The National Antimicrobial Resistance Monitoring System

Patrick McDermott, Ph.D.
Director, NARMS
U.S. Food & Drug Administration
Center for Veterinary Medicine
Office of Research
Laurel, MD USA
Center for Veterinary Medicine Strategy

Aimed at assessing relationships between antimicrobial use in food animals and the potential human health consequences

Multi-pronged approach that includes:

- Education/outreach activities
- Expanded research activities
- Revised safety assessment process (GFI #152) 2003
- Revised judicious use guidance (GFI #209) 2012
- Industry guidance on phasing out production uses (GFI #213)
- Update on veterinary feed directive
- Enhanced surveillance activities (NARMS) 1996
- Better antimicrobial use information (ANPRM)
- Participation in international activities (WHO, PAHO, OIE, Codex)
Challenges of Integrated Surveillance for Antimicrobial Resistance

- Gathering accurate information is expensive and laborious
- Burden of illness and food consumption data are needed for design and prioritization of pathogens and commodities
- Sound sampling scheme along the food chain is critical
- Cooperation of, and good communication between, agriculture and public health sectors
- Collaboration and information sharing between laboratorians, epidemiologists, industry and public health officials within and across sectors
Challenges of Integrated Surveillance for Antimicrobial Resistance

• Political/financial support - Requires recognition of the public health issues and the need for ongoing risk assessments
• Establish a process for review and enhancement
• Remain flexible in order to stay current
• Understanding the implications of the data and the need for research
• Publishing findings to different audiences in a timely manner
• Using the data to formulate sound public health policy
• International harmonization and cooperation
NARMS Objectives

1. Monitor trends in antimicrobial resistance among foodborne bacteria from humans, retail meats, and animals

2. Disseminate timely information on antimicrobial resistance to promote interventions that reduce resistance among foodborne bacteria

3. Conduct research to better understand the emergence, persistence, and spread of antimicrobial resistance

4. Assist the FDA in making decisions related to the approval of safe and effective antimicrobial drugs for animals
Human Salmonella Surveillance Sites *

1996: 14 sites

1999: 17 sites

2002: 28 sites

2003: 53 sites
Human *Campylobacter* Surveillance Sites
Animal Source of Isolates

FSIS PR/HACCP samples

Western Lab

Midwestern Lab

Eastern Lab

ARS/NARMS Lab receives Salmonella isolates

Chicken carcasses for Campylobacter, E coli, Enterococcus
1. Are there inherent biases in the sampling strategies employed in NARMS? If so, how can they be improved to ensure that the data and our interpretation are scientifically sound given current resources?

2. Are there epidemiological and/or microbiological research studies that would better serve the goals of NARMS and the regulatory work of FDA?

3. Are our current plans for data harmonization and reporting appropriate? If not, what would you consider the top priorities for advancing harmonized reporting?

4. Are the current NARMS international activities adequate to address the worldwide spread of antimicrobial-resistant foodborne bacteria?
Focus Areas and Key Findings

1. Research studies
   - Encouraged further development and expansion
   - Emphasis on hypothesis-driven and collaborative research

2. Data harmonization and reporting
   - Need for an integrated database and timely reporting

3. International activities
   - Strongly endorsed continuation and expansion of international activities, including training

4. Sampling strategies
   - Use national, random sampling when possible
     - When not feasible, further stratify data or use a more targeted sampling strategy
1. Laboratory Method Meeting
Sep 10-12, 2008. Athens GA

- Revised NARMS Goals
- Sample and isolate processing
- Established research working groups (Lab, Epi, Mol.)
- Serotyping and species identification
- QC organisms and susceptibility testing
- Criteria for repeat testing
- PFGE updates
- Microarray and Luminex
- ARIS vs. manual AST for *Enterococcus*
- Other laboratory methods issues
  - Developed a laboratory methods manual
2. Data Management Meeting  
Aug 5-7, 2009. Rockville MD

• NARMS integrated database and analytical tools  
  – Currently in Phase III of B/A contract
• Linking NARMS with other programs (e.g., PulseNet )
• NARMS Working Group breakouts
• Sampling
• Strategic Planning  
  – Developed 5Y Strategic Plan
3. International Partners Meeting
July 15-16, 2010 Atlanta GA

- **International**
  - WHO, EFSA, OIE, PAHO, PHAC, Korean, China, Denmark, Africa, IFAH

- **Research**
  - Molecular biology of resistance
  - Genomic typing tools

- Presented draft 5Y Strategic Plan
4. Sampling Meeting
July 2011, St. Louis, MO

- Revising animal and retail meat sampling
- Including industry stakeholders, academic experts and consumer representatives
- Explored potential partnerships to obtain samples
- Discussed best use of resources to meet public health goals

- Sept 2012 – meeting of the retail meat sites at White Oak
NARMS Strategic Plan

Goal 1: To develop, implement and optimize a shared database, with advanced data acquisition and reporting tools

Goal 2: To make sampling more representative and more applicable to trend analysis

Goal 3: To strengthen collaborative research projects to address high risk food safety issues

Goal 4: To support international activities which promote food safety, and mitigate the spread of antimicrobial resistance
NARMS Initiatives - FY2011

CDC

- **Expand Outbreak Isolate Testing.** CDC will expand antimicrobial susceptibility testing of isolates from *Salmonella* outbreaks. This additional testing will allow CDC to more fully use the rich epidemiologic data that is typically available from outbreak investigations.

- **Link Foodborne Disease Surveillance Data.** Link NARMS data with information in other surveillance systems (FoodNet, PulseNet, OutbreakNet). Currently, this type of linking is very labor-intensive and it must be redone whenever up-to-date information is needed.

USDA

- **ARS is coordinating 5 on-farm pilot studies:** dairy cattle, beef cattle, swine, broilers and turkeys. *Will include surveys to assess antibiotic use in sampled animals.*

- **FSIS** is working with NARMS to establish long-term in plant sampling of animals, slated to begin in mid-late 2012

FDA

- **Adding 3 retail testing sites in 2012 (MO, LA, WA).** To expand the number of samples collected will improve the ability to determine trends in different strain subtypes

- **Database development**
Science Board Comments on Animal Sampling

- Sampling needs to be nationally representative
- Sampling biases occur as processing plants are not randomly selected
  - USDA encouraged to assess HACCP sampling to see if modifications can make the sample more representative
  - Alternatively, consider an ongoing “baseline” sampling scheme
- On-farm data are essential in understanding movement of resistance from farm to fork
New NARMS Animal Component-2 parts

1. On-Farm

- Collaboration with USDA- Agricultural Research Service (ARS) and University partners
- Randomized nationally representative selection of farms
- Fecal samples
- Drug use information
New NARMS Animal Component-2 parts

2. In-plant

- Collaboration with USDA-Food Safety Inspection Service (FSIS)
- Randomized nationally representative selection of slaughterhouses
- Cecal samples will be added to HACCP samples to better reflect consequences of veterinary antimicrobial use and less confounding by plant contamination
In Plant Sampling

- Finalized an interagency agreement with FSIS to acquire intestinal samples at slaughter
- Goal is to include all plant sizes
- Testing all four bacteria from 6 production classes
  - Beef, dairy, hogs, sows, broilers, turkeys
- HACCP testing will continue
- Goal is a random representative and sustainable animal sampling scheme with benchmarking to baseline studies and comparison with farm data
- Coupled with on farm studies, we will meet the SB recommendations and better serve the goals of the program
## New NARMS Animal Component

### Old system

<table>
<thead>
<tr>
<th></th>
<th>Swine</th>
<th>Cattle</th>
<th>Chicken</th>
<th>Turkeys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Salmonella</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>E. coli</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Enterococcus</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

### New system

<table>
<thead>
<tr>
<th></th>
<th>Swine</th>
<th>Cattle</th>
<th>Chicken</th>
<th>Turkeys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Salmonella</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>E. coli</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
NARMS Retail Meat Surveillance

Partnership with state FoodNet Sites

- CT, GA, MD, MN, TN 1/2002
- CT, GA, MD, MN, TN, OR 9/2002
- CT, GA, MD, MN, TN, OR NY, CA 1/2003
- CT, GA, MD, MN, TN, OR NY, CA, CO, NM 1/2004
- CT, GA, MD, MN, TN, OR NY, CA, CO, NM, PA 1/2008
- CT, GA, MD, MN, TN, OR NY, CA, CO, NM, PA, WA, LA, MO 0/2012

Sampling scheme

- Each site purchases 10 packages each of chicken breasts, pork chops, ground turkey, ground beef per month
- All 11 sites culture for *Salmonella* and *Campylobacter*
- In addition, 3-4 sites (GA, OR, TN, ±MD) culture for *E. coli* and *Enterococcus*
- In 2005, changed from convenience to randomized sampling
Number of Meat Samples Tested

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Chickens</td>
<td>616</td>
<td>897</td>
<td>1172</td>
<td>1194</td>
<td>1196</td>
<td>1072</td>
<td>1310</td>
<td>1320</td>
<td>1320</td>
<td>1320</td>
<td></td>
</tr>
<tr>
<td>Ground Turkey</td>
<td>642</td>
<td>857</td>
<td>1165</td>
<td>1195</td>
<td>1185</td>
<td>1066</td>
<td>1309</td>
<td>1320</td>
<td>1320</td>
<td>1320</td>
<td></td>
</tr>
<tr>
<td>Ground Beef</td>
<td>642</td>
<td>880</td>
<td>1186</td>
<td>1196</td>
<td>1196</td>
<td>1071</td>
<td>1310</td>
<td>1320</td>
<td>1320</td>
<td>1320</td>
<td></td>
</tr>
<tr>
<td>Pork Chops</td>
<td>613</td>
<td>899</td>
<td>1176</td>
<td>1196</td>
<td>1192</td>
<td>1073</td>
<td>1307</td>
<td>1320</td>
<td>1320</td>
<td>1320</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2513</td>
<td>3533</td>
<td>4699</td>
<td>4781</td>
<td>4769</td>
<td>4282</td>
<td>5236</td>
<td>5280</td>
<td>5280</td>
<td>5280</td>
<td>6720</td>
</tr>
</tbody>
</table>

*2011 data is preliminary
Prevalence of *Salmonella*

*2011 data is preliminary*
# Salmonella Serotype Distributions

<table>
<thead>
<tr>
<th>Humans</th>
<th>Chicken Breast</th>
<th>Ground Turkey</th>
<th>Cattle</th>
<th>Swine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteritidis</td>
<td>Typhimurium</td>
<td>Saintpaul</td>
<td>Montevideo</td>
<td>Typhimurium</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>Enteritidis</td>
<td>Heidelberg</td>
<td>Typhimurium</td>
<td>Saintpaul</td>
</tr>
<tr>
<td>Newport</td>
<td>Heidelberg</td>
<td>Typhimurium</td>
<td>Infantis</td>
<td>Infantis</td>
</tr>
<tr>
<td>Javiana</td>
<td>Infantis</td>
<td>Infantis</td>
<td>Saintpaul</td>
<td>Heidelberg</td>
</tr>
<tr>
<td>I 4,[5],12:i:-</td>
<td>I 4,[5],12:i:-</td>
<td>Newport</td>
<td>Heidelberg</td>
<td>I 4,[5],12:i:-</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>Branderup</td>
<td>Montevideo</td>
<td>Javiana</td>
<td></td>
</tr>
<tr>
<td>Montevideo</td>
<td></td>
<td></td>
<td>Enteritidis</td>
<td></td>
</tr>
<tr>
<td>Saintpaul</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Braenderup</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infantis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Antimicrobial Resistance Phenotypes

No resistance for all years for CIP

-In 2011 AMI was removed from the NARMS panel and AZI was added.

*2011 data is preliminary
Ceftriaxone Resistance by Serotype

*2011 is preliminary
Salmonella Resistance to Ceftriaxone: 1996-2011*

*2011 data is preliminary
Salmonella Resistance to Ceftriaxone: 1996-2011*

*2011 data is preliminary
Ceftriaxone-Resistant *Salmonella* Serotypes - 2011*

<table>
<thead>
<tr>
<th>Serotype</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhimurium</td>
<td>22</td>
<td>37.9</td>
</tr>
<tr>
<td>Newport</td>
<td>11</td>
<td>19.0</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>6</td>
<td>10.3</td>
</tr>
<tr>
<td>Dublin</td>
<td>4</td>
<td>6.9</td>
</tr>
<tr>
<td>I 4,[5],12:i:-</td>
<td>3</td>
<td>5.2</td>
</tr>
<tr>
<td>Agona</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>Senftenberg</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>13.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>58</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*In 2011, 58/2,344 (2.4%) NT *Salmonella* from humans were AxoR*

*2011 data is preliminary*
Fluoroquinolone Resistance in *Campylobacter*

**Withdrawal FQ use in chickens - Sept 2005**

- **C. jejuni** Chicken Breasts
- **C. jejuni** Humans

- **C. coli** Chicken Breasts
- **C. coli** Humans

Year:
Gentamicin Resistance among *Campylobacter coli* isolates

Percent Resistance

Year


Humans
Chicken Breasts
Chickens

* Data are preliminary
Antimicrobial Resistance among Non-typhoidal *Salmonella* isolates from Humans, Retail Meats, and Food Animals, by Year, 1996–2009

### Number of Isolates Tested

<table>
<thead>
<tr>
<th>Year</th>
<th>Humans</th>
<th>Chicken Breasts</th>
<th>Ground Turkey</th>
<th>Ground Beef</th>
<th>Pork Chops</th>
<th>Chickens</th>
<th>Turkeys</th>
<th>Cattle</th>
<th>Swine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>1118</td>
<td>90</td>
<td>71</td>
<td>9</td>
<td>30</td>
<td>214</td>
<td>107</td>
<td>24</td>
<td>111</td>
</tr>
<tr>
<td>1997</td>
<td>1227</td>
<td>83</td>
<td>114</td>
<td>3</td>
<td>19</td>
<td>561</td>
<td>240</td>
<td>28</td>
<td>791</td>
</tr>
<tr>
<td>1998</td>
<td>1411</td>
<td>157</td>
<td>142</td>
<td>4</td>
<td>14</td>
<td>1188</td>
<td>713</td>
<td>1100</td>
<td>153</td>
</tr>
<tr>
<td>1999</td>
<td>1172</td>
<td>151</td>
<td>181</td>
<td>8</td>
<td>8</td>
<td>855</td>
<td>518</td>
<td>1188</td>
<td>899</td>
</tr>
<tr>
<td>2000</td>
<td>1410</td>
<td>152</td>
<td>159</td>
<td>13</td>
<td>13</td>
<td>536</td>
<td>244</td>
<td>1008</td>
<td>1158</td>
</tr>
<tr>
<td>2001</td>
<td>1998</td>
<td>99</td>
<td>219</td>
<td>19</td>
<td>18</td>
<td>262</td>
<td>362</td>
<td>670</td>
<td>123</td>
</tr>
<tr>
<td>2002</td>
<td>1835</td>
<td>213</td>
<td>183</td>
<td>23</td>
<td>21</td>
<td>216</td>
<td>216</td>
<td>607</td>
<td>189</td>
</tr>
<tr>
<td>2003</td>
<td>1782</td>
<td>190</td>
<td>241</td>
<td>25</td>
<td>8</td>
<td>227</td>
<td>227</td>
<td>672</td>
<td>189</td>
</tr>
<tr>
<td>2004</td>
<td>2014</td>
<td>225</td>
<td>179</td>
<td>28</td>
<td>8</td>
<td>304</td>
<td>304</td>
<td>702</td>
<td>122</td>
</tr>
<tr>
<td>2005</td>
<td>2173</td>
<td>211</td>
<td>170</td>
<td>33</td>
<td>8</td>
<td>271</td>
<td>271</td>
<td>453</td>
<td>115</td>
</tr>
<tr>
<td>2006</td>
<td>2144</td>
<td>215</td>
<td>161</td>
<td>33</td>
<td>8</td>
<td>443</td>
<td>443</td>
<td>443</td>
<td>200</td>
</tr>
<tr>
<td>2007</td>
<td>2380</td>
<td>238</td>
<td>155</td>
<td>33</td>
<td>8</td>
<td>443</td>
<td>443</td>
<td>443</td>
<td>200</td>
</tr>
<tr>
<td>2008</td>
<td>2132</td>
<td>213</td>
<td>155</td>
<td>33</td>
<td>8</td>
<td>443</td>
<td>443</td>
<td>443</td>
<td>200</td>
</tr>
</tbody>
</table>

Note: The table shows the number of isolates tested from 1996 to 2008 for different sources and years, with specific emphasis on antimicrobial resistance in non-typhoidal *Salmonella* isolates.
NARMS/PulseNet

- *Salmonella* and *Campylobacter* isolates undergo further molecular characterization
  - PFGE analysis
    - Follow CDC guidelines for PFGE analysis
    - Data is shared with PulseNet
    - CVM PulseNet database has more than 12,000 data entries, including
      - 8,380 *Salmonella*
      - 3,439 *Campylobacter*
      - 547 *E. coli*
      - 69 *Vibrio*
  - Isolates can be used for future research projects
    - Attribution
    - Virulence studies
    - Antimicrobial resistance studies
    - Method development
### Multistate Outbreak of S. Heidelberg Infections Associated with Ground Turkey - 2011

<table>
<thead>
<tr>
<th>ID #</th>
<th>State</th>
<th>Source</th>
<th>Year</th>
<th>Serotype</th>
<th>PulseNet Pattern ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>41663</td>
<td>OR</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41664</td>
<td>MI</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41667</td>
<td>OH</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41666</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41671</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41672</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41673</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41674</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41675</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41676</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41677</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41678</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41679</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41682</td>
<td>OH</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41684</td>
<td>MI</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41685</td>
<td>MI</td>
<td>Clinical</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41683</td>
<td>MN</td>
<td>Ground Turkey</td>
<td>2007</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41687</td>
<td>NM</td>
<td>Ground Turkey</td>
<td>2007</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41695</td>
<td>CT</td>
<td>Ground Turkey</td>
<td>2007</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41839</td>
<td>GA</td>
<td>Ground Turkey</td>
<td>2008</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41841</td>
<td>GA</td>
<td>Ground Turkey</td>
<td>2008</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>41853</td>
<td>CO</td>
<td>Ground Turkey</td>
<td>2008</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>42370</td>
<td>MD</td>
<td>Ground Turkey</td>
<td>2010</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>42399</td>
<td>NM</td>
<td>Ground Turkey</td>
<td>2010</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>42331</td>
<td>MN</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>42338</td>
<td>NM</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>42344</td>
<td>GA</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>30657</td>
<td>NM</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
<tr>
<td>30684</td>
<td>NM</td>
<td>Ground Turkey</td>
<td>2011</td>
<td>Heidelberg</td>
<td>JPDXO1.0056</td>
</tr>
</tbody>
</table>
SNP matrix - S. Heidelberg
NARMS Research to Support FDA’s Mission

1. Determine the genetic diversity within bacterial populations to understand the movement of bacteria through the food chain
   Collaborations with CFSAN-MRC and CFSAN-College Park
   US-EU consortium on NGS

2. Characterize genetic mechanisms of resistance
   Collaborations with many partners at universities (Univ. MD) and government (CFSAN, CDC, USDA)

3. Examine the role of animal feeds in the ecology of resistance
   ORA - feeds and imports surveillance
Summary

- Comprehensive susceptibility data can be used for regulatory decision making, including pre-approval of new animal antibiotics.
- Most extensive national program for integrated laboratory based surveillance of bacteria in foods:
  - Only national program that provides routine isolates for analysis.
  - Strong stakeholder support.
- Leverages existing public health infrastructure:
  - Partnership with FoodNet, PulseNet, USDA-FSIS & USDA-ARS.
- Making improvements to overcome limitations based on original NARMS design.
- Infrastructure in place for hypothesis-driven food hazard analyses.
- Provides food safety officials with ongoing baseline data on the prevalence of specific pathogens in food supply:
  - Provides bacterium/commodity data needed for attribution.
Challenges & Future Needs

- Overcoming the inherent limitations because NARMS was built on existing infrastructure
  - Animal sampling –
    - Sampling at slaughter (FSIS): sustainable, representative, random, cost effective
    - Sampling on-farm with antibiotic use information in some cases (ARS): value added.
  - Adding 3 retail meat testing sites (WA, LA, MO)
- Examining other pathogens and commodities as needed without compromising core monitoring functions.
  - Seafood, feeds - MRSA, ESBLs
- Transitioning to WGS hardware and bioinformatics
- Need for detailed drug use information in food animals
- Continued database development
- Incorporating ORA data into NARMS
- Anticipating feed safety/security events with appropriate method development
- Environmental routes of dissemination
Acknowledgments

**NARMS FDA**
- Dr. Heather Tate
- Dr. Shaohua Zhao
- Dr. Daniel Tadesse
- Jason Abbott
- Sherry Ayers
- Sonya Bodeis-Jones
- Emily Crarey
- Sharon Friedman
- Stuart Gaines
- Carol Henderson
- Claudine Kabera
- Claudia Lam
- Sampa Mukherjee
- Jonathan Sabo
- Thu Thuy-Tran
- Shenia Young

**NARMS CDC**
- Dr. Jean Whichard
- Dr. Beth Karp
- Dr. Maria Karlsson
- Dr. Jason Folster
- Dr. Felicita Medalla
- Regan Rickert
- Kevin Joyce
- Rebecca Howie
- Allison O’Donnell
- Jared Reynolds
- Julian Grass
- Melissa Pitcher
- Andre McCullough
- Julia Taylor

**NARMS USDA**
- Dr. Paula Fedorka-Cray
- Dr. Mary Torrence
- Dr. Jonathan Frye
- Dr. Charlene Jackson
- Jovita Haro
- Takiyah Ball
- Tiffanie Woodley
- Jodie Plumblee
- Dr. Mary Torrence
http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/default.htm