Epidemiologic Approaches for Food Safety

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USDA/CSREES
Epidemiology..

“the study of the distribution and determinants of health-related conditions or events in defined populations, and the application of this study to control of health problems”

- J. Last
Epidemiology

- Scientific approach for public health
- Provides the scientific method to identify and evaluate risk factors
- Provides a way to measure the impact of interventions/prevention and control strategies
- Design and analysis of surveillance databases
Epidemiology

- Determine and evaluate sampling strategies
- Determine sensitivity/specificity of new diagnostics
- Provide population data for risk assessments
32.1 Epidemiologic Approaches to Food Safety

- Established in 1999 to provide funding for epidemiologic research
- Over $33 million awarded
- Only existing research program to fund large epidemiologic studies in food safety
Epidemiologic Approaches for Food Safety

**Goals** - Enhance epidemiologic methods; improve the understanding of epidemiology, ecology and risk factors of foodborne disease; provide specific intervention/control strategies; to develop outcome measurements; address emerging issues in food safety and public health

**Objectives** -
- Identification or evaluation of risk factors
- Quantifying effect on foodborne disease from interventions, management strategies, prevention or control programs
- Development of quantitative outcome measures
Risk Factors

- Organic vs conventional dairy farms in 4 state region (matched on herd size)
- Environmental, farming, and processing effect on microbial contamination of produce
- Role of lairage and transportation on *Salmonella in swine*
Human/Animal Studies

- Genotypic and phenotypic diversity of *Salmonella typhimurium* in 2 county area, CA
- Cohort study of humans and differences in their exposure to antimicrobials, cattle, and beef products
- Pediatric diarrheal diseases and link to food handling and food sources
- Oysters and *Salmonella*
Prevalence of *Salmonella* spp.

Shellfish Growing Regions

Sampling of 13 States

- East Coast
- Gulf Coast
- West Coast
<table>
<thead>
<tr>
<th>West Coast bay (state)</th>
<th>% Oysters positive</th>
<th>East Coast bay (state)</th>
<th>% Oysters positive</th>
<th>Gulf Coast bay (state)</th>
<th>% Oysters positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1W (OR)</td>
<td>19.4 20</td>
<td>1E (ME)</td>
<td>27.8 45</td>
<td>1G (FL)</td>
<td>0 100</td>
</tr>
<tr>
<td>2W (OR)</td>
<td>2.8 21</td>
<td>2E (ME)</td>
<td>0 72</td>
<td>2G (FL)</td>
<td>5.5 85</td>
</tr>
<tr>
<td>3W (WA)</td>
<td>11.1 0</td>
<td>3E (VA)</td>
<td>0 42</td>
<td>3G (FL)</td>
<td>16.7 0</td>
</tr>
<tr>
<td>4W (WA)</td>
<td>0 22</td>
<td>4E (NY)</td>
<td>0 38</td>
<td>4G (FL)</td>
<td>77.8 6</td>
</tr>
<tr>
<td>5W (WA)</td>
<td>16.7 0</td>
<td>5E (NY)</td>
<td>0 19</td>
<td>5G (LA)</td>
<td>0 97.5</td>
</tr>
<tr>
<td>6W (WA)</td>
<td>36.1 5</td>
<td>6E (ME)</td>
<td>41.7 12.8</td>
<td>6G (LA)</td>
<td>0 100</td>
</tr>
<tr>
<td>7W (CA)</td>
<td>0 5</td>
<td>7E (DE)</td>
<td>0 23</td>
<td>7G (LA)</td>
<td>0 100</td>
</tr>
<tr>
<td>8W (AK)</td>
<td>0 39</td>
<td>8E (DE)</td>
<td>0 93</td>
<td>8G (FL)</td>
<td>5.5 78</td>
</tr>
<tr>
<td>9W (AK)</td>
<td>0 39</td>
<td>9E (NY)</td>
<td>0 0</td>
<td>9G (FL)</td>
<td>0 0</td>
</tr>
<tr>
<td>10W (OR)</td>
<td>0 15</td>
<td>10E (SC)</td>
<td>0 95</td>
<td>10G (MS)</td>
<td>0 100</td>
</tr>
<tr>
<td>11W (AK)</td>
<td>0 19</td>
<td>11E (NY)</td>
<td>0 24.6</td>
<td>11G (LA)</td>
<td>0 75</td>
</tr>
<tr>
<td>12W (AK)</td>
<td>0 8</td>
<td>12E (NJ)</td>
<td>2.8 63</td>
<td>12G (LA)</td>
<td>0 100</td>
</tr>
</tbody>
</table>

\(^a\)Sal., *Salmonella* is expressed as the percentage of oysters positive in the bay.

\(^b\)Coli., fecal coliforms. Fecal coliforms are expressed as the percentage of oysters above the MPN.
• Conclusions:

• *Salmonella* was isolated from oysters obtained from all three coastal areas with a prevalence high of 78% and an overall prevalence of 7.3%
• The majority of the *Salmonella* isolates were of the Newport serotype
• Multiple antibiotic resistance was noted in *Salmonella* isolates especially to tetracycline and ampicillin
• Restriction patterns of *Salmonella* DNA were very similar within and between bays
• RT-PCR values ranged between $10^4$ to $10^6$ *Salmonella* per gram of oyster meat
Objective I: Selected Results from Farm Surveys

Field Source
- 50% report animals near or in crop fields
- 6% have barriers to keep animals out of fields
- 6% test produce items for fecal indicators

Human Source
- 56% report that ill workers are sent home
- 22% report that workers are required to wash hands before work
- 11% of farmers/laborers were familiar with the terms “GMP”, “GAP”, or “HACCP”
Objective II: Produce Quality Data

General Microbiological Quality
- Microbial quality of produce in the field varies between and among produce types
- Low level of *E. coli* contamination in leafy greens; higher level in cantaloupe
- Relatively high prevalence of *E. faecium* and *E. faecalis* in fresh produce with varying degrees of antibiotic resistance but virtually none of human clinical relevance

Pathogens
- *Salmonella* detected only in cantaloupe (3.3%)
- *Listeria monocytogenes* and *E. coli* O157:H7 were not detected in any produce items
Table 4. *Enterococcus* isolates by commodity type

<table>
<thead>
<tr>
<th>Commodity (N=141)</th>
<th># of Domestic</th>
<th># of Imported</th>
<th># of <em>Enterococcus</em> Isolates (% total isolates)</th>
<th>E. faecium</th>
<th>E. faecalis</th>
<th>Other <em>Enterococcus</em> spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>0</td>
<td>15</td>
<td>7 (5)</td>
<td>6 (4)</td>
<td>0 (0)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0</td>
<td>45</td>
<td>35 (25)</td>
<td>27 (19)</td>
<td>3 (2)</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Cilantro</td>
<td>42</td>
<td>30</td>
<td>77 (55)</td>
<td>29 (21)(^a)</td>
<td>38 (27)(^b)</td>
<td>10 (7)</td>
</tr>
<tr>
<td>Parsley</td>
<td>9</td>
<td>0</td>
<td>9 (6)</td>
<td>3 (2)</td>
<td>6 (4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>90</td>
<td>128</td>
<td>65</td>
<td>47</td>
<td>16</td>
</tr>
</tbody>
</table>

\(^a\) 17 isolates were of imported origin, and 12 isolates were of domestic origin

\(^b\) 3 isolates were of imported origin, and 35 were of domestic origin
Prevention/Control

- Effect of chlorine concentration on prevalence and transmission of *E. coli* and *Campylobacter* and water consumption in feedlot cattle
- Novel approach for testing and monitoring feedlot cattle
- Effect of management practices on food safety, feed efficiency and weight gain in feedlots
Antimicrobial Resistance

- Role of clonal dissemination in antimicrobial resistance
- Role of poultry litter in dissemination of genes
- Sources and determinants of Campylobacter infection (fluoroquinolone-resistant) in broilers
Sampling issues

- Sensitivity/specificity of different sampling schemes for detection
- Prevalence estimates for pooled sampling
- Mathematical modeling
Focus from 2006

- Innovative methods or studies to quantify the effect of existing interventions or management strategies on foodborne pathogens or disease;
- Development of new quantitative outcome measures for the impact of intervention or management strategies;
- Identification of new risk factors or quantitative evaluation of existing risk factors that may affect prevalence, transmission, or persistence of foodborne organisms or the prevalence of disease.
FY 2007

- Must have an epidemiologist as an active participant in the study
- Limit $1.0 million
- Funds around 15-20%
- Total budget around $4 million
- Deadline December 14, 2007
- Contact: Dr. Mary Torrence, (202) 401-6357, mtorrence@csrees.usda.gov
Life Lessons…

- Epidemiology and microbiology provide a perfect complement of expertise and synergy in the study of food safety
- Epidemiology provides the necessary scientific approach for food safety
A Multi-disciplinary Team

Food Safety Research and Response Network

- USDA CSREES Cooperative State Research Education and Extension Service (CSREES)
- National Research Initiative
- Food Safety- CAP
- $ 5 million for 4 years
- Lead institution: NC State University
17 Universities
50+ Food Safety Researchers and Support Specialists

Cornell Univ.
Iowa State Univ.
McMasters Univ.
Mississippi State Univ.
N. Dakota State Univ.
The Ohio State Univ.
Tuskegee Univ.
Univ. of Arizona
Univ. of Calif. Davis

Univ. of Calif. Berkley
Univ. of Florida
Univ. of Illinois
Univ. of Kentucky
Univ. of Minnesota
Univ. of Montreal
Washington State Univ.
West Texas A&M Univ.
FSRRN Objectives

- Foster research synergy-
  multidisciplinary cooperation
- Bridge research with real-world
  applications
- Respond to emerging challenges and
  opportunities
- Maximize resources
Food Safety Research and Response Network (FSRRN) Project Management Plan

Advisory Committee  FSRRN Steering Committee

Principal Investigator

Rapid Response Team

Research Project

- Pre-Harvest Food Safety Pathogen Detection, Surveillance and Risk
- Public Health Impact of Pre-harvest Food Safety Pathogens
- Microbial Ecology of Pre-Harvest Food Safety Pathogens
- Cost-effective Intervention Strategies for Pre-harvest Food Safety Pathogens

Administrative

Microbial Core

Epidemiology Core
Initial FSRRN Research Themes

Pre-harvest focused

1) Public Health Impact Food Safety Pathogens;
2) Microbial Ecology Food Safety Pathogens;
3) Food Safety Pathogen Detection, Surveillance & Risk Assessment;
4) Cost-effective Intervention Strategies for Food Safety Pathogens

Catfish ponds in Eastern Mississippi
Microbial Core

- Standardization of pathogen detection protocols
- New assay development
- Developing techniques for pathogen extraction from complex matrices
- Refining techniques for pathogen quantification
- Providing training
Epidemiology Core

- Study design
- Study design standardization
- Information management
- Data analysis
- Risk assessment
- Epidemiologic modeling
- Spatial analysis
Potential

- Targeted projects to aid other Federal agencies
- Flexibility to respond to emerging research questions, data needs or food safety issues
- Flexibility to get or develop needed expertise
- Training of our “future”
- Fund “high risk” research
The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

- Einstein