

Salmonella:

# The Bacteria That Just Keeps Taking

by Ed Haag

Just when we think we are starting to figure it out, salmonella throws us another curve. That is the general consensus of scientists and researchers charged with the task of combating the insidious bacteria.

"Salmonella can be very tough to deal with," says Helen Aceto, epidemiologist and biosecurity director at the University of Pennsylvania's School of Veterinary Medicine.

"Once one of the new resistant strains — like *Salmonella newport* (*S. newport*) — establishes itself, it is extremely difficult to clear."

When *S. newport* first began emerging on

Pennsylvania farms, Aceto and others noticed that this new strain was different from previously identified salmonellas. "We

used to have trouble getting environmental samples (samples taken from locations other than directly from infected cattle) on farms that had clinically infected cattle," she says. "When newport first appeared on the scene, we could find it everywhere."

Aceto recalls finding live *S. newport* in locations ranging from water troughs to seemingly isolated puddles on the farms.

The reason became evident in a research study. Aceto and her colleagues recently

completed documenting the survival of *Salmonella enterica* (*S. enterica*) serovar newport in manure and manure-amended soils. The data showed that the organisms persisted 184, 332 and 405 days in manure, manure-amended nonsterilized soil, and manure-amended sterilized soil, respectively.

But Aceto's experience with *S. newport* extends well beyond the farm and laboratory. On May 10, 2004, the hospital where she practices was closed due to an outbreak of salmonellosis caused by multi-drug-resistant *S. newport* (MDR *S. newport*).

"We decontaminated for three months, and it was murder to get rid of it," she says of the experience at the George D. Widener Hospital for Large Animals at the School of Veterinary Medicine, University of Pennsylvania. "In one building, the only way we could get it free of salmonella bacteria was by gassing it with chlorine dioxide — the same stuff they used in the Hart Senate office building for anthrax decontamination."

## Warning to livestock operators

Aceto notes that during the last two decades more than 2,400 separate strains of salmonella have been identified. Out of that number, two new virulent strains have emerged as dominant in livestock: *Salmonella typhimurium* (*S. typhimurium*) definitive type (DT)104, and *S. newport*. While they have differences, both strains share many of the same characteristics. For example, both salmonellas are most commonly transmitted by fecal-oral contamination from livestock, rodents or birds or by cattle ingesting contaminated feed. Both carry resistance to antibiotics, and both can be transmitted from livestock to people.

What makes salmonella such a difficult bacteria to eradicate once it is established in a herd is the covert nature of the bug. When

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**Fig. 1: Salmonella**



Source: Rocky Mountain Laboratories, NIAID, NIH.



an infected animal's immune system is functioning at a high level, the salmonella bacteria retreats from the lower intestine into the bile duct. There it can remain for long periods of time undetected. Then, when the animal is stressed, the bacteria spreads back into the lower intestine and starts sloughing off large numbers of colonizing cells in the feces.

### ***S. typhimurium* DT104**

The Centers for Disease Control and Prevention (CDC) reported in 2006 that DT104 remains the most frequently detected salmonella serotype in the U.S., representing 16.4% of all cases. This is not good news for beef producers, since it is the salmonella type that has the greatest negative effect on the industry.

An opportunistic pathogen, *S. typhimurium* DT104 attacks newborn animals and is a major cause of calf morbidity and mortality in the United States and in Europe. A U.S. Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) assessment notes that DT104 appears to cause a higher morbidity and mortality rate among infected animals than other salmonella infections. One University of California, Davis, study reports a calf mortality rate of 60% by 10 days of age during a DT104 outbreak exacerbated by very hot weather.

While most salmonella DT104 outbreaks are more likely to exact a lower toll, similar mortality levels have been reported in Britain, where a case-control study of cattle there reported a 40% case fatality rate, with a higher rate among calves than among adult animals.

Calves infected experimentally with *S. typhimurium* develop diarrhea within 48 hours. Death in calves is primarily attributed to dehydration and intestinal lesions. Clinical signs of DT104 in adult animals include pyrexia (fever), depression and mental dullness, decreased milk production, anorexia, dehydration, increased saliva production, and diarrhea progressing to dysentery. Animals may be asymptomatic carriers of DT104 and shed large numbers of organisms for up to 18 months following an outbreak.

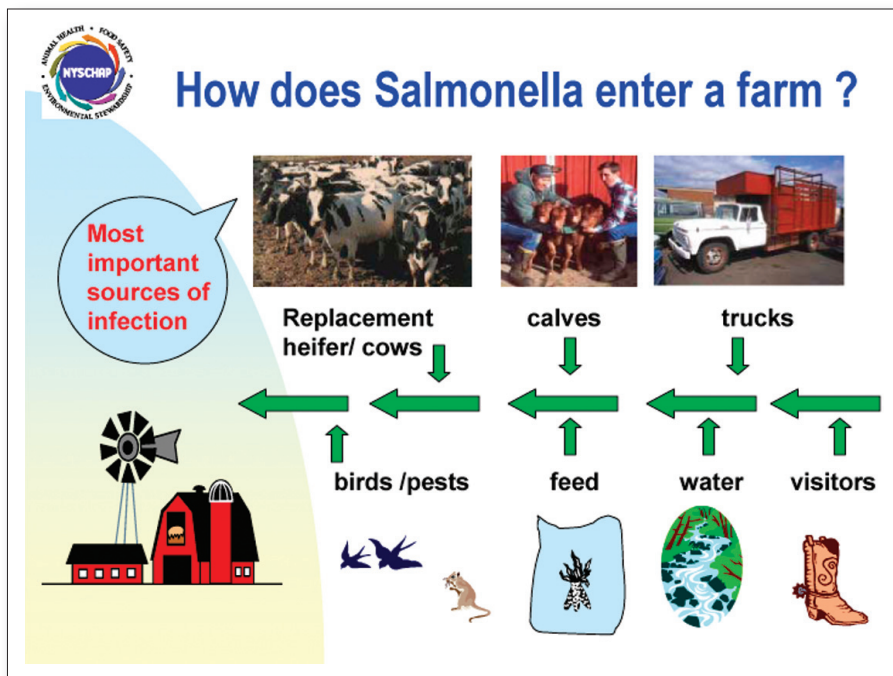
### ***S. newport***

This highly multi-drug-resistant strain first appeared in the United States in 1998 and has since spread to most parts of the nation and to Canada. In 2006, *S. newport* accounted for 9.3% of all salmonella samples submitted for serotyping. It is

►Below: Infected animals and contaminated feed are the two most common ways salmonella is introduced into a previously uninfected herd.



**Fig. 2: On-farm sources of salmonella infection**



Source: Bhushan Jayarao, Department of Veterinary Science, Pennsylvania State University.

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currently the third most frequently detected salmonella in the U.S.

When clinical signs are present, the most common are fever and diarrhea. In the severest of cases this is accompanied by weakness, dyspnea and sudden death.

For confinement and semi-confinement livestock operations such as dairies and intensively managed seedstock ranches, an outbreak of *S. newport* can be particularly devastating. “We have found that, unlike other salmonellas that tend to kill calves, the mortality associated with newport is much higher in adult cattle,” Aceto says, adding that freshening cows and heifers seem to be particularly vulnerable.

She and her University of Pennsylvania colleagues have seen on-farm mortality rates of 40% to 60% in populations of freshening cows that are faced with an outbreak of *S. newport*. The medical response to these incidents are only complicated by the fact that the pathogen is known to be resistant to at least nine of the standard 17 drugs used in enteric bacteria testing and treatment.

For Aceto, this means a major change of

strategy on the part of the livestock operator when dealing with resistant salmonella serotypes like DT104 and *S. newport*. “People who keep livestock must start treating salmonella as a management disease,” she says. “The worst thing you can do with these new, highly-resistant strains is to throw antibiotics at them.”

### Manage for control

She notes that this view is supported by the data she collected from sites that experienced outbreaks of antibiotic-resistant salmonella serotypes. “On the farms that had average management practices, the mortality was 40% to 60% in the at-risk animals, while the farms that had excellent management practices had 40% to 60% morbidity in those animals, but no mortality,” Aceto says. In other words, the farms that had implemented best management practices (BMPs) had animals that got sick from the salmonella but none died, she adds.

Aceto points out that a positive step toward implementing BMPs on a farm is establishing a biosecurity program that

prevents salmonellas from establishing themselves on site. In addition, specific measures should be taken to protect the more vulnerable animals in a herd — cows and heifers that have recently calved and newborn calves — from the effects of a clinical salmonella outbreak if it should occur.

She adds that a good precautionary measure is to remove any sick animals to a hospital pen as soon as they have been identified. These animals should be well away from recently calved cows and heifers and their offspring.

Tom Besser, epidemiologist and professor at Washington State University’s (WSU’s) Department of Veterinary Microbiology and Pathology, agrees that all livestock operations should have biosecurity programs in place to prevent herds from being infected by pathogens like salmonella. He sees infected animals and contaminated feed as the two most common ways the bacteria is introduced into a previously uninfected herd.

“To control the spread of salmonella from animal to animal, appropriate biosecurity

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measures should be taken,” he says. “This means keeping new cattle separate from the herd long enough to know they aren’t carrying the disease.”

He adds that consulting with one’s herd veterinarian as to the best isolation and screening procedures makes a lot of sense.

Besser admits that dealing with contaminated feed is a very different issue.

Historically, contaminated feed, as a known source of salmonella infection in cattle, represents 1% to 3% of all diagnosed cases. But, Besser believes that if research data from an ongoing WSU study proves consistent, that percentage could be higher.

“It is difficult to imagine how you could stop bulk feed from being contaminated with salmonella as it runs from where it is harvested through the transit points to the farms,” he says, adding that one of the goals of WSU’s current salmonella research is to

identify sources of feed that have the lowest risk of contamination.

Meanwhile, for those who are concerned about purchasing contaminated feed, Besser recommends dealing with mills and suppliers who regularly test for salmonella and have a reputation for selling a quality product.

As for avoiding contamination of feed on site, Besser warns that bird and rodent feces are a common and well-documented source of on-farm salmonella contamination. To control starlings, house sparrows and pigeons, Animal and Plant Health Inspection Service (APHIS) researchers recommend depriving them of a feed source by enclosure and habitat modification. This usually means cleaning up feed spills immediately after they occur, modifying or eliminating roosting and nesting sites, and periodically locating and destroying eggs and nests.

Besser notes that reducing the possibility of introducing contaminated feed to a farm isn’t the only reason for demanding quality. “One of the factors closely associated with salmonella is any kind of poor-quality feed,” he says. “Keeping the best-quality feed is one of the most important ways to control the bacteria.”

This is particularly true as it applies to freshening cows and freshening heifers. “Transitional ration management plays a very important part with at-risk adult animals,” Besser says, noting that animals that are in top condition and do not experience feeding stress are more likely to possess immunity factors that will minimize the effect of a salmonella outbreak.

