Szent István University

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Some new aspects of equine pulmonary diagnostics

PhD thesis

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Introduction

My studies do not focus on a single equine disease or a specialized experiment series, but I have examined different aspects of equine pulmonary diagnostics. I have focused on two main fields of lower airway examinations: in the first part I studied the diagnostic value of different techniques and examination types used routinely in the diagnostic work up of chronic equine lower airway cases and in the second part I used thoracic radiography to assess the pulmonary fluid clearance in healthy neonatal foals. The primary aim of both parts of my thesis was to present useful data and recommendations to first opinion veterinary surgeons working in the field.

Even though the respiratory system is one of the most accessible organs for diagnostic testing, it is not always easy to define respiratory diseases in horses. In mature horses results of physical examination can be difficult to interpret accurately and although pertinent ancillary diagnostic modalities can help further characterize and localize causes for respiratory dysfunction, these findings are usually not specific. Diagnostic procedures performed by first opinion veterinarians in the field are often restricted to taking the history and performing clinical examination. Respiratory tract endoscopy, tracheal or bronchoalveolar lavage and blood sampling are sometimes used but other specific ancillary examinations are seldom performed in stable settings.

Respiratory disorders of the newborn foal are some of the most underdiagnosed problems in the field. Early recognition of respiratory abnormalities during the postnatal period is of special importance for successful management of critically ill foals. In most foals, physical examination is not adequate for precise identification of the cause or severity

of respiratory dysfunction, even when clinical signs are present. The skills of history taking and physical examination must be combined with clinicopathologic and diagnostic imaging techniques. Thoracic radiography of newborn foals can easily be performed even in stable settings. A single lateral projection of the thorax of a foal may provide radiographic findings of pulmonary disease Thoracic radiographs of foals made immediately after birth are characterized by a pronounced interstitial-alveolar opacity with blurring of small vessels. This opacity is the result of incomplete lung inflation, the presence of residual fluid in the small airways, and uptake of fetal alveolar fluid into the lung interstitium. Foals with respiratory disease may have a similar radiographic pattern, but it typically persists beyond the normal absorption time. The normal absorption time has not been established before.

Objectives

Our objectives were:

1. to assess the types and frequency of ancillary diagnostic techniques used routinely by first opinion veterinarians when evaluating chronic respiratory cases

2. to evaluate the diagnostic value of different techniques and examination types routinely used in the diagnostic workup of chronic equine lower airway cases in both stable and clinical circumstances.

3. to estimate the prevalence of different chronic equine lower airway diseases among horses admitted to a Hungarian referral clinic.

4. to test the usefulness of thoracic radiography during the postpartum adaptation period to visualize the clearance of fetal lung fluid.

5. to establish the earliest time when normal foals have clear, radiolucent lung fields on thoracic radiographic images.

6. to characterize the radiographic pattern of this clearance.

Diagnostic approaches for the assessment of equine chronic pulmonary disorders

Materials and methods

One hundred horses of different gender, breeds and age (mean 9,1 ± 2,8 years) with chronic respiratory symptoms were involved in this study. Most of the patients (76%) were referred for a second opinion. The same standardized examination protocol was followed in all cases: taking history was followed by clinical examination, respiratory tract endoscopy, tracheal secretion sampling and bronchoalveolar lavage. Grading systems for history evaluation, clinical examination results and respiratory tract endoscopy were developed for statistical analysis.

In 67 cases supplementary laboratory examinations, further diagnostic imaging procedures or bronchodilator test were performed.

We established our diagnoses based on previous criteria described in literature.

Conditional inference tree was used to evaluate the results.

Results and discussion

The case selection comprised horses with recurrent airway obstruction (RAO) (n = 54), inflammatory airway disease (IAD) (n = 20), infectious pulmonary disease (ID) (n = 9), upper respiratory tract functional disorder with small airway inflammation (URFTD with SAI) (n = 13, which consisted of idiopathic left laryngeal hemiplegia (n = 4), dorsal displacement of the soft palate (n = 4), pharyngeal collapse (n = 1), tracheal collapse (n = 1), subepiglottic cyst (n =

1), fourth branchial arch defect (n = 1), and arytenoid chondritis (n = 1)), and undifferentiated cases (n = 4).

Chronic pulmonary disorders were more likely to be diagnosed during the warm months (87% of the cases were diagnosed between March and November), and most horses started to show symptoms or had exacerbated clinical signs also during this period.

The result of the first tree model (**Figure 1**), where we used data usually available through history questionnaire and physical examination carried out by field practitioners in the classification of horses suffering from pulmonary disorders, suggests that horses with RAO will most likely to be found among horses with higher clinical and historical scores. According to this tree model, 38 of the 54 RAO horses and 5 out of 9 ID horses could possibly be classified correctly as RAO or ID patient. None of the 20 IAD and 13 URTFD cases was classified correctly by this model.

For the second tree model we added the data of all ancillary diagnostic procedures. Results of upper respiratory tract endoscopy, neutrophil percentage in the bronchoalveolar lavage fluid, history of previous infection and age variables were selected as the main diagnostic criteria by the model (**Figure 2**).

With the help of this tree model, 41 of the 54 RAO horses, 14 of 20 IAD horses and all 13 URTFD horses were classified correctly as RAO, IAD or URT patient. Only 3 of the 46 non RAO patients were classified as horses suffering from RAO. None of the 9 ID cases was classified correctly by this model.

Even when possibly using all the diagnostic modalities available in clinical settings 4 cases remained without a diagnosis. In contrast to this, 40% of RAO

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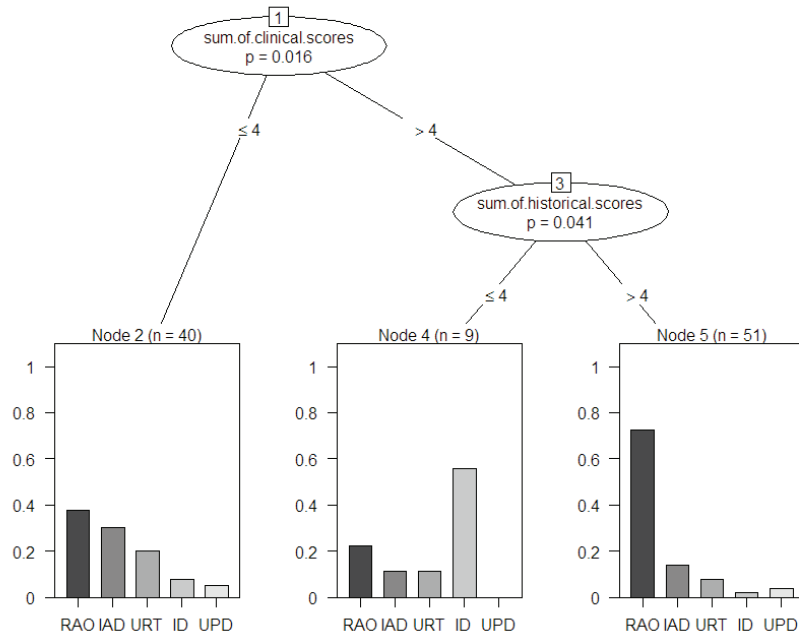and 75% of ID patients were eventually misclassified by the field practitioners previously.

Figure 1. Conditional inference tree built by using data usually available through physical examination and history. RAO: Recurrent Airway Obstruction, IAD: Inflammatory Airway Disease, URT: Upper respiratory tract functional disorders with small airway inflammation, ID: Infectious disorders, UPD: Undifferentiated pulmonary disorders.
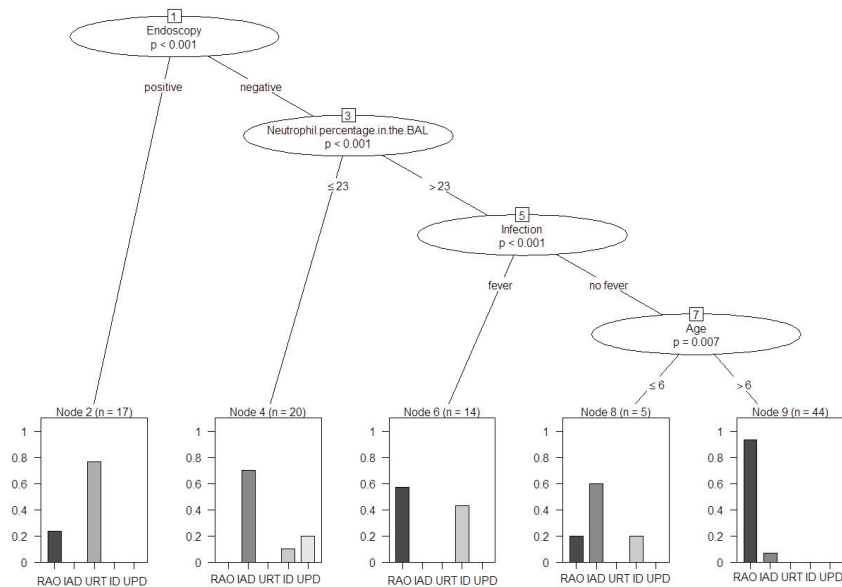
Figure 2. Conditional inference tree built by using data when added the results of ancillary diagnostic procedures. RAO: Recurrent Airway Obstruction, IAD: Inflammatory Airway Disease, URT: Upper respiratory tract functional disorders with small airway inflammation, ID: Infectious disorders, UPD: Undifferentiated pulmonary disorders

We recorded that first opinion veterinary surgeons infrequently use ancillary diagnostic techniques when investigating chronic lower airway disorders. We conclude that taking the history and performing a clinical examination is not sufficient to establish a final diagnosis in these cases. Number of successful diagnostic workup in the field would be higher if first opinion veterinarians used respiratory tract endoscopy and broncholaveolar lavage as basic diagnostic tools in all chronic respiratory cases. These ancillary diagnostic procedures are easily performed in stable circumstances as well. We also

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concluded that establishing a diagnosis in stable circumstances is impossible in approximately one quarter of cases, and it is still challenging in clinical settings.

It is also important to note that RAO appears to be widespread in Hungary, accounting for more than half of chronic pulmonary disorders. Finally, contrary to the current literature, it interestingly occurs mainly during the warm season. The high outdoor dust, air-borne mold and pollen levels and the necessary hay supplementation on pastures during the warm months complicates the optimal management of horses with RAO and commonly induce exacerbations in this period of the year. We cannot exclude that summer pasture associated RAO might complicate the diagnosis establishment in these cases.

Radiographic assessment of pulmonary fluid clearance in healthy neonatal foals

Materials and Methods

One hundred seventy six computed radiographic images of eight newborn foals of different breeds were assessed by three independent reviewers who were unaware of the age and status of the foals. Right-to-left and left-to-right lateral thoracic radiographs were acquired within the first 30 minutes after birth and repeated thereafter at 1, 2, 3, 4, 6, 8, 12, 24, 48 and 72 h. Postnatal activity of the foals was noted and we controlled normal adaptation with physical and clinicopathologic examinations.

To achieve an objective and comparable assessment, a scoring system was developed for radiographic evaluation. In the general assessment, the lung

patterns were graded from 1 to 3. Radiographs with marked pulmonary opacity were scored as 3, radiographs with less opacity but blurring of small vessels were scored as 2, and normal appearing thoracic radiographs were scored as 1. We compared left-to-right and right-to-left radiographs at each given time-point. To compare left versus right laterals a logistic mixed model using Penalized Quasi-Likelihood was. Finally, a slightly different, more sensitive, scoring system was used to grade the four lung quadrants individually. To verify of the interpretations Kendall's coefficient of concordance (Wt) was calculated.

Results and discussion

There was agreement among the interpreters both in the general evaluation (Wt = 0.898, P < 0.001) and in the individual quadrant evaluation (Wt=0.93-0.97, P < 0.001). According to each interpreter, all foals had a clear lung field by the 6th hour after birth. Although there was agreement between observers, the subjectivity of the radiographic evaluation process still has an influence on the results (**Figure 3**). Clearing of the cranioventral and caudoventral lung field preceded that of the dorsal quadrants (**Figure 4**).
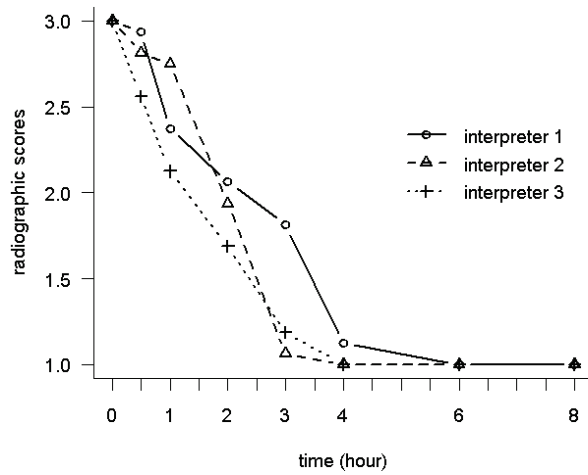
Figure 3. Clearance of thoracic radiographic opacity. Average scores of the three independent interpreters as a function of time after birth. Note differences between interpreters at some evaluation times.
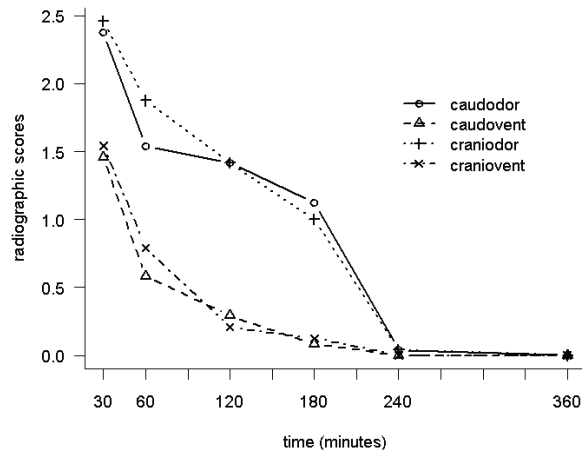

Figure 4. Patterns of radiographic clearance in different lung quadrants: □: cranioventral, +: craniodorsal, ○: caudodorsal, □: caudoventral. Fluid cleared most rapidly from ventral lung fields.

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Six hours after birth is the earliest time when normal foals reliably have clear lung fields on radiographs. Images at this time, and later, can be evaluated successfully and conclusions between physiologic and pathologic conditions can be drawn. Ventral lung cleared first, presumably because this region is bounded by the most flexible region of the thoracic wall (**Figure 5.**). It is most likely that the free expansion of the thorax is important in lung aeration, which is more easily maintained in sternal recumbency or in a standing position.

| Foal A: 30 mins., Score 3 | Foal A: 2 hours, Score 2 | Foal A: 4 hours, Score 1 |
| Foal B: 1 hour, Score 2 | Foal B: 2 hours, Score 2 | Foal B: 4 hours, Score 1 |
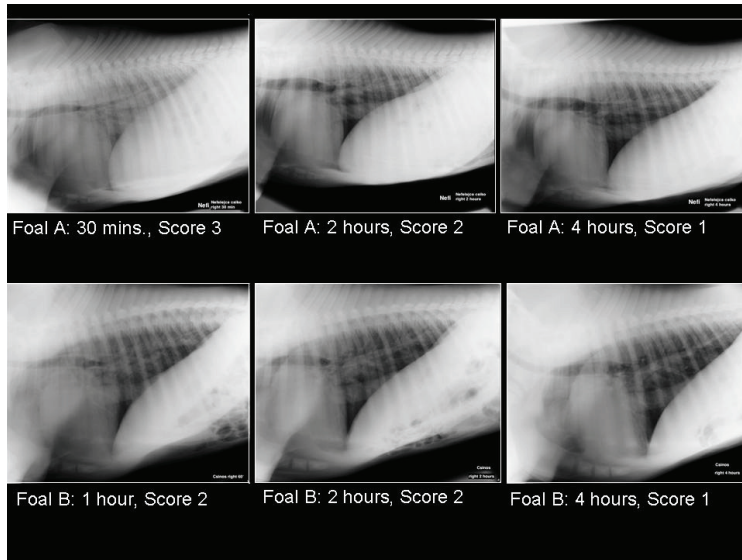
Figure 3. Series of left-to-right lateral thoracic raiographs of two foals (A and B). Note the fluid absorption pattern and change in radiopacity. The clearing of the ventral quadrants preceded that of the dorsal quadrants.

New scientific results

1. We estimated that patients with RAO had the highest prevalence among horses admitted to a Hungarian referral clinic with different chronic equine lower airway diseases.

2. Opposite to previously described scientific results we have found that RAO rather occurs during the warm months in Hungary and possible co-existence of SPA-RAO might complicate both diagnosis establishment and treatment.

3. According to the conditional inference tree method, age of the horse, history, clinical examination, respiratory tract endoscopy and bronchoalveolar lavage cytology proved to be the most valuable tools to define chronic lower airway pathology.

4. It was also concluded that in 22% of cases specific ancillary diagnostic modalities, unavailable for the field veterinarian, were needed to establish the final diagnosis.

5. We found that 4 % of chronic pulmonary cases are left with no definitive diagnosis even in clinical settings when using current understanding and all available ancillary diagnostic techniques.

6. We concluded that serial images taken with a computed radiographic system is useful to follow the postpartum clearance of fetal lung fluid.

7. We radiographicly followed the dynamics of postpartum clearance of equine pulmonary fluid from 30th minutes after birth until 72 hours and concluded that clearing of the equine lung occurs within 3 to 6 hours after birth.

8. We found that ventral lungfields cleared first, presumably because this region is bounded by the most flexible region of the thoracic wall. This stresses the importance of body-position in the postnatal period.

Publications

IF: 6,047

<u>**Publications related to the dissertation**</u>

Full-text papers published in peer-reviewed journals in English

1. Kutasi, **O.,** Horvath, A., Harnos, A., Szenci, O.: Radiographic assessment of pulmonary fluid clearance in healthy neonatal foals. Journal of Veterinary Radiology & Ultrasound, 50. 584-588, 2009. **IF: 0,985**

2. Kutasi, **O.**, Balogh, N., Lajos, Z., Nagy, K., Szenci O.: Diagnostic approaches for the assessment of equine chronic pulmonary disorders. Journal of Equine Veterinary Science, accepted for publication **IF:0,515**

Full-text papers published in peer-reviewed journals in Hungarian

1. Kutasi, O., Reményi, B., Horváth, A., Szabó, F., Machay, K., Szmodits, Zs., Paár, L., Szenci, O.: Csikók mellkasi röntgenvizsgálata : Irodalmi áttekintés, Magyar Állatorvosok Lapja, 129. 579-589, 2007. **IF: 0.104**

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<u>**Publications non-related to the dissertation**</u>

Full-text papers published in peer-reviewed journals in English

1. Kutasi, O., Vörös, K., Paár, L., Szenci, O., Sótonyi, P.: Common atrioventricular canal in a foal. Case report and literature review. Acta Veterinaria Hungarica, 55. 51-65, 2007. **IF: 0.474**

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2. Jakab, Cs., Izing, S., Veres, S., Talpag, B., Molnár, J., **Kutasi, O.:** A lovak daganatos és nem daganatos bőrelváltozásainak előfordulása és hisztopatológiája Magyar Állatorvosok Lapja, 129. 515-524, 2007. **IF: 0.104**

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