Identifying, Treating and Preventing Lameness in Sows

The statements and opinions expressed in this article are those of the author(s).

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Introduction
Lameness is generally defined as “incapable of normal locomotion, deviating from the normal gate [1].” Lameness can result from damage to any of the structures involved in locomotion including the bones, muscles, tendons, nerves and blood supply of the shoulder, hock, stifle, foot, toe or hoof. A significant portion of lesions that can cause lameness are not visible on external examination in typical production settings and similarly a portion of the causes of lameness do not have adequate therapies that can be administered in a production setting. The goal of this discussion is to illustrate how to identify lameness, determine treatment options and apply preventive measures for those causes that can successfully be addressed in a production setting. Figure 1 provides a decision tree to triage suspected lameness issues in a sow population.

Figure 1: Lameness Investigation Decision Tree

Lameness is suspected because of any clinical sign or combination of signs described in the text.

- Multiple animals affected at nearly the same time (within a few weeks)
- Individual animal cases that occur sporadically

Suspect FAD. Suspend animal movements and contact veterinarian immediately

Severe lameness with animals down and rapid spread through the herd (within a few days)?

Are there foot lesions?

Are there swollen joints or lesions on the leg anywhere else other than the foot?

Hoof: Clean and move animal to clean, dry environment, treat topically to prevent infection, consider trimming if overgrown, remove sources of injury, provide supportive care

Sole and/or heel: Clean and move animal to clean, dry environment, remove sources of injury, evaluate body condition for overfeeding, provide supportive care as necessary

Evaluate feeding to increase consumption

Remove to isolated environment, provide appropriate supportive care, consult with veterinarian

Evaluate diets for vitamin or nutrient deficiencies

Potential a skeletal or internal structural problem, provide supportive care in isolated environment, prognosis is poor, consult with veterinarian

Evaluate body condition for overfeeding, provide supportive care as necessary

Unable to access feed and water for >24 hours without assistance?

Consider humane euthanasia to prevent further suffering, have veterinarian perform necropsy to discover exact cause if unknown so that future cases can be prevented

Re-evaluate at least daily, perform and record any treatments per PQA+ guidelines and veterinarian recommendations

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Relevant anatomy

Hoof
The sow foot has four toes of which two are weight bearing and two are not (dewclaws). On the rear legs, the lateral or outside weight bearing toe is larger and generally bears a greater portion of the weight of the sow. It is also more likely to have a lesion that may result in lameness. Each toe has three bones (phalanges) that are aligned end to end with the final bone at the end covered by a hoof composed of hardened (keratinized) cells that form a visible protective layer called the hoof (horn). There is a layer of tissue between the bone and the horn that nourishes the cells providing nutrients and minerals. As cells keratinize and harden, they die and consequently the outer surface of the horn does not have a direct blood supply. This external layer of cells on the horn is dead and as they wear and erode, they are replaced by new cells from the layer nearest the bone which does have an extensive blood supply. It is important to recognize that not all hoof lesions or abnormalities result in lameness and lameness can occur when the hoof appears normal. There has been more study of foot lesions in sows than other causes of lameness and detection of foot lesions is easier than the diagnosis of other lameness problems. Consequently foot lesions are the focus of most discussions of sow lameness.

Figure 2: Sow (left) and cow (right) lateral claw horns viewed from the top position where the toe inserts.

In many species, the horn is responsible for a significant portion of weight bearing while the sole of the foot plays a minor role. In these species, the side walls of the hoof are thicker than the top (plantar) surface. Although comparisons to dairy cows are frequent, there are distinct differences in structure and size relative to the weight of the animal (Figure 2)[2]. Limited measurement of hoof structure has been performed in pigs but preliminary measurements show that in sows, the sides of the hoof are thinner than the top (Dr. Eric Rowe, personal communication). It also appears that the sow bears more weight on the sole of the foot relative to other species increasing the consequences of sole bruises.

Joint
There are approximately 34-36 bones in the sow leg and foot that must successfully articulate for each step. Each joint is comprised of the connection of two or more bones in the leg and each joint is designed to allow a specific range of movement in that joint. Bone surfaces that interact with other bones at joints are covered in cartilage which is smooth, shiny and relatively slick to facilitate movement without injury. Close to the joint in most bones is the physis which is the area of bone growth. Injuries to the physis or cartilage can result in lameness.

The physis is the active region of growth that separates the end of the bone (epiphysis) where the joint exists from the rest of the bone (shaft) structure. This active area of growth is vulnerable to injury until it hardens at the end of bone growth. This occurs between 3 and 7.5 years of age in sows [3]. If the area is crushed by excessive force (such as a heavy pregnant sow having to jump down from a trailer) premature closure can occur and bone growth can be deformed. If this area is subject to increased tension or shearing (such as a slip or fall) separation of the end of the bone from the shaft can occur with result being the same as a fracture. Milder injuries can also occur to this region of the bone and lead to inflammation which weakens the bone or makes the nearby joint painful.

The cartilage at the end of the bone is supported by a bed of capillaries that provide nutrients and support for the cartilage surface. In order for the capillaries to access the underlying cartilage area, the bone under the cartilage is filled with small access tunnels. If severe force causes these tunnels to be crushed or collapsed, the blood supply to the cartilage can be terminated and the cartilage dies. This creates a painful condition where bone rather than cartilage slides at the joint.

Legs
Legs are subject to tendon strains, bruising, fractures and other injuries when mechanical forces are applied but leg structures are not properly aligned. Also, hyperextension of joints due to lateral forces being applied during slips and falls can cause injury. Another potential injury is tissue compression or lacerations including shoulder ulcers or abscesses as shown in Figure 3 and discussed later.

Locomotion versus Lameness disorders

Locomotion
Each sow’s gait or walking pattern is controlled by the brain and produced by the leg structures described above. Since there are a significant number of components (joints, bones, muscle, tendons, hoof, etc) small variations at any point lead to a wide variety of gaits or walking patterns in healthy sows. When patterns of these have been examined in our lab, a high degree of varia-
tion is noted from one sow to the next in regards to foot placement and the “track” that they produce. However, the individual pattern for a single sow seems to be quite consistent. This means that the ability to generalize characteristics for the detection of lameness, especially mild lameness that would best respond to treatment, is very difficult.

**Lameness**

Since lameness is a deviation from normal locomotion, and the normal gait of each sow is varied, intense and frequent observation of sow movement is helpful in detection of lameness. However, in many production settings, sows are housed individually and do require sows to walk significant distances to access resources. While these housing options have been shown in some studies to reduce risk factors for lameness, they also limit opportunities to observe locomotion changes for evidence of lameness as consequence of the remaining risk factors. The expression of lameness and the challenge of observing and diagnosing it is additionally complicated by the physics of the sow. In work by Sun et al [4], the weight placed on each foot was independently measured. It was observed that more weight is placed on the front feet on average than the back feet (~58% vs. 42%). A consequence of this is that mild clinical lameness is more likely to be observed in the back legs than the front. It appears to be more physically challenging for a sow to lift the front foot.

**How to find lame animals and distinguish between causes**

There are very few clinical signs, other than directly observing gait changes, that are specific indicators of lameness in sows, especially sows in individual stall housing. However, there are several potential indications that further evaluation of the feet and legs is warranted:

- **Off-Feed, dehydration or constipation**: Anorexia (off-feed) is certainly not specific for lameness but is probably one of the easiest indicators to observe daily that the sow warrants further investigation. Evidence of a sow being dehydrated includes dry, flaking skin, sunken eyes, chalky residue on vulva or penning after urination. Dehydration is difficult to detect when mild but when water is provided in bowls, troughs or nipples that can only be accessed while standing, it can develop rapidly during severe lameness. Constipation can be indicated by the prolonged absence of fecal production or the passing of very dry, hard pellets of feces in low volumes. There are multiple causes of constipation but limited water consumption and limited feed intake could be tied to lameness when these inputs are designed to be accessed while the sow is standing.

- **Blood or pus on flooring or penning**: Often sows will lay in a sternal position which hides the feet and lower leg. This positioning can also rupture abscesses formed due to infection. If blood or pus is found on the flooring or penning the sow must be examined to find the source. It might be necessary to examine adjacent sows as well. Also, the presence of pus on the unbroken skin of the animal suggests there is a lesion in a hidden location that must be found and evaluated. Since the hoof is designed to protect the end of the leg, it is expected to successfully endure some insult. Determining when scrapes, cuts or cracks are sufficient to cause pain and lameness is a subjective and challenging issue. However, when the lesion or injury is sufficient to cause bleeding it has penetrated to the deep tissues of the hoof that have the blood supply and therefore the tissues that are also innervated. Consequently, bleeding injuries to the sow should probably be assumed to be painful and more likely to require treatment.

- **Toe tapping, weight shifting**: In sow studies of lameness, we have observed a high frequency of animals that will “toe-tap” a single foot or frequently shift weight from side-to-side when lame and standing in a stall. Typically the foot that is lame will be gingerly placed on the flooring and then picked back up nearly immediately and replaced as if the sow is searching for acceptable footing. If the lameness does not predominately affect one leg, but both are affected, there is a frequent shift from one side to other. In work where joint injections are used to create brief, temporary lameness conditions for study of detection equipment, the insult on rear legs resulted in a higher frequency of toe-touching and weight shifting than that same insult on the front legs. This might be a reflection of it being harder to raise the front feet when there is more weight naturally distributed to them. The implications for detecting lameness is that toe-touching and shifting in front legs will be harder to observe for mild lameness on front legs and when observed, might indicate a more severe problem relative to the back legs.

- **Non-weight bearing or carrying a limb**: The extreme of toe tapping would be non-weight bearing such that the sow holds the leg without touching the ground. This suggests a severe and painful injury. If the non-weight bearing occurs only when the sow stands still but she will continue to walk on the affected limb, the injury is less severe and the prognosis much better than if the non-weight bearing is maintained even when the sow tries to walk. This circumstance has a very poor prognosis and is most likely the result of severe structural injury such as a fracture.

- **Excessive effort or vocalization to stand or sit**: Generally the process of standing up consists of two processes for the sow. First, she will arch and leverage the core of the body to roll into a sternal position. While this certainly requires some contribution from the legs, most of the effort uses core muscles to leverage the central mass of the animal and therefore can be accomplished by sows even in relatively severe cases of lameness. The second step involves the extension of the front and back legs nearly simultaneously to stand. It is normal for the front legs to precede the back legs, especially in heavy, late gestation sows such that the sow achieves a ‘dog sitting’ position before rocking forward to stand on the hind legs. Pauses or vocalizations at any point in the process but especially after
the sow is sternal and the legs are being recruited to stand could suggest pain or lameness. Changing the sequence of events to lessen the weight on a leg could also indicate pain or lameness. For example, lame sows with rear legs affected will sometimes kneel in the front legs and return to standing several times before they completely lie down.

- **Shaking, bracing or sliding once standing**: Shaking, bracing against adjacent penning or sliding of the feet once the sow has stood up can suggest muscle weakness and/or fatigue. This is more suggestive of muscle or joint problems than foot or hoof problems. Sliding of the feet can be observed even on relatively dry, high quality flooring if the animal has shifted weight to avoid part of the hoof structure which in turn reduces the surface area in contact with the floor.

- **Laying down to urinate, defecate or eat**: If lameness is localized and the pain is lessened by laying down, the sow might be observed changing behavior to do things from a laying position that would normally occur standing. Generally this suggests severe lameness and or pain.

- **Poor body condition**: Lame animals that are reluctant to stand and eat are likely to lose body condition. Body condition may also play a role in creating lame conditions as described later.

- **Pressure sores or hair loss on one side of the body**: These signs may indicate that the sow prefers to lay on one side of the body due to lameness or leg pain rather than alternating between sides in a more random manner. The side with the hair loss or sores may NOT however, indicate which side has the lameness. In preliminary work where sows were diagnosed as having hoof lameness on one side of the body, continuous observation revealed that the sows spent the majority of their time laying on the non-lame side [Dr. Anna Johnson, personal communication].

- **Facility locations with higher cull frequencies**: Often this can be confounded because specific areas of the farm are designated for particular classes of animals but facility design can cause injury and lameness. If culls seem to originate more frequently from one location of the farm, critical evaluation of the facility structure there is warranted and repairs are required.

- **Reproductive failure**: Specifically, conception failure or anestrus can be a consequence of lameness that prevents the display of behavioral estrus for heat detection. Poor body condition and negative energy balance due to lameness actually reduces conception rate and fertility. Once sows conceive, however, the pregnancy is protected even at high cost to the sow and therefore, abortion and pregnancy loss are not sensitive indicators of lameness.

### Causes of lameness

Because lameness could be the consequence of the malfunction of any part of the very complex locomotor system, there are a wide variety of potential causes and therefore a wide variety of potential interventions. Additionally study of lameness has produced several classification schemes for lameness. Describing all of the possible causes and the relative advantages and disadvantages of each classification scheme is beyond this publication. Rather, the goal is to get the producer to a point of action more efficiently once lameness is suspected.

### Disease:

Primary infectious disease, generally caused by bacteria, is fairly common in growing animals but appears to be fairly uncommon in mature animals such as sows. Likely sows have been exposed to, or vaccinated for, these agents during the growth phase and are more successful at defending against them. Secondary infections of injuries by environmental contaminants can occur and increase the severity of disease but successful intervention in these cases still relies on prevention of the original injury or lesion. Additionally, it is rare in any age group for lameness to be the consequence of disease without additional clinical signs that are not related to the locomotor system such as fever, cough, elevated respiratory rate or abortions.

### Diet:

Bone muscle and hoof health especially in gilts and early parity sows depends on adequate nutrition. Deficiencies in vitamins A, C, D, and E have resulted in locomotor disease and lameness as well as deficiencies in Selenium, Calcium, Niacin, Copper, Manganese, Magnesium, and Zinc. Excessive levels of mycotoxins have contributed to lameness and are suspected to have a direct effect on hoof health as well as potentially interfering with the absorption and utilization of other nutrients. Generally, these deficiencies have to be chronic and sustained for lameness to result as a consequence. Also, with the exception of calcium, phosphorus and Vitamin D deficiencies, it appears to be rare for lameness to occur as a consequence of deficiency without additional non-lameness clinical signs such as skin lesions, diarrhea or blindness.

Since body weight directly affects the forces applied to the leg and foot, the interactions between body condition and lameness are direct and complex. In addition to poor body condition being an indicator of lameness, it may directly cause lameness by creating shoulder sores that are painful to the sow. These sores generally form over the large prominence on the spine of the scapula and several studies have shown a correlation with body condition such that sows with poorer body condition were more likely to have shoulder sores [5,6]. Shoulder sores are costly to rehabilitate and must be prevented. The sow pictured in Figure 3 (shown before and after treatment) required months of treatment, extra feed, veterinary attention and did not produce pigs during that time.

While poor body condition may be a consequence and indicator of lameness, excessive body condition may be a direct cause. Several studies have shown that heel bruises are more frequently associated with higher body condition scores. Additional research is needed to confirm a direct cause and to determine what severity of bruise is required to create lameness.
Because hoof lesions are the easiest locomotor problems to observe in live animals there is more research on the risk factors of hoof lesions than other causes of sow lameness and a few of those have compared environments. As early as the 1950s, studies reported high incidences of foot lesions prior to the industry transition to confinement on concrete surfaces. A comparison of loose housed sows on partially slatted concrete floors versus stalled sows on concrete floors revealed that 96% of cull sows from loose housing and 80% of cull sows from confined housing were observed to have at least one foot lesion [3]. Additionally, solid flooring has been observed to have a higher frequency of hoof lesions than slatted floors. This is poorly understood but may suggest that wet environments that soak the hoof reduce its strength and resilience. Certainly, facility maintenance is a key influence on hoof lesions as cracks, exposed bolts, and sharp edges represent opportunities for hoof damage (See Figure 4 for examples of maintenance issues and hoof lesions).

Strategies for evaluation of sows in stalls
Sows are difficult to examine thoroughly and the feet are generally to most difficult to observe. There are several strategies to improve success:

- **Evaluate at feeding.** Studies show that sows spend 72-98% of their time lying in the pen. Feed provides a strong motivation to stand. If the feeding system is automated then timing observation with feeding is easier. If feeding is done by hand, recruiting an additional person to evaluate from behind while sows are being fed in the front is helpful.

- **Evaluate at breeding.** The presence of a boar is strong motivation when gilts and sows are in estrus and often this is a rare time when sows or gilts tolerate manipulation while standing still and not requiring restraint. As mentioned earlier, the absence of behavioral estrus when it is expected for the sow or gilt may also suggest that there is a lameness problem.

- **Evaluate all animals in farrowing.** This is an opportunity to evaluate every sow at least twice a year and also a way to consistently monitor the herd. This is the time when the sows feet are generally the cleanest and when lying on the appropriate side, well lit by the heat lamp.

- **Clean the feet with a water hose.** The presence of feces and dirt make evaluations misleading.

- **Take digital photos.** Occasionally it is difficult to know if a lesion or crack on a hoof is problematic when observed for the first time and lameness is mild. Commonly, changes that occur in as little as one day can be informative. For example, if the lesion is more swollen, more irritated, oozing a larger volume of exudate or changing color it might suggest that the problem has not been fixed and is, in fact getting worse. Comparing to a digital photo from the day prior can give the caretaker a more direct comparison and enable the detection of milder problems. If problems progress or spread to other animals, the photos are extraordinarily useful for the veterinarian because they give the veterinarian a better understanding of the progression of the lesion which may make disease diagnosis easier resulting in faster treatment selection.

- **Track where lameness is most commonly found in the farm or reproductive cycle and focus attention there.** Typically skeletal problems are most frequent at weaning when sows have begun to use bone stores of calcium to lactate and then are required to travel to the breeding location. Flooring areas around cool cells may be more likely to provide slippery conditions. Areas where access panels exist over manure valves and other equipment might create sharp corners that injure the hoof.

- **Focus on animals with extreme body condition.** As mentioned earlier, over-conditioning is associated with heel bruises and under-conditioning is associated with most other hoof lesions and shoulder sores. While it is not known whether poor conditioning leads to nutritional compromise of the hoof or rather hoof lesions reduce feed intake, the relationship can be exploited to focus more intense monitoring on a subset of sows.
Unfortunately, there is very little research guidance for the treatment of lameness. A systematic review of lameness interventions in 2010 reviewed 1138 research reports and found 4 that were adequately controlled to draw conclusions about lameness [Layman, personal communication]. The review concluded that exercise and niacin supplementation beyond minimum nutritional requirements had no effect on lameness prevalence. From the discussion of causes above, several other preventive and intervention options are obvious. However, a few categories require additional focus.

**Antimicrobials**
Antimicrobials and antibiotics should only be used when a lesion has been identified and there is evidence that bacterial infection is part of the lesion. Signs that bacterial infection have occurred include pus formation, swelling and inflammation such as reddening of the area and / or an unusual foul odor. It appears that these circumstances are a small percentage of sow lameness cases and much more common for growing pigs. Broad spectrum antibiotics effective against enteric contaminates, staphylococcus and streptococcus bacteria are generally the best choice. Specific recommendations are not included here due to the changing regulatory environment of treatment in food animals. However, it should be emphasized that antimicrobial treatment is rarely the solution to sow lameness cases and should be undertaken with veterinary guidance.

**Topical treatments**
Topical disinfectants might be expected to work more effectively on hoof and foot lesions. Most require that the foot be kept fairly clean and dry because efficacy in a wet dirty environment is minimal. Topical drugs are still a route regulated by the FDA in food animals and the same constraints to product selection and legality exist requiring veterinary involvement.

**Pain relief**
There are no drugs approved for pain relief in food animals. Consequently, any use is off-label and therefore subject to the guidelines of the Animal Medicinal Drug Use Clarification Act. A key component of that act is that a valid veterinary-client-patient relationship exists to guide drug use and selection. While it may be necessary to provide pain relief in certain situations, this should also be accompanied with investigation and identi-
fication of the underlying cause of the lameness. Non-steroidal anti-inflammatory drugs (NSAIDs) are approved and used in other food production species in other countries. Controlled study of their value in sow lameness is underway in the United States. Steroids are occasionally employed, especially dexamethasone, for the adjunct treatment of lameness. However, research guiding dosing and risks to pregnancy in adult sows is lacking. Often the potential benefit to the sow for lameness is outweighed by the potential harm to the pregnancy of the sow.

Corrective trimming
When hoof lesions such as overgrown toes are part of the lameness, corrective trimming may be useful to improve the situation. This is employed successfully in other species including horses and cattle. The primary goals are to correct hoof length and the angle of the toe. When performed correctly, this is thought to reduce the excess tension or compression between the horn of the hoof and the bone underneath so that blood supply is uncompromised. Specific recommendations are being developed by private companies and university researchers. Generally, hoof trimming requires restraint of the animal. Pharmaceutical options are very limited for food animals and this has led to the development of various crates that lift the animal for inspection while allowing the feet to hang through the bottom of the crate.

References


