364 Understanding the association between hock and knee injuries on lameness in dairy cattle. A. M. Armstrong1, T. F. Duffield, D. B. Haley, and D. F. Kelton, Department of Population Medicine, Guelph, ON, Canada.

Injuries and lameness are both prevalent across the dairy industry, however, there is little research addressing the potential link between them, and whether one predisposes the other. The majority of lameness studies have focused on hoof lesions and attributed lameness to these lesions. Few studies have examined the proportion of lameness that can be attributed to injuries. The objective of this study is to determine the association between mild, moderate and severe hock and knee injuries with lameness in dairy cattle. This research is being conducted at the Livestock Research and Innovation Centre (LRIC), Elora, Canada from November 2017–2018. Working with the hoof trimmer at the LRIC, cows between 120 and 160 DIM, cows entering the lactating herd, and cows that are being examined as a follow-up to a previous lameness intervention, are being trimmed and scored for the presence of hoof lesions. Currently 136 cows have been enrolled in the study: 114 lactating cows, 5 dry cows, and 17 heifers. All cows at the LRIC are also being assessed weekly for lameness to identify and characterize hock and knee injuries. Hock injuries are being scored on a 4-point scale, 0–3; with 0 indicating no swelling and no hair loss; and 3 indicating major swelling (>2.5 cm), a bald area greater than the size of a 25 cent piece and a lesion on the bald area. Of the sampled cows, hock injury scores of 2 or greater were distributed as follows: 44% on right lateral, 15% on right point, 32% on left lateral, and 8% on left point. Lameness is being scored on a 5-point scale, with 1 being sound and 5 being severely lame. Twenty-six percent of cows had a lameness score of 3, 4% a score of 4, and 22% of cows have been treated for lameness. Lesions included digital dermatitis (3%), white line disease (2%), sole ulcers (1%), the remaining 16% were listed as treated with unknown causes. Based on preliminary analysis (Fisher’s exact test), cows with hock injury scores of 2 or 3 were 3.82 (95% CI: 1.55–10.1) times more likely to be lame than cows with a hock injury score of 0 and 1. The projected implications are to provide the industry with information on the association between hock injuries and lameness and what can be done to decrease their prevalence.

Key Words: skin injury, welfare assessment, machine learning

365 Automatic classification of dairy cattle skin injury type and severity using machine-learning techniques. A. A. Boatswain Jacques1, R. S. Knight1, M. Leduc2,3, V. I. Adamchuk1, and E. Vasseur2, 1Bioresource Engineering Department, McGill University, Montreal, PQ, Canada, 2Animal Science Department, McGill University, Montreal, PQ, Canada, 3Valacta, Sainte-Anne-de-Bellevue, PQ, Canada.

Dairy cattle raised in indoor housing are exposed to potential sources of skin injuries that include swelling, wounds and other visually detectable lesions. Unfortunately, current diagnosis relies on qualitative visual evaluation and requires a trained observer to conduct the assessment. Computer vision assessment can be adapted to screen and potential cattle injuries, allowing any evaluator with minimum injury detection experience to obtain rapid assessment of the severity of cow injury almost instantly. To implement and test such a system, a machine-learning tool was developed using a data set of 2,364 images of both injured and non-injured cows. Skin injuries corresponded to either broken hair (BH), complete hair loss (CHL), white or dry scabs (WDS), red and wet scabs (RWS) and open wounds (WO) and were present at 3 injury locations (knee, lateral calcanei, and lateral tarsal). The data set was split into 3 separate subsets each corresponding to one of the injury locations. Regions of interest (ROIs) were first extracted systematically from each image using a pattern recognition module and were then resized and normalized. ROIs were then passed to a convolutional neural network (CNN) classifier constructed for each injury type in each location. These image subsets were then split into a training set, a validation set, and a test set to allow CNN optimization and evaluation of system performance. The classification accuracy rates of the CNN show an average accuracy of 93.9, 68.1, 76.4, 74.6 and 98.5% accurately detected injuries for BH, CHL, WDS, RWS and WO respectively. A ZeroR classifier predicting the majority category class was used as a baseline, and average accuracy values for this model were 90.3, 61.4, 77.0, 72.2, and 98.7% for BH, CHL, WDS, RWS and WO respectively. The CNN classifier for BH, CHL, and RWS outperformed the ZeroR model and a model performing random class assignment. According to test results, this system can be used as a rapid cow injury screening tool. A more extensive data set is being processed to further increase CNN accuracy.

Key Words: skin injury, welfare assessment, machine learning


The roster of standard operating procedures and recommended practices on dairy farms is constantly evolving, shaped by new technology, science and practical experience. This evolution is increasingly driven by measurable animal welfare outcomes and societal pressures about what is acceptable by consumers. Consumer concerns and questions about management practices need to be addressed using science and ethics. Our objective is to discuss the concern of permanent tethering of lactating cattle, the demographic of dairy farms that utilize tie stall systems, best management practices (BMP) for tie stalls, how tie stalls compare with other housing options based upon animal welfare indicators as well as the economic and societal impact of transitioning away from tie stall facilities. In 2016, the dairy industry was presented with customer concern around tie stalls for lactating cattle and how they potentially limit freedom of movement. The National Dairy FARM Animal Care Program, administered by the National Milk Producers Federation, developed a task force to address the customer concern, as well as to develop BMP for tie stalls. A literature review was conducted to evaluate current tie stall design recommendations and reported rates of welfare indicators. Based on research available, tie stall facilities that implement BMP provide equal opportunities for sound welfare for lactating dairy cattle in comparison to those housed in other types of facilities. Reported disease incidence, mortality, BCS, hygiene and locomotion score of 1 are similar in tie stall and freestall systems. Tie stalls tend to have a greater percentage of cows with a hock and knee score (7.2 vs. 2.1%) and hygiene score of 3 as (17.3 vs 10%) compared with freestall facilities. More research is needed to evaluate the type and

Digital dermatitis is linked to approximately 50% of lameness cases in dairy cattle. These hoof lesions may alter cow feeding and estrus behavior. This study investigated how different hoof lesion sizes and the healing status affect cow activity, rumination, and feeding behavior. Over 2 yr, the rear feet of Holstein cows (n = 219) were observed for digital dermatitis lesions during milking once a month. Each lesion was classified as either small (<0.6 cm), medium (0.6 > 1.27 cm), or large (>1.27 cm). Additionally, each lesion was categorized as active (A) or digressing (D), cows with swollen feet were noted. Cow ear temperature, activity, rumination, and eating behaviors were recorded hourly using CowManager. Only behavior data from the day of each hoof evaluation was used for data analysis. Lesion and behavior data were analyzed to compare differences between cows using PROC MIXED in SAS. The percent of time cows were inactive was not affected by hoof lesion size (30 ± 5%; P = 0.58) or healing status (30 ± 1%; P = 0.77). An interaction between ear temperature and hoof ailment was detected, in which, cows with lesions and high ear temperatures spent the least time (34 ± 2%) ruminating, and cows with at least one swollen rear foot and low ear temperatures spent the most time (44 ± 4% of time; P = 0.03). Hoof lesion size did not influence cow eating behavior (8 ± 1% of time; P = 0.73), but cows with at least one active lesion tended to spend less time eating (7 ± 1% of time) than cows without a lesion (9 ± 0.3%; P = 0.10). High activity was observed more frequently (D: 14 ± 0.6% vs. A: 11 ± 0.9%; P = 0.008) and ear temperature was higher (D: 23.9 ± 0.6°C vs. A: 20.8 ± 0.8°C; P = 0.005) in cows with digressing lesions than cows with active lesions. These results indicate that the size of hoof lesions may not impact cow behavior, but the healing status of lesions may influence cow eating and high activity behaviors. The relationship between ear temperature and hoof lesions should be further investigated. This information implies that heat detection systems, such as CowManager, provide behavioral data that can be used for the early detection of hoof ailments.

Key Words: cow behavior, digital dermatitis, hoof health
gestation may offset discomfort during calving without altering labor times or cortisol concentrations.

Key Words: calving, behavior, cortisol

370 Effects of oral administration of acetylsalicylic acid on physiological parameters and biomarkers of inflammation, pain and stress in organic dairy cows that experienced vulvar lesion at calving. A. A. Barragan1, S. Bas2, L. M. Bauman3, J. Lakritz2, J. Velez2, J. D. Rozo Gonzalez2, G. M. Schuenemann2, and R. J. Van Saun1, 1Department of Veterinary and Biomedical Sciences, Penn State University, University Park, PA, 2Department of Veterinary Preventive Medicine, The Ohio State University, Columbus, OH, 3Department of Veterinary Clinical Sciences, The Ohio State University, Columbus, OH, 4Aurora Organic Farms, Boulder, CO.

Calving is a natural process in dairy farms that allows cows to initiate lactation and provide the future replacements for the herd. During calving, cows can experience damage of the birth canal soft tissues, such as the vulva, which may impair cow performance and well-being. The objective of this study was to assess the effects of treatment with acetylsalicylic acid on physiological parameters and biomarkers of inflammation, pain and stress in dairy cows that experienced vulvar lesions after calving. Cows from 3 organic dairy herds (n = 563) were included in this study. Cows were blocked by parity and calving ease, and randomly assigned to 2 groups: 1) ASP (n = 278): within ~12 h after parturition cows received 4 treatments with acetylsalicylic acid (100 mg/kg; 2 boluses) every 12 h; or 2) PLC (n = 285): within ~12 h after parturition cows received 4 consecutive treatments with gelatin capsules containing water every 12 h. Vulvar lesion scores (VLS; NO = no lesion; MILD = swollen or vulvar laceration > 1 cm; SEVERE = swollen and vulvar laceration > 1 cm) was assessed at enrollment. Blood samples were collected (ASP = 76; PLC = 76) immediately before each treatment administration for assessment of haptoglobin (HP), substance P (SP) and cortisol. Similarly, rectal and vulvar temperatures were measured after blood collection. The data were analyzed using MIXED procedure of SAS as a randomized block design with repeated measures. A greater (P < 0.05) proportion of cows with SEVERE VLS (28.1%) experienced dystocia compared with cows with MILD (13.6%) and NO VLS (9.3%). The vulvar temperature was higher (P < 0.0001) in cows with SEVERE (36.96 ± 0.19°C) and MILD (36.08 ± 0.09°C) VLS compared with cows with NO VLS (35.72 ± 0.10°C). Overall, cows treated with ASP had lower (P = 0.001) concentration of HP. Furthermore, ASP cows with MILD VLS had lower concentration of SP compared with PLC cows with MILD VLS (ASP = 5.2 ± 1.58; PLC = 5.76 ± 1.66; P = 0.018). There was no difference in cortisol concentration between VLS groups. Results of this study suggest that treatment with aspirin may decrease inflammation and pain in cows with vulvar lesions.

Key Words: dairy cattle, vulvar lesion, acetylsalicylic acid

371 Physiological and behavior response of dairy calves disbudded with oral administration of an herbal tincture as a method to reduce pain and stress. H. N. Phillips* and B. J. Heins, University of Minnesota West Central Research and Outreach Center, Morris, MN.

The objective of this study was to investigate the effects of Dull It, an herbal tincture made with white willow bark, St. John’s wort, chamomile, arnica, and fennel, on blood cortisol levels and calf behaviors during and after hot iron disbudding. Holstein and crossbred heifer calves that were 5 to 8 wk of age (n = 54) were housed in 6 pens of 9 calves. Calves were randomly assigned to 1 of 3 treatment groups: 1) Dull It (2 mL) under the tongue before disbudding with a second dose immediately following (D; n = 18), 2) Lidocaine (5 mL/bud) cornual nerve block before disbudding (L; n = 19), or 3) Sham disbudded with a cold hot iron (S; n = 17). Calves were acclimated to handling and restraint 7 d before disbudding. Blood samples for serum cortisol analysis were taken 10 min before and 1, 30, 90, 210, and 450 min following disbudding. Calves were video recorded for frequencies of ears flicks, head jerks, and tail flicks during disbudding and to 6 h after disbudding. Fixed effects for statistical analysis of cortisol were baseline cortisol as a covariate, treatment, and the interaction of time and treatment, and time was a repeated measure using a spatial power covariance structure. For behavior, fixed effects were treatment and the interaction of treatment and time, with time as a repeated measure using a first-order autoregressive covariance structure, and pen was a random effect. At 30 and 90 min after disbudding, the D (28.2 ± 0.28 and 8.4 ± 0.09 ng/mL, respectively) calves had greater (P < 0.01) cortisol than S (9.3 ± 0.09 and 3.3 ± 0.04 ng/mL, respectively) calves. The D and L calves had similar (P = 0.93) cortisol across all time points after disbudding. Calves had similar (P > 0.13) behavior frequencies at disbudding. The L (11.1 ± 0.16) calves had greater (P < 0.01) head jerks 1 to 2 h after disbudding compared with D (2.8 ± 0.16) calves. The D and L calves had similar (P = 0.57) ear flicks at all time points. The D and L calves had greater (P < 0.05) cortisol and pain behaviors after disbudding compared with S calves. In summary, Dull It may be an effective alternative to lidocaine to mitigate pain and stress during and after hot iron disbudding in dairy calves.

Key Words: organic, disbudding, behavior


The objective of this observational study was to describe animal welfare in freestall housed cattle by creating regional benchmarks across the USA. The data were collected from 535 commercial freestall dairy farms from November 2012 to July 2017. Herd size averaged 1,434 (range 105–13,000) lactating cows. The high production Holstein pen was used and benchmarks were created by geographical region: West (WE; n = 87), Midwest (MW; n = 112), Northeast (NE; n = 277), Pacific Northwest (PNW; n = 42) and Southeast (SE; n = 17). Prevalence of clinical lameness was determined by locomotion scoring (LS; 1 = normal, 5 = severely lame; LS ≥ 3 considered lame) were (lsmean ± SE): 22.6 ± 2.6, 29.7 ± 1.3, 30.6 ± 0.8, 24.1 ± 2.0, and 27.38 ± 3.0 for WE, MW, NE, PNW and SE, respectively. Both WE and PNW regions had lower lameness prevalence than MW (P = 0.01, P = 0.02, respectively) and NE (P < 0.01, P < 0.01, respectively), but were not different from SE. No differences in lameness prevalence among MW, NE and SE. Hock injury prevalence (hair loss and/or swollen) were: 22.6 ± 2.6, 29.1 ± 2.4, 32.1 ± 2.3, 19.8 ± 3.0 and 23.1 ± 3.9 for WE, MW, NE, PNW and SE, respectively. Both WE and PNW had fewer hock injuries than MW (P < 0.01, P < 0.01, respectively), NE (P < 0.01, P < 0.01, respectively), but did not differ from SE. Northeast had more hock injuries than the SE (P < 0.01), but were not different from MW. Knee injury prevalence were: 3.8 ± 0.5, 5.1 ± 0.5, 4.7 ± 0.4, 5.1 ± 0.6 and 3.9 ± 1.0 for WE, MW, NE, PNW, and SE, respectively. West had fewer knee injuries than MW (P > 0.13), NE (P = 0.04), PNW (P = 0.02) and were not different from SE. No differences in knee injury prevalence were observed among MW, NE, PNW and SE. Daily lying times (h/d) were 10.14 ± 0.12 for WE, 11.35 ± 0.10 for MW, 11.06 ± 0.06 for NE, 10.05 ± 0.16 for PNW, and
10.00 ± 0.26 for SE. Lying times in the MW were longer than WE (P < 0.01), NE (P = 0.02), PNW (P < 0.01), SE (P < 0.01). Northeast lying times were longer than WE (P < 0.01), PNW (P < 0.01) and SE (P < 0.01). There were no differences in lying time among WE, PNW and SE. Based on these results WE and PNW have better cow comfort than other regions in the USA.

**Key Words:** freestall, welfare, lameness

Remote assessment of herd-level welfare status based on indicators from routinely collected milking records. D. Warner¹,², E. Vasseur¹*, S. Adam¹, M. Villetat Robichaud³, D. Pellerin³, D. Lefebvre¹, and R. Lacroix¹, ¹Valacta, Dairy Production Centre of Expertise Quebec-Atlantic, Sainte-Anne-de-Bellevue, QC, Canada, ²McGill University, Department of Animal Science, Sainte-Anne-de-Bellevue, QC, Canada, ³Université Laval, Département des sciences animales, Québec, QC, Canada.

A welfare assessment tool was developed with the aim to remotely assess welfare status of dairy herds. This tool will help producers benchmark their own performance relative to others, adopt tailored strategies, and monitor whether improvements are effective. The welfare assessment tool was based on 14 indicators, pre-recorded through routinely collected milking records and herd data. Indicators were selected based on advice of dairy experts covering longevity, nutrition, production, health, reproduction, and young stock. All values were normalized and percentile ranks were calculated. Ranks were averaged and agglomerated to a composite herd welfare index (HWI). The percentile rank of each indicator allows us to evaluate herd strengths and weaknesses, and the HWI situates the herd within the population of herds. Based on this approach, a HWI was calculated for 4463 dairy herds in Quebec, Canada. In addition, animal-based measures of herd welfare status (prevalence of lameness and lesions) were collected on 86 tie and free stall herds during summer 2017 to validate the selected indicators and the HWI. Pearson correlation coefficients between the HWI and animal-based measures were −0.41 (lameness), −0.41 (hock lesions), and −0.60 (knee lesions) for tie stall herds (n = 64; P < 0.05) but were not significant (P > 0.05) for freestall herds (n = 22). Based on the HWI, 5 tie stall herds among the 86 herds were situated within the worst 10% of the entire population of herds in Quebec, and showed deficiencies (among worst 25%) in knee lesions (4 herds), hock lesions (3 herds) and lameness (2 herds). In addition, 5 tie stall herds were within the best 10% in Quebec and excelled (best 25%) in lameness (4 herds), and hock and knee lesions (3 herds, respectively). The welfare assessment tool described in this study allows remote assessment and monitoring of the welfare status of dairy herds based on pre-recorded data and can be a powerful tool for producers to evaluate their herd relative to peers and to highlight opportunities for improvements.

**Key Words:** dairy herd improvement, national dairy database, cow welfare