

Multi-Drug Resistant (MDR) *Salmonella* in the U.S. Red Meat Supply: Prevalence, Source, Significance, and Control

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Presentation Outline

- To discuss the following aspects of MDR *Salmonella*:
 - Significance
 - Prevalence
 - Source
 - Control

Salmonella

- CDC estimates: Each year
 - 48 million people get sick
 - 128,000 are hospitalized
 - 3,000 die
- *Salmonella*
 - Estimated illness = 1, 027,561 (2nd leading cause)
 - Estimate hospitalization = 19,336 (1st leading cause)
 - Estimated deaths = 378 (1st leading cause)

Salmonella

- Transmission vehicles
 - Human
 - animal contact
 - contaminated environment
 - food.
- Most infections clears up in 2-4 days
- Some (~2%) require hospitalization and some of those (~2% or ~0.04% of those infected) requires antibiotics therapy.

Salmonellosis caused by antibiotic susceptible Salmonella strains

- Most infections clear up in 2-4 days
- Some require hospitalization
- Treatment with antibiotics is not usually necessary; however, if the infection spreads from the intestines, or otherwise persists, the infection can be treated with antibiotics.

Salmonellosis caused by antibiotic RESISTANT Salmonella strains

- Most infections clear up in 2-4 days
- Some require hospitalization
- Some of those requires antibiotics therapy. Because of resistant to common antibiotics, these strains of salmonella represent a major challenge and hence the significance of MDR-*Salmonella*.

Salmonella

- Regardless of the cause MDR *Salmonella* are on the rise;
 - Livestock production practices,
 - Over prescription by the medical profession
 - Antibiotics use in companion animals
 - Other factors yet to be determined
 - A combination of the above

Ground Beef & Salmonella

- Ground Beef related Outbreaks/Recalls:
 - 2002: MDR S. Newport, 47 cases, 1 death
 - 2004: Susceptible S. Typhimurium, 31 cases

2009

- In 2009 and for the first time ever, in the United States, more beef products were recalled for MDR-*Salmonella* than *E. coli* O157:H7.
- Two recalls
 - Jan 2009 for 826,000 lbs
 - Dec 2008 for 22,723 lbs
- Causative agent for both cases was MDR *Salmonella* Newport

Salmonella in the news

- Italian sausage products
- pistachio nuts
- Peanut Butter
- Leafy greens
- Cantaloupe
- Red pepper
- Other (www.samonellablog.com)



WHEN THE WSJ REPORTS ON THE OVERUSE OF ANTIBIOTICS, WE SHOULD ALL PAY ATTENTION

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“In 2005, despite many detractors, I was asked to give the keynote speech at the CDC PulseNet Conference held in Seattle. During and after my talk, the world did not stop revolving and the sun did come up the next day (although in Seattle it is always a bit hazy)... [Read more >](#)

As I left the stage and headed for the door (I was not invited to stay for lunch) a young, geekish, looking fellow followed me out the door, and to the street as I walked back towards my office. As he furtively looked around to make sure no one saw him taking to “that trial lawyer,” he said to me in hushed tones – “antibiotic-resistant bacteria is a risk to us all.” “It is in animal feed and YOU need to do something about it.” Before I could say anything, he dashed away, hoping that none of his fellow science-types witnessed the exchange.”

Salmonella in the news

- The massive 36 million lbs ground turkey recall in August 2011:
 - MDR *Salmonella* Heidelberg
 - Illness were reported from 32 States
 - 119 illnesses
 - One death
- Another 185,000 lbs was recalled of ground turkey for the MDR *Salmonella* Heidelberg.

USDA-FSIS current focus on *Prevention*

What industry needs to do

- Zero tolerance for recall due to MDR-
Salmonella

Approach to determine pathogen significance

- What is the prevalence?
- Are the current interventions effective?
- What is the prevalence in the ground beef supply – should we be concerned?
- Controls

Prevalence and Characterization of *Salmonellae* in U.S. Commercial Beef Processing Plants

Brichta-Harhay, D. M., M. N. Guerini, T. M. Arthur, J. M. Bosilevac, N. Kalchayanand, S. D. Shackelford, T. L. Wheeler, and M. Koohmaraie. *Appl. Environ. Microbiol.* 74:6289-6297.

Brichta-Harhay, D. M., T. M. Arthur, J. M. Bosilevac, N. Kalchayanand, S. D. Shackelford, T. L. Wheeler, and M. Koohmaraie. (2011) *Appl Environ Microbiol* 77:1783-96.

What is the prevalence?

Site	Summer	Fall	Winter	Spring
Hide	93.8%	88.5%	89.8%	86.1%
Right after hide removal	49.4%	51.8%	55.3%	44.2%
After all interventions	1.3%	0.1%	0.7%	1.1%

Six U.S. Beef Processing plants - sampled fed and non-fed cattle

What is the prevalence?

Site	Plant A	Plant B	Plant C	Plant D
Hide	88%	92.1%	93.1%	84.9%
Right after hide removal	52.2%	67.2%	26.9%	54.4%
After all interventions	1.3%	0.4%	0.1%	1.3%

Poor Dressing

Effective Interventions

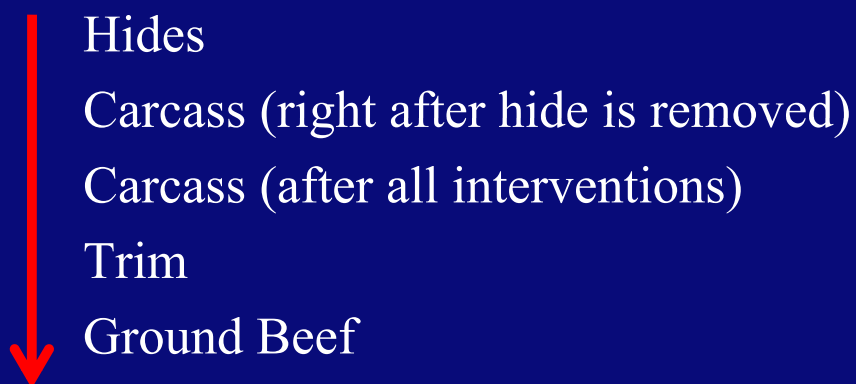
Good Dressing

What is the prevalence?

Site	Plant A (%)	Plant B (%)	Plant C (%)	Plant D (%)	Over all
Hide	88 (7.6)	92.1 (11.2)	93.1 (1.9)	84.9 (46)	89.6 (16.7)
Right after hide removal	52.2 (6.4)	67.2 (8.9)	26.9 (1.3)	54.4 (17.6)	50.2 (11.7)
After all interventions	1.3 (0.8)	0.4 (0.14)	0.14 (0)	1.3 (0.4)	0.8 (0.3)

% MDR Salmonella (defined as resistant to two or more antibiotics)

The Ability to Detect Pathogens

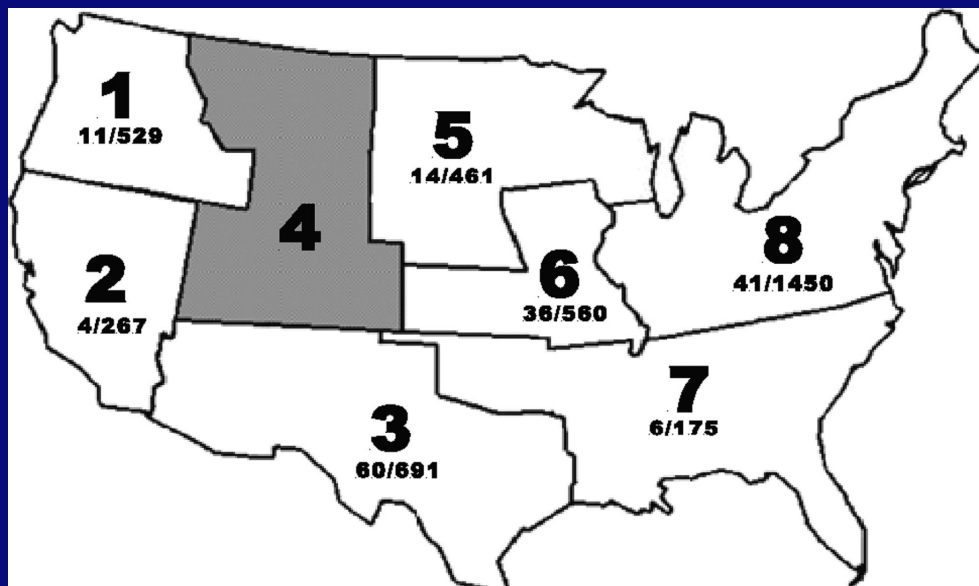


Message: If it is on the carcasses after hide is remove, sooner or later it will be on the subprimals, trim and ground beef.

Prevalence and Characterization of *Salmonellae* in Commercial Ground Beef in the United States

Bosilevac, J. M., M. N. Guerini, N. Kalchayanand, and M. Koochmaraie. 2009. *Appl. Environ. Microbiol.* 75:1892-1900.

Sampling



Project Outline

- 4136 samples
- Screened for Salmonella presence as well as levels (Qualitative and Quantitative assay)
- If present, assay for antibiotic susceptibility
- Conducted DNA finger printing

Results

- The overall prevalence of Salmonella strains was 4.2%.
- Enumeration showed that 94.2% were present at levels below 2 CFU/g.
- Infectious dose: As few as 15-20 cells; depends upon age and health of host, and strain differences among the members of the genus.

Results

- MDR *Salmonella* prevalence was 0.6%.
- MDR strains had resistance to 2-10 antibiotics.
- There were no regional differences in prevalence of MDR *Salmonella*.

Are Current Interventions Effective?

Comparison of Effects of Antimicrobial Interventions on Multidrug-Resistant *Salmonella*, Susceptible *Salmonella*, and *E. coli* O157:H7

Arthur, Kalchayanand, Bosilevac, Harhay, Shackelford, Bono, Wheeler, and Koohmaraie

J. Food Protection, Vol. 71, 2008, Pages 2177–2181

Are Current Interventions Effective?

- *Salmonella* Newport - MDR and Susceptible
- *Salmonella* Typhimurium - MDR and Susceptible
- Interventions:
 - Organic Acids
 - Hot Water

Are Current Interventions Effective?

- No differences were detected in the abilities of these two strain types to survive antimicrobial interventions.
- These results indicate that the drug resistance status of a particular *Salmonella* strain DOES NOT influence the antimicrobial efficacy of the interventions utilized by the modern beef processing plants.

What is the source of *Salmonella* in ground beef ?

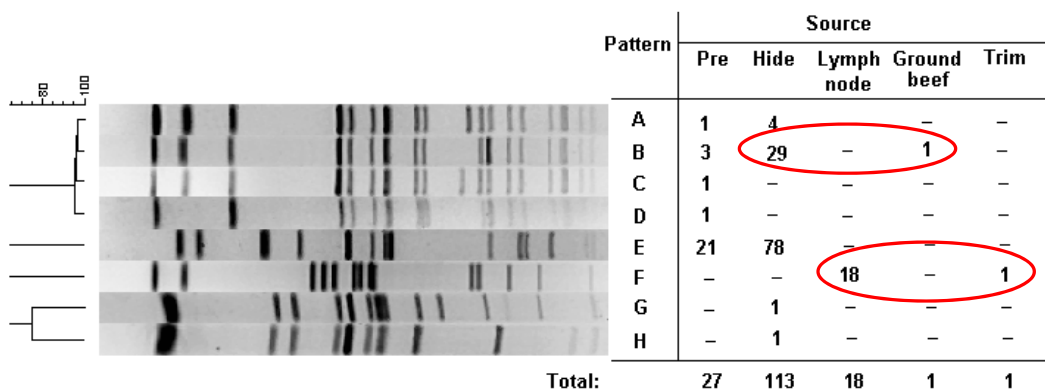
Project Design

- Obtain a group of dairy cows and sample all possible sources of *Salmonella* from the very beginning leading to ground beef:
 - Hides and air
 - Carcasses after hide removal and air
 - Lymph nodes (chuck) and air
 - Trim and air
 - Ground beef and air
 - All sampled were analyzed for the prevalence of *Salmonella*
 - All *Salmonella* isolates were subjected to Pulse-field Gel Electrophoresis (PFGE)

Results

Sample	# Observations	PCR Screen <i>Salmonella</i>	Confirmed <i>Salmonella</i>
Hide	100	95	96
Pre-Evisc Carcasses	100	49	47
Carcasses - Hotbox	50	0	0
Lymph Nodes	100	18	18 (18%)
Trim	14	1	1 (7.2%)
Ground Beef	60	1	1 (1.7%)
Air Samples	33	0	0
Overall	457	164	163

Overall *Salmonella* positive = 35.7%



What do we know?

- Cull dairy cows and sick feedlot cattle are the most probable source of MDR *Salmonella* (any livestock with long term exposure to antibiotics).
- Ground beef sources of *Salmonella* are hides and lymph nodes.

Chances of finding pathogens are much higher in trim than in ground beef

A Proposed Plan for the Control of *Salmonella* and/or MDR *Salmonella* from Ground Beef Supply

A Proposed Plan

- Short term
 - Improved dressing practices – monitor to make sure
 - Remove *major* lymph nodes (*cull dairy cows*)
 - Trim intervention as dumped into combo bins
 - Trim intervention just prior to grinding.
 - Periodic *Salmonella* screening to gauge progress.

A Proposed Plan

- Long term
 - Work with the dairy industry to change practices that causes MDR *Salmonella* – alternative practices.

Other Reports of MDR- *Salmonella* in Lymph Nodes

Study	% lymph nodes positive for <i>Salmonella</i>
Arthur et al (2008)	3.3
Koohmaraie et al. (2008, unpublished)	18.0
Koohmaraie et al. (2009, unpublished)	2.5
Koohmaraie et. al. (2010, unpublished)	1.8
Anonymous (2010)	0.33

Your Best Weapons

- Good Dressing
- Effective Interventions

Tools to Monitor Dressing & Intervention Practices

Good Dressing – Harvesting Monitoring



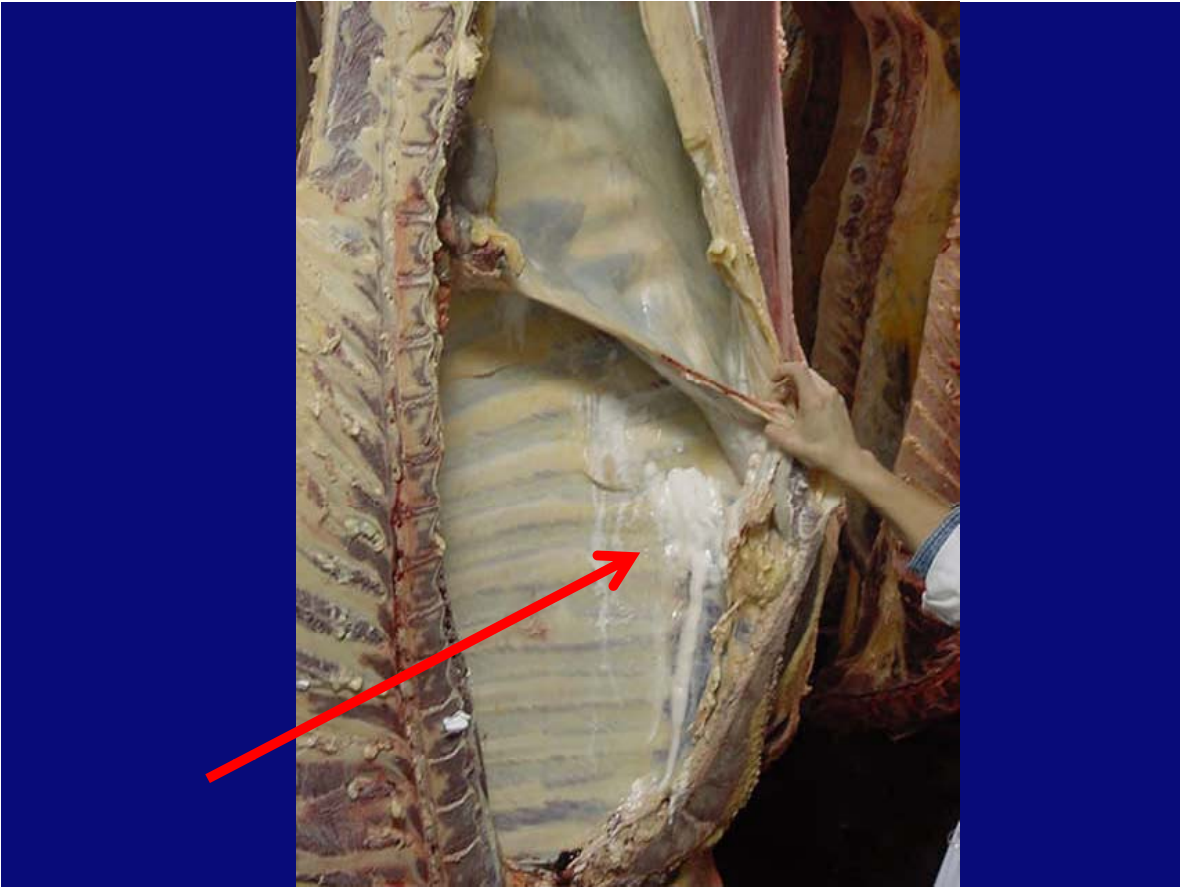
Journal of Food Protection, Vol. 67, No. 4, 2004, Pages 658–665

Effective Interventions- Saving Cream

Tools to Monitor Intervention Efficacy







Conclusions

- MDR *Salmonella* prevalence has increased
- Human get infected through contact with infected human or animals but more often by consuming contaminated food.
- MDR *Salmonella* is prevalent in cattle particularly, sick cattle.
- General consensus is that dairy cows are probably the highest risk cattle.

Conclusions

- MDR *Salmonella* can easily be isolated from feces and hides.
- Commonly used interventions are effective.
- MDR prevalence in ground beef is very low.
- Hide and lymph nodes are the most probable sources of MDR *Salmonella* in ground beef.
- Effective dressing practices should go a long way to control this and other pathogens.

Thank you for listening

For Additional Information Feel
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