ANIMAL BEHAVIOR AND WELL-BEING IV

0052 Sprinkler flow rate affects dairy cattle physiological and behavioral responses.
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The accumulation of heat load can be problematic for dairy cow welfare and productivity. Sprinklers effectively reduce heat load, but little is known about the optimal amount of water needed for cooling or about cattle behavioral responses to this resource. Two studies assessed how flow rate affected: 1) the effectiveness of sprinklers and 2) cattle preferences. In Exp. 1, 19 lactating cows were restrained at the feedbunk for 1 h/d and received 1 of 4 treatments in a crossover design: Control (0 L/min; 3X total) or sprinkler (0.4, 1.3, and ≥ 4.5 L/min, 6X each). Spray was delivered in 4 cycles (3 min on 12 min off). Cooling effectiveness was evaluated using body temperature (BT) and respiratory rate (RR), by taking the differences between measurements recorded before the first spray cycle (-2 min) and after the final cycle (49 min). In Exp. 2, 18 lactating cows were tested in a shaded Y-maze, with 3 pairwise comparisons between either the Control (0 L/min) and/or 0.4 or 4.5 L/min sprinklers. For each pairing, cows chose once daily (12 min/d) for 8 consecutive days. In Exp. 1, BT and RR differed among all 4 treatments: as flow rate increased, so did cooling effectiveness ($P < 0.01$, GLMM). However, for BT, there was an interaction with weather [volume × air temperature (AirT), $P < 0.004$]. At AirT < 28°C, both sprinklers ≥ 1.3 L/min kept BT from rising ($P \leq 0.003$), whereas at AirT ≥ 32°C, only the ≥ 4.5 L/min sprinkler did ($P \leq 0.001$). In Exp. 2, cows choose 0.4 L/min over Control 69% of the time (SE: 9.3%, $P = 0.096$, Wilcoxon signed-rank test) and showed no preferences in the other comparisons (4.5 L/min: 58% vs. Control, SE: 9.4%; 42% vs. 0.4 L/min, SE: 9.6%; $P \geq 0.552$). However, preferences for 4.5 L/min over Control tended to depend on weather ($P = 0.065$, GLMM): at AirT ≤ 24.9°C, the probability of choosing 4.5 L/min was 0.40, whereas at AirT ≥ 30.0°C, this increased to 0.74. In conclusion, sprinkler flow rate influenced both cooling effectiveness and cattle preferences. In warmer weather, sprinklers ≥ 4.5 L/min were most effective and were preferred over shade alone. However, more work is needed to fully understand how cattle choose to use cooling resources throughout the day.

Key Words: heat load, preference, sprinklers

0053 Short-term increases in stocking density did not alter feeding behavior of lactating Holstein dairy cattle.
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Increasing stocking density at key resources may have negative effects on the feeding pattern of dairy cattle. The objective of this study was to determine the impact of short-term increases in stocking density on meal duration and frequency of lactating Holstein dairy cattle. Cows ($n = 136$) were allocated to 1 of 4 groups ($n = 34$), balanced for parity, days in milk (DIM), and milk production. Four stocking density treatments of 100% (1 cow per freestall and headlock), 113%, 131%, and 142% were assigned using a 4 × 4 Latin Square, with treatments imposed for 14-d periods. Twelve cows from each pen were selected to form focal groups, balanced by milk production (50.2 ± 1.1 kg), parity (2.2 ± 0.2), DIM (162.2 ± 7.0 d), BW (700.1 ± 11.0 kg), and BCS (3.09 ± 0.05). On d 11 of each period, feeding behavior was recorded at 10-min intervals for 24 h. Meals were defined as repeated observations of eating with a maximum 20 min of not eating between observations. To evaluate diurnal effects, 24 h of data was divided into BLOCK1 (0400 to 1200 h), BLOCK2 (1200 to 2000 h), and BLOCK3 (2000 to 0400 h), based on milking time. The MIXED procedure of SAS (SAS 9.3, SAS Inst., Cary, NC) was used to determine the effect of stocking density on meals per day, meals per hour, meal duration, time between meals, and meal duration 2 h before and after milking. Stocking density did not affect the number of meals per day ($P = 0.25$), time between meals ($P = 0.93$), number of meals per hour ($P = 0.71$), or meal duration ($P = 0.33$). However, meals were longer during BLOCK1 (38.8 ± 1.2 min) and BLOCK2 (39.7 ± 1.2 min), compared with BLOCK3 (33.8 ± 1.3 min; $P < 0.01$). Feed delivery occurred daily at 0430 h, with feed pushed up throughout the day. This suggests meal length decreases relative to time of feed delivery. However, meal duration increased after milking compared with before milking (29.5 ± 1.0 vs. 21.0 ± 1.0 min, respectively; $P < 0.01$), regardless of stocking density ($P = 0.98$). Short-term increases in stocking density did not impact the feeding pattern of lactating dairy cows. Future studies should investigate ways cattle compensate for increased stocking density while avoiding changes in feeding pattern.

Key Words: dairy cattle, feeding behavior, stocking density

0054 Evaluation of prepartum lying behavior as an indicator of health disorders in transition dairy cows. K. Lobeck-Luchterhand*[1], P. Basso Silva[1], R. C. Chebel[2], and M. I. Endres[1], [1]*University of Minnesota, St. Paul,* [2]*Department of Veterinary Population Medicine, University of Minnesota, St. Paul.*

The objective of this study was to determine if prepartum lying behavior (lying time, lying bouts, or lying bout duration) could be used as an indicator of health disorders in transition dairy cows. Lying behavior of 281 prepartum Jersey cows enrolled 4 wk before expected calving date was recorded using HOBO Pendant G data loggers attached to the cow's rear leg 1 d after entrance into the close-up pen, left on for 12 d, removed for 7 d, and reattached for 12 d or until the cow calved. Blood samples were taken on days in milk (DIM) 3, 10, 17, and 24 for determination of BHBA concentrations. All cows were examined on DIM 1, 4, 7, 10, and 13 for metritis and retained fetal membrane. Locomotion (1 to 5 scale) was evaluated on DIM -28, 0, and 35; cows with locomotion score $\geq$ 3 were considered lame. Data were analyzed using PROC MIXED of SAS. Increased daily lying time was associated with displaced abomasum (Difference, LSMEANS ± SE, min/d; 54.0 ± 13.2; $P < 0.01$), retained fetal membrane (20.4 ± 6.6; $P < 0.01$), twin pregnancies (59.4 ± 14.4; $P < 0.01$), and lameness at DIM 0 (163.2 ± 21.0; $P < 0.01$). Decreased daily lying time was associated with subclinical ketosis (50.4 ± 13.8; $P < 0.01$) and mastitis (34.2 ± 8.4; $P < 0.01$). An increase in the number of daily lying bouts was associated with lameness at DIM 0 (2.28 ± 0.61; $P < 0.01$) and first AI pregnancy (0.24 ± 0.12; $P = 0.04$). A decrease in the number of lying bouts was associated with displaced abomasum (1.45 ± 0.36; $P < 0.01$), retained fetal membrane (0.68 ± 0.22; $P < 0.01$), mastitis (1.21 ± 0.26; $P < 0.01$), and pregnancy loss from first AI (1.46 ± 0.27; $P < 0.01$). Decreases in lying bout duration (min) were associated with subclinical ketosis (14.4 ± 3.0; $P < 0.01$) and first AI pregnancy (2.4 ± 0.6; $P = 0.01$). Displaced abomasum (18.0 ± 3.0; $P < 0.01$) and pregnancy loss from first AI (7.8 ± 2.4; $P < 0.01$) were associated with increased lying bout duration. In conclusion, changes in lying behavior may be an indicator of cows at risk for transition disorders; however, the behavioral relationships were not consistent among the health disorders evaluated in this study.

Key Words: lying behavior, transition cow

0055 Effect of stocking density on social and feeding behavior of prepartum dairy cows. K. Lobeck-Luchterhand*[1], P. Basso Silva[1], R. C. Chebel[2], and M. I. Endres[1], [1]*University of Minnesota, St. Paul,* [2]*Department of Veterinary Population Medicine, University of Minnesota, St. Paul.*

The objective of this study was to investigate the effect of 2 feedbunk stocking densities on prepartum social and feeding behavior of dairy cows. Seven hundred fifty-seven Jersey cows at 4 wk before expected calving date were assigned randomly to 1 of 2 treatments. Treatments were 80% (38 cows/48 headlocks; 80D) or 100% (48 cows/48 headlocks; 100D) feedbunk stocking density. Four pens with sand-bedded freestalls were used: 2 nulliparous and 2 mixed primiparous and multiparous, referred to as "parous" pens over 4 repetitions (total of 350 nulliparous and 407 parous cows were used). Cows were balanced for BCS and cows with a locomotion score > 2 were excluded from the study. Pens were stocked twice a week to maintain the desired stocking density. Displacements from the feedbunk were measured using video recordings during 3 h following fresh feed delivery on d 2, 5, and 7 of each week of the 5-wk rep. Feeding times were measured using 10-min video scan sampling on d 2, 5, and 7 of the first week of the rep and d 2 and 5 for the final 4 wk of the rep. Displacements and feeding behavior data were analyzed using PROC MIXED of SAS with observation day (rep) as repeated measures. The random statement cow ID (pen) was included for the feeding behavior model. The 80D cows had fewer displacements from the feedbunk than 100D cows (15.2 ± 0.7 and 21.3 ± 0.7, respectively; $P < 0.001$). There was a treatment × parity interaction for daily feeding time ($P = 0.014$). Parous 80D cows had a tendency for longer feeding times than parous 100D cows (296.9 ± 3.3 and 289.3 ± 2.9 min, respectively; $P = 0.081$), whereas there was a tendency for longer feeding times for nulliparous 100D than nulliparous 80D cows (251.2 ± 3.2 and 242.8 ± 3.6, respectively; $P = 0.079$). In conclusion, stocking cows at 80% of headlocks reduced displacements from the feedbunk and had a tendency to increase daily feeding time for parous cows but not nulliparous cows.

Key Words: stocking density, transition cows

0056 Using prepartum feeding behavior to identify dairy cows at risk for transition health disorders. K. Lobeck-Luchterhand*[1], P. Basso Silva[1], R. C. Chebel[2], and M. I. Endres[1], [1]*University of Minnesota, St. Paul,* [2]*Department of Veterinary Population Medicine, University of Minnesota, St Paul.*

The objective of this study was to investigate whether changes in prepartum feeding behavior could be used as an indicator of health disorders in postpartum transition cows. Retrospective daily feeding times for 925 Jersey dairy cows within 21 d prepartum were used. Data were from 2 studies: study 1, 209 prepartum cows enrolled in either a stable group of 44 cows moved to a pen with no new cows added during a 5-wk rep or conventional group with cows added once weekly to maintain a desired pen stocking density of 44 cows; or study 2, 716 prepartum cows housed at either 80% (38 cow/48 headlocks) or 100% (48 cows/48 headlocks) feedbunk stocking density with twice weekly entrance of new animals. Prepartum feeding behavior was measured using 10-min video scan sampling for

24-h periods (4 d/wk for study 1 and 2d/wk for study 2). Blood samples were taken on days in milk (DIM) 3, 10, 17, and 24 for measuring BHBA concentrations. Cows were classified with subclinical ketosis when BHBA levels were $\geq$ 1400 μmol/L. All cows were examined on DIM 1, 4, 7, 10, and 13 for metritis and retained fetal membrane. Lameness was evaluated on DIM -28, 0, and 35; cows with locomotion score $\geq$ 3 (1 to 5 scale) were classified as lame. Cows with a health disorder were excluded from the lameness analysis. Other health events were obtained from on-farm records. The MIXED procedure of SAS was used to determine if feeding times were associated with transition health disorders. There was a reduction in daily prepartum feeding time for cows with metritis (Difference, LSMEANS ± SE min/d; 7.4 ± 2.7; $P < 0.01$), ketosis (15.4 ± 7.2; $P = 0.03$), retained fetal membrane (8.8 ± 3.9; $P = 0.02$), mastitis (9.2 ± 4.3; $P = 0.03$), lameness at DIM 0 (56.2 ± 10.0; $P < 0.01$), and lameness at DIM 35 (25.0 ± 6.2; $P < 0.01$), compared with cows without the respective disorder. There was a tendency for a reduction in feeding time for cows with displaced abomasum ($P = 0.09$) and cows carrying twins ($P = 0.08$). In conclusion, prepartum feeding behavior appears to be a useful indicator of cows at risk for transition disorders.

Key Words: feeding behavior, prepartum behavior, transition cows

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0057 Eating and drinking behavior prediction by use of Tri-axial accelerometers in dairy cattle.
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Tri-axial accelerometers are often used to measure behavior in cows (e.g., estrus, standing, and lying). However, there may be other practical uses for accelerometers on dairy farms. Our objective was to determine if accelerometers placed on a collar around the cow's neck can be used to monitor feeding and drinking behaviors. For this study, 12 lactating Holsteins (DIM 76 ± 35) were housed in stanchion stalls and continuously recorded for 6 d (Swann Pro-530 night/day cameras, DVR). Cows were fitted with Onset Pendant G accelerometers on the collar and sampling intervals set at 6 s. Video data were watched and evaluated by the same person. Daily video duration (Video) of each behavior was summarized and compared with daily duration predicted by accelerometers. Three methods were created to evaluate behavior prediction by accelerometers. For method 1 (MET1), data set was constructed based on the mean for the 3 axes recorded. For method 2 (MET2), data set was constructed based on the mean plus the standard error for the 3 axes recorded. For method 3 (MET3), data set was constructed based on the mean minus the standard error for the 3 axes recorded. Four behaviors analyzed were standing and eating with head up (SEHU), standing and eating with head down (SEHD), standing and eating (EAT = SEHU + SEHD), and drinking (DRK). Statistical analysis was performed using the MIXED procedure in SAS. For SEHU, there was difference ($P < 0.001$) between Video (119.0 min) and MET1, MET2, and MET3, and tendency ($P > 0.06$) for differences among MET1, MET2, and MET3. For SEHD, there was a difference ($P < 0.001$) between Video (141.7) and MET1, MET2, and MET3, and tendency ($P > 0.09$) for differences among MET1, MET2, and MET3. For EAT, there was a difference ($P < 0.001$) between Video (260.7 min) and MET1, MET2, and MET3, however, there was no difference ($P > 0.48$) among MET1, MET2, MET3, and EAT. For DRK, there was no difference ($P = 0.89$) between Video (315.3 min) and MET1, MET2, and MET3. The accelerometer under predicted SEHU by 42.6%, 35.4%, and 49.2%; SEHD by 72.0%, 65.3%, and 71.8%; EAT by 57.6%, 51.6%, and 61.05% for MET1, MET2, and MET3, respectively. The accelerometer accurately predicted DRK by 100%, 103%, and 99% for MET1, MET2, and MET3, respectively. In conclusion, accelerometers were successful in predicting drinking behavior.

Key Words: accelerometer, intake, prediction

0058 Herding cows with a robot: The behavioral response of dairy cows to an unmanned ground vehicle.
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Advances in technology could reduce time farmers spend on repetitive tasks. In pasture-based systems, herding cows from grazing areas to the milking parlor is a repetitive task ideally suited to automation. We conducted a field study at Sydney University's dairy farm to determine the behavioral response of dairy cows to a remotely operated unmanned ground vehicle (UGV) across time. Twenty milking cows were separated from the main herd at 0830 h and offered 0.5 ha of an ad libitum kikuyu pasture allocation (50 kg DM/cow to ground level). A pre-defined Fig. 8 route was determined for the UGV within this area. The UGV entered the pasture allocation at 0900 h and traversed this route at a target speed of 2.5 km/h, with the whole procedure repeated 6 times at 15-min intervals. The 0.5 ha was virtually split into 4 sectors. Four observers monitored cows exiting or entering each sector. Data were analyzed by REML, where Cows out = Fixed [Robot (presence/absence) × Traverse number] + Random (Cow). Alongside human observations, 3D LiDAR data from the UGV determined the velocity of cow movement for each traverse. There was a significant effect of Robot ($P = 0.02$) and Traverse ($P < 0.01$) on the number of cows (% of total cows) exiting a sector; however, there was no interaction between these fixed effects. Twice as many cows exited a sector when the robot was present (8%) as compared with absent (4%). More cows exited a sector in traverse 1 (14%) as compared with all other traverses (mean = 4%). The 3D LiDAR data showed a reduction in cow velocity moving away from the UGV for the first 3 traverses (Table 0058). These results show that dairy cows

habituated quickly to an UGV. The greater number of cows exiting a sector in the first traverse was likely associated with an initial period of increased cow movement as cows foraged. Future work will aim to fully automate the process of herding and integrate this process with the monitoring of animal health, ground cover, and soil moisture levels.

Key Words: cow behavior, herding, unmanned ground vehicle

Table 0058. Average (SD) velocity of cows away from the unmanned ground vehicle (UGV; m/s) for traverse 1 to 5

Traverse	Average (SD) velocity of cows moving away from UGV (m/s)
1	0.06 (0.27)
2	0.04 (0.27)
3	0.02 (0.21)
4	0.01 (0.17)
5	0.01 (0.19)

0059 Responses to rectal and uterine palpation for assessment of visceral pain associated with metritis in dairy cows.

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Metritis is a common disease in dairy cattle following calving, but to our knowledge no work has assessed the associated pain. A common method of assessing pain in human and veterinary medicine is through responses during tissue palpation. The objective of this study was to evaluate visceral pain responses in cows with clinical signs of metritis during rectal and uterine palpation. A total of 62 Holstein dairy cows (mean ± SD parity 3 ± 1.5) were subjected to systematic health checks starting d 3 after parturition and continuing every third day for 21 d. Cows were scored for vaginal discharge (0 to 4); 13 cows showed a discharge score ≥ 2 during at least 1 health check; these cows were classified as metritic. A matched (by parity and days in milk at diagnosis) sample of 13 cows was classified as "healthy." Cows showing any other signs of disease (including mastitis, ketosis, and lameness) were not included in the study. Behavioral and physiological responses during palpation were recorded using video and heart rate monitors. The effects of health status (healthy vs. metritic) and exam method (rectal vs. uterine palpation) were tested using the MIXED model. Back arch (cm^2) on the day of diagnosis was higher for metritic cows than healthy cows ($P < 0.01$), with no significant effect of palpation method or interaction. During rectal palpation, back arch averaged (± SE) 28 ± 2.3cm^2 for metritic vs. 18 ± 2.3cm^2 for healthy cows. During uterine palpation, back arch averaged 31 ± 2.3 vs. 19 ± 2.3cm^2, respectively. Standard deviation between normal to normal inter beat intervals (SDNN) and root of the mean square of successive differences (RMSSD) were log transformed before analysis. Both measures varied in response to exam method ($P < 0.05$) but not health status or interaction. The SDNN during rectal palpation averaged (± SE) 2.7 ± 0.16 compared with the uterine palpation 2.1 ± 0.16. Similarly, RMSSD was 1.8 ± 0.14 during the rectal palpation but decreased in the uterine palpation to 1.4 ± 0.14. The heart rate variation measures indicate that both healthy and metritic cows found uterine palpation more stressful than rectal palpation. The back arch results indicate that metritic cows are more sensitive to palpation (both methods) than healthy cows. These results also suggest that these types of veterinary exams may be used to identify cows that are experiencing pain associated with metritis and thus may be useful in deciding which animals will benefit from treatment with analgesics.

Key Words: metritis, pain response, visceral pain