Control of Emerging Foodborne Pathogens (An Industry Perspective)

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Four steps lead from detection to control of emerging pathogens
1. Detection

Laboratory

Healthcare provider

General public

Local Health Department

Local/Region/State/Province/Country

National/Regional Reporting System

Surveillance

Universities

Agencies

Industry

Regulations

Codex Codes of Practice, etc

International Reporting System

New Regulations

Reporting

and

Control
1. Detection

- Laboratory
- Healthcare provider
- General public

2. Investigation

- Local Health Department
- National Health Agencies
- Industry
- Universities
1. Detection
   - Laboratory
   - Healthcare provider
   - General public

Local Health Department

2. Investigation
   - Local/Region/State/Province/Country
   - National Health Agencies
   - Industry
   - Universities

3. Surveillance & Reporting
   - Local/Region/State/Province/Country
   - National Reporting System
   - National Regulations

4. Control
   - Local/Region/State/Province/Country
   - National Reporting System
   - Codex Codes of Practice, etc

International Reporting System
1. Detection
Detecting “new” foodborne pathogens

<1900  V. cholera, T. spiralis, C. botulinum, Salmonella, Shigella

1900-10  B. melitensis

1910-20  S. aureus, foodborne polio

1920-30

1930-40  S. aureus, hepatitis A

1940-50  B. cereus, C. perfringens, V. parahemolyticus
Detecting “new” foodborne pathogens

1950-60  
*L. monocytogenes, C. perfringens, V. parahemolyticus, Anisakidae*

1960-70  
*B. cereus, V. parahemolyticus, V. vulnificus, aflatoxin and other mycotoxins*

1970-80  
*C. jejuni, Y. enterocolitica, Norwalk virus, Giardia, vomitoxin*

1980-90  
*L. monocytogenes, E. coli O157:H7, E. sakazakii*

1990-00  
*Cyclospora, Cryptosporidium, nvCJD*

2000-10  

2. Investigation
Investigation

- Case definition
- Symptoms and severity of disease
- How disease occurs - infection, toxin, virulence factors, etc
- Methods to detect and quantify
- Sources and how humans are exposed
- Effect of temperature, pH, $a_w$, etc. on growth and survival
- Where is control possible in the food chain
- How to control the pathogen (GHP, HACCP)
- Degree of control (prevent, eliminate, reduce)
3. Surveillance and reporting
Some benefits of surveillance

- Trends in the incidence of disease can be measured
- The steps in the food chain that must be controlled can be identified
- The impact of public health policies and industry efforts can be measured
- The role of specific foods can be estimated
Surveillance can lead to control strategies

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- The role of specific foods can be estimated
Targeting specific foods for control
Examples of targeting foods

**Y. enterocolitica**
Raw pork, fermented meats with pork

**L. monocytogenes**
RTE foods in which growth can occur

**E. sakazakii**
Powdered infant formula

**E. coli O157:H7**
Ground beef, leafy greens
Vehicles of foodborne *E. coli* O157 outbreaks in the USA, 1982-2002

Surveillance systems

Enteric pathogens

- Passive systems (e.g., physician reports)
- Active systems
  - CaliciNet
  - European network for Norovirus
  - FoodNet
  - PulseNet
  - Enter-net
  - Global Salm-Surv
WHO Global Salm-Surv Centers of Excellence are designated by the WHO Global Salm-Surv Steering Committee to serve several countries in a region.
Salmonella serotypes 2000-2004

Source: WHO Global Salm-Surv Report 2005
Trends of VTEC 2000-05 (Data from 21 countries)

Anon. 2007. Enter-Net Annual Report for 2005
Examples of targeting pathogens

Which strains are more likely to be involved in human disease?

- *Y. enterocolitica* serotypes 0:3; 0:5,27; 0:8; 0:9
- Certain epidemic clones of *L. monocytogenes*
- Monophasic *S. Enterica* serovar 4, [5],12:1,-
- Certain phage types of *S. Enteritidis*
Trends of *S. Enteritidis* phage types in nine European countries

Historically

- Problems expand as they become more widely known.
- Pathogens with newly acquired virulence factors will spread.
4. Control
Where in the food chain can a pathogen best be controlled?

- Farm
- Aquaculture
- Wild

Processing plant (Magic box)

Retail, foodservice

Home
Commercial issues of emerging pathogens

- Transmission of disease by employees.
  - Noroviruses, Hepatitis A
Commercial issues of emerging pathogens

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- Consumer perceptions about the safety of food.
  - Beef/BSE
  - Poultry/avian influenza
  - Spinach/ *E. coli* O157:H7
  - Tomatoes, peppers/ *Salmonella*
  - Peanut butter/ *Salmonella*
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- Major customers’ (e.g., retailers) reaction.
  - More testing!
Commercial issues of emerging pathogens

- Is it possible to:
  - lessen the impact on your business?
  - shorten the investigational phase?
  - identify and implement controls more quickly?
Industry can improve its management of emerging pathogens
Example: *L. monocytogenes* in RTE meat and poultry products

- Sampled products and environment beginning in 1987
- Shared data with trade association and competitors
- Shared data with USDA from 1990 to 2003
- Developed control measures, shared with competitors and USDA
- Created videos and published best-practice guides
- Held 5 annual workshops for suppliers, customers, co-packers; USDA, FDA, CDC participated
- Shared information with consumer groups
Some control measures that helped

- Validated kill steps (e.g., cooking, fermenting/drying)
- Weekly equipment & environmental sampling program
- Covered & steamed critical equipment (e.g., collators, slicers & packaging equipment)
- Added citric acid to brine chill systems (pH ≤ 3.5)
Some control measures that helped

- Prevented recontamination after the kill step by detecting and eliminating harborage sites
- Improved equipment design for cleanability
- Added inhibitors to products (e.g., lactate, diacetate)
- Pasteurized packaged product (steam, hot water, UHP)
Benefits of the *Listeria* control program

- Consumer protection
- Regulatory compliance
- Business protection
- Refrigerated products have consistently longer shelf lives
USDA results for *Lm* in RTE meat and poultry products

Source: Scott and Huffman. 2007. ISOPOL XVI (Updated with 2007 results)
Listeriosis - USA

Cases per 100,000

National Health Objective
Other examples of success in pathogen control
Chicken at retail - The Netherlands, 1995-2002

Salmonella spp.

Percent of samples positive

Prevalence of *S. Enteritidis* and *S. Typhimurium* in flocks of laying hens: Oct 2004 – Sept 2005

Source: Sheehan and van Oort. 2006. World Poultry 22(9):2-4
Total human salmonellosis 2000-05
(data from 26 countries)

Anon. 2007. Enter-Net Annual Report for 2005
Illness due to *E. coli* O157:H7 - USA

Cases per 100,000

1996 to 2007

National Health Objective
What about the future?

- Improved surveillance systems and methodologies
What about the future?

- Improved surveillance systems and methodologies
- New technologies will be used for control
  - *L. monocytogenes*
    - In-pack pasteurization (e.g., hot water, UHP)
    - Additives to inhibit growth
  - *Salmonella, Campylobacter, VTEC*
    - Vaccination, probiotics, etc will be used to reduce human enteric pathogens in animals
    - Improved decontamination of carcasses
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- The significance of viruses will be clarified and strategies for improved control will be developed
### Viruses

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<thead>
<tr>
<th></th>
<th>% of total foodborne disease</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
</tr>
<tr>
<td>Norwalk-like</td>
<td>66.6</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>0.3</td>
</tr>
<tr>
<td>Astrovirus</td>
<td>0.3</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>0.0</td>
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</tbody>
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Viruses

- Data from 6 states in the USA:
  - ~50% of all foodborne outbreaks were due to noroviruses
  - salads, sandwiches and fresh produce accounted for >56% of those outbreaks.

Conclusions

- Almost 125 years have passed since Koch’s investigation of *V. cholerae*.
- Many new microbial hazards have been discovered.
- Tremendous changes have occurred in the food chain.
- Improved epidemiologic and surveillance systems have expanded our knowledge.
- Industry’s food safety systems can and will continue to evolve to meet the challenges of new emerging pathogens.