J. Koziol
Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Purdue University

J. Schoonmaker, C. Wickware
Department of Animal Sciences, College of Agriculture, Purdue University

M. Kepler
Purdue Extension, Purdue University

C. Croney
Department of Comparative Pathobiology, College of Veterinary Medicine, Purdue University

Bovine Respiratory Disease Complex

Introduction and Significance of BRD Complex

Bovine Respiratory Disease (BRD) is the costliest disease in beef and dairy cattle in North America (USDA, 2011, 2012). Annual economic losses caused by decreased production and increased veterinary costs are in the $800 million to $900 million range in the United States (Johnson et al., 2017). BRD complex is a multifactorial syndrome caused by a composite of host and environmental factors, pathogens, and management practices. For example, the disease is associated with multiple bacteria, including Mannheimia haemolytica, Pasteurella multocida, Histophilus somni, and Mycoplasma bovis, and compounded by viruses, including Bovine Herpesvirus, Bovine Respiratory Syncytial Virus, Parainfluenza 3, Adenovirus, Bovine Viral Diarrhea Virus, and Bovine Respiratory Coronavirus. BRD typically manifests in young, naïve cattle because of nutritional changes, poor housing with wet bedding, overcrowding, co-mingling, stress caused by handling and transport, season (summer and winter) or an underlying viral infection. BRD therefore presents significant challenges for animal health and welfare, as well as the economics of cattle production.

Clinical Signs

Behavioral indicators of sickness provide a pillar for early recognition of BRD in cattle. Subtle signs of depression, lagging behind the herd, changes in feeding habits or in social interactions are often among the first signs recognized. These are followed by more obvious clinical signs, including ocular or nasal discharge, increased respiratory effort, coughing,

depression, ear drooping or head tilt, standing with an arched back, gauntness, decreased appetite or unwillingness to eat at all. These clinical signs can be applied across all classes of beef and dairy cattle. There are several BRD scoring systems that can be used to score and determine if an animal should be more closely examined for disease. These systems include the DART (Depression, Appetite, Respiration, Temperature) method, Clinical Illness Scores for Calves, the UC Davis Bovine Respiratory Disease scoring system app for pre-weaned dairy calves, and the respiratory scoring app from University of Wisconsin-Madison. Both apps can be downloaded for Android or Apple phone users.

Early detection and treatment are key because delayed treatment increases the likelihood of chronic sickness and death within the herd. As the disease progresses and inflammation secondary to the infection affects the lungs, they may become damaged beyond repair. This necessitates early recognition of clinical signs so that treatment may be initiated and unnecessary suffering can be avoided.

Diagnosis

Diagnosis of BRD is largely reliant on human evaluation of cattle, ability to recognize the aforementioned clinical signs, and implementation of the basic strategy of removing individual animals suspected of infection for further evaluation. Cattle are a prey species and tend to hide early sickness behavioral signs. Therefore, it is important to have well-trained personnel who know what to look for and why it is important. Diagnosis often requires more intense chute-side evaluations, consisting of rectal temperature assessment and auscultation of the lung fields. Normal body temperature is 101-102°F for cattle, but environmental temperature and humidity must be taken into account when evaluating rectal temperatures. On examination, rectal temperatures of animals with BRD are usually higher than 104°F. When auscultated using a stethoscope, the lung field may have crackles and wheezes. For additional confirmation of diagnosis, samples can be taken from upper and lower respiratory systems and submitted for bacterial culture and molecular identification of viral infections.

Currently, more advanced chute-side diagnostic methods are limited. Only a few technological advances, such as the Whisper® stethoscope (Merck Animal Health), are available to improve the accuracy of diagnosing animals suffering from BRD. There is also a rapid, chute-side automated white blood cell differential test (QScout BLD; Advanced Animal Diagnostics, Morrisville, NC) that may aid in the diagnosis of BRD.

Treatment

Injectable antibiotics and fever-reducing medications, such as flunixin meglumine, are often the mainstays of treatment once a diagnosis of BRD is made. The veterinarian and producer should work together to formulate a plan for antibiotic use at each operation. Plans are not one size fits all and can be tailored for the unique challenges of each operation, considering risk factors and class of cattle.

Antibiotics that are labeled for treatment and control of BRD must be prescribed by a veterinarian under the guidance of a valid Veterinarian-Client-Patient Relationship (VCPR). Each animal treated for BRD should have a treatment card or file started. Information included on the card typically should include animal ID, age, treatment date, clinical signs, and the antibiotic that was administered (including route of administration). For producers, this is beneficial for multiple purposes. They can:

- Better track treatment expenses;
- Review the effectiveness of treatments based on the number of subsequent treatments needed; and
- Calculate post-antibiotic milk and meat withdrawals for each animal.

Animals experiencing a clinical case of pneumonia are likely to be dehydrated and experiencing pain, which can negatively impact normal drinking and eating behavior. Therefore, the treatment protocol should address pain and dehydration before administering an antimicrobial. Dehydrated animals do not respond well to injectable antimicrobials, and this may cause extended drug clearance by the kidneys, thus increasing the risk for residues in meat and/or milk.

In herd outbreak situations where numerous animals are affected, sample submission may be necessary to learn precisely which types of pathogens (e.g., bacteria, viruses) are impacting a particular set of cattle. The attending veterinarian may elect to submit samples from the respiratory tracts of live or dead animals to an animal disease diagnostic laboratory for identification of which virus or bacteria is causing the clinical illness. In best case scenarios, not only will the causative agent be determined (viral or bacterial) but the most appropriate treatment can be chosen. If the causative agent is bacterial, a list of antimicrobials that can treat the infection can be requested. However, this process can take days and may not be practical in all situations.

Prevention and Control

BRD control requires management of several factors, including overall health and immunity along with proper vaccination. Proper colostrum management and nutrition of pre-weaned calves are critical to ensure adequate body growth, immunity, and health. Vaccination against BRD is broadly accepted as an effective control measure and is widely practiced. However, timing and specific situations, such as entry into a feedlot, must be considered when discussing effectiveness (Theurer et al., 2015; O'Connor et al., 2019). Vaccine-induced immunity may take 14–21 days to develop (Edwards, 2010), and risk factors for BRD morbidity generally occur during the transition from the cow/calf operation to stocker or feedlot situations. These include stressors related to weaning, mixing of animals from different farms of origin (e.g., at an auction barn), transport, and fasting during transport (Cusack et al., 2003; Edwards, 2010).

To increase energy and immune status of calves and prepare them for the stress of transition to a stocker/backgrounder or feedlot situation, ensure that all calves are vaccinated, weaned, and dehorned, and that bull calves are castrated and trained to use a bunk for feed for 4-6 weeks prior to shipping. Calves that are vaccinated and retained on their ranch of origin after weaning (i.e., pre-conditioned) exhibit less morbidity and health costs at later stages in the industry and generate greater net return to the cow-calf producer (Richeson et al., 2019). Thus, following these procedures may facilitate decreased use of antibiotics.

Metaphylaxis, defined as "mass treatment of animal population currently experiencing any level of disease before the onset of blatant illness" (Young, 1995), has been shown to reduce morbidity risk and increase performance in high-risk classes of cattle and may be chosen as a means to control or reduce the number of animals that become ill with BRD.

Need for diagnostic tools and strategies to refine BRD detection

The use of pharmaceuticals in conjunction with efforts to support and improve overall health and welfare of cattle are mainstay approaches to decreasing the impacts of BRD on the cattle industry. Increasing awareness of antimicrobial resistance (AMR) and the resulting need for continued antimicrobial stewardship necessitate treatment innovations within the cattle industries. For example, while the use of antimicrobials for metaphylaxis has proven efficacious in many models, a recent study suggests that this may contribute to increased antimicrobial resistance (AMR) in high-risk stocker cattle (Snyder et al., 2020). A surge in the number of animals that exhibit AMR can result in higher costs for producers due to recurring sickness or overall treatment failure, as well as subsequent loss of animals. Treatment failures may also increase costs for producers as retreatment and increased time for animals to reach market expectations raise total cost per head (Cernicchiaro et al., 2013).

With growing awareness of antibiotic use and heightened concern about the increased detection of antimicrobial resistance, correct diagnosis and antibiotic use in cattle production become more important. Traditional evaluation methods, including use of the technologies described above, and others not mentioned in this article vary in their accuracy of diagnosing BRD. The need for increased accuracy in diagnosis, along with rapid detection of pathogens, warrants exploration of alternative diagnostic methods such as field-deployable sensors and other biosensor technologies (White et al., 2009; Buczinski et al., 2014; Mang et al., 2015).

Summary

Bovine Respiratory Disease has challenged the cattle industries for decades. While efficacious vaccines, increased awareness of the need for healthy immune systems, and innovative antibiotics have all helped with the control of BRD, there is still significant need to reduce the negative impacts of the disease. Accurate diagnosis, continued antimicrobial stewardship, and increased awareness of antimicrobial resistance will require exploration and adoption of new, modern technologies to help lessen the burden of this disease.

References

Abell, K.M., M.E.Theurer, R.L. Larson, B.J. White and M. Apley. 2017. A mixed treatment comparison meta-analysis of metaphylaxis treatments for bovine respiratory disease in beef cattle. J. Anim. Sci. 95:626–635.

Baptiste, K.E. and N.C. Kyvsgaard. 2017. Do antimicrobial mass medications work? A systematic review and meta-analysis of randomised clinical trials investigating antimicrobial prophylaxis or metaphylaxis against naturally occurring bovine respiratory disease. Pathogens and Disease:75: ftx083. doi:10.1093/femspd/ftx083

Buczinski, S., G. Forte, D. Francoz, A.M. Belanger. 2014. Comparison of thoracic auscultation, clinical score, and ultrasonography as indicators of bovine respiratory disease in preweaned dairy calves. J. Vet. Intern. Med. 28:234-42.

Cernicchiaro, N., White, B. J., Renter, D. G., & Babcock, A. H. 2013. Evaluation of economic and performance outcomes associated with the number of treatments after an initial diagnosis of bovine respiratory disease in commercial feeder cattle. Am. J. Vet. Res.74:300-309.

Cusack, P.M., N, McMeniman, and I.J. Lean. 2003. The medicine and epidemiology of bovine respiratory disease in feedlots. Aus. Vet. J. 81:480–487.

Edwards, A. J. 1996. Respiratory diseases of feedlot cattle in the central USA. Bovine Practioner 30:5–7.

Johnson, K.K., and D.L. Pendell. 2017. Market impacts of reducing the prevalence of bovine respiratory disease in United States beef cattle feedlots. Front. Vet. Sci.4: 189.

Jones, M.L., and R.W. Allison. 2007. Evaluation of the ruminant complete blood cell count. Vet. Clin. North Am. Food Anim.Pract. 23:377–402.

Loneragan, G.H., D.A. Dargatz, P.S. Morley, and M.A. Smith. 2001. Trends in mortality ratios among cattle in US feedlots. J. Am. Vet. Med. Assoc. 219:1122–1127. doi:10.2460/javma.2001.219.1122

Mang A.V., S. Buczinski, C.W. Booker, and E. Timsit. 2015. Evaluation of a computer-aided lung auscultation system for diagnosis of bovine respiratory disease in feedlot cattle. J. Vet. Intern. Med. 29:1112-1116.

O'Connor, A.M. D. Hu, S.C. Totton, N. Scott, C.B. Winder, B. Wang, C. Wang, J. Glanville, H. Wood, B. White, R. Larson, C. Waldner, and J.M. Sargeant. 2019a. A systematic review and network meta-analysis of bacterial and viral vaccines, administered at or near arrival at the feedlot, for control of bovine respiratory disease in beef cattle. Animal Health Research Reviews 20:143–162.

O'Connor, A.M. D. Hu, S.C. Totton, N. Scott, C.B. Winder, B. Wang, C. Wang, J. Glanville, H. Wood, B. White, R. Larson, C. Waldner, and J.M. Sargeant. 2019b. A systematic review and network meta-analysis of injectable antibiotic options for the control of bovine respiratory disease in the first 45 days post arrival at the feedlot. Animal Health Research Reviews 20:163–181.

Roland, L., M. Drillich, and M. Iwersen. 2014. Hematology as a diagnostic tool in bovine medicine. J. Vet. Diagn. Invest. 26:592–598.

Richeson, J.T., H.D. Hughes, P.R. Broadway, and J.A. Carroll. 2019. Vaccination management of beef cattle: Delayed vaccination and endotoxin stacking. Vet. Clin. Food Anim. 35:575–592

Snyder, E., & Credille, B. (2020). Mannheimia haemolytica and Pasteurella multocida in Bovine Respiratory Disease: How Are They Changing in Response to Efforts to Control Them? Vet. Clin. North Am. Food Anim.Pract.

Theurer, M.E., R.L. Larson, and B.J. White. 2015. Systematic review and meta-analysis of the effectiveness of commercially available vaccines against bovine herpesvirus, bovine viral diarrhea virus, bovine respiratory syncytial virus, and parainfluenza type 3 virus for mitigation of bovine respiratory disease complex in cattle. J. Am. Vet. Med. Assoc. 246:126–142.

Tornquist, S.J., and J. Rigas. 2011. Schalm's veterinary hematology. Vet. Clin. Pathol. 40:307–313.

USDA. 2011. Feedlot 2011 Part IV: Health and Health Management on U.S. Feedlots with a Capacity of 1,000 or More Head.

USDA. 2012. Dairy Heifer Raiser, 2011. Available at: https://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/dairyheifer11/HeiferRaiser.pdf. (Accessed: 22nd October 2020).

USDA APHIS Veterinary Services National Animal Health Monitoring System (NAHMS). 2019. Antimicrobial Use and Stewardship on U.S. Feedlots, 2017, Report. Available at https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/monitoring-and-surveillance/nahms/antimicrobial_use_2017.

Young, C. 1995. Antimicrobial metaphylaxis for undifferentiated bovine respiratory disease. Compend. Contin. Educ. Vet.17:133-142

White, B.J., and D.G. Renter. 2009. Bayesian estimation of the performance of using clinical observations and harvest lung lesions for diagnosing bovine respiratory disease in post-weaned beef calves. J. Vet. Diag. Inv. 21:446-53