Salmonella Dublin: Clinical Challenges and Control

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Outline of seminar

• Introduction
• Salmonella Dublin vs other serotypes
• Prevalence and current relevance
• Clinical disease – what do we see?
• Diagnostic tests
• Prevention and control
• Therapeutic challenges; the future
Salmonella Classification

- All pathogenic *Salmonella* found in cattle belong to *Salmonella enterica* subsp *enterica*.
- Further divided into serotypes (about 2500 of them) – Typhimurium, Montevideo, Newport, Dublin.
- *Salmonella* Dublin is host adapted to cattle.
- Now widespread across all dairy areas of US.

Salmonella prevalence

*Salmonella* fecal-culture results form 3 NAHMS dairy studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Operations</th>
<th>Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy 1996</td>
<td>19/90 (21%)</td>
<td>189/3,640 (5%)</td>
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<tr>
<td>Dairy 2002</td>
<td>30/97 (31%)</td>
<td>259/3,645 (7%)</td>
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<tr>
<td>Dairy 2007</td>
<td>48/121 (40%)</td>
<td>523/3,804 (14%)</td>
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</tbody>
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Table formatted from USDA-APHIS-VS-CEAH; 2007
Salmonella enterica isolates

NVSL (n = 1750)*

1. Dublin (18%)
2. Cerro (16%)
3. Typhimurium (14%)
4. Montevideo (8%)

WVDL (n = 4976)**

1. Dublin (23%)
2. Cerro (16%)
3. Newport (14%)
4. Kentucky (8%)

* National Veterinary Services Laboratory, Ames, Iowa, 2013
** Wisconsin Veterinary Diagnostic Laboratory, Madison, Wisconsin, 2006 - 2015

Salmonella Dublin: Alike but Different

Non-Dublin Serotypes

• Devastating disease or chronic low-grade problems
• Shows up subsequent to other risk factors
• Mostly spread fecal-oral
• Usually diarrhea – calves or adults, occasionally reproductive losses – late term abortion especially.

Dublin

• Can still present as a devastating outbreak with diarrhea and reproductive losses but..
• Carriers shed in manure, milk, colostrum and other secretions
• Carriers may not be sick – often are not, especially adults
• Diarrhea, respiratory or other – fever unknown origin, joint infections (calves), ill thrift calves, · often much harder to identify.

Morningstar-Shaw et al., 2013
Valenzuela, et al., 2017
Salmonella Testing Strategies

- **Traditional culture using feces**
  - Fecal shedding is sporadic
    - Single negative test does not rule out infection
  - Allows for serotyping and antibiotic susceptibility testing

- **PCR**
  - Increased sensitivity compared to culture
  - Serotyping rarely available
  - Milk, colostrum, respiratory secretions; in addition to feces
  - Cannot perform antibiotic susceptibility testing
Specific Diagnostic Testing for S. Dublin

- Conventional culture with serotyping or PCR (S.Dublin specific)
- Enzyme-linked immunosorbent assay (ELISA)
  - Measures antibodies directed against O-antigens in serum and milk (individual or group)
  - Significantly more sensitive than fecal culture for carrier status
  - ELISA performs best in cattle 3-10 months of age

Salmonella Dublin – Carrier Status

- Very little hard data on the likelihood of becoming a carrier following natural infection.
- Danish data (L.R. Nielsen et al) – probably the most up to date.
- Current definition – 3 strong positive tests (OD reading) by ELISA over 8 month period.
- Do not run ELISA prior to 3 months of age.
- Accuracy of ELISA – best from 3 months through yearling age.
- Dr. Belinda Thompson – at NYS Animal Health Diagnostic Center.
**Salmonella Dublin – Danish Experience**

- Attempts to eradicate S. Dublin are active in some Scandanavian countries
- Extensive use is made of ELISA testing
- “Endemic” herds have seroprevalence of 15% or more
- Endemic herds have higher rates in young (<12 months) than adults
- Clearance followed by reinfection is possible – some of these become carriers
- Risk of becoming carrier – 5-20% of all infections (estimate).

**Salmonella Dublin: Eradication and Testing Programs**

- Culling – not likely feasible in the US
- May require a lot of testing!
  - 3 times, 3 months apart from weaning to breeding age - to identify carriers
  - Periodic testing of animals 2 years and up – colostrum donor selection and pen groupings
  - Negative herd – 4 consecutive quarterly bulk tank ELISAs over a one year period
Salmonella Dublin - Vaccine

EnterVene®-d

- A component of control on some farms.
- Occasional severe anaphylactic reactions (may “test” first on bull calves).
- Given early in life (by injection) to inspire immune response before natural exposure.
- Off label – will cause immune response in pregnant cattle – for possible colostral response.
- Cannot subsequently use serologic (ELISA) testing.
- Other vaccines – no proven efficacy in research studies versus this serotype.

Salmonella Dublin – Control- Key Points - Calves

- Calves:
  - Very rapid removal of newborns.
  - Test colostrum sources – consider pasteurization, replacement products.
  - No waste milk, unless pasteurized.
  - Control is hard with group feeding.
  - Dedicated personnel – for calves and strict hygiene for those with adult cattle contact.
  - Recognize that weaning appears to be high risk period.
  - For heifer rearers – screening of source farms.
Salmonella Dublin – Control - Key Points – Adults

• Adults:
  • Maintain a closed herd
    • If purchasing cattle, ensure a negative serologic test or bulk tank milk sample from herd of origin (ELISA)
  • House sick and transition cows separately
  • Minimize overcrowding
  • Avoid common use equipment for manure and feed handling

Survival in Environment and Disinfection

• Disinfection can be intimidating!
• Most relevant for calf facilities.
  • [www.wvdl.wisc.edu](http://www.wvdl.wisc.edu) - excellent guidelines for cleaning and disinfection protocols.
• NOT power washing – aerosolizes, spreads and contaminates.
www.wvdl.wisc.edu - Cleaning/disinfection for Salmonella Protocol

- Remove all bedding.
- Soak with water – start high, finish low.
- Alkaline foam cleaning – allow to soak for minimum of 15 minutes.
- Rinse with water.
- Acid foam cleaning – allow to soak for minimum of 15 minutes.
- Rinse with water – allow to then dry completely.
- Apply disinfectant – recommend use of chlorine dioxide – appropriate protective wear.
- Best practice – confirm facility free of Salmonella by environmental sampling.

Salmonella – Public Health Concerns

- Established zoonosis – for farmers, calf handlers, families, veterinarians.
- Not just for people with direct contact.
- Contaminated milk (unpasterurized) and meat – usual sources.
- In US – about 2.6 % of bulk tank milk is positive by culture, 11% by PCR – asymptomatic shedders likely responsible.
- Killed by pasteurization – milk product associated human Salmonellosis is extremely rare – raw milk is the usual source.
Salmonella and Antimicrobial Resistance

- Increasing public health concern.
- Increasing prevalence of MDR strains of *Salmonella enterica* from cattle.
- Modern molecular diagnostic techniques allow for precise tracking of human disease isolates to animal sources – will increase the scrutiny that industry is under in future.
- Science linking “farm to fork” regarding antimicrobial resistance being the fault of antimicrobial use in food animals – still weak.
- Helke et al 2017 – review of 858 publications on drug resistant foodborne salmonellosis in humans – no studies that linked human MDR *Salmonella* back to farm.

Salmonella isolates – UW Veterinary Hospital Experience

1. *Salmonella* Cerro (30%)
2. *Salmonella* Newport (27%)
3. *Salmonella* Dublin (14%)

- Some resistance patterns, but mostly susceptible to several legal antibiotic choices
- S. Newport isolates display most significant resistance patterns
  - Ampicillin and Ceftiofur
Future Challenges

• It seems inevitable that some multi-drug resistance strains with no/very few legal therapeutic options will emerge

• Greater disease traceability – food safety
  • Molecular techniques will allow precise tracebacks/links between food producing animals and human cases of Salmonellosis

• Increasing prevalence of S. Dublin positive cattle and herds is occurring
  • Will near term economics dissuade testing for many producers?
  • Already negatively impacting pre and post weaning calf losses on many operations