0.02°C, respectively) than in calves with CDS 3 (38.3 ± 0.02°C) and were affected by duration of cold exposure (time; P<0.01). Shivering was not affected by CDS but was affected by time (P<0.01). Glucose concentrations were higher (P<0.01) in CDS 3 calves (110.1 ± 1.6 mg/dL) than in CDS 1, 2, or 4 calves (77.2, 86.4, and 89.0 ± 1.3 mg/dL, respectively) and changed over time (P<0.01). Cortisol concentrations were higher in CDS 1 calves (80.0 ± 1.7 ng/mL) than in CDS 2, 3 or 4 calves (62.7, 58.2, and 57.7 ± 2.0 ng/mL, respectively) and were affected by time (P<0.01). We conclude that severe dystocia (CDS 3) resulted in lower calf rectal temperature, reduced serum cortisol, and increased serum glucose which could affect the ability of the calf to withstand cold stress. Minor dystocia did not cause and timely cesarean delivery prevented, the physiological aberrations encountered in severe dystocia.

Published by Elsevier Science Inc.

Key words: calves, dystocia, cold response, cesarean delivery

Acknowledgments: Appreciation is expressed to D.R. Armstrong, N.R. Bellows, S.E. Bellows, D.A. Phelps, J.L. Wilkerson, C.R. Harris, and M.E. Woods for technical assistance and to M.E. French for all editing and processing of the manuscript. This research was conducted under a cooperative agreement between USDA-ARS and the Montana Agric. Exp. Sta. Mention of a proprietary product does not constitute a guarantee or warranty of the product by USDA, Montana Agric. Exp. Sta., or the authors and does not imply its approval to the exclusion of other products that may also be suitable. USDA, Agricultural Research Service, Northern Plains Area, is an equal opportunity/affirmative action employer and all agency services are available without discrimination.

*Correspondence and reprint requests: Livestock and Range Research Laboratory, Miles City, MT 59301.
INTRODUCTION

Patterson et al. (27) reported 64% of the calf mortality occurring during the first 96 h after birth resulted from dystocia. Climatic conditions affect neonatal survival (4, 10) and calf mortality increased at low environmental temperatures. The Cow/Calf Health and Productivity Audit (33) summarized calf deaths in 23 states and reported 20.2% of the deaths in calves under 500 pounds were associated with adverse weather. Dystocia affects survival in newborn calves by inducing trauma, hypoxia and acidosis as well as reduced blood supply to organs, skeletal muscle and brown adipose tissue (1, 8, 14, 34). Hypoxia reduces summit metabolism and nonshivering thermogenesis by affecting the central and sympathetic nervous systems (12, 13, 20). But little information is available regarding how the severity of dystocia might interact with cold environmental temperature and affect the potential survival of a calf. The objective of this research was to evaluate effects of the severity of dystocia on rectal temperatures and serum glucose and cortisol in newborn calves exposed to 0°C and to determine what effect cesarean delivery had on these endpoints.

MATERIALS AND METHODS

The study involved 26, F₂-crossbred calves of Hereford (n=13); Limousin (n=2); or Piedmontese (n=11) breeding. Calves were sired by F₁-crossbred bulls that were of either 50% Hereford, 50% Limousin, or 50% Piedmontese breeding that were bred to similar-breed, F₁-crossbred dams. Calves studied were born in normal presentation, position and posture (28) and were selected on the basis of severity of dystocia at parturition. Dams were maintained on a gestation diet of corn silage, ground hay and soybean meal (22) that met or exceeded NRC nutrient requirements. Dams gained 0.5 kg daily for the last 60 d of gestation. Starting at approximately Day 273, dams were observed every 2 h for signs of impending parturition, and once Stage II (labor; 28) started were observed continuously. If Stage II was not completed within 2 h after appearance of the allantochorion, delivery was completed with obstetrical assistance by trained, experienced personnel. Parturitions were scored from 1 to 4, with 1 = no assistance (n=8); 2 = minor dystocia requiring manual (hand traction) assistance (n=7); 3 = severe dystocia requiring use of a mechanical calf puller (n=5); and 4 = major dystocia requiring cesarean section (n=6). Calving difficulty scores (CDS) were assigned by the trained personnel present at parturition. The decision for cesarean delivery was made after careful evaluation of the relative size of the fetus and of the birth canal, and in no case was the fetus forced into the birth canal before cesarean delivery. The average time from appearance of the allantochorion to completion of the cesarean delivery was 5.0 ± 0.5 h. Cesarean deliveries were completed by practicing licensed veterinarians using an oblique, left-flank incision. Study design and the number of calves per group are shown in Table 1.

Within 30 min after calving and before nursing, calves were removed from their dams, weighed, their rectal temperatures determined with a digital thermometerb and a jugular blood sample obtained from each calf. Calves were then fed 38°C pooled colostrum obtained from a local dairy (30 mL/kg BW) via esophageal tube, and placed back with their dams in a heated barn (22°C) for 3.5 h to facilitate maternal bonding. To prevent confounding of the results by differences in colostrum intake and composition, nursing was prevented during this time by placing muzzles on the calves. At 4 h of age (birth = 0 h), an indwelling catheter (Teflon; .11 cm i.d.) was inserted into the jugular vein using local

bBecton-Dickenson and Company, Franklin Lakes, NJ.
anesthesia and aseptic procedures. A 1-m extension was connected to the catheter to allow blood collection without disturbing the calves. After cannulation, a blood sample was obtained from each calf and rectal temperature measured (sample: -60 min). Calves were then maintained separated from their dams in the 22°C environment for 1 h.

Table 1. Design of study and numbers per subgroup

<table>
<thead>
<tr>
<th>Calving difficulty scores (CDS) a</th>
<th>Calf sex b</th>
<th>Male</th>
<th>Female</th>
<th>Total number of calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

a CDS 1, no assistance given; CDS 2, minor manual assistance; CDS 3, delivery required use of a mechanical calf puller; CDS 4, major difficulty and delivery required cesarean section.
b Data pooled over sire breed and calf sex for final analyses (see statistical analyses discussion).

At 5 h of age, the calves were placed in a 0°C room (22) for 140 min. Rectal temperature measurements and blood samples were taken at 0, 10, 20, 30, 40, 50, 60, 80, 100, 120 and 140 min, and blood volume (10 mL/sample) was replaced with 38°C sterile physiological saline (0.9% NaCl). After collection, blood was placed into 16 x 125-mm test tubes and maintained at 2°C. Blood was processed within 12 h following collection to yield serum and then stored at -20°C until concentrations of cortisol and glucose were determined. Concentrations of serum cortisol were determined using enzymatic reaction kits c (kit 031), and the intra-and interassay CVs were 4.4 and 10.8%, respectively. Spectrophotometric techniques were used to determine serum concentrations of glucose (kit 1520 d). Before each blood sample and rectal temperature measurement, calves were assigned shivering scores as follows: 1) no shivering; 2) moderate shivering of muscles in the back and legs; and 3) intense shivering of muscles in back, legs and face of the calf.

Data were analyzed by statistics for repeated measures (15) as a split plot in time with CDS in the whole plot. Whole plot error was the pooled variation among calves treated alike. The CDS 1 calves were born in dry lot and exposed to varying environmental temperatures, while CDS 2, 3 and 4 calves were delivered in an obstetrical area maintained at 22°C. Therefore, environmental temperature at birth was used as a covariate in the analyses. The data obtained at 30 min of age (with the exception of birth weights) through 140 min of cold exposure were analyzed with and without using birth weight as a covariate. Analyses results were essentially identical so means summarized in the following tables and figures are results without the covariate. Duration of time in the cold room (time) and interactions with time were in the subplot and tested with the residual mean square as the error term. Birth weights were analyzed with standard GLM procedures (29). When data were assembled for analyses, a total of 10 cells

c Pantex, Santa Monica, CA.
d DMA, Inc., Arlington, TX.
contained 0 animals when the study summary included sire breed and calf sex. Examination of data means for sire and calf sex indicated no obvious or consistent effects of these 2 variables, and sire breeds were essentially distributed randomly throughout the CDS categories. Data were then pooled over sire and calf sex for final analyses. Correlations were calculated among all variables measured and were near 0 and nonsignificant. Values are not presented or discussed further.

RESULTS

Data obtained from calves at 30 min of age and from -60 through 140 min of cold exposure are summarized in Tables 2 and 3, respectively. Additional summaries of changes in calf data over time in the cold room are summarized in Figures 1 through 4.

Birth Weight

Birth weight differences among CDS were highly significant (P<0.001; Table 2). When birth weight was used as a covariate, differences in rectal temperature and glucose became nonsignificant. This result and the positive, essentially straight-line, positive relationship between birth weight and CDS agrees with numerous other studies (5, 11) and emphasize the importance of fetal oversize resulting in fetal-maternal disproportion (9) as a major contributor to dystocia.

Table 2. Effects of dystocia on calf data at 30 minutes of age

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dystocia score</th>
<th>Pooled</th>
<th>Prob-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Number calves</td>
<td>8</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Birth weight (kg)</td>
<td>30.5</td>
<td>35.9</td>
<td>38.0</td>
</tr>
<tr>
<td>Rectal temperature (°C)</td>
<td>39.6</td>
<td>38.8</td>
<td>38.8</td>
</tr>
<tr>
<td>Shivering score</td>
<td>1.04</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>53.6</td>
<td>166.1</td>
<td>174.5</td>
</tr>
<tr>
<td>Cortisol (ng/mL)</td>
<td>58.5</td>
<td>76.1</td>
<td>90.2</td>
</tr>
</tbody>
</table>

Rectal Temperature

Rectal temperatures of calves at 30 min of age were not affected by CDS (Table 2). However, temperatures from 60 min before through 140 min of cold exposure were affected by both CDS (P<0.01) and time in the cold room (P<0.001; Table 3). At time -60 (Figure 1), rectal temperatures of calves with CDS 2 and 4 were the highest, followed by CDS 1, with the lowest temperatures for calves with CDS 3. Temperatures at time -60 were obtained during the time calves were in the controlled 22°C environment, suggesting the CDS 3 calves had difficulty maintaining body temperature even in a relatively warm environment. The rectal temperature change over time resulted in peak average values after 30 min of cold exposure with temperatures at 140 min returning to approximately the same average value found at the beginning of cold exposure (Table 3).

The CDS-by-time interaction was not significant, but a plot of that interaction is shown in Figure 1. This method of data presentation was chosen for the sake of clarity. Plots for CDS 1, 2 and 4 show little difference in absolute or temperature change values, but temperatures for CDS 3 calves were lower
throughout the -60 through 140 min cold exposure. In addition, the temperature increase response to cold exposure was lower in CDS 3 than in CDS 1, 2 or 4 calves. The temperature of CDS 3 calves showed a potentially ominous drop the last 20 min of cold exposure. We conclude from these results that CDS 3 calves had abnormal thermogenic activity, resulting in reduced ability to respond to cold exposure and difficulty in maintaining body temperature.

Table 3. Least-squares means for variables studied from -60 to 140 minutes

<table>
<thead>
<tr>
<th>Item</th>
<th>Rectal temperature (°C)</th>
<th>Shivering score</th>
<th>Serum concentrations (mg/dL)</th>
<th>Cortisol (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dystocia score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>39.0</td>
<td>2.4</td>
<td>77.2</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>39.3</td>
<td>2.1</td>
<td>86.4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>38.3</td>
<td>2.2</td>
<td>110.1</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>39.0</td>
<td>2.1</td>
<td>89.0</td>
</tr>
<tr>
<td>Pooled S.E.</td>
<td></td>
<td>0.02</td>
<td>0.04</td>
<td>1.87</td>
</tr>
<tr>
<td>Probability</td>
<td>P&lt;0.01</td>
<td>NS</td>
<td>NS</td>
<td>P&lt;0.05</td>
</tr>
</tbody>
</table>

Time (minutes)

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Rectal temperature (°C)</th>
<th>Shivering score</th>
<th>Serum concentrations (mg/dL)</th>
<th>Cortisol (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-60</td>
<td>26</td>
<td>38.8</td>
<td>1.0</td>
<td>102.0</td>
</tr>
<tr>
<td>0</td>
<td>26</td>
<td>38.8</td>
<td>1.1</td>
<td>89.7</td>
</tr>
<tr>
<td>10</td>
<td>26</td>
<td>38.9</td>
<td>2.3</td>
<td>88.2</td>
</tr>
<tr>
<td>20</td>
<td>26</td>
<td>39.0</td>
<td>2.3</td>
<td>91.4</td>
</tr>
<tr>
<td>30</td>
<td>26</td>
<td>39.1</td>
<td>2.4</td>
<td>90.2</td>
</tr>
<tr>
<td>40</td>
<td>26</td>
<td>39.0</td>
<td>2.5</td>
<td>91.7</td>
</tr>
<tr>
<td>50</td>
<td>26</td>
<td>39.0</td>
<td>2.5</td>
<td>91.2</td>
</tr>
<tr>
<td>60</td>
<td>26</td>
<td>39.0</td>
<td>2.4</td>
<td>88.6</td>
</tr>
<tr>
<td>80</td>
<td>26</td>
<td>38.9</td>
<td>2.4</td>
<td>89.3</td>
</tr>
<tr>
<td>100</td>
<td>26</td>
<td>38.8</td>
<td>2.4</td>
<td>86.2</td>
</tr>
<tr>
<td>120</td>
<td>26</td>
<td>38.8</td>
<td>2.5</td>
<td>90.5</td>
</tr>
<tr>
<td>140</td>
<td>26</td>
<td>38.6</td>
<td>2.5</td>
<td>89.2</td>
</tr>
</tbody>
</table>

Pooled S.E.     | 0.04                    | 0.07           | 2.40                        | 3.34             |

Probability     | P<0.001                 | P<0.001        | P<0.01                      | P<0.001          |

*aDuration of time in the cold room starting at 0 through 140 min.

Shivering Scores

Differences in average shivering scores are summarized in Tables 2 and 3 and by CDS in Figure 2. Scores were not affected by CDS but changed over time in the cold room (P<0.001). Little or no shivering was noted at 30 min after birth or at 60 min before cold exposure. Scores changed rapidly upon exposure to 0°C, reaching the peak value at 40 min and remaining high until 140 min. Figure 2 shows the similarity of these changes during the entire -60 through 140-min period of cold exposure for calves in all 4 CDS.
Figure 1. Least-squares mean (pooled SEM = 0.08) plot of rectal temperatures of calves differing in dystocia scores (CDS) exposed to 0°C for 140 minutes. CDS, P<0.01; time, P<0.001; CDS x time, P>0.10.

Figure 2. Least-squares mean (pooled SEM = 0.15) plot of shivering scores of calves differing in dystocia scores (CDS) exposed to 0°C for 140 minutes. CDS, P>0.10; time, P<0.001; CDS x time, P>0.10.

Serum Glucose Concentrations

Average glucose concentrations at 30 min of age (Table 2) were affected by CDS (P<0.05) with serum glucose concentrations being lowest in CDS 1 calves, highest in calves with CDS of 2 and 3, with CDS 4 calves in the intermediate range. Average concentrations of glucose from 60 min before and during the 140 min cold exposure were not affected by CDS (P>0.10) but were affected by time in the cold room (P<0.01; Table 3). Glucose concentrations were highest at -60 min, dropped to 89.7 at Time 0, increased to 91.7 at 40 min and were relatively stable throughout the remaining time of cold exposure (Table 3). The dystocia-by-time
interaction was not significant, but the plot of this interaction is shown in Figure 3. This plot shows little difference in absolute or change in concentration values for CDS 1, 2 or 4 calves. The CDS 3 calves maintained average glucose concentrations at a relatively higher level than CDS 1, 2 and 4 calves throughout the study period.

![Graph showing glucose concentration over time for CDS 1, 2, 3, and 4 calves.]

Figure 3. Least-squares mean (pooled SEM = 4.5) plot of glucose concentrations (mg/dL) of calves differing in dystocia scores (CDS) exposed to 0°C for 140 minutes. CDS, P > 0.10; time, P < 0.01; CDS x time, P > 0.10.

Serum Cortisol Concentrations

Average serum cortisol concentrations at 30 min of age were not affected by CDS (Table 2). However, cortisol concentrations from -60 through the 140-min cold exposure period were affected by CDS (P < 0.05) and time in the cold room (P < 0.01; Table 3). Cortisol concentrations were highest in CDS 1 calves, with little difference among CDS 2, 3 or 4 calves. Average cortisol concentrations increased rapidly upon cold exposure, reaching maximum levels at the 20-min sampling. Concentrations were variable, but tended to decrease during the remainder of the cold exposure period (Table 3). The CDS-by-time interaction was not significant but was plotted and results are shown in Figure 4. It can be seen that CDS 1 calves had a greater increase in cortisol concentration upon cold exposure and maintained greater concentrations than CDS 2, 3 or 4 calves throughout the cold exposure period.

DISCUSSION

Increased body temperature is a normal thermogenic response to cold exposure and is critical for survival of the neonate in adapting to the transition from life in utero to an often hostile environment at birth. This response involves thermoreceptors present in the skin, spinal cord and hypothalamus that perceive cold sensation resulting in thermogenic stimulation (19). In contrast to findings in the present study, Vermorel et al. (34) reported rectal temperatures at birth were higher in calves experiencing dystocia than in calves born without dystocia. Massip (24) and Hoyer et al. (18) concluded that extended periods of labor contractions and trauma during difficult parturition increased levels of hypoxia and acidemia, and decreased thermogenesis and subsequent survival of the neonatal...
calf. Vermorel et al. (34) reported lower rectal temperatures at 1.5 to 10 h of age in calves that experienced dystocia than in eutocial calves. Thus, the difference between the cited study and our present work may be due to the amount of time elapsing before the occurrence of dystocia was recognized.

![Graph](image)

Figure 4. Least-squares mean (pooled SEM = 6.3) plot of cortisol concentrations (ng/mL) of calves differing in dystocia scores (CDS) exposed to 0°C for 140 minutes. CDS, P<0.05; time, P<0.001; CDS x time, P>0.10.

Results of the present study indicate thermogenic response and temperature maintenance of calves with CDS 1, 2 and 4 were similar and more favorable than noted in CDS 3 calves. Severe hypoxia has been shown to decrease nonshivering thermogenesis, stimulate the central and sympathetic nervous systems, and stimulate release of catecholamines (13, 17, 20, 23). The release of catecholamines (norepinephrine) in neonatal ruminants increased blood flow (2) and increased heat production derived from brown adipose tissue (3, 32). We speculate from the results reported in these references that increased release of catecholamines during prolonged and difficult parturition, as occurred in CDS 3 calves, could possibly overstimulate heat production from brown adipose tissue and depress or even exhaust the nonshivering thermogenic system, resulting in heat loss and hypothermia over the 7-h period in our study. We also recognize that trauma associated with severe dystocia, including depression of physical activity, could be responsible for a major portion of these responses.

The shivering scores were similar among all calves, regardless of CDS. We interpret this similarity to indicate shivering response to cold exposure, as measured by our scoring system, was at or near maximum for all calves. Although not significant, the increase in shivering score was greatest for CDS 1 calves, with CDS 4 calves reaching their maximum score at 50 min.

Serum glucose concentrations were highest in CDS 3 calves suggesting they were mobilizing more glucose in attempts to produce a thermogenic response. However, since rectal temperatures of these calves were lower and did not increase upon cold exposure as did temperatures of CDS 1, 2 or 4 calves, the thermogenic mechanisms of CDS 3 calves may have been less active or of lower efficiency, resulting in reduced glucose utilization and the apparent increase in glucose was a result of an accumulation of glucose in the blood stream. Other possibilities are that this may be a reflection of mobilization of liver glycogen.
induced by adrenaline and cortisol or a result of hypoxia-induced glycolysis (21, 24). In addition, newborn calves suffering hypothermia due to excessive heat loss during exposure to cold had increased concentrations of glucose and nonesterified free fatty acids, possibly a reflection of a final attempt to increase body temperature (16, 26). Again, we recognize that the trauma associated with CDS 3 may be responsible for at least a portion of the observed response. The answers to these possibilities await further research.

The highest concentrations of serum cortisol in CDS 1 calves and the similar (lower) cortisol concentrations among CDS 2, 3 and 4 calves correspond to results reported by Stott and Reinhard (31). They attributed the high cortisol levels to ambient temperature stress, which was lower for their eutocial calves. This may have also played a role in the present study, since CDS 1 calves were born outside in dry lots while CDS 2, 3 and 4 calves were delivered in an obstetrical barn. This barn was maintained at 22°C compared with an average environmental temperature of 5°C (± 4°C) during delivery of CDS 1 calves. However, we attempted to account for this difference by using environmental temperature as a covariate in the statistical analyses. We also suggest that CDS 1 calves experienced less stress during birth than did the CDS 2, 3 and 4 calves. The higher cortisol concentrations in the CDS 1 group may represent a near maximum response to cold stress (a new challenge) that resulted in higher concentrations of serum cortisol whereas the response in the CDS 2, 3 and 4 calves represented a somewhat residual response due to the maximal response being elicited by dystocia. But cold stress elicited an increase in cortisol concentrations in all calves which is in agreement with work reported by Bell and Thompson (7) and Bassett and Alexander (6). These workers suggested that the increased cortisol may have resulted in increased availability of substrates from lipid, glycogen and brown adipose tissue stores to the shivering muscle for thermogenesis. However, Scarpace et al. (30) suggested if this scenario did occur it could negatively influence nonshivering thermogenesis.

Results of this study show that severe dystocia as represented by CDS 3 caused such significant changes in the metabolism and thermogenic physiology of the affected calves, that they could negatively affect the transition from intra- to extra uterine environment and depress survival. These findings extend the results of Vemorel et al. (34) and Odde (25), who reported that dystocia affected metabolic processes in the calf. A significant finding of our present study is that the problems of severe dystocia either did not occur in minor dystocia or were negated or prevented by a timely cesarean delivery. This was in spite of the CDS 4 calves averaging 6.4 kg heavier weight than the CDS 3 calves. As pointed out in Materials and Methods, no calves were forced into the birth canal before a decision was made to complete delivery by cesarean section. This decision was based on careful evaluation of the size of the calf (palpation of hoof, metacarpus, and/or head size) and hand-delivered traction to determine if it was possible to bring the calf into and through the birth canal. Results of this study emphasize that timely, correct cesarean delivery can prevent problems created by severe dystocia and can be a wise option. Individuals on the calving/obstetrical crew need to be well trained in determining when the option of cesarean delivery is justified. In addition, the potential survival of calves delivered under conditions of severe dystocia (CDS 3) is likely to be compromised, and these calves will need extra care following delivery if survival is to be assured.
REFERENCES


