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SYMPOSIA AND ORAL SESSIONS
Animal Behavior and Well-Being: Pain and Discomfort in Farm Animals

819 Pain and discomfort in farm animals. S. T. Millman,* *Iowa State University, Veterinary Diagnostic and Production Animal Medicine, Ames.*

Animal pain is at the forefront of public concerns about animal welfare. In the field, animal caregivers and veterinarians must recognize species-specific and insult-specific responses to pain for timely diagnosis and treatment of ill and injured animals within the herd or flock. State animal protection laws typically prohibit "unnecessary pain and suffering," and provide exemptions for customary livestock husbandry practices. However, defining what pain may be deemed "unnecessary" and which routine surgical procedures are "customary" is a contentious debate for the legal system and for livestock producers. Regional differences exist in terms of husbandry practices that are criticized, as well as the manner in which animal pain is addressed by animal producers, veterinarians, and policymakers. Differences in regulations and policies about painful husbandry procedures occur partly due to cultural reasons and public pressure, as well as understanding of animal welfare science, practical and economic constraints for implementation by producers and differences in data requirements for drug approval by regulatory agencies, especially for food producing species. Pain is defined by the International Association for the Study of Pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage." For both humans and animals, affective states such as pain can only be measured indirectly, and hence present challenges when designing experiments to gather empirical data. Whereas verbal self-reporting is the Gold Standard for pain assessment in humans, non-verbal procedures such as operant preference/avoidance tests are needed to enable animals to respond to our questions about their feelings of pain and distress. Interdisciplinary research teams, including animal scientists, biomedical scientists, agricultural engineers and applied ethologists, are developing novel and emerging techniques to facilitate scientific scrutiny of animal pain, to explore endogenous mechanisms of analgesia and to evaluate novel and currently available pain mitigating interventions. Understanding species-specific responses to pain and techniques to measure animal pain and distress in the laboratory or on farm, and efficacy of pain mitigating interventions are essential for development of socially acceptable husbandry guidelines, effective management of convalescent livestock and decision-making about humane endpoints, culling and euthanasia.

Key Words: pain, analgesia, animal welfare

820 The impact of housing and exercise on inflammatory molecules in the joints of open gilts. M. W. Orth,* J. M. Mapes, C. I. Robison, J. E. Link, and G. M. Hill, *Michigan State University, East Lansing.*

Osteoarthritis, a degenerative disease of articular cartilage, can contribute to the incidence of lameness in sows. Housed in gestation crates, sows spend much of their reproductive lives with limited mobility. Joint disuse may exacerbate joint degeneration. Degradation of articular cartilage produces an inflammatory process within the joint. The purpose of these studies was to determine if housing type and exercise affect the production of inflammatory molecules in joints. The objective was to measure concentrations of prostaglandin E2 (PGE2), interleukin-6 (IL-6), and leukotriene B4 (LTB4) in radioulnar joint synovial fluid. In Study 1, 16 Yorkshire × Landrace gilts, with an average BW of 125 kg, were housed in gestation crates (C, n = 8) or pens (P, n = 8) for 8 wk. Crates measured 0.6 m × 2.1 m and pens measured 2.4 × 3.0 m, with 4 animals per pen. In study 2, 18 gilts of the same breed cross (average BW of 114 kg) were housed in crates of the same dimensions. For 8 wk, 9 gilts ran 217 m, 5 d/wk (E), while the other 9 gilts remained in crates without exercise (NE). In both studies at the end of 8 wk sows were harvested and both forelimbs were collected from each gilt and placed on ice. Legs were cleaned of soft tissue while maintaining a closed radioulnar joint. Synovial fluid samples were collected via hypodermic needles, placed in microcentrifuge tubes, and stored at −80°C. Concentrations of PGE2, IL-6, and LTB4 were measured in the synovial fluid. There were no differences in PGE2, IL-6, or LTB4 concentrations between C and P gilts in Study 1. In Study 2 concentrations of IL-6 and LTB4 were not different between E and NE gilts. Non-exercised gilts had higher PGE2 concentrations than E gilts. Prostaglandin E2 is produced by articular cartilage as a result of trauma or degradation and inhibits collagen synthesis and activates matrix metalloproteinases. Therefore, higher concentrations of PGE2 in the joints of NE gilts over a period of time may be problematic. Even a short daily bout of exercise may reduce or prevent the production of inflammatory molecules in sedentary animals.

Key Words: inflammation, housing, exercise

821 Argon versus CO_2 gas induction of unconsciousness in piglets. L. J. Sadler*[1], T. M. Widowski[2], C. Wang[1], A. K. Johnson[1], and S. T. Millman[1], *[1]Iowa State University, Ames, [2]University of Guelph, Guelph, Ontario, Canada.*

The objective of this study was to compare efficacy of argon and CO_2 gases to induce unconsciousness and effects on piglet distress. Sixty-six 7-d-old piglets (BW 3.27 ± 0.24) from 11 litters were utilized. Three treatments were compared: 100% CO_2, 100% argon (ARG) and a control novel odor (peppermint: ODOR), supplied at 35% chamber volume exchange rate/min. Piglets were tested as pairs utilizing a modified Euthanex AgPro (Value-Added Science and Technology, Mason City, IA). Piglets were placed in the box and exposed to gas treatment until 30 s after loss of posture, at which time they were removed, checked for signs of sensibility (corneal reflex, pupil dilation and nose prick), and then placed in a pen until normal behavior resumed. ODOR piglets remained in the box for 14 min. Digital audio recordings were collected using a Marantz PMD 661 recorder and Crown PZM185 microphone during exposure to gas and analyzed with the STREMODO program for distress vocalizations. Individual piglets were weighed on d0 and d+1 relative to treatment and at weaning. Pupil dilation occurred in more ARG than CO_2 pigs (59% vs. 23%, $P = 0.02$), but there were no differences between gases for other signs of sensibility ($P > 0.1$). Piglets exposed to ARG took longer to lose posture ($P < 0.001$; 70 ± 8 vs. 214 ± 6, s) and to regain sensibility ($P = 0.03$; 371 ± 62 vs. 567 ± 64, s). ARG piglets performed more distress vocalizations while in the box compared with the other 2 treatments (ARG 8.8 ± 0.38, CO_2 0.34 ± 0.88 and ODOR 0.23 ± 0.25, % conscious time in which piglets were

emitting a distress calls, $P < 0.001$). There were no ADG or weight differences between treatments. In conclusion, ARG to induce insensibility was more distressing for piglets than CO_2 based on number of distress calls, and increased latencies to loss of posture and return of sensibility.

Key Words: insensibility, distress, argon

822 Return to sensibility: Use of yohimbine (alpha 2-antagonistic reversal agent) for anesthetized sows. M. D. Pairis*[1], A. K. Johnson[1], S. T. Millman[2], K. J. Stalder[1], and L. A. Karriker[2], *[1]Iowa State University Department of Animal Science, Ames, [2]Iowa State University Veterinary Department of Production Animal Medicine, Ames.*

The objective of this study was to evaluate yohimbine efficacy as an anesthetic reversal agent for sows. A total of 12 mixed parity sows (233.6 ± 18.7 kg) were individually housed in pens. Sows were anesthetized using a combination of Xylazine (4.4 mg/kg), Ketamine (2.2 mg/kg), and Telazol (4.4 mg/kg) injected IM. Following a 20-min stabilization period, palpebral reflex was tested to confirm insensibility, and sows were injected with either S (0.1 mg/kg) or Y (0.1mg/kg) IM in the neck. Following anesthetization, 2 anesthesia reversal treatments were compared in a cross over design; TRT 1: sterile saline (S; n = 12) and TRT 2: yohimbine (Y; n = 12). A 3-point scale (0 = alert, 1 = diminished response, 2 = unresponsive) was used to score 5 sensibility responses every 10 min. including; human approach test (HAT), sow posture, palpebral reflex, jaw tone, and nose prick. Data were analyzed using PROC MIXED of SAS. For all sensibility parameters (mean ± SE), sows returned to sensibility faster when treated with Y compared with S; palpebral reflex (45.2 ± 10.7 vs. 115.3 ± 11.2 min) jaw tone (71.3 ± 23.2 vs. 271.8 ± 25.9 min) nose prick (73.9 ± 22.5 vs. 200.8 ± 23.5 min) HAT (187.2 ± 32.6 vs. 413.1 ± 33.8 min, $P < 0.001$), and sow posture (293.54 ± 35.5 vs. 458.3 ± 37.9 min), respectively. In addition, Y reduced overall recovery time by 172 min (289.9 ± 41.0 Y vs. 461.9 ± 42.4 S min, $P < 0.001$). In conclusion, Yohimbine is an effective reversal agent in sows. Yohimbine use reduced overall recovery time and reduced latency to regain sensibility. This drug may be a tool that veterinarians and researchers can use to ensure that sows recover from anesthesia with minimal complications more quickly. Yohimbine should be considered as an adjunct treatment when anesthetizing sows based on welfare benefits associated with faster return to sensibility and reduced recovery time.

Key Words: anesthesia, yohimbine, swine

823 Herd-level risk factors for hock injuries in US freestall herds. A. K. Barrientos*[1], N. Chapinal[1], D. M. Weary[1], E. Galo[2], and M. A. G. von Keyserlingk[1], *[1]Animal Welfare Program, University of British Columbia, Vancouver, British Columbia, Canada, [2]Novus International Inc., St. Louis, MO.*

The aim was to investigate herd-level risk factors associated with the prevalence of hock injuries on Holstein herds in the northeastern United States (NE; n = 38) and California (CA; n = 38). One group of high production multiparous cows was monitored on each farm and data on housing, production, management, lying behavior and the condition of the hocks were collected. Focal cows (38 mean ± 3 SD), randomly selected from the assessment group, were evaluated for hock injuries on a scale of 1 to 5 (1 = healthy and 5 = evident swelling and severe lesion). Outcome variables were the (logit-transformed) proportion of cows having at least a minor hock injury (≥2) or moderate-to-severe injury (≥3). Univariable associations ($P \leq 0.05$) between predictors and outcome variables are presented. Prevalence of overall and moderate-to-severe injuries in the NE averaged (±SD) 80.7 ± 22.6 and 55.4 ± 27.6, respectively. The odds of either injury decreased with access to pasture (OR ≤0.17), deep bedding (OR ≤0.05), sand bedding (OR ≤0.06), bedding dry matter (%; OR ≤0.96), daily lying time (h/d; OR ≤0.51), lying bout duration (min; OR ≤0.93), and bedding hygiene (OR ≤0.25). The odds of these injuries increased with the number of lying bouts (OR ≥1.36), group variation in lying bouts (OR ≥1.80), brisket board height (cm; OR ≥1.09). Prevalence of overall and moderate-to-severe injuries in CA averaged (±SD) 56.7 ± 21.8 and 16.2 ± 17.1, respectively. The odds of overall hock injuries in CA decreased with daily lying time (h/d; OR = 0.52) and increased with stall stocking density (%; OR = 1.04). The odds of moderate-to-severe hock injuries decreased with herd milk production (OR = 0.72 for a 1,000-kg increase). These results suggest that improvement in barn design and management can decrease hock injuries.

Key Words: leg injury, animal welfare, barn design

824 Herd-level risk factors for lameness in US freestall herds. N. Chapinal*[1], A. K. Barrientos[1], M. A. G. von Keyserlingk[1], E. Galo[2], and D. M. Weary[1], *[1]Animal Welfare Program, University of British Columbia, Vancouver, BC, Canada, [2]Novus International Inc., St Louis, MO.*

The objective was to identify herd-level risk factors for lameness in free stall housed Holstein herds in the northeastern United States (NE) and California (CA). Measures of productivity, management, housing, lying behavior and gait scores for the high producing group were collected in 40 farms in NE and 39 in CA. Predictors associated with the (logit-transformed) proportion of lame or severely lame cows at $P < 0.20$ were submitted to a multivariable general linear model and retained if $P < 0.05$. Prevalence of clinical lameness averaged (±SD) 30.8 ± 15.5% in CA and 54.8 ± 16.7% in NE; whereas, severe lameness averaged 3.6 ± 4.2% in CA and 8.2 ± 5.6% in NE. In the NE, clinical lameness decreased with herd size, deep bedding, and access to pasture, and increased with average herd lactation number and sawdust bedding. Severe lameness decreased with herd size, access to pasture, deep bedding, sand bedding, bedding hygiene and raising of heifers on farm. The final model for clinical lameness ($R^2 = 0.55$) included herd size (OR = 0.94, CI = 0.91–0.97, for a 100-cow increase), deep bedding (OR = 0.51, CI = 0.35–0.75) and average herd lactation number (OR = 2.45, CI = 1.49–4.00). The final model for severe lameness ($R^2 = 0.60$) included herd size (OR = 0.93, CI = 0.89–0.96, for a 100-cow increase) and deep bedding (OR = 0.35, CI = 0.23–0.53). In CA, clinical lameness decreased with herd size, water trough space per cow, bedding hygiene, and presence of rubber in the alley to the milking parlor, and increased with the variability of the lying bout duration. Severe lameness decreased with bedding hygiene, frequency of manure removal in the pen, and average frequency of lying bouts, and increased with average lactation number, average lying bout duration and variability of the lying bout duration. The final model for clinical lameness ($R^2 = 0.48$) included variability of the lying bout duration (min; OR = 1.06, CI = 1.03–1.09) and presence of rubber in the alley (OR = 0.54, CI = 0.35–0.81). The model for severe lameness ($R^2 = 0.42$) included variability of the lying bout duration (min; OR = 1.07, CI = 1.02–1.12) and average lactation number (OR = 3.33, CI = 1.58–7.01). In conclusion, changes in management factors may help decrease the prevalence of lameness on dairy farms.

Key Words: cow comfort, barn design, lying behavior

825 Differences in pain thresholds associated with active and healing digital dermatitis lesions in dairy cattle. J. H. Higginson Cutler*[1], D. F. Kelton[1], G. Cramer[2,1], J. Walter[1], and S. T. Millman[2], *[1]University of Guelph, Guelph, ON, Canada, [2]Cramer Mobile Bovine Veterinary Services, Stratford, ON, Canada, [3]Iowa State University, Ames.*

Lameness is one of the primary animal welfare concerns in the dairy industry. Digital dermatitis, an infectious cause of lameness, is common in dairy cattle and appears to be painful. The pressure algometer is a tool that reliably quantifies pain responses in cattle and swine. The objective of this study was to determine pain thresholds associated with active and healing digital dermatitis lesions. Two hundred fourteen cases of digital dermatitis were enrolled in this trial, with a convenience sample (n = 129) re-examined either once or twice 3 to 12 d following treatment with tetracycline hydrochloride. Cows were restrained in a hydraulic lift table for hoof exams and lesion identification. Digital dermatitis lesions were classified as active, healing or healed. The 1 cm diameter tip of the pressure algometer was pressed against the lesion until the cow performed a leg withdrawal response, and the corresponding force was recorded in kg. Data were censored at 25kg, the maximum pressure recording limit for the device. Regression analysis of survival data, with robust sandwich variance estimates aggregated over cow, was used to distinguish pain associated with active, healing, or healed cases of digital dermatitis. Pain thresholds were significantly different between lesions that were classified as active, healing, or healed ($P < 0.0001$), with mean force (±SD) of 7.90kg (±9.45), 12.84kg (±10.49) and 25.0kg (±0) for active, healing and healed lesions, respectively. Contrast statements demonstrated that all 3-way comparisons were significantly different ($P < 0.001$). Measurement of pain thresholds using pressure algometry confirmed that digital dermatitis lesions are painful. Although pain is reduced during the healing stage relative to the initial active stages of disease, cattle remain twice as sensitive to pressure during healing versus when lesions are fully healed. These results indicate pain management should be considered when treating digital dermatitis, and pressure algometry could be used in future research to determine efficacy of pain management interventions for lameness in cattle.

Key Words: pain, digital dermatitis, lameness

826 Effects of anti-GnRF vaccine Bopriva and band castration on acute indicators of pain in feedlot beef cattle under North American management practices. S. Marti*[1], M. Devant[1], S. Amatayakul-Chantler[2], L. A. Jackson[3], E. D. Janzen[4], and K. S. Schwartzkopf-Genswein[5], *[1]IRTA-Ruminant Production, Animal Nutrition, Management, and Welfare Research Group, Caldes de Montbui, Barcelona, Spain, [2]Veterinary Medicine R&D, Pfizer Animal Health, Parkville, Victoria, Australia, [3]Veterinary Medicine R&D, Pfizer Animal Health, Kalamazoo, MI, [4]University of Calgary Veterinary Medicine, Calgary, AB, Canada, [5]Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

Angus bulls (n = 60; 257 d of age; initial BW 358.8 ± 3.98 kg) were used to study the effect of an anti-GnRF vaccine and band castration on acute indicators of pain. Cattle were randomly assigned to 1 of 3 treatments: Bulls (C), band-castrated animals without pain mitigation (B), and animals administered an anti-GnRF vaccine Bopriva (I). Animals were randomly assigned to one of 6 pens and were fitted with a radio frequency ear tag so that individual animal feed intake could be recorded daily using an electronic feed bunk monitoring system. Two doses of Bopriva were administrated on d −35 and 0, and band-castration was performed on d 0. Visual analog scores (VAS) indicative of pain or discomfort were used to visually assess the behavioral responses of the bulls to the treatments on d −36, −35, −1, and 0 and salivary cortisol on d −35 and 0 as well as at −30, 0, 30, 60, 120, and 270 min post castration. Blood samples were collected on d 1, 2, 5, and 7 for determination of complete blood count (CBC). Data were analyzed using a mixed-effects model with castration, time and their interactions as main effects. No treatment differences in salivary cortisol or VAS ($P = 0.76$ and $P = 0.33$, respectively) were observed on d −35. However, on d 0, B cattle had greater ($P < 0.05$) salivary cortisol concentrations (4.6 ± 0.45 nmol/L) than C or I cattle (3.1 ± 0.45 and 3.3 ± 0.45 nmol/L, respectively). Also, VAS assessed on d 0, was 78.2 and 78.9% greater in B than C and I cattle, respectively. CBC did not differ ($P > 0.05$) between treatments on d 0, 1, and 2. However, on d 7, platelet concentration was greater ($P < 0.01$) in I than in C and B cattle. There was no indication that vaccination with Bopriva caused physiological or behavioral changes indicative of pain or discomfort. In contrast, band-castration resulted in elevated cortisol and VAS scores indicative of a pain response. Administration of Bopriva may be a welfare-friendly alternative to traditional castration methods for beef cattle.

Key Words: beef welfare, anti-GnRF vaccine, band castration

827 Effect of road transport and lairage on body temperature of feedlot steers. J. B. Gaughan*[1], S. L. Bonner[2], I. D. Loxton[3], and R. J. Lawrence[4], *[1]The University of Queensland, Gatton, Qld, Australia, [2]FSA Consulting, Toowoomba, Qld, Australia, [3]Beef Support Services, Yeppoon, Qld, Australia, [4]Integrated Animal Production, Toowoomba, Qld, Australia.*

The effects of 6.5 h transport, location within truck trailer, and 16 h in lairage (LAR) following transport on the body temperature (TB) of 60 Angus steers (120 d grain-fed) were studied. Steer TB was obtained at 30 min intervals via transmitters surgically implanted 150 d before transport. Cattle were weighed and randomly allocated to a truck pen (10/pen) on loading. The truck had 3 upper deck (UD) pens (unshaded) and 3 lower deck (LD) pens (shaded). Ambient temperature (TA) and relative humidity (RH) were obtained every 30 min from loggers placed within each truck pen and at 4 lairage locations. During the trip TA was greater (29.7 ± 0.14°C;$P < 0.05$) on the UD compared with 28.5 ± 0.12°C on the LD. RH was lower ($P < 0.05$) on the UD compared with the LD at 31.8 ± 0.48% and 34.4 ± 0.41% respectively. At LAR mean TA and RH were was 24.4 ± 0.16°C and 52.4 ± 0.36% respectively. During loading TB increased from 39.4 ± 0.11°C to 40.2 ± 0.11°C. On commencement of travel TB of UD and LD cattle were 41.0 ± 0.08°C and 40. Nine ± 0.08°C ($P = 0.62$) respectively. Time series analysis was used to determine the effects of travel duration, time in LAR and location within truck on TB. Over the first 3 h of travel TB of LD cattle fell by 1.1 ± 0.7°C ($P < 0.01$) compared with 0.8 ± 0.7°C for UD cattle. Overall UD cattle TB (40.5 ± 0.11 C) were greater ($P < 0.01$) than LD cattle (40.0 ± 0.12°C). When the truck stopped for welfare checks (n = 4) TB of UD cattle increased by 0.5 to 1.1°C and 0.1 to 0.2°C for LD cattle. When travel re-commenced TB returned to the pre-stoppage values. On arrival at LAR the TB of UD and LD cattle were 40.1 ± 0.11 and 39.9 ± 0.11°C respectively ($P = 0.08$). During 16 h in LAR there were no differences between UD and LD cattle (mean TB = 39.3 ± 0.01°C; $P = 0.11$). Minimum TB (38.9 ± 0.11°C) occurred at 0300 h, and then increased gradually (39.4 ± 0.13°C) to 0900 h. The TB increase was likely due to human activity and animal movement within pens. Cattle previously on the UD were exposed to solar radiation and therefore had a greater heat load than those on the LD. However this did not appear to have any carry-over affects while the cattle were in LAR.

Key Words: transport, body temperature, steers