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Salmonella Biosecurity:
Protecting yourself and your cattle

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Salmonella are **ubiquitous** bacteria, which means they are widely distributed in our environment. They are commonly associated with animals and animal products such as raw meats, poultry, eggs, raw vegetables, and unpasteurized milk and dairy products. Human risk factors for becoming infected with *Salmonella* include contact with animals including cattle, horses, poultry, dogs, cats, and reptiles, or their feces.

Zoonosis is a term that describes microbial agents that normally exist in animals, and can infect and cause disease in humans exposed to those infected animals. The most common zoonotic agents that can be passed from livestock manure to people include *Salmonella, Cryptosporidia, Campylobacter, E.coli, and Giardia*.[12]

Salmonella is a leading cause of bacterial diarrhea in humans with 94 million human cases and 115,000 deaths annually. Many people with uncomplicated salmonellosis may recover on their own or only require fluids to prevent dehydration. Antibiotics and antidiarrheal drugs are generally not recommended to treat human cases of salmonellosis.[13]

The *Salmonella* genus of bacteria are individually named as *Salmonella enterica* serovars and there are over 2,500 serovars. "Enterica" refers to "intestinal" and describes the gastrointestinal symptoms that result from infection with these serovars. *Salmonella enterica* serovars include *Dublin*, *Heidelberg, Typhimurium,* and *Newport.* A recent Wisconsin outbreak has been traced back to the serovar *Heidelberg.*

Investigation into *Salmonella enterica* serovar *Heidelberg*

The Center for Disease Control (CDC) reports thirty-six people from ten states were infected with the outbreak strain of *Salmonella enterica* serovar *Heidelberg* from January 27, 2015 to January 16, 2017. No deaths were reported, but 13 individuals were hospitalized. When interviewed, 25 (69%) reported contact with dairy bull calves or other cattle. Traceback information identified most of the calves originated in Wisconsin, from multiple farms and animal markets, including one market where environmental sampling confirmed the presence of the outbreak serovar. In 2011, the CDC had reported the incidence rate of *S. Heidelberg* infection had been decreasing following a peak in 1987.[3]

The biggest concern with the *Heidelberg* serovar involved in the 2016-17 outbreak is its pathogenicity and its multi-drug resistance. Only one antimicrobial drug is an effective treatment option for human cases, and **no effective treatment options exist for cattle.**[14]

Current *Salmonella* control measures for cattle target maternity and periparturient areas.

Stuttgen photo.

Take-home messages

- ***Work to decrease environmental exposure***
- ***Practice biosecurity and GMPs for herd health (see last page of this publication)***
- ***Vertical transmission may occur***
- ***Treatment and vaccination may not help***
- ***Select cattle for natural resistance***
- ***New feed supplements may help***
- ***Wear PPE and wash your hands!***

Calves infected at birth

The primary source of *Salmonella* infection for calves is from fecal-oral transmission occurring at birth; from the maternity area; or from suckling manure on udders, teats, bellies, or legs of their dams. Following ingestion, *Salmonella* colonize the newborn's intestinal tract, invading immune cells, and then are transported by immune cells throughout the body. One experimental study isolated *Salmonella* from tissues within three hours after receiving an oral inoculation. In a longitudinal dairy study, 65% of calves were determined to be shedding *Salmonella* in their feces within 24 hours of birth.[8]

Clinical signs caused by *Salmonella* vary depending on the serovar involved, dose the calf receives, presence of other infectious agents, and the calf's nutritional and immune status. Due to *Salmonella* toxins, calves may simply be found dead during peracute infections. Acute infections present as a high fever, which may persist several days, and scours. Scours may present as watery, voluminous, bloody and contain mucus and fibrinous casts of the intestinal lining. Absence of fever should not rule out *Salmonella* because transient fevers occur and calves become hypothermic 12-24 hours before death.

Salmonella enterica serovar *Dublin* may become host-adapted. Clinical signs reoccur, or are seen in older cattle, and often chronic lung infection and arthritis develop. *S. Dublin* may be diagnosed as a cause of calf respiratory disease at weaning and may cause a gangrenous necrosis of hooves. Subclinical carriers of *S. Dublin* appear normal and go on to shed this bacteria in their feces and milk, thereby maintaining a source of infection in the herd.[8]

Vertical transmission

Texas researchers[7] recently concluded that fetal infection with *Salmonella* occurs. Apparently healthy newborn calves were found to have *Salmonella* in various tissues immediately upon birth, and this infection did not occur from fecal-oral transmission. Transmission occurred from the dam to the calf during the pregnancy (vertical transmission). It was not determined from this study how or when the dam became sub-clinically infected.

An intra-cellular pathogen, *Salmonella* evades the host immune response, enabling it to pass undetected between the dam and the fetus. The fetus fails to recognize it as non-self and its immune system fails to respond to the *Salmonella.*

Additional research needs to be done to completely understand the ramifications of fetal infection. If calves are born already infected, then current environmental control practices in maternity areas will have limited success in controlling *Salmonella* on a farm.[7]

Clean calving environments

A clean calving environment is important for *Salmonella* control. Conditions that are muddy, wet, and hot or cold require calves to use energy to combat high levels of bacteria, including *Salmonella.* Therefore, calves in such conditions have less energy available for growth. Neonatal calves have little gastric acid production during their first 5–7 days of life, which leaves them vulnerable to enteric pathogens.

Mother nature attempts to protect the vulnerable newborn in the form of colostrum ingested at birth. Good quality colostrum, which is free of fecal contamination, provides protection against *E. Coli,* rotavirus, corona virus, and *Salmonella* for the first 7–10 days of life.

Remove biofilms

Calving and calf areas, livestock trailers, and other areas suspect of being contaminated with *Salmonella* must be cleaned and disinfected to remove "biofilms" (i.e., layers of micro-organisms). This is particularly important for multi-drug resistant *Salmonella* serovars, given the human and bovine health implications and lack of antimicrobials available.

All surfaces must be properly cleaned before the disinfectant is applied. If these areas are not properly cleaned, the disinfection step is much less effective at killing pathogens. High-pressure washing should not be used because of the risk of cross-contaminating the environment and aerosolizing contaminated material. While high pressure washing does remove gross soils, such as dried fecal material, it does not consistently remove bacterial biofilms. Biofilm removal is an essential and vital component of proper cleaning.[15]

The Wisconsin Veterinary Diagnostic Laboratory (WVDL) Disinfection and Cleaning Protocol, available at www.wvdl.wisc.edu., lists rinsing and foaming steps using both alkaline and acidic cleaners to remove *Salmonella* biofilms. Reinfection on the affected premises is highly likely and has been detected; therefore, it is highly recommended to perform environmental testing for *Salmonella.* The WVDL has kits specific to this type of testing.[15]

New technologies

Biotechnology companies have identified a cattle genotype conferring natural resistance to *Salmonella*. 35% of non-black cattle have this genotype and 5% of black cattle have this genotype.

A feed supplement for calves or adult cattle has been developed that interferes both with the gut's ability to allow *Salmonella* to attach and minimizes normal gene expression of *Salmonella's* virulence. This is accomplished as an outcome of changes in the chemical and/or microbiologic gut profile that results when these supplements are fed.[2]

Markets and transporters

Young dairy calves are the most likely cattle to harbor multi-drug resistant *Salmonella.* Calves exposed in the maternity pen by immune-suppressed dams are likely to begin shedding bacteria due to stress during transportation. Mixing young susceptible calves during transport increases the overall infection rate.

Salmonella may persist in market and trailer environments. Surfaces the calves contact are generally not cleaned sufficiently to remove biofilms.[16,17]

Salmonella can not only survive, but can multiply, in the environment. *Salmonella* has been found to persist up to six years in feces present in the environment. [5]

Manage periparturient dairy or beef facilities

- Follow SOPs for cleaning and disinfection to remove biofilms on indoor facilities
- Just-in-time calving pens must be cleaned and disinfected to remove biofilms between calvings
- Outdoor paddocks must be sloped, well-drained, and protected from the wind; if using enclosures, they must be well-ventilated and follow SOPs to clean and disinfect to remove biofilms from surfaces calves contact
- The Sandhill Calving System helps reduce calves' risk of exposure to multiple pathogens

Salmonella prevalence

Beef herds

Geography appears to influence the prevalence of *Salmonella* within beef feeding facilities. Feedlot prevalence increases in the southern United States, with Texas having the highest prevalence of *Salmonella.* However, very little clinical disease is seen in feedlots. *Salmonella* on cattle hides is a risk factor for contaminating meat in the packing plant. Risk to humans also occurs when trim containing *Salmonella*-infected lymph nodes is ground into hamburger.

Recent studies indicate up to 30% of cattle peripheral lymph nodes (located within fat between the muscles of the legs, shoulders, or flanks) that is harvested for hamburger contains *Salmonella.* In a study of commercial ground beef from seven regions of the United States (n=4,136 samples collected over 2 years), *Salmonella* was recovered from 4.2% of ground beef samples.[6]

Research at the Meat Safety and Quality Research Unit (U.S. Meat Animal Research Center, Clay Center, Nebraska) found the presence of *Salmonella* from southern cattle lymph nodes was 1% in cull cows and 11% in feedlot cattle, with a higher prevalence of 30-50% of flank lymph nodes infected during the seasonal peak of midsummer through late fall. Rather than by the typical fecal-oral route, researchers theorize peripheral lymph nodes become infected when *Salmonella* gains transdermal entry from cuts or scrapes on the hide or from biting flies or foot rot from the feedlot environment.

They also routinely recovered *Salmonella* from 30-60% of fecal samples from healthy southern-fed cattle during summer and fall. In contrast, the overall prevalence in Colorado is less than 1%.[13] More research is needed to understand these regional differences.[11]

Dairy prevalence

Studies conducted by several universities found that dairy calves shedding *Salmonella* are not associated with herd size or type of farm production. Additionally, it did not matter if the dairy farm used organic or conventional methods.[1,4]

Finding asymptomatic calves shedding *Salmonella* on dairies in Minnesota, Wisconsin, Michigan, and New York was associated with using maternity areas as a hospital area. When maternity pens were used as sick-cow pens more than once a month, the odds of isolating *Salmonella* in calf feces doubled compared to dairies that did not house sick cattle in maternity pens.[4,5]

Maternity areas and calf housing were two places most likely to harbor multi-drug resistant *Salmonella* in Texas.[13] Periparturient cows were found to be the adult cattle group most susceptible to *Salmonella* infection.

Purchasing herd additions from off-farm sources also increased the odds of culturing *Salmonella* from feces of apparently healthy calves. A California study found farms that received animals from other sources were 35 times more likely to have calves that were shedding *Salmonella* in feces than herds that did not receive such animals.[1]

The U.S. Department of Agriculture National Animal Health Monitoring System (NAHMS) Dairy 2007 study reported 13.7% of cows from 121 herds in 17 dairy states had fecal cultures positive for *Salmonella*.[10]

Periparturient areas must remain dry. Sloped paddocks allow for drainage.

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Biosecurity programs

Biosecurity programs are disease control programs designed to reduce the risk of disease and production consequences by minimizing the risks for exposure to infectious agents. Biosecurity programs may include steps to increase immunity to infectious agents.

Numerous control points exist to prevent introduction of *Salmonella* onto the farm and its transmission around a farm. The direct and opportunity costs of achieving control of these points is often significant and logistically difficult, with real effectiveness sometimes limited; however, do your best to control what you can. Your investment in biosecurity for cattle and human health is well worth the effort.

Additional information on biosecurity programs is available from Wisconsin DATCP, Division of Animal Health **https://datcp.wi.gov/Pages/Programs_Services/BasicBiosecurity.aspx**. Work with your veterinarian to determine biosecurity programs that meet your farm's goals.

Good management practices (GMP) for cattle health

- Vaccinate for endemic diseases
- Know health/vaccination history of incoming animals
- Isolate new arrivals
- Individually identify every animal
- Monitor and inspect animals daily for signs of illness; early intervention is key
- Do not place cattle of different ages in the same pen
- Clean equipment, boots and clothing between animal groups with different health status
- Work from younger or healthier animals to older higher risk animals
- Invest in laboratory diagnoses
- Develop treatment and vaccination SOPs with your veterinarian
- Promptly euthanize animals that are not going to recover
- Necropsy animals that die from unknown causes
- Promptly remove dead animals from the farm: appropriately compost, render, or bury—do not drag out to the woods!
- Place dead stock removal areas on the farm's perimeter
- Minimize fence line contact with neighboring animals
- Maintain fences to keep your animals in and other animals out
- Purchase feed from reputable sources
- Minimize fecal contamination of feed
- Prevent off-farm vehicles from driving in areas that contact animals or feed

Horn flies

Horn flies have been implicated in the transmission of *Salmonella.* Obligatory blood feeders, horn flies create skin lesions or take advantage of available lesions to obtain blood. They mechanically inoculate microorganisms found on hides as they feed. Female flies leave cattle long enough to lay eggs in the environment, inoculating additional contamination when they next feed. *Salmonella* ingested by feeding flies were found to survive in fly intestines for up to five days, serving as a source of transmission in fly feces.[9]

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