Contents

Preface: Bovine Respiratory Disease: What’s New? xv
Amelia R. Woolums and Douglas L. Step

Bovine Respiratory Disease: Looking Back and Looking Forward, What Do We See? 239
Robert A. Smith, Douglas L. Step, and Amelia R. Woolums

Changes in cattle feeding in the twentieth century led to the “Golden Age of Cattle Feeding” on the US High Plains; this was accompanied by recognition that bovine respiratory disease (BRD) is the leading cause of feedlot morbidity and mortality. Decades of research have illuminated the multiple viruses and bacteria that contribute to BRD, which led to vaccines and antimicrobials to prevent, treat, and control BRD. Despite these discoveries, feedlot BRD morbidities do not appear to have changed substantially over this time. New technologies are being developed that have the potential to improve accuracy of BRD detection.

Mannheimia haemolytica and Pasteurella multocida in Bovine Respiratory Disease:
How Are They Changing in Response to Efforts to Control Them? 253
Emily Snyder and Brent Credille

The bacteria Mannheimia haemolytica and Pasteurella multocida contribute to bovine respiratory disease (BRD), which is often managed with antimicrobials. Antimicrobial resistance in these bacteria has been rare, but extensively drug-resistant strains have recently become common. Routine antimicrobial use may be driving this resistance. Resistance spread is caused in part by propagation of strains harboring integrative conjugative elements. The impact of antimicrobial resistance on treatment outcomes is not clear, but clinical observations suggest that response to first treatment has decreased over time, possibly because of resistance. Clinicians should consider antimicrobial resistance when designing BRD treatment and control programs.

Pathogenesis and Virulence of Mycoplasma bovis 269
Jose Perez-Casal

Mycoplasma bovis is an important component of the bovine respiratory disease complex and recent reports identified that other species are also affected by M bovis. Control of the disease caused by M bovis has been unsuccessful owing to many factors, including the capacity of M bovis to evade and modulate the immune system of the host; the lack of known virulence factors; the absence of a cell wall, which renders antibiotics targeting cell–wall synthesis unusable; and the failure of vaccines to control disease on the field. The current knowledge on virulence and pathogenesis is presented in this review.
Histophilus somni: Antigenic and Genomic Changes Relevant to Bovine Respiratory Disease

Randal M. Shirbroun

Histophilus somni is associated with several disease syndromes in cattle and plays an important role in the bovine respiratory disease complex. H. somni isolates exhibit significant differences in terms of susceptibility to inactivation by normal serum corresponding to the general ability to cause clinical disease. Isolates possess a variety of virulence factors, and variation in virulence factor expression is well recognized and associated with antigenic differences. Sequencing of genes associated with known virulence factors has identified genetic variability between isolates. The antigenic and genomic differences represent significant challenges to the host immune system and are problematic for vaccine design.

Respiratory Bacterial Microbiota in Cattle: From Development to Modulation to Enhance Respiratory Health

Edouard Timsit, Chris McMullen, Samat Amat, and Trevor W. Alexander

The respiratory tract of cattle is colonized by complex bacterial ecosystems also known as bacterial microbiotas. These microbiotas evolve over time and are shaped by numerous factors, including maternal vaginal microbiota, environment, age, diet, parenteral antimicrobials, and stressful events. The resulting microbiota can be diverse and enriched with known beneficial bacteria that can provide colonization resistance against bacterial pathogens or, on the contrary, with opportunistic pathogens that can predispose cattle to respiratory disease. The respiratory microbiota can be modulated by nonantimicrobial approaches to promote health, creating new potential strategies for prevention and treatment of bovine respiratory disease.

Viruses in Bovine Respiratory Disease in North America: Knowledge Advances Using Genomic Testing

Robert W. Fulton

Advances in viral detection in bovine respiratory disease (BRD) have resulted from advances in viral sequencing of respiratory tract samples. New viruses detected include influenza D virus, bovine coronavirus, bovine rhinitis A, bovine rhinitis B virus, and others. Serosurveys demonstrate widespread presence of some of these viruses in North American cattle. These viruses sometimes cause disease after animal challenge, and some have been found in BRD cases more frequently than in healthy cattle. Continued work is needed to develop reagents for identification of new viruses, to confirm their pathogenicity, and to determine whether vaccines have a place in their control.

The Immunology of Bovine Respiratory Disease: Recent Advancements

Jodi L. McGill and Randy E. Sacco

Bovine respiratory disease (BRD) remains a leading cause of morbidity, mortality, and economic loss to the cattle industry. The continued high
prevalence of the disease underlines a gap in understanding of the host immune response to respiratory infection. The host immune response is beneficial and detrimental, required for clearing the disease but often leading to tissue damage and long-term defects in lung function. This article highlights advancements made in understanding innate and adaptive immunity in BRD, factors that predispose animals to BRD, and novel intervention strategies that may lead to changes in the approach to treating and controlling BRD.

Host Tolerance to Infection with the Bacteria that Cause Bovine Respiratory Disease

Laura L. Bassel, Saeid Tabatabaei, and Jeff L. Caswell

Calves vary considerably in their pathologic and clinical responses to infection of the lung with bacteria. The reasons may include resistance to infection because of pre-existing immunity, development of effective immune responses, or infection with a minimally virulent bacterial strain. However, studies of natural disease and of experimental infections indicate that some calves develop only mild lung lesions and minimal clinical signs despite substantial numbers of pathogenic bacteria in the lung. This may represent “tolerance” to pulmonary infection because these calves are able to control their inflammatory responses or protect the lung from damage, without necessarily eliminating bacterial infection. Conversely, risk factors might predispose to bovine respiratory disease by triggering a loss of tolerance that results in a harmful inflammatory and tissue-damaging response to infection.

Bovine Respiratory Disease Influences on Nutrition and Nutrient Metabolism

Clinton R. Krehbiel

Bovine respiratory disease (BRD) complex remains one of the greatest challenges facing beef cattle producers, veterinarians, and feedlot managers. In receiving, stocker/backgrounding, and feedlot cattle, BRD has been associated with decreased dry matter intake and daily gain, resulting in economic losses during the feeding period. Inflammation associated with BRD has the potential to decrease carcass yield and quality. Newly received calves are at various risks to contract BRD. Proper nutrition for newly received calves is key to recovery from stress associated with weaning and transport. This article reviews nutrient impacts on BRD and BRD impacts on nutrient metabolism.

How Does Housing Influence Bovine Respiratory Disease in Confinement Cow-Calf Operations?

Terry J. Engelken

Confined cow-calf operations are a relatively new production model in the United States. As with any new technology, there will be a learning curve for producers and veterinarians as we attempt to optimize animal health and profitability. It is critical that cattle are managed properly in these units if disease issues are to be minimized. Allowing for adequate space in the pen and at the feed bunk is a critical factor affecting animal welfare, nutritional management, and disease transmission.
How Does Housing Influence Bovine Respiratory Disease in Dairy and Veal Calves? 385
Theresa L. Ollivett

Bovine respiratory disease (BRD) is a leading cause of morbidity and mortality in young cattle. Housing factors that lead to poor ventilation and stagnant air are often considered the primary reasons for high levels of endemic disease. This article reviews the literature from the past 40 years in order to determine which housing factors have been associated with respiratory disease. Penning strategy and its affect on calf respiratory health were most commonly studied. The wide variation in disease definitions and quality of reporting make drawing conclusions from the available literature extraordinarily difficult.

Bovine Respiratory Disease Diagnosis: What Progress Has Been Made in Clinical Diagnosis? 399
Sébastien Buczinski and Bart Pardon

Bovine respiratory disease (BRD) complex is a worldwide health problem in cattle and is a major reason for antimicrobial use in young cattle. Several challenges may explain why it is difficult to make progress in the management of this disease. This article defines the limitation of BRD complex nomenclature, which may not easily distinguish upper versus lower respiratory tract infection and infectious bronchopneumonia versus other types of respiratory diseases. It then discusses the obstacles to clinical diagnosis and reviews the current knowledge of readily available diagnostic test to reach a diagnosis of infectious bronchopneumonia.

Bovine Respiratory Disease Diagnosis: What Progress Has Been Made in Infectious Diagnosis? 425
Bart Pardon and Sébastien Buczinski

When it is desired to identify infectious agents involved in an outbreak of bovine respiratory disease, a variety of possible sampling methods may be used. For field use, the deep nasopharyngeal swab, transtracheal wash, and nonendoscopic bronchoalveolar lavage are most feasible. At present, bacterial culture and polymerase chain reaction testing are most commonly used to identify infectious agents. Interpretation of test results can be challenging, particularly for opportunistic pathogens. Evidence-based guidelines for precise interpretation of microbiologic tests results are lacking; however, approaches that have been practically useful for the management of bovine respiratory disease outbreaks are presented.

Details to Attend to When Managing High-Risk Cattle 445
John T. Groves

This article provides insights into the management of bovine respiratory disease in high-risk cattle populations. Biocontainment strategies, records, procurement, transport, arrival/receiving management, vaccination, and treatment protocols are discussed from practical and systems-thinking perspectives regarding their impact on health in high-risk cattle.
Arrival management considerations, such as facilities, nutritional management, metaphylaxis, bovine viral diarrhea virus persistent infection testing, parasite control, and castration, are also addressed. Caretaker morale and job satisfaction are suggested as important factors to consider when managing high-risk cattle. The inter-relationships of variables within the system are explored as contributing causative factors to bovine respiratory disease in high-risk cattle.

**Bovine Respiratory Disease Vaccination Against Viral Pathogens: Modified-Live Versus Inactivated Antigen Vaccines, Intranasal Versus Parenteral, What Is the Evidence?** 461

Manuel F. Chamorro and Roberto A. Palomares

Vaccination of cattle against viral respiratory pathogens to minimize losses associated with bovine respiratory disease (BRD) is a common practice among producers and veterinarians. Three different calf populations in which BRD is most prevalent (recently weaned beef calves, preweaning beef calves, and young dairy calves) are the principal focus of morbidity and mortality prevention through vaccination; however, the evidence of vaccination efficacy is inconsistent in the literature. This review addresses the evidence of efficacy of vaccination in the prevention or reduction of naturally occurring and experimentally induced BRD in each calf group.

**Bovine Respiratory Disease Vaccination: What Is the Effect of Timing?** 473

John T. Richeson and T. Robin Falkner

Vaccination is the act of administering a vaccine, whereas immunization may occur if appropriate time is allowed for a competent host immune system to respond to the antigen contained in a vaccine. Timing is critical to ensure bovine respiratory disease (BRD) vaccine safety, efficacy, and efficiency. The current review provides temporal considerations of BRD vaccination within the North American beef production system with focus on vaccination timing in high-risk, newly received beef stocker and feedlot cattle.

**Bovine Respiratory Disease Treatment Failure: Impact and Potential Causes** 487

Calvin W. Booker and Brian V. Lubbers

Bovine respiratory disease (BRD) is often attributed to complex interactions between the host, pathogen, and the environment. Likewise, many BRD treatment failures result from interactions between the host, pathogen, environment, drug, and drug administrator. Investigating and addressing the underlying causes of BRD treatment failures can improve clinical outcomes and animal welfare of future cases, improve morale of employees, reduce direct costs of dealing with BRD treatment failures, refine antimicrobial prescribing practices, and advance antimicrobial stewardship. This article discusses these interactions and provides guidance to veterinary practitioners on evaluating the success of treatment protocols.
Bovine respiratory disease (BRD) is a persistent negative economic impact on beef and dairy industries and the inability to show any progress in controlling BRD is a source of increasing frustration among animal health professionals and the industry. The complex economic structure of the cattle industry leads to market failures in which cow-calf producers do not have sufficient economic incentive to invest in improved BRD control. This leads to higher costs for stocker and feedlot sectors. An industry-wide comprehensive effort is needed to coordinate and motivate enhanced BRD control focusing on producing healthy calves with less morbidity rather than treatment.