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The impact of BRD: the current dairy experience

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Abstract

The primary source of data on bovine respiratory disease (BRD) prevalence in US adult dairy cattle is producer surveys, which estimate that 2.4–2.9% of cattle are affected. This estimate appears low when compared to calculations based on limited data regarding on-farm deaths due to BRD and the number of carcasses at slaughter with severe BRD. These calculations indicate that approximately 3% of dairy cows die on farm or go to slaughter with severe BRD. Not included in these data are cows that are treated for BRD and retained. The primary manifestation of BRD on dairy farms is in calves. Nationwide surveys have estimated that 12.4–16.4% of preweaned dairy heifer calves are affected with BRD, and 5.9–11% of calves are affected after weaning. More detailed prevalence studies have generally included a limited number of small farms, with limited calf age range studied. All studies relied on producer diagnosis. Prevalence in these studies ranged from 0 to 52%, with many cases occurring before weaning, and with BRD being associated with increased calf death rates. BRD affects heifer growth. It appears to have a small effect on age at first calving, and some studies have shown small effects on performance and herd life after calving. First lactation performance of heifers depends on many factors that can obscure the effects of calfhood BRD.

Keywords: bovine respiratory disease, dairy, case definition, diagnosis, heifer performance.

Case definition

Bovine respiratory disease (BRD) must be defined in order to determine its prevalence and economic importance in the US dairy industry. Although there are other respiratory diseases, such as acute bovine pulmonary edema and emphysema, allergic reactions, lungworm, atypical interstitial pneumonia, and calf diphtheria, BRD is commonly taken to mean pneumonia caused by an infectious agent, with inflammation, consolidation, and potential abscessation and fibrosis of the lungs. It can be caused by a number of pathogens, many of which are normal residents of the bovine respiratory tract.

Flöck (2004) enumerates some of the characteristics of the bovine lung that make cattle more susceptible to respiratory disease than other farm animals. In general, cattle have less effective pulmonary clearance mechanisms. Cattle have smaller gaseous exchange capacity and lower alveolar oxygen levels during exposure to high altitudes or high metabolic activity. Low oxygen tension can slow macrophage activity and decrease clearance of debris and pathogens. Compartmentalization of the bovine lung makes cattle more prone to regional hypoxia due to occluded airways, which also results in reduced phagocytic activity and gives pathogens an opportunity to multiply.

In adult dairy cows, a diagnosis of pneumonia is often made when an animal looks sick, has a fever, and shows signs of labored respiration. She might cough and have a nasal discharge. Any cause of fever will generally cause a cow to breathe faster than normal. Many sick cows will stop licking their nose and show an accumulation of mucus in the nostrils. Cows pant and may have elevated body temperature in hot weather. Bovine lung sounds are hard to interpret and faster breathing generally increases the volume of lung sounds. Auscultation is often done in a noisy environment on the farm. True crackles and rhonchi are not heard very often in cattle; 'harsh' lung sounds may just be the result of tachypnea. So cows with fever with no other obvious cause will often be treated and recorded as pneumonia. Cows with emphysema will present with respiratory distress, especially in hot weather, but may not have infectious BRD. Necropsy or carcass inspection at slaughter would give a definitive answer on whether there was inflammation of the lungs, but most dead cows do not get necropsied and slaughter lesions are rarely reported back to the farm.

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Calf raisers know that respiratory disease is one of the main disease entities they encounter, but as with disease in adult cows, there is a similar problem of case definition. On many large calf-raising operations, the treatment crew is trained to respond to illness quickly and decisively. They do not have much incentive to save money on medicine, but they do have a strong incentive to save lives. So it is common that any calf that is off feed, depressed, or breathing hard that does not obviously have diarrhea will be treated for pneumonia. Many of them probably have pneumonia, but there is not a lot of rigor to the diagnosis. The McGuirk (University of Wisconsin) scoring system (University of Wisconsin-Madison, 2012) has given calf raisers a useful tool for standardizing the diagnosis, but some would still treat calves with a low score because they have learned that early and aggressive treatment is preferable to waiting too long for a confirmed diagnosis. Diagnostic ultrasound may be used to detect consolidation or changes in the pulmonary surface, and may allow more precise diagnosis and prognosis than temperature, clinical signs, and auscultation (Flöck, 2004).

Another factor which impacts accuracy of clinical definition is that few reports exist that indicate how recurrent cases or recurrent treatments are reported on dairy farms. These can be counted as a separate case or as part of the primary case, depending on how much time between treatments is needed to count as a new case.

Septicemia caused by *Salmonella* spp. can present in its early stages as a depressed, febrile calf that is breathing quickly. This will often be recorded as BRD and treated with an antibiotic. During an outbreak, which usually results from sanitation failures, the apparent BRD treatment rate can be very high. *Salmonella* can spread rapidly and mimic BRD.

BRD in adult dairy cattle

There appear to be no comprehensive epidemiological studies of BRD in adult dairy cattle. The National Animal Health Monitoring System (NAHMS) 2002 and 2007 (USDA, 2002, 2009) surveys used producer interviews to report that 2.4% of cows in 2002 and 2.9% in 2007 were diagnosed with respiratory disease. NAHMS 2007 reported that 11.3% of cow deaths were due to respiratory disease.

In my practice experience on large dairy farms in the Western and Midwestern United States, BRD or pneumonia was rarely diagnosed in adult cows. Cattle on these farms were housed either in open lots or in curtain-sided or open free stall barns with open ridges. It is likely that there is a higher risk of BRD in more traditional tie stall or stanchion barn housing where ventilation may be poor in winter.

McConnel *et al.* (2009) necropsied all of the cows that died or were euthanized on a large Colorado dairy for a year. The risk of death was 6.4 per 100 cow years at risk and the risk of culling was 34.7 per 100 cow years at risk. Culling reasons were not reported in the paper. Comparison of the producer-given reasons for death with the necropsy results revealed that the producer was only accurate about 55% of the time. Of the deaths, about 7% were due to respiratory disease other than aspiration pneumonia.

Rezac *et al.* (2014) analyzed gross pathologic findings in dairy cows slaughtered over 3 days in a plant in the Upper Midwest of the United States. Eighty-seven percent of the 1461 cows were classified as Holstein. Severe BRD was found in 10.3% of the cows.

The 10 year average number of dairy cows culled in the US through 2012 is 2,679,000. Based on Rezac's number, one could estimate that about 275,000 culled dairy cows a year suffer from severe BRD. If we apply McConnel's numbers to estimate that 5–7% of the 9.2 million dairy cows in the US in 2013 die on the farm and 7% of those are for respiratory disease, 32,000–45,000 cows per year probably die on farm of respiratory disease. So roughly 300,000 dairy cows a year would be culled or die because of lung problems. Every $100 of lost cow value due to respiratory disease deaths and culling would represent a loss of $30,000,000 to the industry, in addition to treatment costs and lost milk production.

The NAHMS estimate of 2.4–2.9% of cows diagnosed with respiratory disease implies between 221,000 and 267,000 cows, based on the 2013 cow population. This number probably includes animals that remained in the herds and is less than the above described estimates of respiratory culls and deaths. So NAHMS may underestimate the true prevalence of BRD.

The bacteria commonly implicated in BRD in adult dairy cattle are *Pasteurella multocida, Mannheimia haemolytica, Histophilus somnus, Mycoplasma* spp., and *Trueperella pyogenes* (Rebhun, 1995). These infections may be secondary to viral infections with infectious bovine rhinotracheitis virus, bovine respiratory syncytial virus, or bovine viral diarrhea virus (BVDV). On many farms dairy cows are vaccinated repeatedly with modified live virus vaccines (MLV). In my clinical experience, signs of these viral diseases are rarely if ever seen in herds with consistent MLV vaccination programs.

Outbreaks of adult cow BRD investigated by the University of Wisconsin School of Veterinary Medicine have generally been traced back to lapses in vaccination, the introduction of cattle from other herds or from sales, weather or other stress, or overcrowding (S. McGuirk, personal communication). Overdiagnosis is a factor in some perceived outbreaks. It is often difficult to reach conclusions from diagnostic serology because of the effect of vaccinations, insufficient control samples, and sampling cows too late in the progression of the disease.

BRD in dairy calves

Most of the data on the prevalence of BRD in dairy calves comes from studies on a limited number of farms sampled by convenience, due to location near a university. Most of the herds in these studies have been small by modern dairy standards. Herds were usually not randomly selected, and most studies rely on owner/manager recording of cases, although some investigators verified the diagnosis with visits from study personnel. In many cases the prevalence data comes from studies that were designed to study some other aspect of disease or growth in calves. Most studies appear to have been done on Holstein calves. Many concentrate on a specific age range and few contain data for heifers between weaning and breeding.

The NAHMS 2007 (USDA, 2010) surveyed dairies in 17 states that represented about 80% of US dairy farms and cows and estimated that 12.4% of preweaned heifer calves had BRD and that 11.4% were treated for BRD; 5.9% of weaned heifers were affected and 5.5% were treated. NAHMS 2011 (USDA, 2012) was based on surveys of heifer raisers; this study estimated that 2.3% of preweaned heifers, 1.3% of weaned open heifers, and 0.2% of pregnant heifers died of pneumonia. In this survey 16.4% of preweaned heifers, 11% of weaned heifers, and 1.2% of pregnant heifers were reported to have been treated for BRD. In comparison, the Gold Standard for BRD treatment on dairy farms, established by the Dairy Calf and Heifer Association (Young and Rood, 2010), is less than 10% of heifer calves from 1 to 60 days of age, less than 15% from 61 to 120 days of age, and less than 2% from 121 to 180 days treated for BRD. If these are additive, the cumulative rate to meet the Gold Standard would be 27%. In my clinical experience, there are times when BRD treatment rates on large calf raising operations with excellent colostrum programs are far higher, approaching 50% for certain periods. The effectiveness of colostrum delivery, weather events, and season affect the incidence of BRD. *Salmonella* outbreaks can cause perceived BRD rates to be very high. Some raisers practice metaphylactic treatment of all calves around weaning in order to reduce the incidence.

Waltner-Toews *et al.* (1986a) surveyed 104 randomly selected Holstein herds in Southwest Ontario and collected individual calf data on 35 herds. The investigators collected treatment and morbidity data based on owner reports only up to weaning. Of 1968 calves born, 15% were treated for pneumonia. Heifers treated for pneumonia were 2.5 times more likely to die after 90 days of age than heifers not treated (Waltner-Toews, *et al.*, 1986b). Windeyer *et al.* (2014) enrolled calves at 1–7 days of age and followed them for about 3 months on 19 farms in Ontario and Minnesota. In this study 22% were treated at least once for BRD. Median age at treatment was 30 days. Failure of passive transfer (FPT) of immunoglobulin affected BRD incidence. Calves born in winter had 2.6 times higher odds of contracting BRD than those born in summer, and 1.6 times higher odds than those born in the fall.

Van Donkersgoed *et al.* (1993) collected data on calf health from every calf born in 17 herds around Saskatoon, Saskatchewan. Diagnoses were made either by the managers or by the study veterinarians on their weekly visits. Owners diagnosed pneumonia in 39% of calves, with a median age of 27 days and a recurrence rate of 56%. Veterinarians diagnosed BRD in 26% of calves, with a recurrence rate of 29% with a median age of 36 days.

Curtis *et al.* (1988) studied 1171 calves on 26 herds near Cornell University, with herd size averaging 64 cows per herd. The study relied on farmer reports, but used clinical signs rather than treatment. The clinical signs included were scours, dullness, respiratory disease, and death. The prevalence of respiratory signs was 7.7% and that of dullness 7.4%. Outside this study, the dull calves might have been recorded as respiratory. The median age of onset of respiratory signs was 25 days. Season had no effect on respiratory disease prevalence. Calves were only studied for the first 90 days of life.

Stanton *et al.* (2010) compared the effect of metaphylaxis with two antibiotics on BRD on a New York calf raising facility. Calves were enrolled and treated with antibiotics at weaning. In this study 14.3% of calves were treated for BRD before enrollment. By 6 weeks after enrollment, 13.2–22.4% of calves had been diagnosed with BRD. BRD had a significant effect on weight and height gain for the 6 weeks after enrollment.

Lundborg *et al.* (2005) studied risk factors for infectious diseases in calves up to 90 days of age in Sweden. The investigators enrolled 3081 females in 122 herds (herd size 28–94 cows). Farmer treatment records were used to enroll calves; veterinarians visited every 2–3 months. Calves were housed indoors either in single pens, small group pens, or large groups with automatic feeders. The median percentage diagnosed with BRD on these farms was 3%, with a range from 0 to 52%. The 30th to 80th percentile of prevalence was 0–11.4%. The study looked at a wide range of risk factors for BRD and found that ammonia concentration in the air, BVDV infection in the herd, and drafts were the significant factors in their model. Paradoxically, lower ammonia levels were positively correlated with BRD rate.

Donovan *et al.* (1998b) studied the association between passive immunity and health on two large dairies in Florida. The definition of pneumonia in this study included a minimum age of 29 days. Twelve percent of the enrolled heifers died and 21% were diagnosed with pneumonia. Passive immunity protected calves from respiratory disease early in life but the effect disappeared as calves got older. The case fatality rate for pneumonia was 13.8% and pneumonia caused 21.9% of all deaths. The number of days a calf was treated for pneumonia before 6 months of age was associated with decreased average daily weight gain from birth to 6 months (10.5 gm d^{-1}), but respiratory disease treatment did not affect growth in height. Respiratory disease after 6 months of age did not affect weight or height gain in their model (Donovan *et al.*, 1998a).

Sivula *et al.* (1996) studied 845 heifer calves from birth to 16 weeks of age on 30 southern Minnesota farms with herd size ranging from 40 to 112 cows. In this study 7.6% of calves were treated for pneumonia, with a case fatality rate of 9.4%. Thirty-six percent of calves had FPT, but there was no significant difference in the incidence of respiratory disease between FPT and non-FPT calves. Calves treated for respiratory disease did not seroconvert to respiratory viruses. *Pasteurella multocida, M. haemolytica*, and *Mycoplasma spp.*, but no respiratory viruses, were isolated from calves that died of BRD. In another Minnesota study, Lago *et al.* (2006) studied BRD and pen microenvironments in 13 naturally ventilated calf barns. 12 calves per barn were selected and scored. In this study 14.3% of the calves scored had BRD using the McGuirk (University of Wisconsin) scoring system (University of Wisconsin-Madison, 2012), with a range from 0 to 37%. Decreased air bacteria counts in the pen, solid barriers between pens, and the ability of calves to make a

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nest in deep bedding were associated with lower rates of BRD. The study suggested that providing deep bedding was a more effective preventive measure than enclosing the calf pen on all sides.

In summary, the published studies on BRD incidence in dairy calves were mostly done in small herds, and show a range of cumulative incidence from 0 to 52%. The median ages at treatment in the studies show that preweaned calves, which are often housed individually, are at risk for BRD. No studies addressed the issue of management around weaning, but there is a broad agreement among clinicians that conditions at weaning and the first introduction of calves to group life can increase the risk of BRD. Exposure to coccidia in group pens may be a part of this increased risk, and in my observation coccidiosis and increased rates of BRD often go together. Empirically, mixing calves of different sizes at weaning appears to increase the risk of BRD. It is best to wean into uniform small groups and to make sure that the calves learn where feed and water are available.

Effects of BRD on heifer performance

One would expect that BRD in calves would have a significant effect on the performance of heifers after they calve. In my experience, most culling of heifers that are not growing appropriately appears to be due to chronic respiratory disease; at least many culls have a history of repeated treatment for BRD. However, BRD mostly affects young heifers and it is difficult to separate the effect of early BRD from other factors that influence first lactation or later performance, such as age at first calving (AFC), size and weight at calving, dystocia, and season of calving. AFC in turn is strongly influenced by age at first insemination and breeding efficiency and is highly correlated with size and weight. The evidence in the literature is equivocal. Some of the effect of BRD may wash out in the cited studies because of the number of factors analyzed in the statistical models. Some of the effects of BRD on growth in young calves have been cited. One might ask whether BRD impedes growth or whether slower growing or underfed calves are at higher risk of BRD.

Rossini (2004) examined records from 2556 cows in one herd in Virginia. Disease data was based on operator records. Forty-eight percent of animals were treated for calfhood BRD. The AFC was about 14 days higher in heifers that had multiple bouts of BRD; those with only one bout calved 6 days later than calves not treated for BRD. A higher percentage of heifers that had BRD calved after 25 months. There was no difference in 305 day milk yield, fat yield, or somatic cell count. Protein yield decreased by .05 kg d^{-1} in animals that had respiratory disease. Disease-free calves had a 5% greater chance of staying in the herd through 305 days and 8% greater chance of staying through 730 days compared to calves with two or more disease occurrences.

Bach (2011) reviewed treatment and production records of 7768 Holstein heifers that were raised on one heifer raising operation and returned to 133 herds in Spain. Heifers that had four or more bouts of BRD before first calving had 1.87 greater odds of not completing first lactation than those that did not have BRD. As the number of BRD episodes increased, heifers had a decreased proportion of days of productive life as a percentage of days alive. There was also an 8 day difference in average AFC between heifers with no BRD and those with 4 or more bouts.

Heinrichs and Heinrichs (2011) used a linear mixed model to examine 10 years of data from 795 calves from 21 farms in two counties in Pennsylvania. They did not differentiate between BRD and digestive disease. Days ill in the first 4 months of life decreased first lactation 305 day Mature Equivalent (305ME) milk yield by 126 kg, protein yield by 4 kg, and fat yield by 5 kg. There was no effect on culling age, lifetime milk or component yield. In contrast, Warnick *et al.* (1997) analyzed lactation data from the calves in the study by Curtis *et al.* (1988). Calfhood disease as recorded by producers had no effect on herd life.

Stanton *et al.* (2012) analyzed first lactation performance of the heifers in their study of the impact of metaphylaxis on postweaning BRD. Calves were all treated with an antibiotic at weaning, and subsequent BRD events were recorded for 60 days post weaning. Sixty-three to 73% of heifers that had BRD survived to first lactation, compared to 84% of heifers that did not develop BRD. Median AFC was 12 days longer for heifers treated for BRD, as compared to those not treated.

In summary, BRD in heifer calves appears to have a small but statistically significant effect on AFC and may affect herd life and milk and milk component yield. However, all the effects reported to date are relatively small and may not be economically significant on the farm. All disease recording in these studies was by owners or managers.

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