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# How do sow postures change when lameness is induced using a chemical synovitis model?

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ABSTRACT

Lameness detection using objective behavioral parameters provides an opportunity for timely treatment which, in turn, could improve sow welfare and reduce economic expense. Therefore, the objectives of this study were to (1) determine sow posture frequencies and duration (2) ascertain the postural sequence and time when standing to lying and vice versa and (3) to record time spent for sows to access feed when lameness was induced using a chemical synovitis model. Lameness was induced in 24 multiparous, non-pregnant, crossbred Newsham, maternal-cull sows by injecting amphotericin B in the distal interphalangeal joint space. The experimental design was a 3 (days) x 2 (rear feet) factorial arrangement where sow was the experimental unit. All sows were video recorded in their home pens continually over a 12-h period (0600–1800 h) on the sound day (1 d pre-induction), on the most lame day (1 d post-induction) and the resolution day (6 d post-induction). Three postures (standing, lying and sitting), an unknown category, three lying positions (lying left lateral, lying right lateral and lying sternal), time to change postures, the number of postures used to go from lying-standing and standing to lying and time to reach feeder on the raised step were collected. Sows spent less time standing on the most lame day compared to sound and resolution days ($P < 0.05$). Sows performed fewer standing and sitting postural adjustments on the most lame day compared to the sound day ($P < 0.05$). Lame sows transitioned through fewer postures and moved more quickly through the standing to lying transition on the most lame day compared to sound and resolution days ($P < 0.05$). Sows had a higher percentage of time lying laterally on the most lame day compared to sound and resolution days regardless of which foot was injected ($P < 0.05$). There were no observed differences in time (s) for sows to reach the feeder over treatment days ($P > 0.05$). In conclusion, these results support the use of behavioral indicators as an objective tool for detecting sow lameness when using this transient lameness model.



## 1. Introduction

The United States Department of Agriculture reported that lameness was the fifth reason producers cull gilts and sows from the breeding herd (USDA, 2012). Lameness can negatively affect animal welfare (Heinonen et al., 2013), economical return due to reduced longevity and increased replacement rates (Sonderman et al., 2009; Stalder et al., 2004). Naturally occurring lameness may result in wide variations of sow behavioral responses (i.e. the time spent lying or the number of times a sow changes their postures) based on the severity, location and type of injury (Parsons et al., 2015), and this can make early identification of lameness on farm challenging to the caretaker. In the U.S., the main lameness detection tool on farm are subjective standing and walking gait score analysis, so U.S. swine producers continue to fund research on sow lameness with an emphasis on identifying novel but objective on-farm tools that can assist them in identifying and treating lameness (NPB, 2016).

To address the concern relating to an unknown lameness etiology when testing novel lameness tools, Karriker et al. (2013) validated that amphotericin B induced a predictable, acute and transient sow lameness model when injected in the distal interphalangeal joint space. Hence, this chemically induced synovitis model provides a known population status regarding lameness severity and duration that enables the testing of lameness detection tools. Previous kinematic and mechanical nociceptive threshold tests (Mohling et al., 2014a, 2014b) and biomechanic tests (Karriker et al., 2013; Mohling et al., 2014a; Sun et al., 2011)

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have been validated using this chemical synovitis model. Pairis-Garcia et al. (2015) and Parsons et al. (2015) validated standing and lying sow frequencies using this model with and without the application of non-steroidal inflammatory drugs (NSAID). However the percentage of time a sow is engaged in standing, lying and sitting and how this model changes a sow's ability to control her movements when moving through postural sequences without NSAID usage has yet to be quantified. Therefore, the objectives of this study were to (1) determine sow posture frequencies and duration (2) ascertain the postural sequence and time when standing to lying and vice versa and (3) to record time spent for sows to access feed when lameness was induced using a chemical synovitis model.

## 2. Materials and methods

The protocol for this study was approved by the Iowa State University Institutional Animal Care and Use Committee. Sows' were cared for in accordance with the United States Animal Welfare Act and the *Guide for the Care and Use of Laboratory Animals, 8th Edition*. Lameness induction resulted in transient pain states but the experiment was designed to allow each sow to serve as her own control, thus reducing the total number of sows required whilst maintaining sample sizes large enough to achieve statistical power. Investigators established humane end-point criteria in which any sow that was unable to access water for 12 h, access food for 24 h or progressed to non-weight bearing lameness for 48 h was removed from the study and humanely euthanized. No sows met these criteria during this study. All sows were acclimated to housing and handling for 7 d prior to trial initiation (Pairis-Garcia et al., 2014).

### 2.1. Animals and housing

Twenty-four multiparous (mean parity 4; range 2-7), non-pregnant crossbred Newsham maternal line, cull sows were obtained from a commercial farm in Iowa (bodyweight 200.4 ± 8.4 kg). All sows were physically examined prior to selection by a veterinarian in charge with sow lameness expertize. Sows selected for the study were categorized as non-lame (i.e. placed weight evenly on all four feet). Physical examination and lameness evaluation were conducted between each round during the trial to confirm no observable residual lameness was present. Lameness evaluation included the ability of the sow to walk 10-m over a concrete floor with weight placed on all four feet. Each sow received a lameness score (0= normal gait, sow had no difficulty walking and placed even weight on all four legs, 1= abnormal gait, the sow had a shortened stride and/or a pronounced swagger of the caudal part of the body when walking and 2= severe abnormal gait, there was no weight-bearing on the affected limb, or the sow was unable to walk). No sows on trial showed any signs of residual lameness and were classified as non-lame. To avoid confounding injury due to aggression, each sow was housed in an individual home pen; however, sows could see, smell, hear and have nose-to-nose contact with other sows. Each home pen measured 3.7 length × 1.4 width × 1.2 height m and had a solid concrete floor with a boar rubber mat by FarmerBoy (2.4 length × 1.4 width m × 1.9 cm depth with a 1.4 cm perforation size; Meyerstown, PA, USA). Metal fences (1.2 height × 0.8 width m) were affixed to the end of each home pen. Each home pen was provided with chains and plastic toys attached to the home pen gates. Sows were provided ad libitum access to water via one nipple water drinker (Model 65; Trojan Specialty Products, Dodge City, KS, USA) that was positioned over a grate. Sows were hand-fed in their home pens, on a raised step (1.4 length × 0.6 width × 0.2 H m) receiving 2.3 kg of feed in the morning and 0.5 kg in the afternoon. The ration was a custom-mixed diet of 14.8% Crude Protein Total Mixed Ration composed of ground corn, soybeans, and nutrients formulated according to Swine NRC guidelines (NRC, 1998) with no antimicrobials. FDA approved Matrix® (0.22% Altrenogest; Intervet/Schering-Plough, Milsboro, USA; DE-Dose: 6.8 ml–15 mg) was added to 1 kg of feed daily to prevent estrus initiation. Facilities and sows were inspected by caretakers at 0730 and 1530 daily at the time sows were fed.

### 2.2. Induction of lameness

Feed and water was withheld 18- and 1 h respectively prior to anesthesia to reduce vomiting and aspiration risk. Sows were restrained in a standing position using a snare in their home pen and anesthetized. Anesthetic agents were combined and injected at the doses indicated: xylazine (4.4 mg/kg; Anased®, Lloyd Laboratories, Shenandoah, IA, USA), ketamine HCl (2.2 mg/kg; Ketaset®, Fort Dodge Animal Health, Wyeth, Madison, NJ, USA), and tiletamine HCl and zolazepam HCl as an equal weight mixture (4.4 mg/kg; Telazol®, Fort Dodge Animal Health, Wyeth, Madison, NJ, USA) administered intramuscularly. Anesthesia dosages were based on recommendations by St-Jean and Anderson (2006). Anesthetic onset began once anesthetic agents were injected. Ten minutes after anesthesia onset, sows were placed into lateral recumbency, and postural adjustments were made if involuntary movements results in compromised respiratory or circulatory capability. Palpebral reflex was evaluated to confirm insensibility after anesthesia administration. This was determined by placing a finger on the medial canthus of the accessible eye and gently running the finger along the eyelashes. The presence or absence of the palpebral reflex was determined by attempting to elicit a blink response with three successive attempts. After insensibility was established, the toes on the assigned foot were washed with water to remove obvious fecal contamination, and washed for a further 3 min with iodine based surgical scrub (Operand®, Aplicare Inc., Branford, CT, USA) using 10 × 10 cm sterile gauze pad. The foot was then rinsed with 70% isopropyl alcohol until no evidence of the surgical scrub remained. After cleaning, 10 mg amphotericin B (X-gen Pharmaceuticals, Inc., Big Flats, NY, USA) was injected into the distal inter-phalangeal joint (intra-articular space) of both toes in the assigned foot (Karriker et al., 2013). Throughout anesthesia, respiratory rate was measured by calculating chest evaluations, and rectal temperature were monitored every 15 min until sows returned to a standing posture unaided (range 60–120 min).

### 2.3. Experimental design

The experimental design was a 3 (days) × 2 (rear feet) factorial arrangement where sow was the experimental unit. This experimental design provided control of intra- and inter-animal variations in behavioral responses and limited the number of sows required. Sows were randomly allocated to one rear foot for first lameness induction. After completion of the first round, sows were given a 7 d rest period and then the procedures were repeated with the opposite rear foot induced for the second round. Three *days* were compared, *sound* (defined as 1 d pre-induction), *most lame* (defined as 1 d post-induction) and *resolution* (defined as 6 d post-induction), and two rear *feet*: left rear vs. right rear foot. The treatment days of sound, most lame and resolution were selected based on previous experience with the amphotericin B lameness induction model (Karriker et al., 2013; Mohling et al., 2014a, 2014b).