New Techniques to Evaluate Functional Impact of Bovine Respiratory Disease

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Abstract

Despite prophylactic measures, mainly including vaccination programs and management measures, respiratory disease remains the major cause of economic losses in bovine species. Therapeutic strategies include three targets: the etiologic agents, the inflammatory reaction and the mechanical disorders. Choice of treatment is currently main based on the clinician's personal experience.

A theoretical method has been proposed earlier to classify this syndrome into four grades of severity: Grade 1, subclinical disease (no treatment); Grade 2, compensated clinical disease (antibiotics only); Grade 3, noncompensated clinical disease (antibiotics + antiinflammatory drugs and Grade 4, irreversible clinical disease (no treatment). However, objective methods to evaluate immediate, in an easy and cheap way, the functional impact of respiratory pathologies and to determine the level of severity are not available.

Three techniques, each one evaluating the oxygen transport chain at a different level, have been studied and validated, i.e. pulse oximetry, lactate dosage and the lobeline test.

Measurement of arterial hemoglobin oxygen saturation is an important means to evaluate effectiveness of the oxygen transport chain. Assessment is usually performed based on an arterial blood sample analyzed by a blood gas analyzer. This technique presents several disadvantages: it's invasive, discontinuous and expensive. Pulse oximetry is a non-invasive, immediate and cheap method of measuring percentage oxygen saturation of arterial hemoglobin, based on differential absorption of red and infrared light. It showed to be useful and accurate in bovines when the probe was fitted to the animal's tail, even with low values of hemoglobin saturation.

Blood lactate levels are elevated in case of severe bovine respiratory disease because of diminished tissue oxygenation and because of elevated respiratory muscle effort. Assessment used to be done by a complex laboratory test. Recently a handportable apparatus, named "Accusport" and measuring blood lactate concentration immediately, has been introduced in equine medicine. It proved also to be reliable and useful in the evaluation of severity of bovine respiratory disease.

Finally, assessment of ventilatory reserve capacity by administration of lobeline, a respiratory analeptic, revealed to be very sensitive and especially valuable in animals with minor respiratory problems.

The theoretical classification into four grades of severity of bovine respiratory disease is worthless without practical means to evaluate functional impact in the field. The three presented tests could help us to realize this objective and finally economize therapeutic strategies in bovine respiratory disease.

Key words
bovine, respiratory disease, classification, pulse oximetry, lactate, ventilatory reserve

Introduction

Respiratory disease is reported to be the most costly disease of beef cattle.[1] Most calves do need a treatment for respiratory disease during somatic growth. Mortality, diminished zootechnical performances caused by irreversible pulmonary lesions and high costprice of therapeutic interventions explain the enormous economical impact of respiratory diseases. Bovine practitioners dispose of numerous pharmacological substances to treat these pathologies. Those substances can be divided into three major categories: antimicrobial agents, modulators of inflammatory reaction and

substances correcting mechanical disorders. Scientific literature is very well documented in description of the action of numerous pharmacological substances utilized in standardized conditions. On the other hand, the literature concerning the application of therapeutic strategies based on severity of different bovine respiratory syndromes is very scare. As a matter of fact, there are no criteria available based on clinical evaluation or diagnostic tests allowing us to grade the severity of the disease process.[2] Different techniques have been recently investigated by our laboratory to evaluate precisely the functional impact of respiratory pathologies in practice i.e. the lobeline test, pulse oximetry and blood lactate dosage and will be explained below.

Measurement of ventilatory reserve (lobeline test)

Spirometry is used extensively in human medicine to measure the maximal ventilatory parameters (MVP) of patients.[3] Measurement of spirometric parameters allows the characterization of respiratory lesions, improving diagnostic and therapeutic strategies. Since spirometry requires patient cooperation, it has been unavailable in veterinary medicine. Yet, MVP measurement could replace the complicated pulmonary function tests [4] currently used for research and clinical purposes in calves. In a recent study devoted to calves, we showed that the non-cooperation obstacle could be overcome by intravenous injection of lobeline, a respiratory analeptic .[5] According to this, we demonstrated that most calves' MVP could be reliably assessed during the period of maximal ventilatory changes induced by lobeline administration. Afterwards, normal values of MVP and effects of somatic growth on these parameters were defined as equations of prediction relating MVP to biometric variables in healthy Friesian calves and Belgian White and Blue calves.[6] These normal values are required for the determination of pathologic MVP changes induced by calf specific respiratory diseases and for subsequent interpretation of individual MVP values. However, these measurements necessitate the use of a face mask, a pneumotachograph, a differential pressure transducer and a computer system. High costprice of this equipment makes the test worthless in the field. A reasonable alternative was found in the use of an expiratory peak flow meter mounted on a face mask. This small cylindrical apparatus measures the expiratory peak flow instantaneously, without the need for any further instrumentation. Since expiratory peak flow is highly correlated with ventilatory reserve, the lobeline test could finally be used in practice to evaluate severity of disease. The lobeline test, which evaluates the oxygen transport chain at the level of the lung, revealed to be very sensitive and very interesting in cases of minor respiratory problems where pulse oximetry and lactate dosage couldn't detect any changes. Maximal minute ventilation was significantly diminished in subclinically ill animals. Grade 2 animals had a highly diminished maximal ventilation and a significantly elevated basic ventilation. Grade 3 and 4 showed no ventilatory reserve.

Pulse oximetry

Measurement of arterial hemoglobin oxygen saturation is an important means to evaluate effectiveness of the oxygen transport chain. Assessment is usually performed based on an arterial blood sample analyzed by a blood gas analyzer. Pulse oximetry is a non-invasive method of measuring percentage oxygen saturation of arterial hemoglobin, based on differential absorption of red and infrared light and widely used in human anesthesia and ICU. However, in veterinary medicine applications are rather limited.[7,8] Practicality and accuracy of a portable pulse oximeter and the accompanying nasal septum probe (VetOx 4402, SDI, Waukesha, USA) was assessed in 46 healthy and 6 diseased bovines, suffering from acute respiratory distress syndrome.[9] In healthy bovines three different probe sites, i.e. the tail, the nasal septum and the genital mucosae, provided a continuous, stable, intense and regular signal. There was no significant difference between the two methods when the probe fitted to the animal's tail. Shaving, pigmentation and movement artefacts were its most important inconvenients. Difference was statistically significant when the probe was attached to the nasal septum Δ (2.93 %) or to the genital mucosa (only females) Δ (2.2 %). Partial obstruction of the upper airways, head movements and limited mucosal surface in younger heifers respectively appeared to be their major disadvantages. Measurements performed on severely diseased animals (probe placed on the tail) with low values of hemoglobin oxygen saturation showed no significant differences with the reference method and were highly correlated ($r = 0.99$). Therefore, pulse oximetry could provide to the clinicians an accurate, immediate, non invasive and cheap method to assess the arterial hemoglobin oxygen saturation in cattle and to evaluate severity of failure of the oxygen transport chain in case of acute respiratory disease. Pulse oximetry measured alterations of arterial hemoglobin saturation in grade 3 and 4 animals and a saturation <85 % was indicative for an irreversible evolution.

Blood lactate dosage

Blood lactate measurement is a universally used parameter to assess muscular aerobic capacity and physical condition in horses as in man.[10,11] It also re-

vealed to be a reliable prognostic measure in case of colic in the horse.[12,13,14]

Respiratory disease challenges the oxygen transport chain in two ways : a diminished oxygen transfer from the lungs to the arterial blood and an elevated oxygen consumption by an increased work of breathing. The relative contribution of anaerobic pathway to metabolism becomes more important and consequently blood lactate could increase. Since portable blood lactate analyzers are currently available and widely used in human and equine sports medicine,[15] it seemed to be interesting to study the reliability of portable analyzers in calves in the aim of assessing afterwards the interest of blood lactate concentrations in the prognosis of bovine pulmonary disorders. A comparison was made between a reference laboratory method and a portable blood lactate analyzer (Accusport). Accusport is a small, cheap apparatus measuring instantaneously blood lactate concentration in a single droplet of blood based on a biochemical reaction and reflexphotometry. Results of both techniques were statistically different but correlation was very high.[16] Therefore it may be concluded that blood lactate measurement in calves may be performed with portable analyzers and may be used in the field by bovine practitioners. Blood lactate dosage proved to be extremely easy and interesting to separate surviving animals from non-surviving animals. Survivors never had blood lactate concentrations above 4 mmol/L. Non-survivors always showed increased lactate concentrations above 4 mmol/L during the last twenty-four hours of their life. Therefore it may be concluded that this measurement could be a very helpful instrument to increase accuracy of prognosis.

Conclusions

These preliminary results show that the theoretical classification of bovine respiratory disease into different levels of severity can be realized in practice with the help of some simple complementary tests. Measures should be done on a large number of animals to establish precise criteria for every severity level, based on clinical parameters and on results of the above described tests.

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