Sow shoulder lesions: Risk factors and treatment effects on an Ontario farm

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ABSTRACT: The objectives of this study were to identify risk factors for the development of shoulder lesions in lactating sows and to determine if an effective, economical, and practical treatment could be designed. The study was conducted at a 300-sow farrow-to-finish swine farm in Ontario between July and December 2004. Sow data were recorded on either the day of or 1 d after entering the farrowing crate and before farrowing had occurred. The right and left shoulders of the sows were assigned a score between 0 (normal) and 4 (lesion >2.3 cm in diam.) on day 1 of the study and weekly thereafter throughout lactation. If a lesion developed, sows were randomly placed into 1 of 3 treatment groups. Groups consisted of a control group that received no treatment, a group that had a 0.2-cm thick, 60 x 60-cm, stainless steel plate attached to the bottom of the farrowing crate, and a group that had a 3.8-cm thick, 60 x 60-cm rubber mat attached to the bottom of the farrowing crate. Of the 310 sows involved in the study, 107 (34%) developed a lesion with a score of 3 or 4. Multivariate regression analysis identified body condition at weaning, flank-to-flank measurements at weaning, breed, parity, farrowing room section, and weaning weight of the litter as significantly associated with development of a shoulder lesion of score 3 or 4. The average number of days for the lesions to be completely resolved was 25 for sows receiving rubber mats, 32 for the controls, and 39 for the sows receiving stainless steel plates. Rubber mats attached to the bottom of the farrowing crates decreased the time required to heal the lesions when compared with controls. The low cost per mat (less than $0.90 factoring in repeated use) makes it an economical and effective treatment.

Key words: sow shoulder lesion, decubitus ulcer, sow housing

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INTRODUCTION

Decubitus ulcers or pressure sores, comparable to bed-sores in humans, develop over bony prominences and commonly on the shoulders of nursing sows (Edlich et al., 2004). Excessive compression of soft tissues between the prominence and the interface surface (e.g., the farrowing crate floor for sows) results in an interruption of perfusion to the tissues. In humans, if this interruption is continuous for greater than 2 h the damage to tissues may be irreversible (Martin-Du Pan et al., 2004). Pressure sores in sows range in severity from hair-loss and redness to deep decubitus ulcers.

Several sow behavioral studies have shown that during the first week of lactation sows spend on average 86% of their time during the day and 98% of their time at night lying down and that the frequency of sows standing increases after the first week of lactation (de Passille and Robert, 1989; Blackshaw and Hagelso, 1990). The large tuber on the spine of the sow scapula, the long periods of lateral recumbency during farrowing and the first week of lactation, and the restricted mobility of sows in farrowing crates may contribute to formation of these lesions. Sow shoulder lesions affect sow welfare and consumer attitudes toward the swine industry. The objectives of this study were to identify risk factors for development of shoulder lesions and to determine if economical, practical treatments could be designed.

MATERIALS AND METHODS

All procedures involving the sows in this project were approved by a veterinarian and the farm manager.

The study was conducted at a 300-sow farrow-to-finish swine farm from June 2004 to January 2005. The farm was chosen in part because of its high prevalence of shoulder lesions. Three breeds of sow were found on the farm, Landrace, Duroc, and Yorkshire. The farm had 2 separate areas for farrowing sows. There were 5 rooms in section A, each with 6 farrowing crates in a

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row down the center of the room and a walk alley on either end. Section B had 4 rooms, each with 8 farrowing crates, 4 against each side wall with a center walk alley. The 2 areas had different styles of farrowing crates. The crates in section A were 43 × 191 cm and had cast iron, slatted floors under the sows (Figure 1). Section B had crates with dimensions of 64 × 198 cm with a triangular-steel bar floor under the sows (Figure 2). Section B had drip coolers programmed to turn on if the room temperature reached 27°C.

All sows due to farrow during this period were entered into the study. Sow data were recorded either the day of or 1 d after entering the farrowing crates and before farrowing had occurred. On this farm, sows are moved into the farrowing crates 3 to 7 d before farrowing. Factors recorded included sow identification, date of entry into the farrowing crate, farrowing room section, breed, sow body length, flank-to-flank measurement, BCS, and if there were any lesions, redness, or scarring present on either shoulder of the sows. Sow body length was measured in centimeters from the base of the neck to the tail base. The flank-to-flank measurement was taken as described by Iwasawa et al. (2004) and used to categorize sows into 1 of 5 BW categories. Body condition scores of 1 to 5 (1 = thin, 5 = fat) were used as described by Straw and Meuten (1992).

Shoulders of the sows were monitored weekly by the investigator and daily by the farrowing room staff, and lesions were recorded. Lesions were scored on a scale of 0 to 4 according to severity and size (Table 1). When a lesion of severity 3 or 4 was observed, the sow was randomly assigned to 1 of 3 treatment groups. These groups were a control group that received no treatment, a group that had a 0.2-cm thick, 60 × 60-cm, stainless steel plate attached to the bottom of the farrowing crate, and a group that had a 3.8-cm thick, 60 × 60-cm rubber mat attached to the bottom of the farrowing crate. The mat and the plate were attached to the crate's floor with 4 heavy plastic cable ties. They were fixed to the floor of the farrowing crate 15 cm behind the feeder to avoid accumulating spilled feed and to assure the sow's shoulder would come in contact with them when she lay down.

Sows in both farrowing sections were hand-fed twice daily at 0900 and 1600. The amount of feed given at each feeding was recorded by the farm staff on feed cards. Feed for the sows was gradually increased throughout lactation, as is standard practice on swine farms. The study farm followed a protocol to decrease feed by the amount left in the feeder from the previous feeding, if the sow had not completely finished her feed. The average amount of feed and the SD were calculated for the study group for each day of lactation beginning on the day of farrowing. Those sows whose feed consumption was 2 SD below the average daily feed consumption were classified as off-feed for that day. The number of days each sow was off-feed was recorded. Three new binary variables were created for the data, including “was the sow ever off-feed,” “was the sow off feed in the first 1 to 7 d after farrowing,” and “was the sow off feed for more than 3 d consecutively.” Each variable was tested in a univariate analysis with the presence of a shoulder lesion as the outcome.

At weaning, flank-to-flank measurement and BCS were recorded. All sows were weaned into standard gestation crates, with solid flooring on the front two-thirds of the floor and concrete slats on the rear one-third. Those sows with shoulder sores were monitored weekly, and the size and severity of the lesions were measured and photographed until the lesions were completely healed. Treatments were not continued after weaning.

Two separate spreadsheets were created to store the data. One contained all of the sow information and risk factors for the sows in which the collected information was complete. The second contained a subset of those
sows that developed lesions and the information regarding their treatment group and healing progress. In the risk factor data set, sows were categorized as having a lesion if they had an open wound (lesion score of 3 or 4) on either shoulder. The risk factor data set was analyzed in STATA (Statacorp LP, College Station, TX). A preliminary univariate regression analysis was conducted testing all risk factors individually for associations with the outcome variable of “lesion.” All continuous predictor variables were initially tested as such, then reclassified and tested as categorical (ranked if applicable and regular) and then potentially as binary variables. Stepwise regression analysis was then completed and included all predictor variables. Those variables that were significant (P < 0.01) in the preliminary analyses were included in a manually built, multivariable, logistic regression model. Again in the multivariable model, continuous predictor variables were reclassified to select the best fit for the model.

The lesion progression data were analyzed in Statistix (Analytical Software, Tallahassee, FL) using an analysis of covariance (ANCOVA) to determine if the average time to heal differed significantly among treatment categories. Factors suspected to affect the healing time of the lesions were included in the analysis. Tukey’s pairwise comparison test was used to determine specifically which treatment groups were different.

### RESULTS

Results from the preliminary univariate and stepwise regression analysis of risk factors for developing shoulder lesions determined that the number of stillbirths or mummies per litter, the total live born, and being off-feed for 1 or more days were not significantly associated with lesions and were not included in the final model.

For the risk factor data set, holding all other variables constant, BCS and flank-to-flank measurement at weaning, breed, parity, farrowing room section, and weaning weight of the litter were all risk factors (P < 0.05) for a sow to develop a shoulder lesion. The R² for the final model was 0.18. The complete model is shown in Table 2.

Sows having a BCS of less than 3 at weaning were 3.7 times more likely to develop a shoulder lesion than those who had a BCS of 3 or greater (P < 0.05). Similarly a flank-to-flank measurement of 97 to 104 cm at weaning increased the risk of developing a lesion by 2.8 times over those in the referent BW category with a flank-to-flank measure of 104.5 to 113.5 cm (P < 0.05).

Landrace or Duroc sows were 3 and 4.6 times (respectively) more likely to develop shoulder lesions than Yorkshire sows (P < 0.05). First litter sows and those sows that were fifth parity and over had a greater risk of shoulder lesions than sows that were second to fourth parity (odds ratio = 2.3, P < 0.05 and odds ratio = 3.4, P < 0.05, respectively). Sows kept in the farrowing crates in section B were 2.3 times more likely to develop a shoulder lesion than those kept in the crates in section A (P < 0.05). As the weaning weight of the sow’s litter increased by 1 kg the risk of the sow developing a shoulder ulcer increased by 1.1 (P < 0.05).

Forty-six sows were monitored for lesion progression, 20 controls, 20 with rubber mats and 6 with stainless steel plates. Use of the stainless steel plates was discontinued when the producer and researcher determined a consistent negative effect on healing. Sows in the rubber mat treatment group had a significantly decreased lesion healing time than the control sows or those on stainless steel plates. The average healing time for control sows did not differ significantly from those on stainless steel plates. The ANCOVA table and treatment group means are presented in Table 3.

### DISCUSSION

Deen and Anil (2005) suggested that the likelihood of a sow being removed from a herd increased if she has a low feed intake during d 2 through 14 of lactation. Inappetance could represent a number of problems such as disease, injury, or environmental problems. Sows that are off feed may spend more time lying down, which could increase the risk of developing shoulder lesions. However, on this farm, no association between being off feed and shoulder lesions was found. This may indicate that inappetance is not a representative indicator of increased lying time on this farm. The feed data could not account for inadequate energy intake for individual sows. For example, some sows could be eating an average or an above average amount of feed for the farm but still need more nutritional energy.

Body condition score is commonly given as a risk factor for sows developing shoulder lesions, both anecdotally from producers and in the literature (Davies et al., 1997; Reese et al., 2005; Rosendale and Nielsen, 2005). Sows with a low BCS (thin) are considered more likely to develop a lesion because they have less of a

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**Table 1. Shoulder score definitions**

<table>
<thead>
<tr>
<th>Score</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No lesion or scarring of skin over the tuber of the scapula</td>
</tr>
<tr>
<td>1</td>
<td>No current lesion but previous scarring of skin over the tuber of the scapula</td>
</tr>
<tr>
<td>2</td>
<td>Skin is reddened over the tuber of the scapula</td>
</tr>
<tr>
<td>3</td>
<td>Broken skin over the tuber of the scapula &lt; 2.3 cm in diameter</td>
</tr>
<tr>
<td>4</td>
<td>Broken skin over the tuber of the scapula ≥ 2.3 cm in diameter</td>
</tr>
</tbody>
</table>

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Table 2. Multivariate logistic regression model of risk factors for developing a shoulder lesion

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaned over 9 piglets</td>
<td>1.69</td>
<td>0.87 to 3.28</td>
<td>0.119</td>
</tr>
<tr>
<td>In farrowing crate over 30 d</td>
<td>1.62</td>
<td>0.93 to 2.83</td>
<td>0.087</td>
</tr>
<tr>
<td>Under BCS 3 at weaning</td>
<td>3.67</td>
<td>1.33 to 10.10</td>
<td>0.012</td>
</tr>
<tr>
<td>Flank-to-flank of 90 to 96.5 cm at weaning</td>
<td>1.06</td>
<td>0.39 to 2.90</td>
<td>0.909</td>
</tr>
<tr>
<td>Flank-to-flank of 97 to 104 cm at weaning</td>
<td>2.82</td>
<td>1.25 to 6.35</td>
<td>0.012</td>
</tr>
<tr>
<td>Flank-to-flank of 114 cm and greater at weaning</td>
<td>1.99</td>
<td>0.89 to 4.47</td>
<td>0.094</td>
</tr>
<tr>
<td>Landrace</td>
<td>3.00</td>
<td>1.61 to 5.64</td>
<td>0.001</td>
</tr>
<tr>
<td>Duroc</td>
<td>4.62</td>
<td>1.87 to 11.40</td>
<td>0.001</td>
</tr>
<tr>
<td>Parity 1</td>
<td>2.32</td>
<td>1.17 to 4.59</td>
<td>0.016</td>
</tr>
<tr>
<td>Parity 5 and greater</td>
<td>3.43</td>
<td>1.64 to 7.16</td>
<td>0.001</td>
</tr>
<tr>
<td>Farrowing section</td>
<td>2.28</td>
<td>1.30 to 3.99</td>
<td>0.004</td>
</tr>
<tr>
<td>Litter weaning weight</td>
<td>1.1</td>
<td>1.00 to 1.04</td>
<td>0.029</td>
</tr>
</tbody>
</table>

1A measure of the strength of association between having the risk factor if shoulder lesions are present compared with when shoulder lesions are absent; a value of 1.00 is interpreted as no association.

cushion of fat and muscle covering the tuber of the spine of the scapula. However, on some farms, well-conditioned sows sometimes develop lesions as well. On the study farm, the relationship between BCS at weaning and lesions may be explained by a loss of condition during lactation associated with high milk production or inadequate energy intake.

Flank-to-flank measurements can be used to estimate BW categories of sows (Iwasawa et al., 2004). As the BW of a sow increases so should the pressure of the flooring on the tuber of the scapula when the sow is lying laterally. For this reason Reese et al. (2005) stated that heavier sows are at a greater risk of shoulder lesions. Whereas heavier sows may experience increased pressures when lying laterally, it is likely that there is a point where BW becomes protective against developing a lesion because there is an increased depth of fat or muscle over the tuber of the scapula. Body weight does not describe body condition.

McGlone et al. (2004) found that a sow’s body dimensions increased by predictable increments with each parity, which may explain the association between older sows and shoulder lesions on this farm. Older sows that are larger in stature may have a harder time getting up within the confines of the farrowing crate and therefore remain lying down for greater periods of time. In a study on nursing behavior and activity of lactating sows, Thodberg et al. (2002) found that gilts had fewer postural changes on the day of farrowing than second parity sows. The same researchers also found that the older sows ended a greater proportion of nursing sessions (rather than allowing piglets to end the session) than did gilts. Gilts, therefore, may have longer periods of lateral recumbency, which could increase their risk of developing shoulder lesions.

The increased risk of shoulder lesions in section B may be attributed to several factors that differ between the 2 sections such as room temperature, the use of drip coolers, and the farrowing crate flooring. However, this can only be speculated because data to test each of these specific risk factors could not be separated (e.g., all section B crate designs, flooring, and presence of

Table 3. Analysis of covariance table for the number of days to heal lesions

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean sum of squares</th>
<th>P-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>486.07</td>
<td>243.03</td>
<td>5.23</td>
<td>0.01</td>
</tr>
<tr>
<td>Parity</td>
<td>6</td>
<td>406.29</td>
<td>67.71</td>
<td>1.46</td>
<td>0.24</td>
</tr>
<tr>
<td>Breed</td>
<td>2</td>
<td>153.57</td>
<td>76.79</td>
<td>1.65</td>
<td>0.21</td>
</tr>
<tr>
<td>Days treated</td>
<td>1</td>
<td>423.10</td>
<td>423.09</td>
<td>9.10</td>
<td>0.01</td>
</tr>
<tr>
<td>Error</td>
<td>23</td>
<td>1,069.64</td>
<td>46.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariate summary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covariate Coefficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days</td>
<td>0.66</td>
<td>0.22</td>
<td>3.02</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

Means of treatments for days to heal lesion

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n</th>
<th>Mean</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>20</td>
<td>32.08</td>
<td>1.66</td>
</tr>
<tr>
<td>Mat</td>
<td>20</td>
<td>25.04</td>
<td>1.83</td>
</tr>
<tr>
<td>SS</td>
<td>6</td>
<td>39.20</td>
<td>3.60</td>
</tr>
</tbody>
</table>

1Mat = rubber mat; SS = stainless steel plate.
drip coolers were the same, and all factors in section A room were the same). In a separate study on the same farm, time-temperature recorders were placed in 2 rooms of section A and section B at the time the sows were loaded into the farrowing crates. The recorders remained in the rooms until weaning with temperature being recorded every hour. Data were recorded in the summer; and during the day and the night, average room temperatures were significantly greater in section B than in section A (unpublished data).

Section B had drip coolers positioned over the shoulder region, whereas section A did not have drip coolers. In human studies of pressure lesions, increased body temperature and exposure to moisture are considered significant risk factors (Le et al., 1984; Leigh and Bennett, 1994). Davies et al. (1996) hypothesized that prolonged exposure to moisture created by drip coolers over the shoulders of sows could increase the risk of shoulder ulcers.

Metal slatted flooring is a risk factor for having more sows with lesions when compared with those housed on solid concrete. The observation that lesions tend to resolve quickly after weaning when sows are on solid floors in loose or crated gestation housing also supports this finding. Solid floors provide more surface area to support the tuber of the scapula, therefore reducing the pressure and shearing forces applied to the tissues over this region. Slatted flooring causes the sow’s total BW to be supported by a smaller total surface area, and different slab and slot widths would affect floor surface area. The triangular-steel bar flooring has a lesser amount of surface to lie on because the slats were a smaller width (1 cm) than the slots (openings = 1.2 cm). The cast iron had slats and slots of equal size (1.3 cm each).

The relationship between weaning weight of a sow’s litter and shoulder lesions may be linked to nursing behavior, milk production, or both. Knol et al. (2005) stated that heavier litter weaning weights were associated with both heavier carcass and ham weights. Because good mothering characteristics, high milk production, and heavy litters at weaning are important for profitable pig production, it is desirable to keep sows with these traits in the herd. If sows are being culled from the herd due to the presence of shoulder lesions, there would be an economic benefit in attempting to treat or prevent shoulder lesions.

Providing a solid, cushioned surface under the sow’s shoulder helped reduce healing time of the lesions. Rubber mats for this study were reused approximately 7 to 10 times each. A mat for 1 crate costs approximately $6. With reuse the cost becomes less than $0.90, making this an economical and effective treatment. The steel plates were cross-hatched (checker plate) to provide better traction; however, all 6 sows in this group had difficulty getting up and standing on this flooring. For this reason, sows in this group may have spent a greater amount of time lying, which could have increased lesion healing time compared with the controls. This treatment was discontinued early for the same reason.

**IMPLICATIONS**

Shoulder ulcers can affect the welfare of sows, consumer attitudes toward the swine industry, and possibly farm economics. Therefore, it is important to prevent or treat shoulder lesions if they occur. Shoulder ulcers on this farm resulted from many factors including body condition score and body weight at weaning, breed, parity, litter weaning weight, and environmental factors in the farrowing rooms. Whereas the sow lesion risk factor regression model was statistically significant, it only explained approximately 18% of the variation in the data. Other risk factors not examined in this study exist. Securing a rubber mat over the slatted metal flooring of a farrowing crate decreased the time needed to heal shoulder ulcers.

**LITERATURE CITED**


APPENDIX 1. SUMMARY DATA

Total number of sows in study: 312;
Total number of sows with lesion score 3 and 4: 107;
Sows with lesions on left shoulder: 67;
Sows with lesions on right shoulder: 75;
Sows with lesions on both shoulders: 35;
Frequency of BCS at weaning: BSC2 = 4; BSC2.5 = 30; BCS3 = 170; BCS3.5 = 82; BCS4 = 21; BCS4.5 = 4;
Frequency of flank-to-flank measures at weaning: FF < 90 cm = 3; FF90–96.5 cm = 57; FF97–104 cm = 140; FF104.5–114 cm = 97; FF > 114 cm = 15;
Sows in section A: 171;
Sows in section B: 141;
No. of sows in parity 1: 89;
No. of sows in parity 2, 3, and 4: 157;
No. of sows in parity 5 and over: 66;
No. of Landrace sows: 188;
No. of Yorkshire sows: 88;
No. of Duroc sows: 36;
Average total litter weaning weight: 67.288 kg;
Average number weaned: 9;
Daytime average summer temperature, section A: 23.4°C;
Daytime average summer temperature, section B: 23.9°C;
Nighttime average summer temperature, section A: 22.1°C; and
Nighttime average summer temperature, section B: 23.6°C.