In 2016, CDC responded to an outbreak of multidrug-resistant *Salmonella* Heidelberg in people who had contact with dairy calves. These infections caused more hospitalizations in people and higher death rates in calves than normally seen in *Salmonella* outbreaks and were resistant to multiple antibiotics.

CDC found that this strain of *Salmonella* had a novel antibiotic resistance gene¹ and recognized that additional scientific investigation was needed to learn how this multidrug-resistant strain emerged and spread.

Dairy calves are susceptible to some strains of *Salmonella*. There are multiple opportunities for introduction of this bacteria along the farm-to-fork continuum of veal calves and dairy beef products, including transmission (spread) of multidrug-resistant strains between calves and through the environment.

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¹ Conferring resistance to trimethoprim/sulfamethoxazole

**SNAPSHOT**

- The project examined the presence and transmission of *Salmonella* at different points in the dairy calf production process: in markets, at farms, during transportation, and in slaughter holding pens.
- The findings informed mitigation strategies to reduce the spread of antibiotic-resistant bacteria among calves, people, and the environment.
- Improving infection control throughout calf production will reduce the spread of antibiotic-resistant *Salmonella* in people, animals, and the environment.
RESULTS

Salmonella in Livestock Markets

- 191 environmental samples were tested from 24 livestock markets in the Midwest. More than 97% were positive for Salmonella.
- Serotypes that typically cause severe disease in calves and people were found, including Newport, Dublin, and Typhimurium. Many of the strains identified were resistant to several antibiotics.2

Salmonella in Barns, Trailers, and Harvest Plant Holding Pens

- Environmental samples were tested from five barns, 10 trailers used to haul calves to the harvest facility, and the holding pen at a slaughter plant.
- Salmonella was found in 22% of barn samples, 74% of trailer samples, and 93% of holding pen samples.

Salmonella Transmission in Calves

- 30% of calves were infected with Salmonella. Infection may lead to contamination of ground beef products.
- Genetic similarity provides evidence that exposure to Salmonella in trailers and holding pens may have resulted in infection in calves.

FUTURE DIRECTIONS

Evidence-based cleaning and disinfection protocols throughout calf production will help protect calves and people, reduce burden of Salmonella in food production, and reduce the spread of antibiotic resistance and resistance genes in animals and the environment.

2 Ampicillin, clindamycin, florfenicol, gentamicin, neomycin, penicillin, sulfadimethoxine, spectinomycin, tetracycline, tiamulin, tilmicosin