

Dealing with *Salmonella* and *Clostridium* Problems on our Dairies

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Introduction

Salmonella and *Clostridial* bacteria can be the cause of serious gastrointestinal diseases of cows and calves. While both types of bacteria can target the intestinal tract, cause death by the systemic effects of toxins, and show up clinically as bloody diarrhea, they are very different in many other respects. In addition, *Salmonella enterica* is one of the most serious foodborne pathogenic bacteria in the United States. An environmental reservoir is frequently the source of *Salmonella*, a gram negative bacterium that has the capacity not only to survive but multiply in the environment. Peek et al. found the organism on 45% of 20 Wisconsin free stall dairies that had no history of clinical Salmonellosis. Environmental contamination is usually the result of fecal shedding. According to a recent study (Callaway et al.), 56% of 16 herds tested had at least one cow with a positive manure culture and about 10% of almost 1000 samples cultured positive. Over time, Fossler et al. report that almost 90% of dairies had at least one positive cow and 5% of the cows cultured were positive. Rarely considered part of the normal flora of the intestinal tract, asymptomatic cattle can shed *Salmonella* for prolonged periods after infection and, in the case of *Salmonella Dublin* infection, some cattle may be intermittent shedders for life.

Clostridial organisms, on the other hand, are for the most part, normal flora of cattle and only become problematic with dietary stress, injury, changes in management, parasitism or other unusual circumstances that set up a favorable growth environment and result in production of potent toxins. *Clostridium perfringens*, the organism of concern in enterotoxemia syndromes of cows and calves, is not the same Clostridial species responsible for the putrid smell associated with the fermentation of wetter silages. The organism occurs widely in the environment and in the gastrointestinal tract of most mammals. *C. perfringens* type A is routinely isolated from soil and clinically normal animals. Types C and D are only rarely isolated from soil but they can be isolated from asymptomatic animals. When found in silage, *C. perfringens* is likely the result of fecal or animal tissue contamination.

Disease Syndromes

Salmonella spp. infection occurs when a susceptible animal ingests the bacteria. Dairy cattle ingest feed or water that has been contaminated with feces from animals shedding the organism. It may be difficult to tell which cows are shedding bacteria because asymptomatic and subclinically affected cows can shed as many organisms in their manure as the cows that are sick with salmonellosis. Other sources of infection may be rodents, birds (including waterfowl), flies, feral cats, dogs, raccoons and, rarely, people. The principal route of infection is fecal-oral. Saliva, nasal secretions, colostrum and milk can also be the source of organisms shed from sick animals and oral transmission from these sources is another way to spread disease on a dairy. Cow to cow transmission is typical but other animals, insects, birds, people, vehicles, medications,

equipment and utensils can facilitate transmission of the organisms. Though less likely, it is also possible that aerosol transmission of *Salmonella* may occur under some types of housing conditions.

Salmonellosis has a wide spectrum of manifestations in cattle. Asymptomatic, mild clinical or fulminant bacteremia/septicemia and endotoxemic infections can occur. The manifestations vary with virulence of the strain, infectious dose, age of the animal and immunity of the host. Some dairies first experience salmonellosis as an outbreak of high fevers, bloody diarrhea, acute respiratory disease and/or deaths. *Salmonella* outbreaks commonly last several months. On many other dairies, salmonellosis is an opportunistic infection. Recurring problems of diarrhea, fevers and low milk production typically occur in the fresh cow group and/or hospital pen with extension into the young calves, just weaned calves or other high-stress cattle groups. On some farms, clinical signs only occur in the calves where the problem may be diarrhea, fulminating blood-borne infections or severe, life-threatening pneumonia.

Clostridial diseases are not spread from animal to animal and the mere presence of the organism in the intestine is not sufficient to cause Hemorrhagic Bowel syndrome (HBS), abomasal ulcers, abomasitis, abomasal tympany, gas gangrene, sudden death, dead gut or enterotoxemia. Susceptible animals are those that have the organism and have one or more of the risk factors that are discussed below.

In the last few years, producers and their veterinarians have recognized with increasing frequency, a syndrome in adult cattle that is referred to as Hemorrhagic Bowel, Bloody Gut or Jejunal Hemorrhage Syndrome (JHS). While no specific cause has been elucidated, *Clostridium perfringens* type A is believed to play some role in the syndrome based on recovery of large numbers of this organism from most (but not all) cases of JHS. The disease syndrome is characterized by a sudden onset, when affected cows are unexpectedly off-feed, produce little or no milk, have a painful or distended abdomen, hemorrhage into their intestine, make very little manure and can die acutely despite medical and/or surgical intervention.

In calves, a sudden onset of abdominal distension with pain, depression, feed refusal and sudden death have associated with abomasal ulcers, inflammation and gas in the wall of the stomach. While there can be more than one cause for this syndrome, researchers have isolated *Clostridium perfringens* type A from affected calves and reproduced the disease by placing the organism in the rumen of susceptible calves. Post mortem examination shows inflammation of the lining of the rumen and abomasums, with ulceration and hemorrhage. *Clostridium perfringens* type C causes necrotic enteritis in newborn calves. Affected calves may die before they develop diarrhea. Calves are suddenly depressed, weak, may be distended or show abdominal pain. If diarrhea develops, it may have blood and tissue streaks. Intensive care with antitoxin, fluids, antibiotics and anti-inflammatory drugs is necessary but frequently unsuccessful. As described, these signs are not specific for *Clostridium* and other causes such as salmonellosis, coccidiosis, and unusual forms of *E. coli* should be considered. Post mortem examination shows small intestine necrosis and hemorrhage. *Clostridium perfringens* type D produces the classic overeating disease, a syndrome more important in lambs than in calves. The disease is characterized by sudden death in thrifty, well-fed calves. Other affected calves may be neurologic, uncoordinated, trembling, recumbent with head back or convulsing. Other diseases such as septicemia, polioencephalomalacia,

lasalocid overdose, salt poisoning and *E. coli* can produce similar signs. The post mortem examination will reveal pulpy kidneys and brain edema and glucose in the urine.

Management is thought to play a critical factor in many of the clostridial disease syndromes. Clostridial diseases are usually sporadic on most dairies; a cluster of cases can occur over a relatively short period of time on others and some farms seem to struggle with continuous problems either in cows or milk-fed calves. In general, clostridial diseases are sudden in onset, fulminating in severity and the first sign of illness may be death. *Clostridium perfringens* types A, C and D can cause gas in gut tissue, bloat and/ or intestinal hemorrhage but affected calves or cows may die before blood, blood clots or diarrhea is passed. Because treatment success is rare, emphasis is properly placed on preventive measures.

While a positive fecal culture is the basis for a *Salmonella* diagnosis, *Clostridium* proliferate after death, often to the exclusion of other normal flora, and can invade tissues beyond the gut potentially yielding false positive culture results in calves and cows that die from other causes. Thus, isolation of the bacteria in a post mortem sample is not sufficient basis for a diagnosis. From suspect animals, rapid harvest and appropriate preservation of tissues prior to submission for culture is essential. Combined findings of the organism, toxin production, compatible history and lesions are necessary to confirm a *Clostridium* diagnosis.

Risk Factors

Protracted or recurring salmonellosis can be the result of a number of factors – persistence in the environment, persistent *Salmonella* carriers or prolonged shedding of the organism after infection, reinfection of susceptible animals or persistence of risk factors. Identification and management of relevant risk factors is one of the best ways to control the disease. The herd level risk factors that have been identified with salmonellosis are listed below:

- Commingling of sick, hospital, lame, treated or cull cows with fresh cows
- Lack of isolation of sick cows
- Not using monensin in weaned calf or bred heifer diets (Fossler et al)
- Purchased concentrate or protein feed storage in buildings not enclosed or having wet commodity storage areas
- Access of lactating or dry cows to surface water like lake, ponds, streams or rivers
- Liquid manure disposal, especially when applied to fields containing roughage eaten or grazed by cattle
- Free stall or confinement housing
- Seasons other than winter
- Expansion or purchase of cattle from dealers
- Presence of wild birds, cats, wild geese or rodents in feed and housing areas
- Feeding brewers products to cattle
- Skid loaders used for manure removal crossing feed alleys or transporting feeds
- Feeding colostrum from cows sick with salmonellosis
- Feeding colostrum from *Salmonella Dublin* infected cow

The most common syndrome linked to *Clostridium*, specifically *Clostridium perfringens* type A in adult cattle is Hemorrhagic Bowel (HBS) or Jejunal Hemorrhage

syndrome (JHS). HBS is more common in mature cows than in first calf heifers and bulls, but many dairies report problems in cattle of all ages and stages of lactation. Initial reports of HBS showed a predilection for older cattle 100-110 days in milk but the disease can be seen at any stage of lactation, in dry cows and even in mature breeding bulls at stud. Brown Swiss appear to be at greater risk for the syndrome but it can be seen in any dairy breed. Most cattle appear to be in good health immediately prior to the development of HBS, although there may be, as yet poorly elucidated, herd risk factors such as sub-acute rumen acidosis on problem farms. There does not appear to be a consistently increased level of other production related diseases such as subclinical milk fever (hypocalcemia), mastitis or ketosis on dairies that experience HBS but there is undoubtedly much about this condition that we do not yet understand. An association between HBS and other diarrheal diseases such as Salmonellosis, Bovine Virus Diarrhea (BVD), Winter Dysentery, Johne's disease or parasites is not apparent on affected dairies. Other risk factors that may play a role in the HBS of cattle are listed:

- High production, physiologic stress, immune-suppression
- Rations rich in energy, protein and low in fiber
- Second lactation or greater cows
- Recent feed change
- Rumen acidosis
- Excessive rumen fill with spillover into the intestine of contents with high soluble protein and carbohydrate levels
- Decreased intestinal motility
- Inconsistent feed and nutrient intakes
- Spoiled/moldy feeds or poor management of silage bunker face
- Pumping manure onto standing crops

For *Clostridial* problems in calves, the risk factors are different and include the following:

- Ingestion of *C. perfringens* in the first few days of colostrum feeding
- Ingestion of protein-rich diet in a protease-deficient intestinal tract allows rapid growth of *C. perfringens* organisms.
- Protein-rich milk replacers and/or high grain consumption may be risk factors
- Inconsistent feeding practices – feed changes, temperature, mixing, frequency, volume
- Limited access to water after feed consumption
- Abnormal intestinal flora from abundant oral medications
- Stressful interventions that result in erratic intakes

Treatment

For Salmonellosis and Clostridial diseases, the treatment options are largely supportive and the outcome with Salmonella is usually much more favorable than with Clostridial syndromes. Early identification is a critical part of success. Calves and cows at risk for Salmonellosis can be monitored by rectal temperature. At the first sign of a 1.5

to 2 degree rise in temperature, anti-inflammatory drugs, antibiotics and/or fluids can be administered. Fluids to correct dehydration are essential. When a skin tent on the neck of an adult dairy cow persists for more than 5 seconds, rehydration requires the administration of 10 to 20 gallons of a balanced electrolyte solution. Dehydrated calves require 3 to 4 qt of balanced electrolyte solution in addition to the normal daily liquid feed intake. Anti-inflammatory drugs like banamine and antibiotics are usually added. The location of *Salmonella* inside the cell makes antibiotic penetration at an effective level challenging and much of the disease severity is due to the endotoxin released from dying bacteria. Antibiotic efficacy for clostridial diseases is also limited because the clinical signs are primarily a function of the toxins released. Rapid intravenous administration of hypertonic saline solution (2 L to adult cows, 150 cc to a calves) followed by water or electrolyte solution consumption can provide important resuscitation to extremely toxic animals. HBS-affected cattle may require laxatives, motility stimulants or surgery to relieve obstructing blood clots in the intestine. Unfortunately, recurring clots, poor motility and intestinal necrosis (death) are responsible for limited surgical success. Calves with clostridial syndromes can be given *Clostridium perfringens* C and D antitoxin but there is probably limited cross protection of the antitoxin for *Clostridium perfringens* type A syndromes.

Vaccination and Control

As elucidated above, identification and management of relevant risk factors are the most effective ways to control salmonellosis and clostridiosis. For dairies dealing with *Salmonella*, prevention begins with maternity pen management. The calving area should enjoy short term use by calving cows exclusively. Calves must be moved or isolated in a safe, well bedded area within 30-minutes of birth. Four quarts of colostrum from a single healthy, vaccinated donor whose udder was well prepared prior to milking is essential. Add nothing to the colostrum. Feed colostrum replacement or supplement products mixed in water as described on the label. Have enough esophageal feeders on hand to avoid successive uses before disinfecting. Communal warming, drying areas for calves are only appropriate if calves are moved there within 30-minutes of calving. Transport carts, wheel barrows or vehicles that move multiple calves appear clean but frequently are a reliable source of *Salmonella* organisms. Keep hands out of feed and mouths of calves. Remove feed refusals (liquid and dry) from the environment of calves and do not feed adult cow herd feed refusals to susceptible heifer groups. Keep the bedding in calf stalls deep and dry. Have 10% more pens than calves at maximum occupancy to allow for cleaning, removal of all organic debris and disinfection prior to subsequent use.

Maximize the intestinal resistance of cows and calves by limiting antibiotics to those that are needed and providing them for the shortest duration that is appropriate. Limit management, treatment, or other interventions to those that are effective and not harmful. Choose the most strategic time for stressful interventions. Enhance facility comfort and ventilation. Feed additives like mannan oligosaccharides and beta glucans may enhance enteric immunity, reduce binding of pathogenic organisms, improve intestinal energy efficiency, adsorb toxins or reverse some types of immune suppression. Studies with products like Bio-Mos and Omnigen-AF included in feeds of calves, cows and/or sheep are responsible for increasing use of these products on many dairies. Feed

additives are no substitute for appropriate attention to comfort nutrition and disease control. Ration formulation, feed management, and attention to practices that minimize stress are essential.

Until recently, there was no approved vaccine available for protection of cattle from *Clostridium perfringens* type A. Because of that, there was considerable use of autogenous vaccines (bacterin-toxoids) to *Clostridium perfringens* type A isolated from affected herds. To be effective, any effective product must be made under fermentation processes that are maximized for bacterial growth and toxin production using a genotypically appropriate *Clostridium perfringens* type A. The new *C. perfringens* Type A bacterin-toxoid from Novartis is being more widely used and testimonials are the best evidence we have for its efficacy on dairies. In the cases of HBS that researchers at Colorado State University College of Veterinary Medicine have investigated, the *Clostridium perfringens* type A isolated from diseased bowel are not from a single strain but are genetically diverse. This may place limitations on the ability of any *C. perfringens* Type A bacterin-toxoid to prevent the disease. Other herds have used *Clostridium perfringens* type C and D toxoid or 7- and 8-way *Clostridium* bacterin-toxoids. Some herds report a reduction in prevalence of HBS by vaccinating 2 to 3 times per year with these products. For the prevention of clostridial diseases in calves, colostrum from cows vaccinated with *C. perfringens* type C is most effective way of providing them with timely immunity.

Traditional *Salmonella Typhimurium* and *Dublin* bacterins were not very effective in preventing and controlling clinical infections. The mechanism by which these bacteria cause disease limited the ability of the antibody response generated by these vaccines and autogenous bacterins to be protective. Attempts to create safe, but effective commercial vaccines brought few new products to the market but provided the gram negative core antigen vaccines (J-5, J-Vac and Endovac-Bovi) that could be relied upon to attenuate the severity of clinical salmonellosis in adult cows and calves that received colostrum from vaccinated donors. A live vaccine, Entervene-D (Fort Dodge) emerged as an effective way to control *Salmonella Dublin* in young calves but side-effects in young animals is always a potential problem. Recently, with the commercial release of the SRP (siderophore receptor protein) *Salmonella* vaccine from Agri-Labs, there is a safe and effective way to block an important pathway that *Salmonella* needs for infection, division and survival in its host. The vaccine reduced shedding of *Salmonella* in a field trial and appears to be cross-protective against many strains. Field experience has been good and safety has been excellent. Calves can acquire an effective level of immunity after consuming colostrum from vaccinated cows. Effective vaccination is just one part of the prevention and control plan that must be implemented to eliminate the serious problem that our dairies face with salmonellosis. Implement control of anything in the livestock environment that can perpetuate the organism – rodents, flies, nuisance birds, feral dogs and cats.

Finally, always remember that *Salmonella* infection can be transmitted to people on the dairy by feces gaining access to the mouth of susceptible individuals. Avoid potential problems by remembering these steps:

- ◆ Use coveralls or an outer layer of protective clothing that is left at farm or at the site of contamination
- ◆ Use gloves and protective footwear that can be left at the site, scrubbed or disinfected
- ◆ Always wash hands before eating or holding young children
- ◆ No eating or drinking in work areas
- ◆ Don't drink raw milk

Selected References

Callaway TR, Keen JE, Edrington TS, Baumgard LH, et al. Fecal prevalence and diversity of *Salmonella* species in lactating dairy cattle in four states. J Dairy Sci 2005;88:3603-3608.

Fossler CP, Wells SJ, Kaneene JB, Ruegg PL et al. Herd-level factors associated with isolation of *Salmonella* in a multi-state study of conventional and organic dairy farms I. Prev Vet Med 2005; 70:257-277.

Peek, SF, Hartmann FA, Thomas CB, Nordlund KV. Isolation of *Salmonella* spp from the environment of dairies without any history of clinical salmonellosis. J Am Vet Med Assoc 2004;225:574-577.