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

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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 of 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

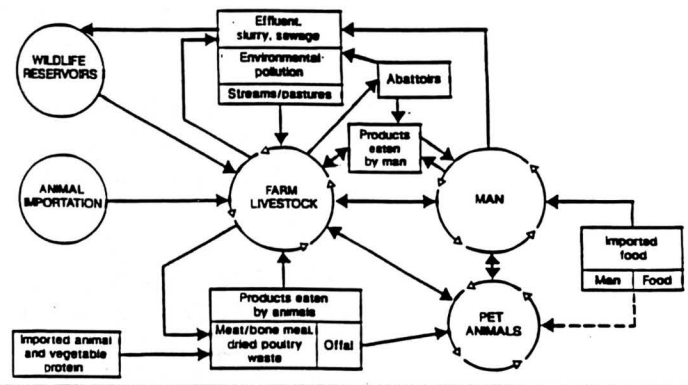
Some obstacles to on-farm *Salmonella* control are: 1) lack of good screening tests to detect herd infection, 2) the need for sensitive and specific individual animal tests to detect cases and carriers, 3) inadequate research linking the suspected risk factors with the disease, 4) poor awareness that a *Salmonella* problem exists on a producer's 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 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.

Figure 1. Potential Risk Factors for Salmonellosis in Dairy Herds

Herd Factors	Individual Factors
1. Larger operations	1. Young calves (3-6 weeks old)
2. Free-stall housing	2. Starvation
3. Manure handling practices (i.e. proper disposal)	3. Concurrent disease (i.e. rota, cryptosporidia)
4. "Open" herds	4. Stress associated with transport
5. Contaminated feeds	5. Poor immunoglobulin levels
6. Vectors (i.e. birds, cats, rodents)	
7. Concurrent disease (i.e. BVD, Johne's, IBR)	
8. Calf-feeding practices (improper utensil cleaning)	

Figure 2. Cycle of *Salmonella* Transmission



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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.

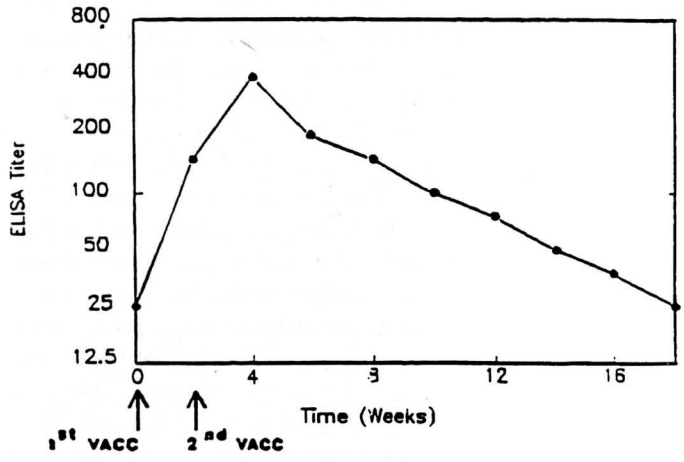
Identification and isolation of infected animals is the cornerstone to control, because afflicted animals may be shedding billions of *Salmonella* organisms. Therefore, calves or cows exhibiting fever, diarrhea, or depression should be isolated until culture results are available. To evaluate the extent 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 fed 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 feces 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.

Figure 3. Mean Serum IgG ELISA Response of Cows Vaccinated With Killed *Salmonella* Bacterin

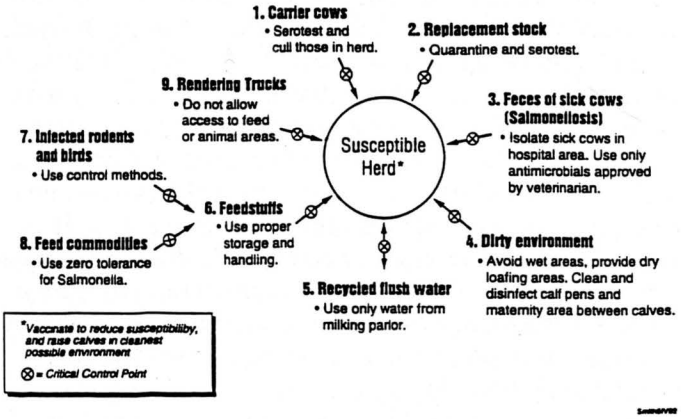


Control Measures

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 con-

trol 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]

Figure 4. Critical Control Points in Controlling *Salmonella* in Cattle



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 fed 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* outbreak, 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.

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Evaluation of Crestar, a synthetic progestogen regime, for synchronizing oestrus in maiden heifers used as recipients of embryo transfers.

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Veterinary Record (1994) 134, 92-94.

Crestar consists of an ear implant containing 3mg norgestomet combined with an intramuscular injection of 3mg norgestomet and 5mg oestradiol valerate. Its effectiveness for synchronizing oestrus in embryo transfer recipients was evaluated in comparison with a progesterone-releasing intravaginal device (PRID) and prostaglandin regimen, using 334 maiden heifers. The treatment devices were inserted on day 1, prostaglandin was administered to the PRID-treated heifers on day 8 and the devices were removed on day 10. High proportions of the heifers were seen in oestrus within five days of the removal of the devices after both the PRID prostaglandin (90.4 per cent) and Crestar (86.2 per cent) treatments. The interval from the removal of the device to the onset of oestrus was significantly shorter for Crestar than for PRID prostaglandin treated heifers (45 vs 51 hours, $P<0.001$), and the duration of oestrus was significantly longer (13 vs 10 hours, $P<0.01$). The PRID prostaglandin treatment resulted in a higher degree of synchrony than the Crestar treatment (74.1 per cent vs 61.8 per cent, $P<0.05$). There were no significant differences between the treatments in the proportions of the heifers selected as embryo transfer recipients or in the proportions which became pregnant after embryo transfer.

Reproductive parameters in Chianina cows

C. Boiti, V. Beghelli, C. Canali, and L. N. L. Castiglione.
Obiettivi e Documenti Veterinari, 1989, 2, 53-59.

In 84 Chianina cows which calved during one year, milk samples were collected at two day intervals from parturition until day 120 post-partum. Progesterone profiles were then studied for each cow. On the basis of progesterone concentration, the restoration of ovarian activity in the post-partum period was accurately determined. Cyclic ovarian activity was always preceded by a rise in milk progesterone concentration usually of short duration. In 90% of the cases investigated, the recovery of ovarian cyclicity occurred about 37 days after calving. The duration of anestrus, however, was greatly influenced by the calving season, level of nutrition, restricted housing, prolonged suckling and summer high temperatures. According to our data, these factors prolonged ovarian inactivity, in the worst conditions, for 60 days after calving. Therefore, the long calving interval, which is peculiar to this breed, was mainly due to the high incidence of sub-oestrous conditions associated with an overall low efficiency in estrus detection. By means of progesterone profiles, specific pathologies of the reproductive tract, early embryonic mortalities and not timing inseminations, were easily detected. However, the overall rate of occurrence was relatively low and cannot really justify the long calving interval observed, while, on the contrary, may explain the high number (2.2) of services per pregnancy.