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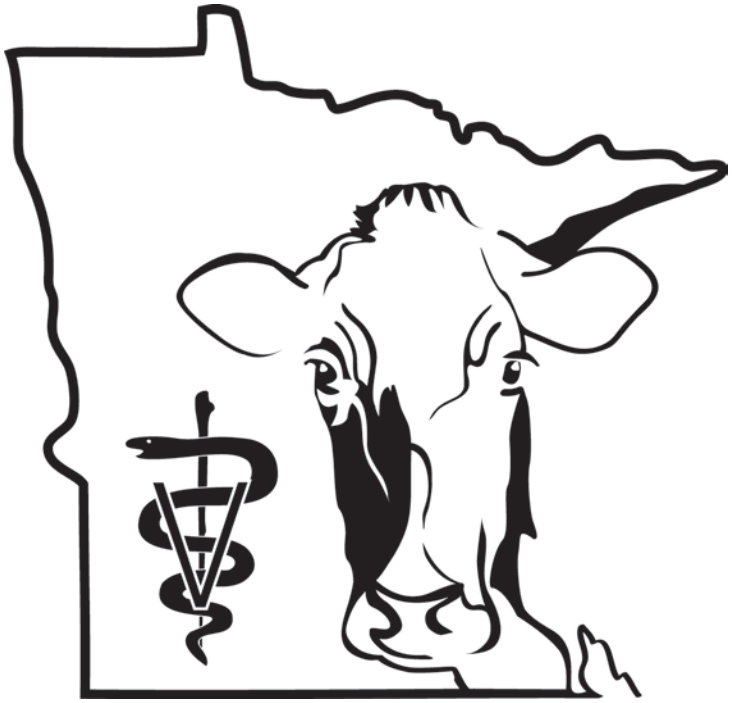


ST. PAUL, MINNESOTA
UNITED STATES OF MINNESOTA

Reducing the Risk of Salmonella Spread and Practical Control Measures in Dairy Herds

Dr. Jeff Bender
University of Minnesota
College of Veterinary Medicine
Department of Clinical and Population Sciences
St. Paul, Minnesota

There has been a dramatic increase in the number of bovine Salmonella isolations made over the past few years as well as the appearance of serotypes not usually isolated at the Minnesota Veterinary Diagnostic Laboratory [1]. With this increase, is the growing public concern regarding the safety and quality dairy products. The objective of this paper is to increase practitioners' knowledge of methods which control the spread of Salmonella and to minimize its effects when identified on dairy operations.

The Problem

Some obstacles to on-farm Salmonella control are: 1) lack of good screening tests to detect herd infection, 2) the need for sensitive and specific individual animal tests to detect cases and carriers, 3) inadequate research linking the suspected risk factors with the disease 4) poor awareness that a Salmonella problem exists on a producers farm, 5) limited understanding of the economic impact of the problem on the producer as well as the industry, and 6) overuse of antibiotics to solve and control bacteriologic problems. Inherent with these problems is the organism itself with some 2200 different serotypes each with differing virulence. In cattle, the two most common isolates are S. dublin and S. typhimurium. S. dublin, a host-adapted strain, can cause a permanent carrier status in cattle resulting in continued shedding of the organism into the environment through feces, milk, and aborted tissues.

There are a number of risk factors potentially associated with Salmonella infection. Some documented herd risk factors include larger herds, freestall housing, "open" herds, feeding Salmonella contaminated rendered products, other concurrent herd diseases (such as BVD, Johne's, and fascioliasis), lack of on-farm quarantine practices, improper cleansing of calf feeding utensils [2,3], and vectors such as birds and rodents. Individual risk factors include young animals usually between 3 and 6 weeks of age, debilitating diseases, starvation, and stress associated with transport (figure 1). Considering of the environmental, host, and agent factors, the cycle of transmission is complex (figure 2)[4]. The important point to remember in the transmission cycle, is that Salmonella once introduced within the herd will self-perpetuate among cows and calves if left unchecked. For example, S. dublin infected raw milk may contain up to 10^5 organisms per milliliter of milk [5]. Often the infected calf becomes a Salmonella "factory," shedding millions of organisms into the environment.

Outbreak Procedures

During an outbreak, the investigator needs to 1) identify and isolate sick cows or calves 2) identify the source, 3) institute hygienic procedures to control the continued spread of infectious organisms, and 4) prevent re-introduction.

Identification and isolation of infected animals is the cornerstone to control, because afflicted animals may be shedding billions of Salmonella organisms. Therefore, calves or cows exhibiting fever, diarrhea, or depression should be isolated until culture results are available. To evaluate the extent of the problem, temperatures of all herd members should be taken to identify any suspect animals. Animals with temperatures over 103.5 °F should then be segregated to minimize spread. Prompt care of sick animals should be instituted with antibiotics, fluids and electrolytes, and nonsteroidal anti-inflammatory drugs. Appropriate antimicrobial therapy should be based upon bacterial culture and sensitivity. Also potentially contaminated raw milk should not be feed to calves nor humans!

In addition to the herd history and the clinical presentation, knowing the serotype will often direct the investigation to one of three sources. These sources are either 1) contaminated feed, 2) carrier animals, 3) vectors such as birds or rodents. Therefore, cultures should be taken from fecals of sick and healthy animals, and appropriate necropsy specimens as refrigerated mesenteric lymph nodes, liver, spleen, and a tied-off segment of affected intestine. Other samples such as water, feed, milk filters, and drain cultures may be necessary to identify sources as well as to evaluate the extent and the progress of treatment and control. Additional fecal cultures from other animals such as dogs, cats, and rodents may indicate a pattern of spread or identify potential vectors.

Once the infectious animals are segregated, then we as practitioners need to encourage producers to set-up isolation facilities and practice sanitary management practices such as using foot baths, minimizing contact with sick animals, and thorough cleaning and disinfection of infected areas during an outbreak. Footbaths containing phenols, iodophores, or chlorines, should be placed at the entrance of the isolation area and changed on a regular basis. Physical contact of sick calves or cows should be limited to one person, whose sole responsibility is the care of the infectious animals. Other appropriate control measures include frequent and proper disposal of manure. For example, the front-end loader should not be both a manure scoop and a feed scoop. Nor should carcasses or contaminated milk be disposed of near feed areas. Complete disinfection of any contaminated areas is a must. This may include the use of quaternary ammoniums or phenols to calf utensils or manure removal, drying, and resting (approximately 2 weeks) of drylot housing. It also may be necessary to fence off ponds or streams to prevent contamination of surface water during an outbreak. Also, considering the ability of Salmonella to remain viable in manure for extended periods, veterinarians need to regularly wash their boots and change their coveralls [7].

Vaccination has also been proposed as a control measure to reduce the severity of the outbreak. If used, this should be done in addition to the other management techniques

described above. Currently, only inactivated (bacterin) vaccines are available in the United States. These killed products elicit good humoral antibody response. However, good humoral response does not correlate well with protection (figure 3)[6,9]. It appears that local, humoral, and cell-mediated responses are necessary to provide adequate protection. In Europe, several attenuated live vaccines are being used [10,11]. These vaccines show some promise for the future. The current recommendations for bacterin use, is to vaccinate during the dry cow period to increase colostral antibodies.

Control Measures

As important as controlling the epidemic within a herd, is the need to prevent recurrence and spread to other susceptible farms. Hopefully, better preventive measures can be defined with studies showing the strength of association between individual risk factors and clinical disease. In the mean time, we need to educate our clients on the need to take prompt action when suspect signs such as fever, abortions, diarrhea, or death appear. Early prevention and isolation of infected animals will minimize morbidity and mortality as well as expense. Other control measures include proper disposal of manure, control over rodent and bird populations, careful attention to feed storage, avoidance of Salmonella contaminated feeds, and proper quarantine procedures for new herd members and potential sick animals
(figure 4)[12].

Some suggestions for proper manure disposal include spreading on flat areas which have direct sunlight and preferably on crops versus grazing areas. If contaminated slurry is spread on grazing areas, a 4 to 5 week resting period is recommended. The resting period after spreading manure on pasture can be up to 6 months [15,16]. Frequent manure removal is also necessary especially in contaminated calf areas.

Also of concern, is Salmonella contaminated animal by-products. It was estimated in 1991 that 21% of samples submitted by participating renders in the National Rendering Association were positive [13]. This raises some alarming questions in light of the increased use of rendered animal products in feeds. A recent study done here at the University of Minnesota indicates that cows feed meat and bone meal with varying levels of Salmonella contamination did not shed detectable organisms in milk or feces. However, Salmonella was isolated from the rumen contents and mesenteric lymph nodes of these cows [14]. Hence, this may suggest that low levels of exotic strains of Salmonella contaminated feeds or pastures may not pose a problem in healthy cows. However, continued efforts should be in place to reduce Salmonella numbers in animal by-products. Additionally, feed storage areas should be protected from moisture and bird and rodent excreta. Limiting vector numbers and access to feed, may involve setting up bait areas for rodents or controlling the number of cats and dogs by neutering. For more specific measures in rodent and bird control the appropriate professionals should be consulted. Also, rendering and milk trucks should not have access to feed areas, because the vehicles may carry infection from other operations.

Furthermore, producers should be encouraged to build quarantine facilities when

constructing new buildings[15,16]. New additions to a herd should be purchased from a herd with a known health status, and later quarantined for at least 21 days. Convincing the well established herd owner of the need to provide quarantine facilities may seem impossible, but citing examples of nearby outbreaks and the cost associated with that outbreak may aid your arguments. Ideally, all herds should act as closed herds and therefore have no need to purchase a "clean-up" bull or replacement heifers [13,14].

Of those herds, which have a Salmonella dublin outbreaks, it may be necessary to do a herd serologic evaluation. A recent ELISA test developed at University of California, Davis by Dr. Brad Smith, will help identify the carrier animals [6]. This test involves the collection of sera samples and subsequent retesting again in 60 days. The cost is $1.50 per animal. These carriers once identified should be removed from the herd to prevent further infection. This test may also be a screening test for new herd replacements. Recently, several Danish herds have eradicated S. dublin within 2 years after implementing such a test and cull program [17].

Summary

With increased importance placed on the quality and safety of dairy products, a greater emphasis will be directed to control infectious organisms such as Salmonella all along the food processing chain. Therefore, a better understanding of measures that reduce and control the spread of Salmonella will be important in the future. The above outline will by no means eradicate Salmonella from all farms, but hopefully provides insight in how to manage an outbreak and limit the continued spread of the infection to other producers.

Figure 1. Potential Risk Factors for Salmonellosis in Dairy Herds

Herd Factors

1. Larger operations
2. Free-stall Housing
3. Manure handling practices
   (i.e. proper disposal)
4. "Open" Herds
p5. Contaminated Feeds
6. Vectors
   (i.e. birds, cats, rodents)
7. Concurrent Disease
   (i.e. BVD, Johne's, IBR)
8. Calf-feeding practices
   (improper utensil cleaning)

Individual Factors

1. Young calves (3-6 weeks old)
2. Starvation
3. Concurrent disease
   (i.e. rota, cryptosporidia)
4. Stress associated with
   transport
5. Poor immunoglobulin
   levels

Figure 2. **Cycle of salmonella transmission.**

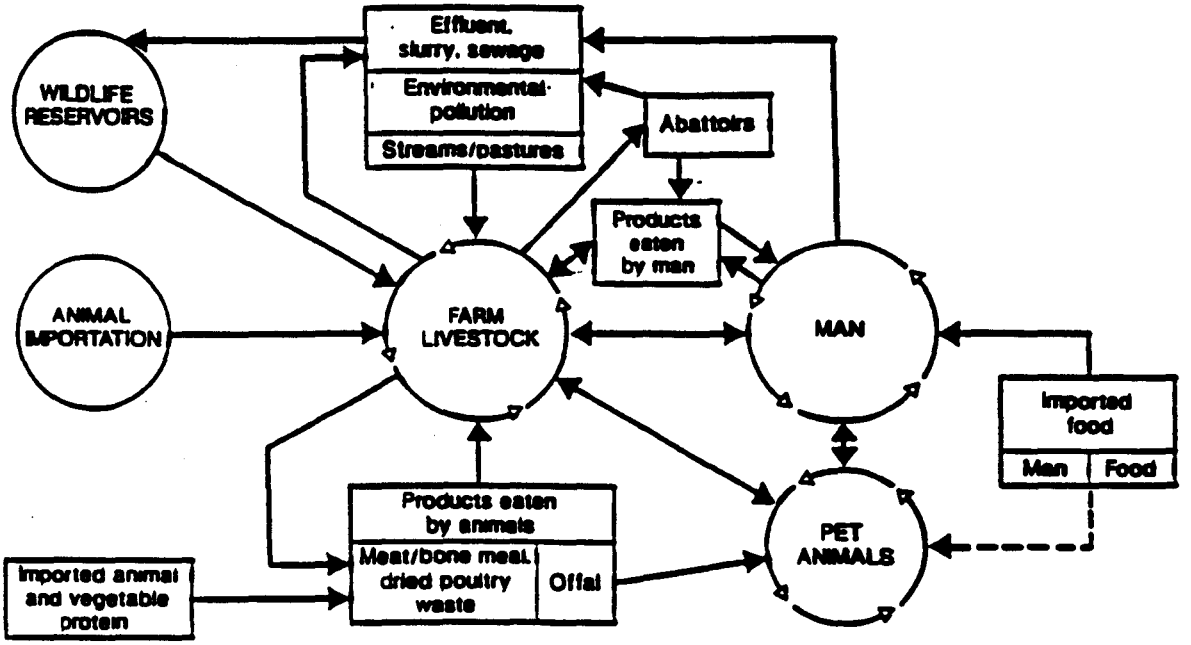
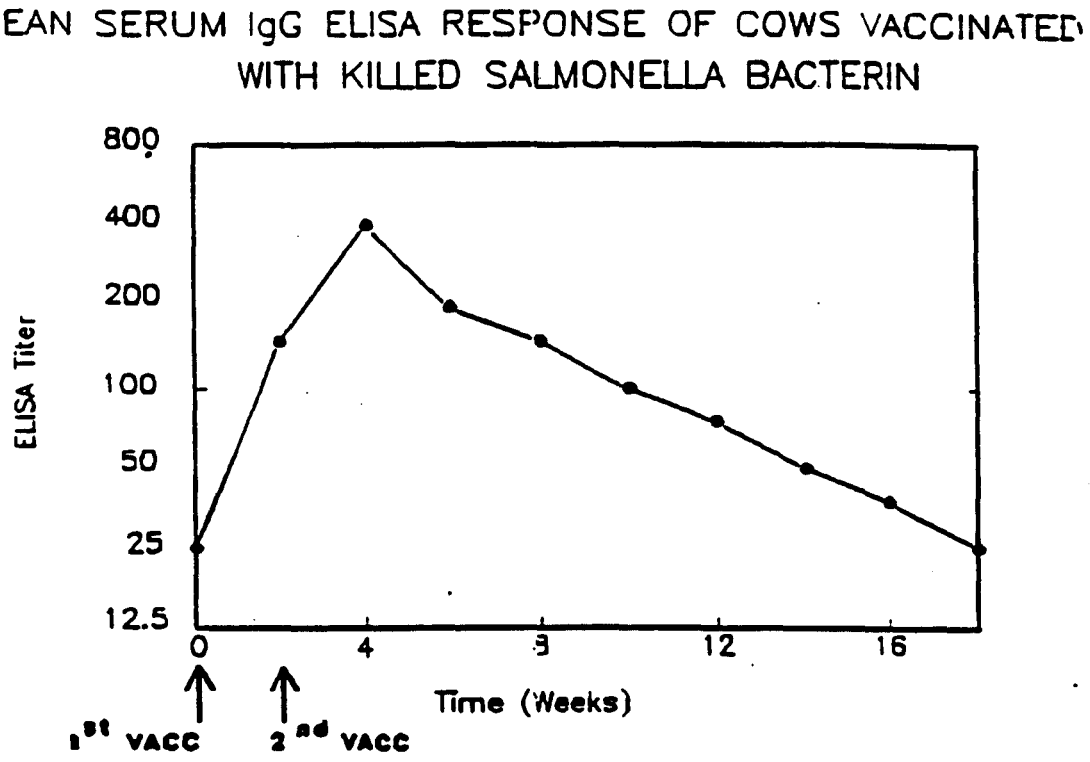


Figure 3.


MEAN SERUM IgG ELISA RESPONSE OF COWS VACCINATED
WITH KILLED SALMONELLA BACTERIN
ELISA Titer
800
400
200
100
50
25
12.5
0
4
8
12
16
Time (Weeks)
1st VACC
2nd VACC