Multi-state MDR *Salmonella* Heidelberg outbreak associated with dairy calf exposure

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Multi-agency Collaboration

- Communication between state and federal human and animal health agencies and laboratories
- Outbreak identification
  - Messaging
  - Investigation
Investigation partners

- Wisconsin Department of Public Health
- Wisconsin Veterinary Diagnostic Laboratory
- Wisconsin State Laboratory of Hygiene
- Wisconsin Department of Agriculture Trade and Consumer Protection
- Wisconsin local health departments
- University of Wisconsin Extension
- US Department of Agriculture, APHIS
  - Veterinary Services
  - National Veterinary Services Laboratories
- Centers for Disease Control and Prevention
  - Enteric Zoonoses Team, NARMS and PFGE Laboratories
- Non-Wisconsin state and local health departments in:
  - Missouri, Minnesota, Iowa, North Dakota, Oklahoma, California, Idaho
People infected with the outbreak strains of *Salmonella* Heidelberg, by state of residence, as of February 12, 2018 (n=56)
Human Surveillance Systems

• Case reporting and follow-up
  • Public health interviews
    • *Salmonella* cases
    • Animal exposures

• Laboratory surveillance
  • >95% of isolates and specimens forwarded to Wisconsin State Laboratory of Hygiene (WSLH)
  • Serotyping and PFGE on all isolates
  • Antimicrobial susceptibility testing (AST)
  • Whole genome sequencing (WGS) capability
PFGE Outbreak Patterns
Preliminary Investigation

- Review of PFGE results determined calf and human isolates were closely related PFGE patterns
- Human and animal isolates were reported to be multi-drug resistant (MDR)
- Human case patients reported contact with calves
- Calf submission as a result of calf morbidity and mortality
Preliminary Investigation

- Wisconsin Veterinary Diagnostic Laboratory (WVDL) review of *Salmonella* data:
  - Increase MDR S. Heidelberg isolates since 2015
  - Calf mortality reported
  - No common submitter or source farm, most from within WI

- Additional PFGE of cattle S. Heidelberg isolates was initiated with WSLH
AST and WGS

- Antimicrobial susceptibility results
  - Susceptible to azithromycin, gentamicin, meropenem
  - Reduced susceptibility to ciprofloxacin
  - No effective treatment options exist for cattle
- Whole genome sequencing (WGS)
  - Conducted on representative human and animal isolates
  - 0-18 Single nucleotide polymorphisms (SNPs) difference between most animals and human isolates suggests they are highly related
Multi-state Investigation

- Nationally: 56 cases
  - 15 states; WI (18) and other states (38)
  - Onset dates: 1/27/15 – 2/12/18.
  - Age range: <1 to 72 years (median: 16 years)
  - 40% hospital
  - No deaths reported

*First WI case*

Date of Illness Onset

2015

2016

2017
Multi-state Investigation

- Epidemiologic, traceback, and laboratory findings linked the outbreak to contact with dairy bull calves.
  - Nationally, 66% case patients reported exposure to cattle or dairy bull calves
  - 80% of Wisconsin patients reported cattle exposure
- Traceback of calves conducted from WI and non-WI case patients led to bull calves from livestock markets in Wisconsin
DPH Investigation Objectives

- Public health prevention messaging
  - Reduce risks
- Increase awareness
  - Veterinarians
  - Producers
  - Diagnostic Laboratories
- Increase awareness in potentially affected farms or facilities
  - Biosecurity and management practices
  - Limit transmission
Salmonella bacteria can be found everywhere in the environment. Every year, the bacteria cause nearly one million food borne illnesses nationwide. In Wisconsin, Salmonella is a common cause of gastrointestinal illness and is reportable. Certain strains can be more harmful than others. The Wisconsin Department of Health Services (DHS) is assisting in investigating an outbreak of multi-drug resistant (MDR) Salmonella Heidelberg infections believed to have come from contact with dairy bull calves.

**WHAT IS NEW?:**

- DHS has identified contact with dairy bull calves purchased in Wisconsin as the likely source of most of the 2016 infections.
- Nationwide, twenty-one people from 8 states have been infected with the outbreak strain of Salmonella Heidelberg during January 11, 2016 to October 24, 2016. Eight people were hospitalized, and no deaths have been reported.
- November 29, 2016: Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) has released a press release from animal health officials.

### Wisconsin Salmonella Heidelberg Case Count - 2016

<table>
<thead>
<tr>
<th>Wisconsin Case Count</th>
<th>12</th>
</tr>
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<tbody>
<tr>
<td>National Case Count (Including Wisconsin cases)</td>
<td>21</td>
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</tbody>
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**FARM WORKER HEALTH AND SAFETY**

**FREQUENTLY ASKED QUESTIONS**

**2016-2017 INVESTIGATION**
HANDWASHING AFTER ANIMAL CONTACT

WHY IS THIS IMPORTANT?

Whether you live on a farm or go visit a petting zoo, there are many ways to interact with the animals around you. When visiting animals or their environment, it is important to remember that they have germs, which can cause illness.

WHO SHOULD WASH THEIR HANDS?

Everyone should wash their hands! However, the following groups should take special care around animal excreta:

- Young children
- Old people
- People with weakened immune systems

WHEN TO WASH YOUR HANDS?

- After touching animals or their living area
- After leaving the animal area
- After tending to the animals
- After handling animals' excreta

HOW TO WASH YOUR HANDS?

1. Wet your hands with clean, running water (warm or cold), and apply soap.
2. Lather your hands by rubbing them together between your fingers, making sure to get the soap under the nails and between the fingers.
3. Scrub your hands for at least 20 seconds, including between your fingers, and rinse your hands under clean, running water or dry them with a clean towel.
4. Rinse your hands with water and dry with a clean towel or air dryer.
5. Dry your hands using a clean towel or dry them with an air dryer.

WASH YOUR HANDS!

STAYING HEALTHY WHILE WORKING ON A FARM

Human health is related to the health of animals and the environment. For example, some diseases can be shared between animals and people. These are called zoonotic diseases. When working on a farm, it is common for germs (e.g., Salmonella, E. coli, or Campylobacter) to pass from animals to people. For this reason, it is important to follow good hygiene practices to protect yourself and your family.

HOW CAN I PROTECT MYSELF AND MY FAMILY?

- Always wash hands thoroughly with soap and water after touching or working with livestock, handling equipment used on animals, or coming into contact with anything in the area where there are animals.
- Use separate shoes, work gloves, and clothing when working with livestock.
- Change or take off soaked clothing and boots before getting into vehicles. Wash hands after removing any clothes and shoes you wore while working with livestock.
- Do not eat or drink in areas where livestock are present.
- Do not drink unpasteurized (raw) milk or serve it to others.
- Make sure to supervise small children when they spend time with animals and discourage behaviors that can increase their risk of getting sick.
- When caring for calves with diarrhea (scours), it is especially important to practice good hygiene and biosecurity. This will help prevent the spread of potential germs between calves as well as reduce the chances you, your coworkers, and your family members could become sick.
- Young children and immuno-compromised persons should not have contact with calves, especially those with diarrhea (scours).
Ag Outreach

- WVDL messaged to clients
- Cleaning recommendations
- Notify of zoonotic potential
- Encourage testing
- UW Extension
- Flyer
- Producer Meetings
- DATCP
  - Biosecurity webpage
- Links to DPH
- WVMA
  - Update to members
Animal Health Investigation

Objectives

• Assist public health’s investigation.
  • Not a reportable disease in animals.
• Conduct traceback to potentially affected farms or facilities.
  • Ensure awareness of disease outbreak and zoonotic potential
  • Biosecurity and management practices can be evaluated
• Provide resources for reducing risk
  • Limit transmission
Traceback

- Traceback conducted by DATCP
  - Animal truckers, dealers and markets required to keep records of who they buy from and deliver to.
  - Young dairy calves don’t always need to be identified with an official identification (official ear tag).
Challenges

• Nonregulated disease
• Animals commingled from multiple locations
• Official identification not always required/traceable
• Haulers move between multiple facilities/locations
Traceback

- 8 Interviews completed
- All dairy farms
- 5 farms had $<60$ cows, 3 farms had $>900$ cows
- 7 farms sold calves in last 6 months
- 3-10 bull calves sold on 4 small ops, 100’s on the large farms
- Most bull calves sold within 5 days of age, 1 farm averaged 14 days of age
- All sold calves received colostrum prior to leaving

- None of the calves sold had ear tags prior to leaving the farm
Traceback

• No farms bought calves
• 5 farms had no illness in calves sold
  • 1 farm – few with scours
  • 1 large farm had S. Dublin isolated from calves in the past and *Salmonella* from the cows
• Cleaning
  • 6 farms had no information on the cleanliness of the calf transport vehicles
  • 1 farm reported cleaning after each load
  • 1 farm after more than 3 shipments
• No farms reported family members or workers having diarrhea in the past 6 months.
Traceback

• Identified several livestock markets in Wisconsin where affected calves were sold.
  • One market appeared in numerous legs of trace.
  • Sampling conducted in cooperation with this facility.
Livestock Facility Traces/Sampling

- Traceback from a livestock market
  - Identified multiple farms where affected cattle may have originated.
  - Cattle move through the livestock facility multiple days each week from more than 100 farms across the Wisconsin.

- Environmental testing at the facility and trailers identified the outbreak strain.
Environmental Sampling Results from Market

- Disclaimer
  - Only one facility was sampled
  - Multiple facilities were associated with the outbreak
  - If tested, assume that we would find in other locations
- Purpose of investigation
  - Common risk factors
  - Limit spread
- Practice of commingling, transporting, resorting animals, provides opportunity for geographically widespread transmission of numerous pathogens
Environmental Sampling Results from Livestock Facility

- Environmental cultures for *Salmonella* are enriched to enhance chances of recovery
  - Results are not quantitative
  - Multiple colonies present on the plates
    - Plates from enriched samples may have grown 50 colonies
    - Only selected up to 3 colonies to check for group B
Environmental Sampling Results from Market

- 46 Samples Collected
- Cultured at WVDL-Barron
- 43 Grew *Salmonella*
  - 15 Non-group B *Salmonella*
  - 28 Group B positive
    - 10 Heidelberg
      - All matched outbreak strains
Livestock Market

- Reviewed protocols
- Updated C/D protocols
- Discontinued high pressure spraying prior disinfection
- Developed monitoring strategies with veterinarian
Calf Case Investigations

- Calf tissue or fecal samples submitted to WVDL
  - Matched the outbreak strains
  - Initial phone contact to farm owners and herd veterinarians
    - Information on human health risks
    - Resources
Summary of Initial Phone Interviews

• 10 farms interviewed
• Farm sized ranged from 10 to over 4,000 animals
• Mortality rates highly varied
• 9 of 10 farms purchased any cattle or calves in 2016
• 8 of 10 farms sold calves in 2016
• 3 of 10 farms had human illness
• Discussed Follow-up study
SALMONELLA HEIDELBERG: AN ON-FARM STUDY OF DAIRY OPERATIONS

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VETERINARY SERVICES
OCTOBER 22, 2018
Department of Animal Health
Wisconsin Salmonella Heidelberg Cases

39 Farms
25 Counties

18 Human
14 Counties

County with a Human Case
Cattle Cases
1
2

Map prepared 9/13/2016 by DATCP 068 (datagis@wisconsin.gov)
Investigation Plan

Design a case-control study using WI Veterinary Diagnostic Laboratory submissions

- ~16 case farms, ~32 control farms (2 controls/case)

  Case: S. Heidelberg isolated from dead calves  
  Control: S. Heidelberg not isolated from calves or operations

Collect samples for *Salmonella* isolation
Investigation Plan

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**Key questions:**
- What are the sources of *S. Heidelberg*?
- What practices are involved in the spread of *S. Heidelberg*?
- What practices can be implemented to control *S. Heidelberg*?
Case – Control Study Focus

Herd Inventory and Demographics

Herd Additions and Biosecurity

Calf Sales, Movement, and Health

Calving, Colostrum, and Preweaned Calf Management

Cattle Health

Feeding and Preventive Practices

Housing

Human Illness

Case and Control Calf Information
Materials and Methods

Case-control study

- Herd Additions and Biosecurity

- Fishers Exact test in SAS
  - $P$ value $< 0.1$
Materials and Methods

Case-control study
- Herd Additions and Biosecurity
- Fishers Exact test in SAS
  - $P \text{ value} < 0.1$

Targeted sampling areas likely to yield S. Heidelberg
- Screened for S. Dublin
Materials and Methods

Case-control study

- Herd Additions and Biosecurity
  - Fishers Exact test in SAS
    - $P \text{ value} < 0.1$

Targeted sampling areas likely to yield S. Heidelberg
- Screened for S. Dublin

Samples tested at NVSL and WVDL
- Boot cover swabs
- Swiffer wipes
Results

Case Control Questionnaire
  ◦ 17 cases
  ◦ 14 controls

Environmental Sampling
  ◦ 16 cases
  ◦ 13 controls

February 17, 2017, through August 13, 2018
Results

Herd Inventory and Demographics

Herd Size

- Small (1-99 head)
- Medium (100-499)
- Large (500+)

Case and Control

Percent

P value = 0.4
Results

Herd Additions and Biosecurity

- Herd additions

\[ P \text{ value} = 0.03 \]
Results

Herd Additions and Biosecurity

- Herd additions as a percentage of calf inventory

Average herd additions brought on
Cases – 116%, Controls – 14%

P value < 0.01
Results

Herd Additions and Biosecurity

- Source of additions

\[ P \text{ value} = 0.48 \]
Results

Herd Additions and Biosecurity

- Source of additions

\[ P \text{ value} = 0.02 \]
Results

Herd Additions and Biosecurity

- Source of additions

\[ P \text{ value} = 0.02 \]
Results

Herd Additions and Biosecurity

- Cleaning calf transport vehicles to the operation

\[ P \text{ value} = 0.03 \]
Results

Herd Additions and Biosecurity

- Disinfecting transport vehicles after cleaning

![Bar chart showing the frequency of disinfecting transport vehicles.

Yes: Case and Control groups.
No: Case group.
Unknown: Control group.

P value = 0.12]
Results

Herd Additions and Biosecurity

- Distance calves transported

![Graph showing distance calves transported by case and control groups. The graph indicates that case groups were more likely to transport calves over 50+ miles compared to control groups. The y-axis represents the percent, and the x-axis represents the maximum distance (≤50 miles, >50 miles). The diagram indicates a statistically significant difference with a P value of 0.03.]

P value = 0.03
Results

Herd Additions and Biosecurity

- Calf housing cleaned with water/steam

\[ P \text{ value} = 0.41 \]
Results

Calf Health
- Mortality

\[ P \text{ value} = 0.03 \]
Culture Results

278 samples cultured

*Salmonella* Heidelberg
- 51 of 278 = 18.3%

Any *Salmonella*
- 126 of 278 = 45.3%

Case farms - 16
- No *S. Heidelberg* found on 6 farms
- No *Salmonella* found on 2 farms

Control farms - 13
- No *S. Heidelberg* found
- No *Salmonella* found on 4 farms

![Source of *S. Heidelberg* Positive Samples](chart.png)
Percent Samples Positive for *Salmonella*

**Case**

**Control**

Farm

- Heidelberg
- Salmonella
Results

Source of calves
  ◦ Dealer/market

Proportion purchased
  ◦ >100% of current herd size

Distance traveled
  ◦ >50 miles

Cleaning equipment / housing
  ◦ Higher for case farms

Frequently found in calf areas

Booties
  ◦ Detected S. Heidelberg if present in any other sample

Workers are likely spreading the disease on the operation
**Salmonella Heidelberg Infections in Dairy Calves Can Be Deadly: What Producers Need to Know**

Salmonella Heidelberg is a bacteria that can cause serious illness in calves and humans. Infected calves infected with S. Heidelberg may develop diarrhea or di abruptly without any clinical signs. People infected with S. Heidelberg can develop diarrhea, fever, and abdominal cramps, which typically last from 4 to 7 days.1

An outbreak of multidrug-resistant (MDR) S. Heidelberg was recognized in Wisconsin dairy calves in 2016. To date, this MDR S. Heidelberg has been isolated from dairy calves in several States, with the majority of isolates originating in Wisconsin.1 The S. Heidelberg strains isolated from dairy calves are different from those found in swine and poultry.

Currently, no approved antimicrobial drugs are effective against the S. Heidelberg strains isolated from calves.1 Therefore, affected calves should receive supportive care, including fluid and electrolyte therapy. Calves should continue to be fed milk during the course of the disease, in addition to receiving electrolyte therapies. Withholding milk can lead to death.2

How to prevent a potential outbreak

Operations that acquire calves from dealers, sire breeders, auctions, or markets are more likely to experience an outbreak of S. Heidelberg. This is likely because transport stress makes calves more susceptible to infection and more likely to shed S. Heidelberg and commingling of calves from multiple sources increases the risk of exposure for naïve animals.

To help prevent outbreaks, producers are advised to maintain a dairy herd and a slaughter herd (i.e., do not bring cattle onto the operation), if possible. If it is not possible, producers should take the following precautions:3

- Obtain calves only from trusted sources.
- Confirm all purchased calves have adequate positive transfer (PS) and are free of Salmonella.
- Minimize transportation distance.
- Confirm that all transport vehicles are washed and disinfected between each calf load.

What to do for suspected S. Heidelberg

A producer who suspects an S. Heidelberg outbreak is occurring should contact a veterinarian. To aid diagnosis, the veterinarian might recommend necropsying calves that have died and submitting tissue samples to a diagnostic laboratory. The veterinarian should request a serovar of any Salmonella isolated, as well as antimicrobial susceptibility testing.

The veterinarian and producer should discuss treatment options for sick calves, as noted above, with supportive care is critical for affected calves. Also, it would be helpful for the producer and veterinarian to review the calves' vaccination program. Although commercially available Salmonella vaccines are available, their efficacy against S. Heidelberg is unknown. The veterinarian can also help develop effective cleaning protocols that follow the biosecurity practices above.

After the environment is cleaned, it might be useful to submit samples to ensure that cleaning and disinfection methods eliminated the organism. Special boot covers that collect bacteria from the environment can be worn throughout the calf-raising area after it is cleaned and can then be submitted to the laboratory for culture.

How to keep people safe during an outbreak

S. Heidelberg appears to be easily passed from sick or dead calves to people. The organisms can be passed via direct contact with infected calves or via indirect contact, such as through cleaning the calf area.4 To avoid human infection with S. Heidelberg, producers should take the following precautions:

- Wear PPE when handling sick or dead calves, or when cleaning the calf-raising area.
- Always wash hands and clean or change footwear and when handling calves or working in the calf area.


For more information, contact

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NRRC Building E, M.S. 267
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Fort Collins, CO 80526-0117
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http://www.aphis.usda.gov/nahms

**References**


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**Conclusion**

S. Heidelberg can cause severe illness in calves and people, and it can be deadly for calves. S. Heidelberg is resistant to antimicrobials approved for calves, so supportive care is the recommended treatment. To minimize potential exposure and help prevent an outbreak, producers are advised to avoid contact with the herd, use disposable steps to capture and spread the organism.2

To determine whether the organism is present in the herd or purchase all calves from trusted sources, properly clean and disinfect calf-raising areas, and use PPE.

If an outbreak is suspected, producers should work with their veterinarians to submit samples for diagnosis, treat sick calves, and implement cleaning and biosecurity practices to prevent further spread.
People infected with the outbreak strains of *Salmonella* Heidelberg, by state of residence, as of February 12, 2018 (n=56)
Potential Next Steps

WI Bulk-tank filter prevalence study
- How widespread is the problem?
- ~ 350-400 farms in sample

Longitudinal calf study – origin → transport → destination
- When does shedding start?
- What ages are most susceptible?
- What travel distances present increased risks?
- What is the effect of weather?

Passive transfer status study
- Multiple markets/dealers
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