Acknowledgements
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References

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21. Relationship between pig carcass tail lesions and lung lesions
Van Staaveren N.1,2, *; Vale, A.10; Manzanilla, E.G.10; Hanlon, A.2 and Boyle, L.A.10

Abstract
Tail biting is common on farms that are more prone to disease. Tail lesions can be associated with poor health either directly by providing a route of entry for pathogens or indirectly as conditions which trigger tail biting may also affect pig health. The aim of this study was to investigate the relationship between carcass tail lesion and lung lesion severity scores in Irish slaughtered pigs. Factory visits occurred over 5 days (Jan – March 2015) and tail lesion score (0 – 4) according to severity, sex, and kill number was recorded for every pig after scalding and dehairing. The lungs from each carcass were scored for lesions using an adapted version of the BPEX pig health scheme. Presence of pleuropneumonia (APP), abscesses and pyaemia was recorded. The severity of enzootic pneumonia (EP-like lesions) was recorded on a scale of 0 – 50 and grouped into none/mild (score 0 – 10), moderate (score 11 – 20) and severe (score 21 – 50). Severity of pleurisy was scored on a 0 – 2 scale with a separate variable for lungs that were attached to the chest wall (score 2). These lungs could not be assessed for other lung lesions and therefore a separate database was created for assessing the pleurisy lesions (n = 5,628) while the final database contained animals (n = 4,491) with records for tail lesions, EP-like lesion scores and pleurisy (level 0 + 1). Associations between tail lesions and sex and the different lung lesion outcomes were analysed using generalized linear mixed models (PROC GLIMMIX) with random effect for batch. EP-like lesions and pleurisy were the most common lesions, though large variation existed between batches. Pigs with severe tail lesions tended to have more severe pleurisy where the lungs remained attached to the chest wall than pigs with moderate tail lesions. No other associations between tail lesion scores and lung lesions were found. Although tail lesions on the carcass may not be an accurate predictor of lung health, tail lesions are important welfare indicators and respiratory disease is among the most significant infectious conditions affecting pigs. Thus, recording of tail and lung lesions at meat inspection provides valuable information regarding the on-farm health welfare of pigs.

Introduction
Surveillance tools assessing animal health and welfare are essential to assist the pig industry in monitoring and correcting problems associated with disease and poor welfare. Tail biting is an abnormal behaviour performed by pigs which reflects and causes poor welfare. Tail biting may also reflect poor health which could explain why it is more common on farms that are prone to disease (Moinard et al., 2003; van den Berg et al., 2005). There are two possible explanations for this link. Respiratory diseases (e.g. pleurisy/pneumonia) and other diseases have risk factors in common with tail biting which could explain why tail biting is thought to be more common on farms that are prone to disease (Moinard et al., 2003). For example, a higher prevalence of gastric lesions was observed in pigs coming from farms that showed signs of tail biting (van den Berg et al., 2005). Secondly, the damage resulting from tail biting provides a route of entry for pathogens which can then be haematogenously disseminated to different organs including the lungs leading to abscession (Heinonen et al., 2010; Schröder-Petersen and Simonsen, 2001). Elbers et al., (1992) found moderate correlations between inflammation of the tail and pneumonia, lung abscesses and severe pleurisy. Pigs with moderate tail lesions had higher odds of having abscesses or lung lesions (pleuritis and embolic pneumonia) and this risk increase with more severe tail lesions (Marques et al., 2012). In contrast, Kritas and Morrison (2007) found no association between enzootic pneumonia and tail lesions but did find a relationship between severity of tail lesions and the occurrence of abscesses and pleuritic lesions in the lungs. Although tail damage is
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One health approach under a concept of farm to fork

recorded during meat inspection, it often only the presence of severe tail damage that is noted (EFSA, 2007). A limited number of studies have examined the occurrence of tail lesions of differing severity but in many studies pathological lesions were scored as binary, i.e. presence or absence, or only recorded when the lesions was the cause of condemnation (Harley et al., 2014; Sanchez-Vazquez et al., 2011; Valros et al., 2004). The extent of the relationship between tail lesions and mild pathological lesions has not been established. To the authors’ knowledge, the only other study which examined the severity of both tail lesions and other pathological lesions was conducted by Munsterhjelm et al., (2013), when investigating characteristics of tail biters and victims. Victim pigs had higher tail lesion scores both on a macroscopic and histological level and a higher severity score for respiratory organ inflammation (Munsterhjelm et al., 2013). The aim of this study was to investigate the relationship between carcass tail lesion and lung lesion severity in Irish slaughter pigs. It was hypothesised that there would be a relationship between lung health scores and carcass tail lesion scores reflecting the association between pig health and welfare on farm.

Material and Methods

The study was designed as an observational study conducted in an Irish pig factory with a line speed of 6 pigs per minute. Factory visits were conducted between January and March of 2015 assessing a total number of 6,244 pigs. After scalding and dehairing, one observer scored carcasses for tail lesion severity per Kritas and Morrison (2007) according to severity (0: no evidence of tail biting; 1: healed/mild lesions; 2: evidence of chewing or puncture wounds, but no evidence of swelling; 3: evidence of chewing or puncture wounds with swelling and signs of possible infection; 4: evidence of chewing or puncture wounds with severe swelling/infection or open, gaping wound where tail used to be) and recorded the sex, kill number and farm identification. On the viscera line the lungs were removed from the carcass and numbered to correspond to the carcass. Lung lesions were scored using an adapted version of the BPHS (BPEX; Ellerbroek et al., 2012; Sanchez-Vazquez et al., 2011). Enzootic pneumonia-like lesions (EP-like lesions) were scored on a 0 – 50 scale according to the number of lung lobes and the percentage of each lobe affected (accessory lobe was excluded due to time constraints). Mild and severe pleurisy were recorded and a separate recording was made for severe pleurisy when the lungs were attached to the chest wall and therefore not removed from the carcass. Finally the presence of pleuropneumonia (APP), abscesses and pyaemia was recorded.

All statistical procedures were conducted using SAS V9.3 (SAS Inst. Inc., Cary, NC). Data from batches smaller than 30 pigs were omitted from analysis (Stark, 2000). Tail lesion scores were collapsed into none/mild (score ≤1), moderate (score 2) and severe lesions (score ≥3). The prevalence of the different tail lesion and lung lesion outcomes was calculated using descriptive statistics for each batch. Due to the low prevalence of APP and pyaemia these were excluded from further analyses. EP-like lesions were grouped into categories none/mild (score 0 – 10), moderate (score 11 – 20), and severe (score 21 – 50) (adapted from BPEX, 2007) and binary scores were created for each category. Pleurisy scores were separated into binary scores for mild and severe pleurisy and lungs that remained attached to the chest wall. Lungs with severe pleurisy or those that remained in the carcass could not be assessed for the other lung lesions. Therefore, a separate database was created for assessing the pleurisy lesions while the final database contained animals with records for tail lesions, EP-like lesion scores and pleurisy (level 0 + 1). Associations between tail lesions and sex and the different lung lesion outcomes were analysed using generalized linear mixed models (PROC GLIMMIX) with random effect for batch within herd.

Results

A final study population of 4,491 pigs was obtained after removal of small batches and missing data. Moderate tail lesions were found in 7.5% of the pigs and 2.3% of the pigs had severe tail lesions. EP-like lesions (58.16%) and pleurisy (42.6%) were the most frequently occurring lung lesions but however there was large variation between batches. Tail lesion score was not associated with EP category, pleurisy or abscesses (Table 1). However, tail lesion score tended to be associated with lungs that remained in the carcass due to severe pleurisy (P = 0.1). Pigs with severe tail lesions tended to have the lungs attached to the chest wall more often than pigs with moderate tail lesions (OR = 4.1; 95% CI 1.10 – 15.3; P < 0.05).

Discussion

Both EP-like lesions and pleurisy were commonly observed during the study, however no association with tail lesion scores was found. Similarly, Kritas and Morrison (2007) found no significant association between severity of tail lesions and the percentage of lungs affected by EP-like lesions and suggested that this could be explained by the fact that Mycoplasma hyopneumoniae does not spread to the lungs hematogenously (Kritas and Morrison, 2007). Previous case-control studies found a higher odds of pleurisy in tail bitten pigs compared to unburnt pigs (Kritas and Morrison, 2007; Marques et al., 2012). We found a tendency for pigs with more severe tail lesions to have higher odds of being affected with severe pleurisy, where lungs were attached to the chest wall, compared to pigs with moderate tail lesions. The reasons for the absence of differences in pleurisy between pigs with none/mild tail lesions and those with severe tail lesions are unclear and require further investigation.

The main practical limitation of the study was the line speed (6 pigs/min), placing a time constraint on the assessment of lung lesions in each pig. Nielsen et al. (2015) found a moderate correlation between lung lesions recorded at routine meat inspection and lung lesions recorded at systematic health monitoring. Differences in observer sensitivity and the differing objectives of public health versus animal health monitoring may explain why the results of our study are different from those of Teixeira et al. (in preparation) who found significant

### Table 1. The percentage of pigs (n = 4,491) affected by lung lesions in each tail lesion category

<table>
<thead>
<tr>
<th>Tail lesions</th>
<th>None/mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP-like lesions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None/mild EP</td>
<td>86.69</td>
<td>85.76</td>
<td>86.41</td>
<td>ns</td>
</tr>
<tr>
<td>Moderate EP</td>
<td>8.59</td>
<td>9.20</td>
<td>7.77</td>
<td>ns</td>
</tr>
<tr>
<td>Severe EP</td>
<td>4.71</td>
<td>5.04</td>
<td>5.83</td>
<td>ns</td>
</tr>
<tr>
<td>Pleurisy*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild pleurisy</td>
<td>22.73</td>
<td>20.63</td>
<td>16.30</td>
<td>ns</td>
</tr>
<tr>
<td>Severe pleurisy</td>
<td>20.27</td>
<td>18.20</td>
<td>23.70</td>
<td>ns</td>
</tr>
<tr>
<td>Lungs in chest</td>
<td>2.62</td>
<td>1.21</td>
<td>5.19</td>
<td>0.1</td>
</tr>
<tr>
<td>Abscess**</td>
<td>0.72</td>
<td>1.19</td>
<td>1.94</td>
<td>ns</td>
</tr>
<tr>
<td>APP***</td>
<td>0.22</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Pyaemia</td>
<td>0.02</td>
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* Dataset including all levels for pleurisy (i.e. 0 - 2) contained 5,628 pigs
** 4,483 pigs scored (missing n = 8) *** 4,487 pigs scored (missing n = 4)
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Conclusion

This study is the first to report the prevalence of lung lesions in Irish slaughter pigs. The prevalence of enzootic pneumonia and pleurisy are high giving cause for concern. Data on tail and respiratory lesions suggest that measures to improve animal health, animal welfare and reduce economic losses are required on some farms. Our results suggest that poor welfare as measured by tail lesions is not necessarily associated with poor lung health in pigs, except in the case of severe pleurisy whereby the lungs stay attached to the chest wall. Although tail lesions on the carcass may not be an accurate predictor of lung health, tail lesions are important welfare indicators and respiratory disease is among the most significant infectious conditions affecting pigs. Thus, recording of tail and lung lesions at meat inspection provides valuable information regarding the on-farm health and welfare of pigs.

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