

# Pleurisy evaluation on the parietal pleura: an alternative scoring method in slaughtered pigs

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## Summary

The present study aims to develop and assess an alternative method for scoring pleurisy in slaughtered pigs. Overall, data indicates that pleurisy can be scored effectively and efficiently by inspecting the parietal pleura. Moreover, this evaluation can be suitably carried out on digital images, thus optimizing the workload of veterinarians.

**Key words:** swine, slaughterhouse, pleurisy, scoring methods

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## Resumen - Evaluación de pleuresía en la pleura parietal: un método alternativo de puntuación en cerdos sacrificados

El objetivo del presente estudio es desarrollar y evaluar un método alternativo de puntuación de pleuresía en cerdos sacrificados. En general, la información indica que la pleuresía puede evaluarse efectiva y eficientemente mediante la inspección de la pleura parietal. Además, esta evaluación puede hacerse apropiadamente en imágenes digitales, optimizando así la carga de trabajo de los veterinarios.

## Résumé - Évaluation de la pleurésie sur la plèvre pariétale: une méthode alternative de pointage chez les porcs abattus

La présente étude visait à développer et évaluer une méthode alternative de noter la pleurésie chez des porcs abattus. Globalement, les données indiquent que la pleurésie peut être notée de manière efficace et compétente en inspectant la plèvre pariétale. De plus, cette évaluation peut être effectuée adéquatement sur des images digitales, optimisant ainsi la charge de travail des vétérinaires.

The slaughterhouse is recognized worldwide as a useful check point for assessing the health status of livestock, as well as the effectiveness of strategies implemented to prevent or treat disease conditions. This is especially true for pigs, since their lifespan does not permit the full healing of lesions, which are often still evident at slaughter.<sup>1-4</sup>

Several methods have been developed to quantify the impact of diseases. However, the greatest attention has always been paid to the so-called porcine respiratory disease complex, which deeply reduces the profitability of pig farming.<sup>3-5</sup>

Regardless of the animal species and the disease taken into consideration, each scoring method should fit some general requirements: a) it should be simple, fast, and compatible with the slaughter line speed; b) it should be easily standardizable and

reproducible; and c) it should provide data that can be easily interpreted and analyzed.<sup>3</sup>

Pleurisy is commonly observed at necropsy or during the postmortem inspection at the abattoir, its prevalence often being close to or above 50% in slaughtered pigs.<sup>2</sup> Multiple pleurisy scoring systems have been developed over the years; among these is the slaughterhouse pleurisy evaluation system grid (SPES),<sup>6</sup> which suitably meets the above criteria and is widely used to quantify pleurisy caused by *Actinobacillus pleuropneumoniae* (App) infection.<sup>2,3,7</sup>

The present work aims to assess an alternative method to score pleurisy in slaughtered pigs, based on the inspection of the parietal pleura. This method has been compared with the SPES grid, which is considered the gold standard in this field of study. The feasibility of scoring pleurisy on digital images has also been thoroughly examined.

## Materials and methods

### Animals

A total of 476 heavy pigs (9-11 months of age; 150-180 kg) were included in the present study. These pigs were slaughtered in Central and Northern Italy, between November 2017 and June 2018. The study was performed in 2 distinct steps, scoring pleurisy at the slaughterhouse and using digital images.

### Scoring pleurisy at the slaughterhouse

Two hundred sixteen slaughtered pigs were investigated. The scoring was carried out by 3 skilled veterinary surgeons after a training period and reaching consensus about how to score and record lesions. Specifically, the presence or absence and the features of pleurisy were evaluated.

A veterinarian was stationed on the slaughter line where the postmortem inspection of viscera is usually performed. The inflammatory reaction of the visceral pleura (ie, the serous membrane lining the lungs) was scored according to the SPES grid (Table 1) and reported in an *ad hoc* format.<sup>6</sup> Another veterinarian was at a different point of the slaughter line and inspected the parietal pleura (ie, the serous membrane lining the chest wall). The presence or absence of

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**Table 1:** Scoring pleurisy by the SPES method<sup>6</sup>

Score	Features of pleurisy, considering the extension and localization of lesions
0	Absence of lesion.
1	Pleurisy affecting the cranial-ventral portion of the lung; interlobar adhesion.
2	Discrete, unilateral pleurisy of the diaphragmatic lobe.
3	Discrete, bilateral pleurisy of both the diaphragmatic lobes; large, unilateral adhesion affecting the diaphragmatic lobe.
4	Large, bilateral adhesions between both the diaphragmatic lobes on one side and the chest wall on the other.

SPES = slaughterhouse pleurisy evaluation system.

pleurisy was reported in an *ad hoc* format and scored using the pleurisy evaluation on parietal pleura (PEPP) scale as detailed in Figure 1. Pleurisy was scored in each area regardless of the extent of lesions in order to limit the subjectivity of the judgment. According to the SPES grid,<sup>6</sup> considering the topography of the thoracic organs and that App-induced lesions usually affect the diaphragmatic lung lobes,<sup>8</sup> the following scores were established: 1 point for pleurisy affecting the cranial area of the parietal pleura; 2 points for pleurisy affecting the middle area of the parietal pleura; 3 points for pleurisy affecting the remaining caudal area of the parietal pleura. The points of both carcass halves are summed for a total score for each pig ranging from 0 to 12 (explanatory examples are shown in Figure 2).

### Scoring pleurisy using digital images

The reliability of scoring pleurisy on digital images was also evaluated. A veterinarian scored lesions at the slaughterhouse using the PEPP method and took pictures of all the animals under study ( $n = 260$ ). These pictures were shared with 2 veterinarians, who independently applied the PEPP method, being unaware of the score given at the slaughterhouse.

### Statistical analysis

The suitability of the sample size was assessed for a generalized linear model using G\* Power.<sup>9</sup> The mean scores obtained by applying SPES and PEPP were compared according to the diagnostic outcome (negative vs positive) by one-way analysis of variance. The relationship between the scores obtained with the 2 methods was evaluated using the Pearson's linear correlation coefficient ( $r$ ). The functional relationship between the variables measured with the 2 scoring methods was solved by linear regression analysis, whose statistical significance was evaluated by the analysis of variance; the

appropriateness of the fitting was estimated using the coefficient of determination ( $R^2$ ).

The correlation among the scores obtained by applying the PEPP method at the slaughterhouse and on digital pictures was investigated and expressed by the Pearson's linear correlation coefficient ( $r$ ). Finally, the agreement between the 2 veterinarians scoring pleurisy on digital images was measured by the Cohen's kappa coefficient ( $\kappa$  value).

## Results

### Scoring pleurisy at the slaughterhouse by SPES and PEPP methods

The presence of visceral pleurisy was demonstrated in 109 of 216 pigs (50.46%), while no pleural inflammation was detected in the remaining 107 of 216 pigs (49.54%) by the application of the SPES grid. On the same pigs, the application of the PEPP method demonstrated the presence of inflammatory reactions of the parietal pleura in 108 of 216 pigs (50%), while the remaining 108 of 216 pigs (50%) were considered healthy.

The scores obtained using both SPES and PEPP are shown in Figure 3. The similarity between the 2 scoring systems appears quite evident, although based on a different reference scale. In particular, the total number of healthy pigs (score 0) was almost identical. Actually, 8 pigs showing interlobar adhesions (score 1 with the SPES grid) were erroneously regarded as healthy by applying the PEPP method; on the other hand, 7 pigs with small lesions affecting the cranial intercostal spaces (score 1 with the PEPP method) were missed by applying the SPES grid.

Overall, the PEPP method was able to effectively discriminate diseased from healthy pigs ( $P < .001$ ), when compared with the SPES grid. The scores obtained with the 2 methods showed a very high Pearson's correlation coefficient ( $r = 0.913$ ), which was statistically significant ( $P < .001$ ). The linear regression

analysis indicated that the coefficient of determination was very high ( $R^2 = 0.833$ ) and statistically significant ( $P < .001$ ).

### Scoring pleurisy using digital images

Scoring lesions on digital images proved to be quite easy and fast (around 8 pigs/minute, including recording scores in a spreadsheet). The scores obtained using the PEPP method at the abattoir and on digital images are shown in Figure 4, which underlines the high level of similarity among independent investigators. In particular, the number of healthy pigs (score 0) was almost identical, ranging between 140 to 144 of 260 pigs. The correlation among the investigators proved to be very high and statistically significant ( $r = 0.89$  and  $0.94$ ;  $P < .001$ ). Finally, the agreement between the 2 veterinarians scoring pleurisy on digital images was also very high ( $\kappa$  value = 0.852).

## Discussion

The examination of slaughtered pigs is extremely useful and cost-effective to assess the health status of livestock, along with data collected in the herds (eg, clinical signs, necropsy findings, consumption of drugs, daily weight gain, and feed efficiency) or resulting from laboratory tests (eg, serological surveys).<sup>3,5</sup> For this reason, the assessment of innovative and suitable scoring methods is always highly desirable.

*Actinobacillus pleuropneumoniae* is the etiologic agent of porcine pleuropneumonia, a respiratory disorder of pigs distributed worldwide, causing significant economic losses to the swine industry.<sup>8</sup> A large body of evidence indicates that a high prevalence of chronic adhesive pleuritis at slaughter is very suggestive of previous App infection, thus further emphasizing the importance of the abattoir as a valuable source of data.<sup>2,5,10,11</sup> Different scoring systems have proven suitable to quantify App lesions. However, the SPES grid is the only one that can be reliably

**Figure 1:** The parietal pleura was divided into three, easily identifiable areas: 1) from the 1<sup>st</sup> to the 3<sup>rd</sup> intercostal space; 2) from the 4<sup>th</sup> to the 6<sup>th</sup> intercostal space; and 3) all the remaining caudal intercostal spaces.



assessed under field conditions, hence why it is considered the most informative system worldwide.<sup>7</sup>

Overall, our data indicate that the SPES and PEPP methods provide well matching results. We consider this to be widely expected, as pleurisy usually involves both pleural sheets (visceral and parietal), with very rare exceptions being possible (eg, interlobar pleuritis). Therefore, the PEPP scoring method could represent a reliable alternative to the SPES grid.

Obviously the PEPP method, like all the others, shows both strengths and weaknesses. For example, the inspection of the parietal pleura may not be compatible with the simultaneous evaluation of other lesions (eg, pneumonia, pericarditis, parasitic hepatitis). On the other hand, the PEPP method seems to be simple, not very influenced by possible confounding factors (eg, blood staining, lung scarring), and it can be applied in alternate locations on or off the slaughter line. In addition, it could be much faster than other methods if all carcasses are available at the end of the slaughter chain.

In our opinion, the effective application of the PEPP method on digital images could be particularly useful. The same approach appears difficult if not impossible for the SPES method because of a number of practical issues: (a) the difficulty in obtaining good quality images of the lungs along the slaughter chain; (b) the presence of large amounts of blood on the surface of viscera, including lungs; and (c) the inspiration of blood and water into the lungs from the scalding tank. Our data indicate that scoring pleurisy on digital pictures of the chest wall is fast, relatively simple, and easily standardizable, providing results which are largely comparable with those obtained by a veterinarian at the slaughterhouse. Therefore, this could be timesaving, efficient, and effective, notably streamlining the workload of the investigators.

### Implications

- Pleurisy evaluation of parietal pleura was effective and efficient.
- Using PEPP on digital images was effective and optimized inspector time.

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### Conflict of interest

None reported.

### Disclaimer

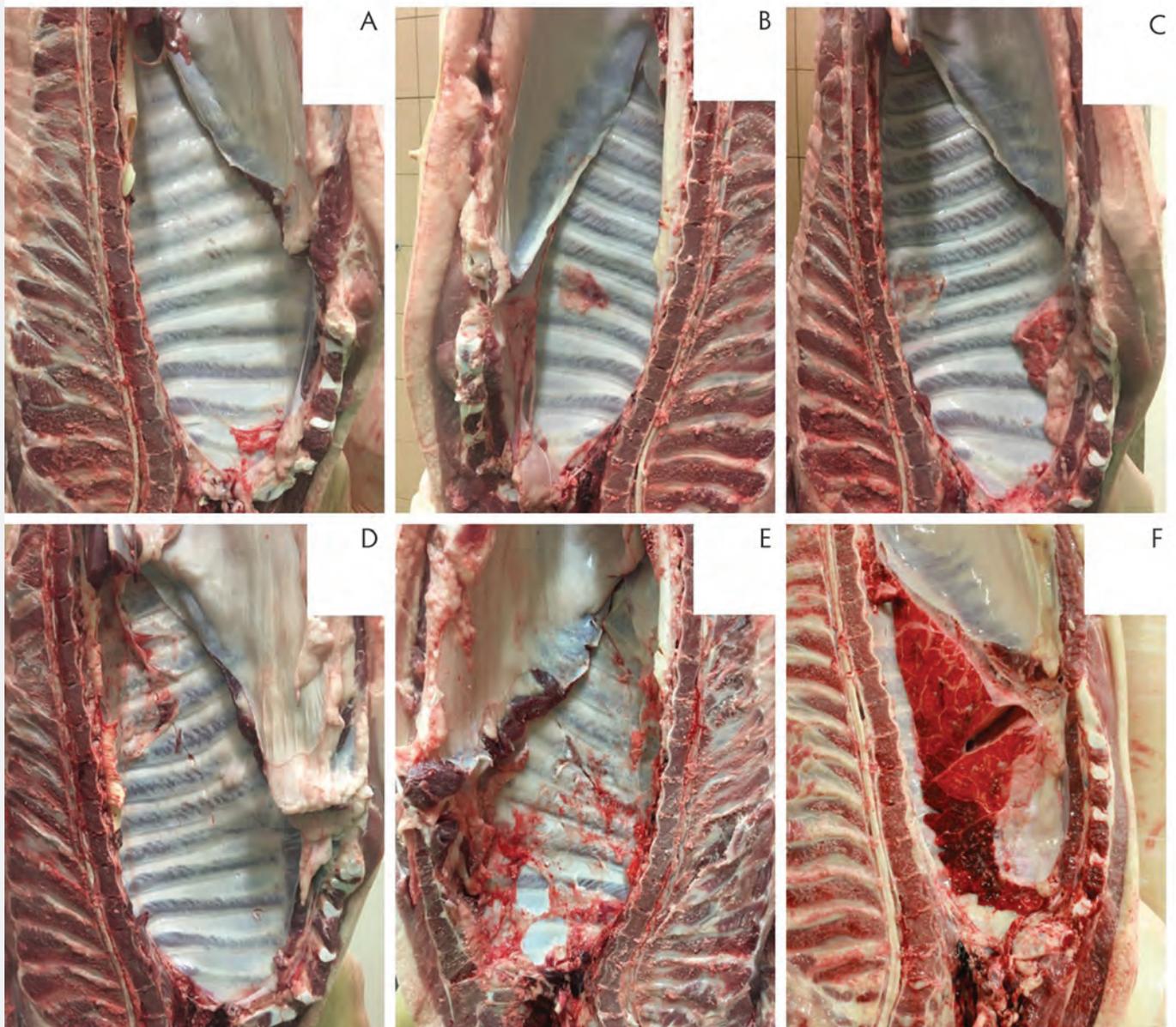
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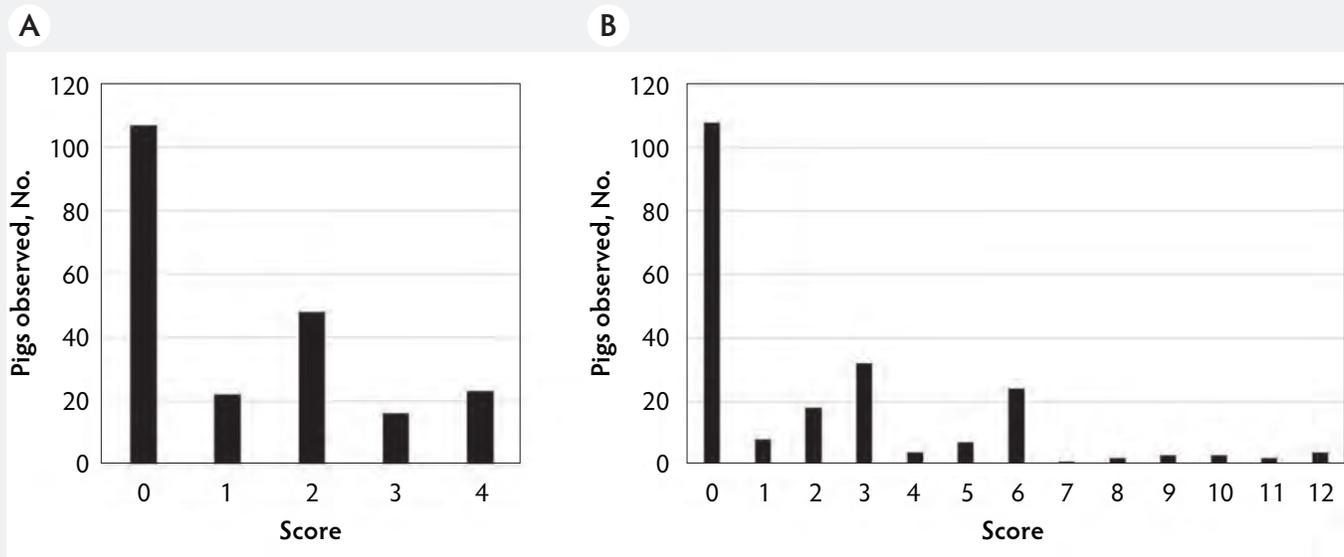
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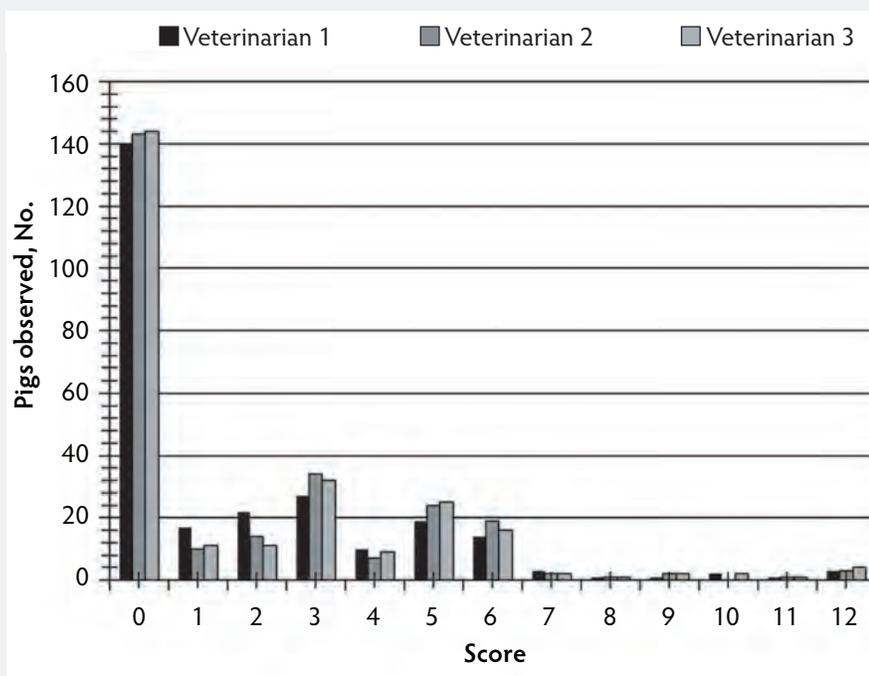
**Figure 2:** Scoring pleurisy using the PEPP method. A) Pleurisy affecting the cranial portion of the chest wall, corresponding to a score of 1. B) Pleurisy of the 4<sup>th</sup> and 5<sup>th</sup> intercostal spaces, corresponding to a score of 2. C) Pleurisy affecting both the cranial and the middle portion of the chest wall, corresponding to a total score of 3. D) Pleurisy affecting the caudal intercostal spaces, corresponding to a score of 3. E and F) The entire parietal pleura was affected by pleurisy, corresponding to a total score of 6. The points of both carcass halves are summed for a total score for each pig ranging from 0 to 12. PEPP = pleurisy evaluation on parietal pleura.



**Figure 3:** Pleurisy scores obtained by applying the A) SPES and B) PEPP pleurisy evaluation systems. Approximately, 50% of the pigs evaluated showed no pleural lesion and obtained a score of 0 using both scoring systems. The distribution of scores using the SPES system was rather uniform, with a score of 2 most frequently recorded. Using the PEPP method, most of the pigs with pleural lesions received scores of 1 to 6, with a small number of pigs scoring > 7. SPES = slaughterhouse pleurisy evaluation system; PEPP = pleurisy evaluation on parietal pleura.



**Figure 4:** Pleurisy scores obtained by applying the PEPP method to carcasses at slaughter (veterinarian 1) and to digital pictures of the carcasses (veterinarians 2 and 3). PEPP = pleurisy evaluation on parietal pleura.



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