Introduction

Cattle with clinical signs of illness (fever, diarrhea) and positive fecal cultures for Salmonella seroconvert. This indicates infection with Salmonella.

Cattle (or horses, etc.) with no signs of illness and positive fecal cultures for Salmonella often do not seroconvert. This indicates colonization with Salmonella. Colonization refers to Salmonella passing through or residing in the intestinal tract without invading. In certain situations many cattle in a group may be colonized, and Salmonella can often be cultured from the environment on dairies. This tends to create confusion as to the significance of a positive culture for Salmonella.

Salmonella can be present and affect or not affect a particular animal’s outcome. This fact has led to some misinterpretation, with some clinicians considering Salmonella as part of the normal fauna. Such an approach is equivalent to driving 70 miles per hour down a highway in a thick fog thinking that if you don’t worry, nothing bad will happen.

In the next 2 hours we will learn how to drive through that fog successfully.
Part I: Example:

Problem: 1. Sick/dying fresh cows/calves  
2. Salmonella in milk

History: Typical drylot dairy management. Noticed a few fresh cows with diarrhea a week ago. Now have 5 sick. Several got very ill, lactation markedly decreased, 1 died yesterday. Sick cow pen is same as fresh cow pen.

PE: Examination of 4 ill cows yields these findings:
• Fetid diarrhea
• Three febrile
• HR 80 to 92/minute
• Average 1 weak rumen contraction per 2 minutes, rumen empty.
• All cows gaunt, eyes sunken, 5% to 10% dehydrated.
• Scleral injection in ¾
• Reproductive tract involuting normally and udder is normal

Plan: Isolate sick cows – stop putting sick cows in with fresh cows in “hospital pen”.
• Clean up and disinfect pen where sick cows left diarrhea. Use bleach (2 to 4 ounces/gallon water) to disinfect. One cow with diarrhea can excrete several trillion Salmonella per day.
• Treat sick cows with intravenous and oral fluids and electrolytes, ceftiofur, and banamine.
• Stop workers/family from drinking bulk tank milk.
• Stop feeding sick cow colostrum and milk to calves.
• Supply oat hay to sick cows to encourage them to eat (grass hay for cows is like soup and crackers for sick humans).
• Do CBC on 2 sick cows.
  · 1 has neutropenia and 1 has neutrophilia
  · left shift in both
  · elevated fibrinogen (Salmonella causes inflammatory diarrhea).
  · low plasma proteins
• Do fecal culture for Salmonella
  · find group B Salmonella in 4/5
  · request susceptibility testing and serotyping
• Do necropsy on dead cow
  · lesions of enteritis and typhlitis
  · several tissues positives for group B Salmonella

Interpretation: Fever, depressed appetite and decreased milk production, left shift, elevated fibrinogen, and finding group B Salmonella in tissues and feces indicates that Salmonella is likely cause of illness and death.

Most common highly pathogenic group B Salmonella is S. Typhimurium.
Control: Depends on: 1. Decreasing exposure to pathogens. One thousand Salmonella to a cow may not cause illness, but 100 million will. 2. Maximize host resistance. The baby calf and fresh cow are the most susceptible on the dairy.
Part II

A Tale of Three Dairies

ref: Anderson RJ, House JK, Smith BP et al
Epidemiologic and biological characteristics of salmonellosis in three dairy herds.
JAVMA 219 (3), August 2001. pages 310-322

I. DAIRY 1

- Drylot 1400 to 1500 cows. Normal management.
- **S. Dublin (D), S. Muenster (E1), and S. Typhimurium (B)** in bulk tank. Checked because they sell raw milk.
- **No clinical signs of salmonellosis**
- Over last 18 months, cows persistently seropositive for group D were culled as S. Dublin carriers.
- Serologic profile of 390/1432 cows revealed 27% seropositive for one or more Salmonella serogroups (B, C1, E). The animals positive for group D had been culled.
- Fecal cultures of 1000 cows yielded 15 (1.5%) positive comprised of C1, C2, E1, and B.
- Cultures from feed and environment yielded 17 serotypes (9 serogroups, most B, C, D, E, with one K and one G2).
- **Green chop fed to fresh cows contained same serotypes as cows and bulk tank.**
- River water used to sprinkle alfalfa for green chop was positive for same serotypes. Found sewage effluent contamination up river.

II. DAIRY 2

- Drylot, freestall, 800 cows. Normal management.
- Six months ago had fresh cows with diarrhea and some deaths, isolated S. agona (B).
- Recently fresh cows with LDA, Ketosis, metritis, hypocalcemia. 80% of LDA’s were dying. Heifers affected more than cows. S. Montevideo (C1) was isolated from 11/15.
- S. Menhaden (E), S. Agona (B) and S. Newbrunswick (E) isolated from some animals also.
- Crops (8/50) and creek water positive for S. Montevideo and S. Menhaden. Salmonella was found in flood irrigated corn stalks up to 6 feet above ground, indicating that it enters roots in irrigation water to contaminate feed.
- 97/97 wildlife specimens including mice, rats, opossums, squirrels and birds were positive for same serotypes.
- **Same serotypes of Salmonella isolated from bulk tank milk.**
- Herd became seropositive
  - 86% to group C1
  - 58% to group B
  - 49% to group E
- At this point, much less illness although dairy was crawling with Salmonella
- Demonstrates how group C Salmonella persist on a dairy and how herd immunity influences clinical signs.

III. DAIRY 3
• Drylot, 7500 cows. Normal management.
• Starting 6 weeks ago with very hot weather, calf mortality had soared to 60% by 10 days of age. Simultaneously more sick/dying fresh cows. We found high gossypol in their diet and reduced the amount of cottonseed being fed.
• 83% of dead calves positive for S. Typhimurium (B), with some also having group C2, C3, and E1 Salmonella.
• These same serogroups isolated from cow feces, feed and water.
• Salmonella isolated from 9/14 samples of cottonseed at dairy and 4/6 samples of cottonseed at gin. Water used to irrigate the cotton (not near the dairy) was positive for same serotypes. Human sewage effluent contaminated the water source.
• Serotesting showed that 55% of cows were seropositive at peak of problem, 14% several months later, indicating likely point source outbreak.
Part III

Conclusions

What do we know?

1. Not all of the 2200 serotypes of Salmonella are equally pathogenic.
   - *S. Typhimurium* (B) is very pathogenic.
   - *S. Newport* (C3), *S. Montevideo* (C1), and other group C Salmonella are very common and can be very pathogenic.
   - *S. Dublin* (D) can be very pathogenic, esp. causing septicemia in calves.
   - Group E Salmonella are common, but only occasionally cause clinical illness.
   - Other serogroups are less common to rare, and rarely cause clinical illness although they can.

2. Salmonellosis should be diagnosed by finding appropriate clinical signs, and positive organ cultures or multiple positive primary fecal cultures (as opposed to those which have small numbers and only come up on enrichment). Concurrent diseases such as LDA, BVD, nutritional problems and heat stress can predispose animals to clinical salmonellosis.

3. Herds seroconvert within 30 to 60 days when exposure occurs. The most invasive serogroups (B, C, D) appear to result in some of the most consistent seroconversions. Once herd seroconversion occurs, clinical cases subside and are largely limited to new animals unless heavy exposure of calves continues.

4. Group C Salmonella tend to persist on a farm for years. When bedding containing 100 Salmonella/gm is wetted in warm weather, the numbers can bloom up to $10^6$ Salmonella/gm. Dry bedding is very important (also to prevent coliform mastitis).

5. Salmonella can frequently be found in low numbers in bulk tank milk.

6. Salmonella can be found on most dairies if one looks hard enough. It may not be causing a contemporary clinical problem. Some serotypes of Salmonella have low pathogenicity for cattle and rarely cause clinical illness.

7. Salmonella are frequently recycled by water and feed from crops to cows and back again. In the future, dairies should use clean irrigation water on crops used as feed, or at least check that Salmonella has been destroyed in lagoon by fermentation process.

8. Ensilage will destroy Salmonella if the pH is less than 4.5 as with corn, but may not for grass silage in which the pH remains above 4.5.

9. Control of Salmonella depends on keeping exposure limited to small numbers of organisms, and on maintaining maximum host resistance. Calves and fresh cows are the most susceptible groups, and thus must be isolated from animals with diarrhea. The traditional “hospital pen” containing fresh cows and sick cows must not persist.
Fresh cows around parturition are susceptible because they have rumen fauna not as resistant to Salmonella multiplication as cows on full feed.

10. **Salmonella Dublin** (D) is maintained by carrier cows which can be identified by having persistent titers. Culling these cows is the best control method identified to date. The new genetically altered **S. Dublin** live vaccine for calves, called Entervene by Fort Dodge, is also useful.

11. Commercial and autogenous killed bacterins do result in an increase in titer in animals over 12 weeks of age, but even with two doses this increase is limited to 60 to 90 days after which the ELISA titer drops. There are no controlled studies which demonstrate that these killed vaccines protect fresh cows from salmonellosis. Some controlled studies done on calves receivingcolostrum from vaccinated cows show partial protection against challenge up to about 3 weeks of age, but little beyond that age.

12. Direct calf vaccination with killed bacterins does not appear efficacious. Vaccination of young calves with modified live Salmonella vaccines can be protective. A genetically altered live **S. Dublin** vaccine is currently marketed by Fort Dodge in the U.S.

13. There are no studies regarding the benefit of vaccination of calves or cows with **Endo Vac Bovi** or **J5 E. coli** in preventing salmonellosis or improving survival. It is likely to help improve survival, and is unlikely to prove to be harmful unless adverse reactions to endotoxin in vaccine occur. This is most likely in hot weather, so be careful.

14. Treatment of clinical salmonellosis should include banamine, an approved and effective antimicrobial drug such as ceftiofur, florfenicol, or ampicillin, fluid therapy, and good nursing care. Antimicrobial susceptibility testing is important, since many resistant strains emerge.

15. As in people, initial source of Salmonella is often contaminated feed. Salmonella can enter via roots and be found in all parts of the plant. In controlling Salmonella, the entire ecosystem needs to be considered. Cows can contaminate the environment, but human effluent can contaminate feeds and lead to Salmonella in milk and meat.

Additional recent reading:
