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INFECTIOUS DISEASE: REVIEW ARTICLE

Assessment of *Mycoplasma hyopneumoniae*-induced Pneumonia using Different Lung Lesion Scoring Systems: a Comparative Review

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Summary

Mycoplasma hyopneumoniae is the primary aetiological agent of swine enzootic pneumonia (EP) and one of the major contributors to the porcine respiratory disease complex (PRDC). Gross lung lesions in pigs affected by EP consist of cranioventral pulmonary consolidation (CVPC), usually distributed bilaterally in the apical, intermediate, accessory and cranial parts of the diaphragmatic lobes. Several lung scoring methods are currently in place for the evaluation of CVPC. The aims of this study were (1) to review the lung lesion scoring systems used to assess pneumonia associated with *M. hyopneumoniae* infection, and (2) to evaluate eight of these scoring systems by applying them to the lungs of 76 pigs with experimentally-induced *M. hyopneumoniae* pneumonia. A significant correlation between all lung lesion scoring systems was observed and the coefficients of determination in a regression analysis were very high between each pair-wise comparison, except for a unique scoring system based on image analysis. A formula of equivalence between lung scoring methods was developed in order to compare the results obtained with these methods. The present review provides a basis for comparison (even retrospectively) of lesions evaluated using different lung scoring systems.

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Introduction

Pneumonia is one of the most frequent lung lesions observed in pigs at the slaughterhouse, with prevalence ranging from 19% to 79% (Fablet *et al.*, 2012). *Mycoplasma hyopneumoniae* is one of the most important primary bacterial respiratory pathogens associated with such lung lesions (Fraile *et al.*, 2010). *M. hyopneumoniae*, in combination with other pathogens, is the primary aetiological agent of swine enzootic pneumonia (EP) and is one of the main players in the porcine respiratory disease complex (PRDC) (Thacker and Minion, 2012).

M. hyopneumoniae-like gross lung lesions consist of purple to grey areas of pulmonary consolidation, mainly located bilaterally in the apical, intermediate, accessory and the cranial parts of the diaphragmatic lobes (Maes *et al.*, 2008). Such lesions are referred to in the present review as cranioventral pulmonary consolidation (CVPC). Microscopically, infiltration of inflammatory cells into the alveoli and bronchi and lymphocyte accumulation around airways and blood vessels is seen in affected lungs (Thacker, 2004). Swollen lobules occur in the early and middle stages of infection, while chronic lesions consist generally of interlobular scarring with tissue retraction (Maes *et al.*, 2008).

Several lung scoring methods are currently in place for evaluating CVPC at the farm, abattoir and experimental inoculation levels. At the farm level, necropsy examination followed by lung lesion scoring is highly recommended when severe coughing is observed in the animals. In such a scenario, the presence of CVPC may be indicative of *M. hyopneumoniae* involvement. However, since other microorganisms can produce similar lesions, laboratory testing is needed to confirm involvement (Thacker, 2004; Sibila *et al.*, 2009). At the abattoir level, evaluating lung lesions is commonly used to estimate the prevalence and severity of respiratory diseases and their impact on carcass market price, risk factor assessment and vaccine efficacy (Sibila *et al.*, 2009; Merialdi *et al.*, 2012). Abattoir surveillance may also be useful for detecting subclinical disease (i.e. no apparent clinical signs, but presence of lung lesions) or incipient cases, but it does not necessarily provide information about on-going respiratory problems at the farm level (i.e. during the rearing period, as lesions may have healed by the time animals are slaughtered; Noyes *et al.*, 1990; Sibila *et al.*, 2009). In experimental conditions, lung lesion scoring is used to study the pathogenesis of the infection and/or to assess antibiotic or vaccine efficacy (Kobisch and Friis, 1996).

Different CVPC scoring methods have been described in the literature, but there have been few comparisons made between them (Morrison *et al.*, 1985; Mousing and Christensen, 1993; Davies *et al.*, 1995). Such limited information might imply that differences in lung lesions found between studies may just reflect differences in scoring techniques (Morrison *et al.*, 1985).

CVPC not only has negative effects on the health of pigs, but also on their average daily weight gain (ADWG) and, therefore, on the profit margin for each animal (Maes *et al.*, 1996; Thacker and Minion, 2012). However, information related to the precise economic losses derived from the presence of such lesions can be difficult to interpret. Until now, the information available has been contradictory (Maes *et al.*, 1996; Thacker and Minion, 2012).

The aims of the present study were (1) to review the lung lesion scoring systems used to assess pneumonia associated with *M. hyopneumoniae* infection, and (2) to evaluate eight of these scoring systems by applying them to the lungs of 76 pigs with experimentally-induced *M. hyopneumoniae* pneumonia.

A Review of Scoring Systems for Cranioventral Pulmonary Consolidation

In order to quantify a lesion, it is necessary to score the extent of the pathological change. The ideal lung lesion score should be objective, repeatable, appropriate for the study design and be able to facilitate statistical analyses (Morrison *et al.*, 1985). Seven CVPC scoring systems reported in the scientific literature