Bovine thoracic ultrasonography: a potential tool for the management of bovine respiratory disease

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Abstract

Bovine respiratory disease (BRD) continues to be the major animal health concern facing the North American cattle feeding industry. Despite improvements in technologies and the development of new antimicrobials, morbidity and mortality rates have remained flat or even increased. Thoracic ultrasonography (TUS) is a technology that has shown promise as a chute-side diagnostic tool for BRD. Degree of lung consolidation, as determined by TUS, has been negatively correlated to clinical outcome in cattle pulled for signs attributable to BRD and not treated with antimicrobials (negative controls). Thoracic ultrasonography is relatively simple to perform, and many of the available ultrasound machines and probes used for bovine reproductive ultrasonography can also be used to examine the lungs and pleura. While the procedures and techniques for large-scale use in a production setting remain to be validated, practitioners may currently be able to use the technology to add accuracy and value to their recommendations for case management of individual animals.

Key words: bovine, cattle, ultrasound, BRD

Résumé

Le complexe respiratoire bovin (CRB) demeure la préoccupation la plus importante au niveau de la santé animale dans le secteur du bétail pour l'alimentation en Amérique du Nord. En dépit des percées technologiques et du développement de nouveaux agents antimicrobiens, les taux de morbidité et de mortalité restent inchangés ou ont même augmenté. L'échographie thoracique est une technologie prometteuse qui pourrait servir d'outil de diagnostic du CRB à même l'enclos. Le degré de consolidation dans le poumon, tel que déterminé par l'échographie thoracique, montre une relation négative avec le résultat clinique chez les bovins retirés en raison de signes attribuables au CRB et non traités avec des agents antimicrobiens (témoins négatifs). L'échographie thoracique est relativement simple à utiliser et plusieurs des échographes et des sondes échographiques utilisés pour l'échographie du système reproducteur chez les bovins peuvent être utilisés pour l'examen des poumons et de la plèvre. Bien que les procédures et techniques pour l'utilisation à grande échelle en milieu de production restent à valider, les praticiens peuvent dès maintenant utiliser cette technologie pour augmenter la précision et ajouter de la valeur à leurs recommandations pour la gestion des cas individuels.

Introduction

In recent decades, multiple new antimicrobial treatment options have become available for use in feedlot cattle. Unfortunately, even in the face of these new antimicrobials, death loss for feedlots has remained similar or even increased during the same time period.[16] According to the National Animal Health Monitoring System (NAHMS) survey data from 1994, 1999, and 2011, death loss for all feedlots greater than 1000-head capacity that were surveyed was 1.1%, 1.3%, and 1.6% respectively.[16] Bovine respiratory disease (BRD) remains the primary health concern for the North American cattle feeding industry.

Commonly used criteria for determining disease in feedlot cattle can be summarized with systems such as DART (Depression, Appetite, Respiration, and Temperature); although peer-reviewed references for DART are lacking.[10] While these descriptions attempt to apply objective criteria to disease detection, good pen-riding is a combination of art and science. Multiple studies have evaluated the presence of lung lesions at slaughter and correlated these back to feedlot performance and previous treatment data. Animals with lung lesions present at slaughter range from 42 to 87%, and the presence of lesions in treated and untreated animals range from 40 to 97% and 37 to 83%, respectively.[4,7,9,13,14,15,17] These findings indicate that many animals with BRD or subclinical BRD may be missed by conventional means of disease detection and that a subset of animals treated for BRD may be misclassified and not require treatment. Lung lesions present at slaughter have been associated with poorer average daily gain (ADG) during the feeding period,[4,15,17] and the severity of lesions have been correlated to the degree of impact on ADG.[13]

While working towards systems that reduce the impact of BRD on beef production it is important to consider antimicrobial stewardship. Some current indications for antimicrobial use will face increased public scrutiny and government regulation in the coming years. However, it is our responsibility as practitioners to go above and beyond these measures to ensure that antimicrobials are used in a prudent and responsible manner. Some regulation may be unavoidable; however, industry initiative on this topic and the further development of new or existing technologies that may improve identification of animals truly in need of antimicrobial therapy may help in the fight to keep these valuable

tools available for practitioners and producers.

In this day and age, with decreasing technology costs and increasing value of cattle, new technologies that may aid in the diagnosis and classification of BRD deserve increased attention. One technology that shows promise as a means of determining the degree of lung pathology is the use of thoracic ultrasonography (TUS). Thoracic ultrasonography has been proven to be well correlated with lung pathology present at necropsy[8,11] and has high specificity as a tool for diagnosing BRD in dairy calves.[6] In addition, following some basic training, TUS is a procedure that can be performed accurately by individuals with no prior background with ultrasound interpretation.[5] Therefore, it is a logical and practical option to evaluate as an augment to clinical impression score for the classification of BRD in the feedlot. By using such technologies to more accurately and specifically diagnose BRD and better classify the severity of disease in affected individuals, there may be opportunity to differentially treat animals, thus producing better outcomes and reducing total antimicrobial use.

Thoracic Ultrasonography

Thoracic ultrasonography is a relatively simple procedure to perform chute-side. Equipment needed includes an ultrasound machine, probe, and conducting agent. The most useful probe is a linear array in the range of 5 to 8 MHz; however, curvilinear or convex probes may also be used. The benefits of a linear array are: 1) it allows for good contact between the probe and skin due to the relatively flat nature of the hide within the intercostal spaces, 2) this is a commonly used probe for transrectal ultrasound and is commonly found in practices; or even in feedlots where ultrasound is used to determine pregnancy status of heifers on arrival. For a conducting agent, 70% isopropyl alcohol is an economical choice and allows for appropriate image quality. No clipping of the hair is necessary unless there is significant tag that requires removal. The lungs and pleura are examined by positioning the probe longitudinally within the intercostal spaces and scanning a region that approximates the auscultable lung field, focusing on the cranioventral regions near the heart. In feedlot cattle, the front limb precludes evaluation of the right cranial lung lobe, which is most often affected by BRD.

Many good resources are available on lung ultrasonography,[2,3,8,11] and an in-depth explanation falls beyond the scope of this paper. In brief, normal aerated lung will reflect all sound waves creating a hyperechoic line at the pleural surface. The visceral pleura can be seen sliding across the parietal pleura during inspiration and expiration. The lung parenchyma is not examined in normal lung and a reverberation artifact is often seen deep to the pleural surface. When lung becomes consolidated, the visceral pleura loses its sharp definition and heterogenous echotexture is present in lung parenchyma as sound waves pass through areas of fluid-filled alveoli (hypoechoic) and are reflected by air filled bronchi (hyperechoic). In severely consolidated lung, the entire parenchyma is fluid filled and takes on a more homogenous hypoechoic echotexture (also termed hepatization of lung due to the similar appearance as normal liver). Other possible ultrasonographic lesions of varying significance include pleural effusion, pleural irregularities, abscesses, and comet tails.

Feedlot Applications

There is minimal research published on the use of TUS in a feedlot setting. The first study in a feedlot setting was performed by Abutarbush and colleagues in 2006-2007[1] to evaluate utility of TUS at first diagnosis for BRD using a case:control design. These researchers scanned 3 intercostal spaces on the right side of the animal at time of first treatment for BRD and determined that there was no correlation between TUS and subsequent animal health outcomes.[1] They did, however, postulate that TUS may be of some value in certain populations, such as those suffering from a longer course of disease (e.g. animals in the chronic pens).[1]

A second case:control study performed in 2012 to evaluate TUS findings during the natural progression of BRD showed a strong negative correlation between degree of consolidation and subsequent clinical outcome (defined as death prior to the end of the 15-day trial period).[12] In this study, case animals were not treated with antimicrobials as an objective of the study was to follow natural progression of BRD, and the entire lung field was scanned for lesions on both sides of the animal.[12] When evaluating the agreement between consolidation diagnosis in the right and left lungs, the kappa agreement was moderate (0.50; 95% confidence interval from fair to good (0.25 to 0.74)), suggesting that at least a region of both lungs must be scanned for accurate assessment.[12] Additionally, this study[12] used a 5 to 8 MHz linear array whereas the previous study[1] utilized a 3.5 MHz sector probe. These above mentioned differences in study design may have contributed to the conflicting findings between the 2 studies. It was also determined that 9 sites (4 right and 5 left hemithorax) had an odds ratio significantly greater than 1 ($P<0.05$) for predicting negative outcome when consolidation was present at time of enrollment.[12] The locations outlined by these sites primarily encompass a region caudal to the heart at, or ventral to, the level of the shoulder joint, highlighting a more targeted area for future work evaluating the use of TUS in a feedlot setting.

While there is still much to be done in evaluating this technology for large scale use in the feedlot, practitioners should be aware of this tool and consider TUS as an aid in the diagnosis and management of individual cases. When asked to evaluate or make management decisions on an individual animal, TUS can add to the value of recommendations provided. Many practitioners already have equipment suitable for performing TUS, as many ultrasound machines

and probes routinely used for reproductive work will also provide diagnostic images of the lungs in the bovine.

Conclusions

Thoracic ultrasonography may prove a valuable tool for diagnosing and further classifying severity of BRD in feedlot cattle. A strong negative correlation exists between degree of lung consolidation present at time of initial pull and subsequent outcome in calves not treated with antimicrobials (negative controls). While TUS may not be practical for all applications on the feedlot, there is the potential that this tool may be valuable in certain scenarios. By merging the art of good pen-checking with the science of improved technologies, producers and practitioners can achieve new levels of disease detection, diagnosis, and management. Further research on this topic is warranted, and the goal of future work should be to identify applications of TUS that provide an economic advantage to the producer.

Practitioners should be aware of this technology and may be able to incorporate it as an additional tool for diagnosis and management of individual cases.

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