Bird’s Eye View of Prevalence of MDR Salmonella and other Gram-negative Bacteria in Poultry
Perspectives & unanswered questions

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Outline

• Most-prevalent poultry-associated Salmonella serotypes (MPPSTs) in the US Poultry
• Overview of Antibiotic Resistance Among MPPSTs
  • Internationally acquired multi-drug resistant (MDR) Salmonella Kentucky infection in WA State
  • Few other examples of MDR MPPSTs with potential international origins
  • Prevalence of MDR Gram-negative bacteria in backyard poultry flocks in WA State

Are all MPPSTs “clinically significant”?

1. CDC: All MPPSTs (except S. Kentucky) are identified as clinically significant.
2. Why S. Kentucky is not considered clinically significant?

Most-prevalent poultry-associated Salmonella serotypes (MPPSTs) isolated from the US poultry meat

- S. Kentucky: ~369 million carcasses
- S. Senftenberg: ~3.5 million carcasses

Are all MPPSTs “clinically significant”?

1. CDC: All MPPSTs (except S. Kentucky) are identified as clinically significant.
2. Why S. Kentucky is not considered clinically significant?
Antimicrobial resistance testing of MPPSTs (Shah lab)

• 1. Salmonella isolate collection

Avian Health & Food Safety Lab, Puyallup, WA
Field Disease Investigation Unit, Pullman, WA

• 2. Serotyping

• 3. AMR testing

• 12 "medically-important" antibiotics
• 7 antibiotic classes

AMR in Salmonella Kentucky isolated from the US Poultry

Source: FDA-NARMS, March 2017

AMR in Salmonella Kentucky isolated from the US Poultry

Resistance pattern Poultry Human

MDR (≥2 antibiotic classes) Common (~70%) Yes (~5%)
3rd Gen Cephalosporins Yes (~3%)

Cip (Ciprofloxacin)

POULTRY: Ciprofloxacin resistance is very common (>80%)
Poultry branch: No resistance to Ciprofloxacin

Human branch: Ciprofloxacin resistance likely originates from domestic sources (e.g., poultry or cattle or other)

AMR in Salmonella Kentucky (Poultry vs Human)

Resistance pattern Poultry Human

MDR (≥2 antibiotic classes) Common (~70%) Yes (~5%)
3rd Gen Cephalosporins Yes (~3%)

Cip (Ciprofloxacin)

1. Why MDR is more common in human clinical isolates?
2. Why only human clinical isolates display resistance to Ciprofloxacin or Nalidixic acid (fluoroquinolones)?
### Cip® S. Kentucky isolated in WA State likely originates from International sources?

**HUMAN BRANCH**
- 11 out of 18 patients (61%) had a history of travel to Egypt, Tanzania, India, Ethiopia, Ivory Coast, Morocco

**POULTRY BRANCH**
- 1 out of 8 patients (13%) had a history of travel to Ecuador

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### Are there other MPPSTs that likely originate from international sources?

<table>
<thead>
<tr>
<th>Resistance pattern</th>
<th>Sources</th>
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</thead>
<tbody>
<tr>
<td>MDR (13 antibiotics)</td>
<td>Poultry</td>
</tr>
<tr>
<td>Carbapenem</td>
<td>Poultry</td>
</tr>
</tbody>
</table>

**Source:** FDA-NARMS, March 2017

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### International Spread of an Epidemic Population of Salmonella enterica Serotype Kentucky ST198 Resistant to Ciprofloxacin

- The global establishment of a highly-fluoroquinolone resistant Salmonella enterica serotype Kentucky ST198 strain

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### Ciprofloxacin Resistant Salmonella enterica Serovar Kentucky in Canada

**Abstract**
- We isolated 126 Salmonella enterica serovar Kentucky from 38 outbreaks in Canada between 2008 and 2012
- The isolates were isolated from human and animal sources with a higher proportion of international travel
- The drug resistance pattern was fluoroquinolone resistant (CIP), nalidixic acid resistant (NAL), and resistant to streptomycin (STR), ampicillin (AMP), and sulfonamides (SUL)

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### Salmonella in Spices: FDA Study Finds 7 Percent of Imported Spices Are Contaminated, Which Are The Worst Offenders?

**Abstract**
- About seven percent of imported spices tested by the U.S. Food and Drug Administration (FDA) were contaminated with pathogens, according to a new study published in Food Microbiology. The FDA will release a comprehensive analysis related to this study soon.

**Source:** The New York Times.
Global kitchen

Antibiotics use = Resistant bacteria
Antibiotic use in animals = Resistant bacteria in human

Study objectives
1. Determine the prevalence of MDR Gram-negative bacteria
2. Determine the prevalence of Salmonella

Study design
- A total of 34 poultry flocks enrolled in the study
  - June 2016 – August 2016
  - ~50 mile radius of Seattle area

Prevalence of multi-drug resistant (MDR) Gram-negative bacteria in the backyard poultry flocks in Washington State

Study design
- Households with <30 hens/flock
  - Range: #2 to 30 hens (one flock with 32 hens)
  - No history of antibiotic usage
  - Most flocks used commercial feed
  - Most also fed kitchen scraps
  - Some had ducks, goats, sheep, rabbits

Melissa Beard
Dr. Narayan Paul
Ava Clareidge
Study design

• Sampling sites (4 samples/flock)
  • A total of 136 DRAG SWABS/COOP samples

  1. Waterer/Feeder
  2. Coop
  3. Nest
  4. Random site (visible fecal matter)

Study design

➢ Isolation of MDR Gram-negative bacteria including Salmonella

DRAG SWAB/COOP SAMPLES
Buffered Peptone Water (BPW)
MAC (Ceftiofur)
Select unique CefR colony morphotypes
Identification by MALDI-TOFF (score ≥2)

Antimicrobial resistance in Gram-negative bacteria isolated from backyard flocks

• AMR testing
  ➢ 17 antibiotics (8 classes)

Prevalence of CefR bacteria isolated from backyard flocks

• Isolated 142 unique CefR Gram-negative bacteria
• Each flock yielded >1 CefR bacteria
• Only one flock was positive for Salmonella (CefR)

MDR in Gram-negative bacteria from backyard flocks

Agrobacter spp. (n=32), 32 AMR patterns
  MDR (n=31), 72%
  ESBL (n=10), 23%
  Imipenem/Erithromycin resistant (n=22), 48%
Prevalence of MDR in Gram-negative bacteria from backyard flocks

<table>
<thead>
<tr>
<th>Bacterial species (n=1)</th>
<th>AMR pattern</th>
</tr>
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<tbody>
<tr>
<td><em>Bordetella trematum</em></td>
<td>AAmcNaSNaXICtx</td>
</tr>
<tr>
<td><em>Hafnia alvei</em></td>
<td>AAmcAnCipXICtxCaz</td>
</tr>
<tr>
<td><em>Ochrobactrum intermedium</em></td>
<td>AAmcCSXICtxCaz</td>
</tr>
<tr>
<td><em>Stenotrophomonas maltophilia</em></td>
<td>AAmcSXICtxCaz</td>
</tr>
<tr>
<td><em>Salmonella spp.</em></td>
<td>G</td>
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</table>

Why should you care about these MDR bacteria?

1. Most of these bacteria are increasingly reported as a cause of nosocomial infections & secondary infection in immunosuppressed individuals

2. Most of these bacteria are commonly associated with spoilage of refrigerated meat

Bacterial species (n=10), 12 patterns of AMR

MDR in Gram-negative bacteria from backyard flocks

Bacterial species (n=22), 12 patterns of AMR

ERIPTENEM RESISTANT (n=10, 45%)
Antibiotics use = Resistant bacteria?
Antibiotic use in animals = Resistant bacteria in human?

Thank you

• Shah lab members
  - Narayan Paul, Post-Doc Fellow
  - Carson Sakamoto, DVM student & Research Fellow
  - Melissa Board, DVM student & Research Fellow
  - Ava Claridge, Undergraduate student

• Collaborators
  - Dr. Rocio Crespo, AHFSL, Puyallup, WA
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  - Dr. William Sischo, FDIU, Pullman, WA
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