Shoulder lesions in sows: A review of their causes, prevention, and treatment

Fiona C. Rioja-Lang, MSc, PhD; Yolande M. Seddon, MSc, PhD; Jennifer A. Brown, MSc, PhD

Summary
Severe shoulder lesions in sows are manifested as ulcers comparable to pressure ulcers in humans. In sows, shoulder lesions appear on the skin overlying the bony prominence of the scapula, and are most commonly observed in the first weeks of lactation. Shoulder ulcers arise due to prolonged compression of blood vessels around the tuber of the scapular spine when the sow is lying, leading to insufficient blood circulation, necrosis, and subsequent ulceration. Due to the nature of shoulder lesions and their estimated occurrence (5%-50% of breeding sows worldwide), they represent an obvious welfare concern. There is also an economic impact due to labor time for treatment, medication, and premature culling of sows. While multiple factors contribute to ulcer development, maintaining optimum body condition in sows appears to be a key factor in prevention. This review summarizes the literature on sow shoulder ulcers, including the causes, prevention, and treatment. Regular monitoring of lesions is recommended, as this will help to identify individual farm causes and prevention measures. While much is known about shoulder ulcers, we conclude that there are significant gaps in the scientific literature regarding the mechanisms of development and healing, pain caused, and effective means for treatment and prevention.

Keywords: swine, sows, shoulder lesions, review, welfare

Received: November 7, 2016
Accepted: November 3, 2017

Resumen – Lesiones de hombro en hembras: Una revisión de sus causas, prevención, y tratamiento

Las lesiones severas de hombro en hembras se manifiestan como úlceras comparables a las úlceras de presión en humanos. En las hembras, las lesiones de hombro aparecen en la piel sobre la prominencia de hueso de la escápula, y se observan más comúnmente en las primeras semanas de lactancia. Las úlceras de hombro surgen debido a la compresión prolongada de vasos sanguíneos alrededor del tubérculo de la espina escapular cuando la hembra está acostada, llevando a una circulación de sangre insuficiente, necrosis, y la ulceración subsecuente. Debido a la naturaleza de las lesiones de hombro y su ocurrencia estimada (5%-50% de las hembras de cría en todo el mundo), estas representan una obvia preocupación de bienestar. Hay también un impacto económico debido al tiempo de trabajo utilizado para su tratamiento, medicación, y el desecho prematuro de hembras. Si bien, múltiples factores contribuyen al desarrollo de la úlcera, mantener una condición corporal óptima de las hembras parece ser un factor clave en su prevención. Esta revisión resume la literatura de las úlceras de hombro en hembras, incluyendo las causas, prevención y tratamiento. Se recomienda el monitoreo regular de las lesiones ya que esto ayudará a identificar las causas individuales en la granja y las medidas de prevención. Aunque se sabe mucho de las úlceras de hombro, concluimos que hay una falta significativa de datos en la literatura científica sobre los mecanismos de desarrollo y curación, dolor causado, y medios efectivos de tratamiento y prevención.

Résumé – Lésions aux épaules chez les truies: Revue des causes, de la prévention et du traitement

Les lésions sévères aux épaules chez les truies se manifestent comme des ulcères comparables aux ulcères de décubitus chez les humains. Chez les truies, les lésions aux épaules apparaissent sur la peau recouvrant la proéminence osseuse de l’omoplate, et sont le plus fréquemment observées durant la première semaine de lactation. Les ulcères de l’épaule surviennent suite à la compression prolongée des vaisseaux sanguins autour de la tubérosité de l’épine scapulaire lorsque la truie est couchée, entrainant une circulation sanguine insuffisante, de la nécrose, et une ulceration subséquente. Étant donné la nature des lésions aux épaules et leur fréquence estimée (5%-50% des truies reproductrices mondialement), elles représentent un souci évident relativement au bien-être. Il y a également un impact économique étant donné le temps passé pour traiter, la médication, et la réforme prématurée des truies. Bien que de multiples facteurs contribuent au développement des ulcères, le maintien de la condition corporelle optimale des truies semble être un facteur clé dans la prévention. Cette revue résume la littérature sur les ulcères de l’épaule chez les truies, incluant les causes, la prévention et le traitement. Une surveillance régulière des lésions est recommandée étant donné que ceci aidera à identifier les causes dans les élevages de manière individuelle et les mesures de prévention. Bien que plusieurs choses soient connues sur les ulcères de l’épaule, nous avons conclu qu’il y a des lacunes importantes dans la littérature scientifique en ce qui concerne les mécanismes de développement et la guérison, la douleur causée et des moyens efficaces de traitement et de prévention.

FCRL: Prairie Swine Centre, Saskatchewan, Saskatoon, Canada.
YMS: Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Canada.
JAB: Prairie Swine Centre, Saskatchewan, Canada, and Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Corresponding author: Dr Fiona C. Rioja-Lang, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush Campus, Midlothian, EH25 9RG, UK; Tel: 52-999-2326; E-mail: Fiona.lang@ed.ac.uk.

This article is available online at http://www.aasv.org/shap.html.

Introduction

Several terms are used to describe skin sores in the shoulder region of sows. These include (but are not limited to) shoulder lesions, shoulder ulcers, decubital shoulder ulcers (stemming from the Latin word “decumbere” meaning to lie down),1 shoulder sores, and abrasions. The terms “shoulder lesions” and “shoulder ulcers” are often used, erroneously, as synonyms. Jensen10 rightfully pointed out that when considering skin sores in the shoulder region of sows, it is essential to differentiate between shoulder ulcerations and non-ulcerating shoulder lesions. Shoulder lesions can take any form, from mild with intact epithelium or simple abrasions, to severe. Shoulder ulcers are a more severe subset of shoulder lesions where there is necrosis of epidermis, loss of basement membrane, and effacement of superficial adnexal structures, manifested and commonly referred to as “open sores.”3 Decubital shoulder ulcers in sows are comparable with pressure ulcers in humans (bed sores).

In sows, shoulder ulcers often appear over the underlying bony prominences, in which the amount of soft tissue (eg, muscular and [or] adipose tissue) between the skin and bone is insufficient to distribute external pressure.4 The reduced body condition of sows during lactation, combined with the prolonged recumbency during nursing, increases the incidence of shoulder ulcers.5 However, the precise mechanism behind the development of shoulder lesions is not well understood. There remain several opinions as to how and why pressure leads to tissue breakdown.6 It is thought that the ischemia (restriction of blood flow) results in insufficient blood circulation, causing necrosis and subsequent ulceration. Severity depends on the force and duration of the pressure, but is also influenced by the robustness of the skin.4 Prospective and cross-sectional studies have determined that these wounds typically develop in the first week after farrowing.7,8 It is estimated that the majority of shoulder lesions are present for at least 2 to 3 weeks and that some lesions will develop into ulcers during this period.6 The severity of shoulder lesions can vary greatly, ranging from superficial lesions to deep subcutaneous ulcers.

For this review, the term “shoulder lesion” will be used to broadly refer to abnormal structure of skin, and “shoulder ulcer” will be used to specifically identify a wound with loss of overlying epithelium. The occurrence of shoulder lesions as established by cross-sectional studies on-farm and in abattoirs reveals a large between-herd variation in lesion prevalence, from 4.6%3 to 50%.5 Where studies have taken repeated data from herds, a large range of within-herd prevalence has also been found (eg, Cleveland-Nielsen et al 200410), which reflects sow management decisions. A summary of studies recording the prevalence of shoulder lesions is presented in Table 1. These studies cover a variety of housing types, genotypes, and stages of gestation, and include both ante- and post-mortem observations, which must be considered alongside results. Regardless, the large between-herd variation in prevalence highlights the influence of farm facilities and sow management on the development of lesions. Surveys may underestimate the prevalence of shoulder ulcers because sows with severe ulcers may be euthanized, and thus not recorded. On the other hand, survey summaries may overestimate the prevalence of shoulder ulcers because lesions (eg, abrasions) that are not ulcerated may be included in the definition. While this research suggests that shoulder lesions likely have an economic impact on pork production, there is currently no information on the overall cost of this problem, or the cost-benefit of treatment options.

The degree of pain caused by shoulder lesions is poorly understood, however human patients with pressure ulcers self-report pain.19,20 On the basis of human literature, sows may also experience varying degrees of pain at different stages of severity.21 Presently, no pain relief is typically given for the treatment of shoulder lesions or shoulder ulcers. Ulcers also provide a portal of entry for pathogens that may cause local or systemic infection.4

Materials and methods

The objective of this review was to collect and review the literature related to sow shoulder lesions from a range of sources, to explore the major causes leading to their development, treatment, and prevention, and to identify potential areas for future research. The information presented is excerpted from a comprehensive report that was funded by the National Pork Board. This review is targeted towards pork producers, veterinarians, researchers, and students. The main databases used were AGRICOLA, CAB International, Scopus, and Science Direct. Because of the limited literature available, both peer-reviewed and non-peer-reviewed resources were evaluated for inclusion. The non-peer-reviewed information was largely published by industry or academics (eg, National Pork Board, British Pork Executive, or conference abstracts). They were still based on science, but did not go through the same rigorous process as a peer-reviewed journal article. Very old studies, > 30 years old, were unlikely to be relevant due to the changing nature of the swine industry (eg, heavier animals, larger litters). After the initial collection of material, the literature selection was refined to remove older studies. References from as early as the 1980s were included if they provided useful information that is relevant to present-day sow management.

Causes of shoulder lesions

Anatomy of the sow shoulder

The scapula or shoulder blade of the pig is a large, flat bone located over the rib cage with muscle attachment by M infraspinatus, M supraspinatus, and M deltoideus. From the cranial aspect (front), a ridge or spine is present on the side of the scapula that terminates dorsally in a large bump, known as the prominent tuber. When the sow lies laterally, the anatomy and location of the prominent tuber results in pressure being exerted on the overlying tissue, and predisposes this area to pressure ulcers.

Sow-related risk factors

Numerous pig-related risk factors have been identified as contributing to the development of shoulder lesions, including (but not limited to) body condition post farrowing,5,26 parity,18,23 health status (underlying disease),18 lameness,11,23 previous history of shoulder lesions,24 weaning weight of the litter,18 lactation length,23 sow behavior (unrelieved pressure),6 breed,18 and genetics.5,26 Studies have found that sows with a body condition score (BCS) < 3 at weaning,17 or ≤ 2 during gestation,18 have a three-fold greater likelihood of developing shoulder lesions than do those with BCS ≥ 3. A low BCS reduces the cushion of fat covering the tuber of the scapula,17 increasing the likelihood of lesion development. Anil et al11 studied 162 sows from four US farms and reported that longer lactation periods presented a risk for increased likelihood of lesion development. Similarly, a...
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>No. of sows in study</th>
<th>% of sows observed with lesions</th>
<th>Method: Post mortem/ante mortem</th>
<th>Findings/association with lesion prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anil et al¹¹</td>
<td>2006</td>
<td>United States (USA)</td>
<td>162</td>
<td>33%, of which 19% bilateral lesions</td>
<td>On-farm (4 herds), before weaning</td>
<td>↑ Longer lactation length&lt;br&gt;↑ BCS ≤ 2&lt;br&gt;↑ Lameness&lt;br&gt;← Parity&lt;br&gt;↔ Farrowing performance</td>
</tr>
<tr>
<td>Bausted and Fredriksen¹²</td>
<td>2006</td>
<td>Norway</td>
<td>3048</td>
<td>10%</td>
<td>Post mortem (4 abattoirs)</td>
<td>↓ BCS&lt;br&gt;↑ Body size</td>
</tr>
<tr>
<td>Cleveland-Nielsen et al¹⁰</td>
<td>2004</td>
<td>Denmark</td>
<td>23,794</td>
<td>0% to 40% within herd prevalence</td>
<td>Post mortem (207 herds, sampled in 4 abattoirs)</td>
<td>Large within and between herd prevalence: indicates varying management and farm factors</td>
</tr>
<tr>
<td>Davies et al⁷</td>
<td>1996</td>
<td>USA</td>
<td>1916</td>
<td>8%, of which 4% bilateral</td>
<td>On-farm, (one herd)</td>
<td>↓ BCS</td>
</tr>
<tr>
<td>Davies et al⁸</td>
<td>1997</td>
<td>USA</td>
<td>147</td>
<td>16% to 48%</td>
<td>On-farm (prospective study)</td>
<td>↑ Parity&lt;br&gt;↓ Scapular tuber depth significantly associated with ulcers and ulcer size</td>
</tr>
<tr>
<td>Deen¹³</td>
<td>2010</td>
<td>USA</td>
<td>157</td>
<td>33%</td>
<td>On-farm</td>
<td>↓ Increased backfat at 109 days gestation&lt;br&gt;↑ Cast iron slats&lt;br&gt;↓ Rubber mats&lt;br&gt;↑ Lameness&lt;br&gt;↑ Time in lateral recumbency</td>
</tr>
<tr>
<td>Havn and Poulsen¹⁴</td>
<td>2004</td>
<td>Denmark</td>
<td>429</td>
<td>14% to 37%</td>
<td>On-farm</td>
<td>↑ In farrowing area&lt;br&gt;↑ BCS&lt;br&gt;↑ Parity</td>
</tr>
<tr>
<td>KilBride et al¹⁵</td>
<td>2009</td>
<td>United Kingdom</td>
<td>344</td>
<td>10%</td>
<td>On-farm (4 lactating sows from 86 herds)</td>
<td>↓ Outdoor housed sows&lt;br&gt;↑ Fully slatted floors&lt;br&gt;↓ &gt; 20 cm between tail and back of crate</td>
</tr>
<tr>
<td>Knauer et al¹⁶</td>
<td>2007</td>
<td>USA</td>
<td>3146</td>
<td>18%</td>
<td>Post mortem</td>
<td>↓ BCS</td>
</tr>
<tr>
<td>Dahl-Pederson et al¹⁷</td>
<td>2013</td>
<td>Denmark</td>
<td>2733</td>
<td>5%</td>
<td>On-farm (37 herds)</td>
<td>↔ Condition of concrete floors in farrowing pen&lt;br&gt;↓ BCS</td>
</tr>
<tr>
<td>Ritter et al⁹</td>
<td>1999</td>
<td>USA</td>
<td>1751</td>
<td>5%</td>
<td>Post mortem</td>
<td>↓ BCS</td>
</tr>
<tr>
<td>Zurbrigg¹⁸</td>
<td>2006</td>
<td>Canada</td>
<td>312</td>
<td>34%</td>
<td>On-farm</td>
<td>↓ BCS&lt;br&gt;↑ Flank-to-flank at weaning, breed, parity, farrowing room section, weaning weight of litter</td>
</tr>
</tbody>
</table>

* Arrows denote the relationship between risk factor and development of shoulder lesions: ↑ = positive association; ↓ = negative association; ↔ = no relationship.

BCS = body condition score.
heavier litter weaning weight was identified as a significant risk factor on one Canadian farm, and Ocepek et al identified purebred maternal sow lines, and high-producing first-parity sows in particular, as being at greater risk. These studies link shoulder lesions to high maternal investment by the sow. Ultimately, these factors can be mitigated by appropriate management of the sow during the lactation period. Therefore, competent management of high-producing sows during lactation, or lack thereof, may have the greatest impact on lesion development. Three conditions that create inappetence in the sow, namely, disease, injury, and climatic extremes, create challenges to maintaining sow condition, especially during lactation. Furthermore, these factors can also influence sow activity and lying patterns, which may further increase the risk of lesion development. Hence, rapid identification of the cause of inappetence and prompt interventions to rectify are keys to reducing the risk of lesion development.

Heritability of shoulder lesions Several researchers have estimated the heritability of shoulder lesions or have observed breed differences in the prevalence of shoulder lesions. Lundeheim et al reported that shoulder ulcers are a heritable trait, specifically, the heritability was estimated at 0.13, which was based on a population of Swedish Yorkshire sows (including 4336 farrowings in 2634 sows). Veland et al reported a similar figure for heritability of shoulder ulcers \( (h^2 = 0.18) \) and also calculated the heritability of the size of ulcers \( (h^2 = 0.09) \) in Landrace \( \times \) Yorkshire crossbred sows. Lundgren et al estimated the heritability of shoulder ulcers and the genetic correlations between shoulder ulcers, mean piglet weight, and sow body condition. Data were extracted from the Norwegian litter recording scheme, and the genetic analysis included 5549 Norwegian Landrace sows (7614 lactations) in 45 herds. Their results estimated the heritability of shoulder ulcers to be 0.25. Lundgren et al also found a genetic correlation between shoulder ulcers and mean piglet weight. The correlation was low but positive \( (r^2 = 0.23) \), indicating that the sow’s ability to raise heavy piglets is associated with a higher risk of shoulder ulcers. The authors concluded that high-producing sows are at greater risk of developing shoulder lesions than low-producing sows. This conclusion is supported by recent work by Ocepek and colleagues, who compared productivity and prevalence of shoulder lesions in sows from purebred maternal (Norsvin Landrace) and crossbred (Norsvin Landrace and Swedish Yorkshire) lines. Shoulder lesions were most common in first-parity sows from purebred maternal lines \( (P < .001) \), and were associated with higher litter weights at birth \( (P = .003) \) and weaning \( (P = .05) \), and greater weight loss during lactation \( (P = .016) \). Zurbrigge compared Duroc, Landrace, and Yorkshire sows in a commercial herd in Ontario, Canada, and found that Landrace and Duroc sows were 3 and 4.6 times (respectively) more likely to develop shoulder lesions than Yorkshire sows \( (P < .05) \).

It can be concluded the propensity for a sow to develop shoulder ulcers is heritable, at least in so far as greater prevalence can be found in specific lines. On this basis, it should be possible to reduce their prevalence using appropriate selection and breeding programs. However, the heritability of ulcers is likely to be linked to selection for other production traits, as indicated by the findings of Lundgren et al, which may hinder the ability to reduce their prevalence through selection.

Environmental risk factors Several environmental risk factors have been identified as contributing to the occurrence of shoulder lesions, including flooring type, pen location, temperature and humidity, type of sow housing, and friction properties of the floor. Environmental risk factors can be described at both individual sow and herd level. In farrowing pens (crates), flooring type has been associated with the risk of developing limb and body lesions. Metal slatted flooring is a risk factor for having more sows with shoulder lesions when compared with those housed on solid concrete, because slatted floors support the sow’s body weight over a smaller surface area. KilBriddle et al found there was an increased risk for body lesions when the lying surface was either damaged or soiled when compared to clean, dry, and (or) undamaged floors. Farrowing crate floors should provide a comfortable surface for lying, sufficient space for comfortable nursing, a non-slip surface for rising and standing, and separation from excreta, and must be sufficiently robust for the sow’s size and weight. In the human medical literature it is believed that kinetic friction forces rubbing the skin, possibly in combination with increased skin moisture, contribute to the development of pressure ulcers. Friction, along with other flooring properties, such as abrasiveness, hardness, surface profile, and thermal properties, may all contribute to the development of shoulder lesions in sows and should be explored further.

The location of sows within a farrowing room can also contribute to the development of shoulder lesions because of variation in climatic conditions associated with room temperature fluctuation, location of ventilation units, and the use of drip coolers. No data are currently available regarding the direct effect of temperature on the prevalence of shoulder ulcers in sows. Sow movement is likely reduced at higher temperatures, and could thus be a contributing factor in the development of shoulder ulcers. Citations from human medical literature often conclude that moisture, humidity, and temperature are likely to play a role in the development of bed sores.
There is an increasing global trend to reduce close confinement management of sows. Many countries have placed a ban or partial ban on the use of gestation stalls, and alternate indoor farrowing systems are being explored, from farrowing pens to group lactation systems.\(^{35,38}\) The greater freedom of movement provided to sows in these systems may increase muscle tone and encourage more frequent postural changes, which may help to reduce the incidence of shoulder lesion development in sows. The use of bedding or alternative flooring types (ie, solid flooring, rubber-coated flooring) in these systems may also influence the development of shoulder lesions. Assumptions driving these changes in system design and their outcomes on sow welfare and longevity are worthy of investigation.

**Interventions and treatment**

The primary intervention for sows with shoulder ulcers is to move them into pens with softer flooring. Deep straw bedding provides the correct properties for improving comfort by providing wider distribution of pressure for lying sows. However, in many modern pig production facilities, the use of straw is not feasible because of incompatibility with liquid manure disposal systems.\(^{39,40}\) In Denmark, a pathoanatomical scale from 0 to 4 is used to grade shoulder ulcers, where grade 0 is no lesion and grade 4 is a lesion (ulcer) involving all three layers of the skin and underlying bone. On Danish farms, sows with grade 3 or 4 lesions must be kept loose and have access to soft bedding.\(^{40}\) Rubber mats can provide a means for increasing the comfort of flooring in unbedded systems.\(^{41}\)

For established lesions, there is evidence that rubber mats can be beneficial. In the study by Zurbrigge, sows provided with a mat had shorter healing times (25 days) than did sows housed in a conventional farrowing crate (32 days to heal), or those provided with solid stainless steel plates under the shoulder region.\(^{18}\)

Few commercially available products exist for the topical treatment of shoulder lesions. A study testing AluShield Aerosol Bandage (Neogen, Lexington, Kentucky), a food-animal labelled product specifically for the treatment of wounds, was found to be ineffective. There was no difference in the reduction of lesion size between control and treatment groups (reductions of 66% and 60% respectively), nor a difference in the change of lesion diameter or time to lesion healing between the control and treatment groups.\(^{41,42}\)

A study by Kaiser et al\(^{42}\) compared the effectiveness of a combination treatment of rubber mats and zinc ointment (25% zinc oxide) with a local antibiotic treatment (chlorotetracycline spray) on healing of shoulder ulcers in three sow herds. Sows were paired according to the grade of their ulcer (Danish pathoanatomical scale: 0 to 4) on the first observation and were randomly divided into treatment groups: mats and zinc ointment (Apotekets Baby Zinksalve, Denmark), or antibiotic spray (Cyclo Spray Vet, Eurovet Animal Health B.V., Netherlands). The rubber mat plus zinc oxide treatment had a statistically significant effect, reducing the size of the ulcer on days 14 and 21 of treatment compared to antibiotic spray. For lean sows provided with rubber mats and zinc oxide, the average shoulder ulcer size on day 14 was 3.8 cm\(^2\), versus 9.5 cm\(^2\) when antibiotic spray was used. This treatment appeared to be equally effective in all three herds studied. Therefore, the authors recommended rubber mats as a means to reduce the number of sows that needed to be euthanized, culled, or weaned early due to this type of lesion, and suggested that rubber mats be used preventatively for sows at risk.\(^{42}\)

As an alternative to providing a rubber mat, some Danish producers use a padded shoulder protector (eg, Maxi Pork, designed by Danish company Unitron Scandinavia A/S). The device consists of two layers of foam rubber coated with nylon netting, and straps which allow it to be fastened to the sow. This device is best for treating sows in the early stages of lesion development, before the ulcer has formed, and not for treating the open wound. Producers install the pads on sows as soon as they observe any redness of the skin on the shoulder.

In general, products used to treat decubital ulcers on sows are few and have not been well-evaluated.\(^{42}\) Nevertheless, individual farms should implement procedures for identification, surveillance, and treatment of shoulder ulcers. Future research should focus more on preventative management of sows, as this is a far more effective approach. Traumatic neumomas found in healed ulcerations suggests that sows continue to experience discomfort after ulcer healing;\(^{41}\) however, robust strategies to deal with shoulder ulcers must also be developed, as ulcers will persist until effective means of prevention can be implemented.

**Prevention**

Maintaining an optimum BCS is a critical factor in the prevention of shoulder lesions. Sows need sufficient backfat at farrowing (ideally BCS 3 on a 1 to 5 scale) to maintain sufficient levels throughout lactation. In a study investigating the effect of softer flooring in the farrowing crate on subsequent sow performance,\(^{43}\) fifty-two of 140 sows developed shoulder ulcers (17 were from farrowing crates with rubber mat floors and 35 from farrowing crates without rubber mats).

Analysis revealed that lower backfat thickness at day 109 of gestation was associated with increased likelihood of having shoulder ulcers at weaning. Backfat thickness is affected by a combination of sow genetics and diet. Maximizing feed intake during lactation may be hindered by a variety of factors, including hot temperatures in summer\(^{17}\) or the onset of illness.\(^{41}\) Regular, objective assessment of body condition can assist stockpersons to identify low BCS in individual sows and take appropriate action. New technologies for individual sow feeding during gestation and lactation, which provide feed on demand rather than all at once, may also help to optimize sow body condition. The cause of decreased feed intake needs to be identified promptly to avoid a reduction in body condition. Earlier management interventions to rectify problems will go a long way to preventing development of shoulder lesions and ulcers.

Regular monitoring of early signs of skin insults, such as redness, abrasion, or irritation, are paramount, since early detection and intervention are important and effective in prevention of sow suffering. Lesions may be as subtle as slight redness; the observation of flies on the shoulder crest can be an early indication of an incipient shoulder lesion.\(^{42}\) If these early signs are observed, the floor surface should be checked for roughness. It would be appropriate to place a pad over the affected area of the sow’s shoulder to relieve pressure, or to move the affected sow to a comfort pen with a softer lying surface, such as a rubber mat or deep bedding.\(^{40}\) Lesions should be cleaned and treated with an antiseptic (according to veterinary advice and farm health protocols).

One reason that sows may be reluctant to stand or change position during lactation is locomotor problems. In evaluation of sow lesions at slaughter, Stalder and Karriker\(^{44}\) reported that open shoulder lesions were significantly and positively associated with rear foot abscesses. This suggests sow-herd leg and foot health should be evaluated.
in combination with the goal of reducing shoulder lesions. Uninterrupted lying bouts increase the risk of developing shoulder lesions; therefore, the authors suggest that it may be beneficial to stimulate sow activity by making them stand or move about on a daily basis, particularly in the first weeks post farrowing.

Flooring is an important risk factor. The common use of fully slatted floors increases pressure due to the distribution of body weight over a smaller surface area. The odds of a sow housed on a slatted floor developing shoulder ulcers during lactation was three times higher in sows not provided with rubber mats than in those with rubber mats extending to their hind limbs. The use of alternative flooring in the farrowing pen may benefit the sow by reducing occurrences of a painful condition, while benefiting the producer by subsequent productivity improvement. Regardless of treatment and prevention options, in severe cases sows should be culled or euthanized.

Future research
Numerous gaps exist in our knowledge of shoulder lesions and ulcers, providing a basis for future research, summarized as follows:

- Pathogenesis: Identify the mechanisms by which shoulder lesions and ulcers develop and heal. A better understanding of lesion pathogenesis will help towards identifying effective prevention measures.
- Feeding practices, nutrition, and body condition: Investigation of feed quality, feed delivery, and feeding management (eg, automated or on-demand lactation feeders) for lactating sows and the occurrence of shoulder lesions and ulcers.
- Housing and use of alternate flooring: Studies on alternative flooring for farrowing crates are warranted, with consideration for sow comfort and pressure-relieving properties, while maintaining drainage and cleaning properties. Rubber matting has shown promise, but further evaluation of the physical characteristics, durability, and effectiveness for lesion prevention is required.
- Lying behavior and time in recumbency: Identify whether changes in sow behavior (eg, lying posture and duration) are predictive of lesion development and can be used as risk indicators.

Perhaps just as important as these research topics is the need for greater on-farm monitoring of this condition. The old maxim, “you can only manage what you measure” surely applies to shoulder lesions and ulcers. Lesions can easily be recorded on-farm, either during lactation or as sows exit from farrowing. The increasing use of computerized and automated systems for data collection will make this a simpler task in the future, and can provide an important first step towards increasing recognition of the problem and identification of appropriate treatments.

Conclusions
Estimates of prevalence of shoulder lesions, including ulcers, are reported at 5% to 50% in breeding sows; however, the true incidence of shoulder lesions and (or) shoulder ulcers is not known. Lesions in sows are a painful condition, represent a welfare concern, and benefit from timely interventions. Treatment success of shoulder lesions is enhanced by early recognition and intervention.

Lesions typically develop in the weeks following farrowing, when sows spend the majority of their time lying and nursing. Other factors, such as low body condition score, hard or abrasive flooring, genetic predisposition, and a host of other environment and management factors increase sows’ susceptibility to developing shoulder lesions.

Most of the literature on shoulder ulcers has been in surveys and is epidemiological in nature. The process of wound development and healing is poorly understood, hence research aimed to better understand the underlying causes, progression, effects of pain on productivity, and development of more effective treatment and preventative interventions is warranted.

Acknowledgements
The authors wish to acknowledge funding support which was provided by the National Pork Board, Des Moines, Iowa.

Conflict of interest
None reported.

Disclaimer
Scientific manuscripts published in the Journal of Swine Health and Production are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

References


*44. Stalder K, Karriker L. Evaluation of sows at harvest to determine the incidence of abnormalities that could lead to culling of breeding herd females. Pork Checkoff NPBP#04-127. 2006.


* Non-referreed references.