

## 7. Summary

**Susanne Reißig (2007):**

### **Validation of volumetric capnography to identify clinically inapparent pulmonary dysfunction in the calf**

**Aim:** Volumetric capnography allows assessing of pulmonary function in humans and horses in an easily applicable and non-invasive way. The aim of this study was to examine the applicability of this method in awake, spontaneously breathing calves. Therefore volumetric capnograms of pulmonary healthy calves, calves suffering from clinically inapparent lung diseases and calves experimentally infected with *Mycoplasma bovis* were analysed.

**Methods:** The pulmonary function device „MasterScreen Capno“ (VIASYS™ Healthcare, Hoechst, Germany) was used to determine various capnovolumetric parameters. In the first part of the study, 12 calves without any history of respiratory diseases and 13 calves from stocks with known problems of lower airway affections were investigated capnographically from the second to the seventh month of age (once per month). In the 12 pulmonary healthy calves, the dependence of capnovolumetric parameters on growth and ventilation was investigated. Furthermore, significant differences of the capnovolumetric parameters between healthy and pulmonary affected calves were analysed. In the second part of the study, the capnovolumetric parameters of 12 calves experimentally infected with *Mycoplasma bovis* were compared to those of six non infected animals until day 14 after challenge. As the reference method, impulsosillometric measurements were performed in both parts of the study in order to identify the presence of airway obstructions. In addition, ventilatory parameters were analysed and complementary investigations (clinical examination, direct and indirect evidence of pulmonary pathogens, pathologic-anatomical and histological examination of postmortem tissue samples) were done to evaluate any pulmonary affections.

#### **Results:**

Part 1: In calves without any history of respiratory diseases, the following characteristics were noticed

- a positive linear relationship between the CO<sub>2</sub>-volume exhaled per breath as well as the area under the expiratory CO<sub>2</sub>-curve and the tidal volume,
- a positive linear relationship between the mixing volume expired between 25 und 50 % of the end-tidal CO<sub>2</sub>-concentration as well as the mixing volume expired between 50 und 75 % of the end-tidal CO<sub>2</sub>-concentration and the inspired volume,
- a negative linear relationship between the slope of phase III and the tidal volume and
- a positive linear relationship between the five dead space estimates and the tidal volume.

Despite the absence of clinical symptoms, peripheral airway obstructions were detected in the calves with known respiratory problems in the fourth, fifth and seventh month of life using impulse oscillometry. Furthermore, these calves showed an intensively effort of ventilation at almost each time point of investigation.

Most of the capnovolumetric parameters showed a significant difference between the calves with or without any history of respiratory problems, respectively. In calves with known pulmonary affections, volumetric capnography indicated the presence of airway obstructions by deformations of the capnograms and an increased dead space volume. In comparison to the calves without any history of respiratory diseases, the following characteristics were identified almost month by month

- significantly decreased CO<sub>2</sub>-elimination per breath,
- significant increase of the ratios of the mixing volume expired between 25 und 50 % of the end-tidal CO<sub>2</sub>-concentration and the inspired volume as well as the mixing volume expired between 50 und 75 % of the end-tidal CO<sub>2</sub>-concentration and the inspired volume,
- significantly flatter slope of phase II,
- significantly steeper slope of phase III and
- significant increase of the ratio between dead space volume (determined according to Langley, Wolff and Brunner, or Bohr) and tidal volume.

Serologically, persistent or recurrent chlamydial infections were confirmed in most of the calves with known respiratory problems. The histological examination of lung tissue samples of these animals showed a markedly activated bronchus-associated lymphoid tissue (BALT) causing partial obstruction of bronchiolar lumina.

Part 2: Despite some minor clinical symptoms observed 8 -10 days after challenge, calves experimentally infected with *Mycoplasma bovis* did not show any airway obstructions using the impulse oscillometric system. Furthermore, no significant differences of either ventilatory or capnovolumetric parameters were observed between infected and non infected calves till 14 days after challenge. Nevertheless, *Mycoplasma bovis* was re-isolated in postmortem tissue samples of the respiratory tract of the experimentally infected animals, and a serological reaction against *Mycoplasma bovis* was detectable starting 10 days after infection.

**Conclusions:** Volumetric capnography was found to be suitable for the detection of clinically inapparent obstructiv lung affections in awake, spontaneously breathing calves. In agreement with recommendations from human and equine medicine, capnovolumetric parameters should be analysed taking ventilatory variables into account. Because this method is applicable non-invasively and with a small amount of time, it is recommended for further diagnostic purposes in bovines.