Current Human Illness Surveillance Systems
Apps and Gaps

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Collaborative Food Safety Forum
November 3, 2011
Our Overarching Goal

To gather information from ill persons and their pathogens, and to analyze that information to create knowledge that can be used to prevent suffering and death.
Why conduct surveillance for foodborne illness?

- Detect outbreaks
- Count illnesses, hospitalizations, and deaths
- Determine foods and settings causing illness
- Track trends to determine if control measures are working
- Provide physicians with information for patient care
Cycle of Foodborne Disease Control and Prevention

- Surveillance
- Prevention Measures
- Epidemiologic Investigation
- Applied Research

Measures
Estimates of foodborne illness are helpful for allocating resources. However, it is challenging because it can be caused by many agents (e.g., viruses, bacteria, and chemicals), have multiple sources (e.g., contact with contaminated water), and may be transmitted by foods (e.g., milk, eggs, and seafood). Only a fraction of cases are reported, as many cases are asymptomatic or reported to healthcare providers outside of the foodborne illness reporting system. The estimated number of cases is based on reported cases and estimated underreporting, which is the difference between actual cases and reported cases. The CDC estimates that about 48 million cases of foodborne illness occur in the United States each year, resulting in 128,000 hospitalizations and 2,600 deaths. The actual number of cases is likely much higher, as many cases are not reported or diagnosed.

Foodborne illness acquired in the United States—major pathogens

E. coli O157:H7

This illness is caused by a pathogenic strain of E. coli that produces a Shiga toxin, which is responsible for the symptoms of severe gastrointestinal illness. The illness is typically acquired through consumption of contaminated raw or undercooked meat, particularly ground beef. Prevention measures include thorough cooking of meat, washing hands after preparing raw meat, and avoiding cross-contamination between raw and cooked foods.

Salmonella

This illness is caused by a variety of Salmonella species that infect the gastrointestinal tract and cause symptoms such as fever, diarrhea, and abdominal pain. The illness is typically acquired through consumption of contaminated food, particularly eggs, milk, and leafy vegetables. Prevention measures include proper cooking of food, refrigeration of perishable foods, and thorough washing of hands before and after handling food.

Campylobacter

This illness is caused by Campylobacter jejuni, which is commonly found in the intestines of animals and can contaminate food, particularly chicken, beef, and dairy products. The illness is typically acquired through consumption of contaminated food or water. Prevention measures include thorough cooking of meat, refrigeration of perishable foods, and proper hand hygiene.

Norovirus

This illness is caused by norovirus, which is highly contagious and can be transmitted through food and water. The illness is typically acquired through consumption of contaminated food or water, or through direct contact with an infected person. Prevention measures include proper hand hygiene, avoiding close contact with infected individuals, and avoiding eating or drinking when feeling ill.

Clostridium botulinum

This illness is caused by Clostridium botulinum, which produces a powerful neurotoxin that affects the nervous system. The illness is typically acquired through consumption of botulinated food, particularly home-canned foods. Prevention measures include proper canning techniques and refrigeration of canned foods.

Listeria monocytogenes

This illness is caused by Listeria monocytogenes, which can contaminate a variety of foods, including ready-to-eat foods, dairy products, and fresh produce. The illness is typically acquired through consumption of contaminated food. Prevention measures include proper handling and cooking of food, and proper hand hygiene before and after handling food.
## 31 Pathogens Transmitted Through Food

Scallan et al, Emerging Infectious Diseases, 2011

| BACTERIAL                                      |  | BACTERIAL                                      |  |
|------------------------------------------------|  |------------------------------------------------|  |
| **Vibrio cholerae**                            |  | **Vibrio vulnificus**                          |  |
| **Bacillus cereus**                            |  | **Vibrio parahaemolyticus**                    |  |
| **Brucella spp.**                              |  | **Vibrio spp., other**                         |  |
| **Campylobacter spp.**                         |  | **Yersinia enterocolitica**                    |  |
| **Clostridium botulinum**                      |  | **PARASITIC**                                  |  |
| **Clostridium perfringens**                    |  | **Cryptosporidium parvum**                     |  |
| **E. coli O157, Shiga toxin-producing**        |  | **Cyclospora cayetanensis**                    |  |
| **E. coli non-O157 STEC**                      |  | **Giardia intestinalis**                       |  |
| **E. coli, enterotoxigenic**                   |  | **Toxoplasma gondii**                          |  |
| **E. coli, diarrheagenic other**               |  | **Trichinella spp.**                           |  |
| **Listeria monocytogenes**                     |  | **VIRAL**                                      |  |
| **Mycobacterium bovis**                        |  | **Astrovirus**                                 |  |
| **Salmonella, non-typhoidal**                  |  | **Hepatitis A**                                |  |
| **Salmonella serotype Typhi**                  |  | **Norovirus**                                  |  |
| **Shigella spp.**                              |  | **Rotavirus**                                  |  |
| **Staphylococcus aureus**                      |  | **Sapovirus**                                  |  |
| **Streptococcus spp., Group A**                |  |                                               |  |
### 31 Pathogens Transmitted Through Food

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<th>PARASITIC</th>
<th>VIRAL</th>
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Surveillance data come from many systems.

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*Scallan et al, Emerging Infectious Diseases, 2011*
The U.S. has a Comprehensive System for Foodborne Disease Surveillance

- Composed of many interrelated surveillance systems
- Each system has a different purpose
- Reporting starts locally and goes through the states
Key Role of State Health Departments in Surveillance

- States pass laws requiring doctors and laboratories to notify the health department about certain infections
  - purpose is to detect outbreaks and assess health of their residents

- States build relationships with hospital labs, clinicians, public
  - so they often hear about outbreaks even before data gets into surveillance systems

- States **voluntarily** provide data to CDC
  - they provide most data for case surveillance
  - they investigate and report most outbreaks
State and Local Health Departments Have Competing Priorities

- You want us to subtype all those strains?”
- You want us to find those 2 ill people and ask where they bought their cantaloupe?
- What do you want us to stop doing?
CDC Interactions with State Surveillance Systems

- CDC has no legal authority to mandate any aspect of surveillance
- CDC must collect data from >50 health departments
- Data vary by state in
  - quality and quantity
  - IT systems
- Cooperative agreements ($) between CDC and States can facilitate coordination and data transfer to CDC
  - e.g., FoodNet
    - Corollary: FoodNet surveillance sites are usually in the forefront of identifying and investigating outbreaks
CDC Surveillance Systems rely on connections with state and local health departments…

- FoodNet
- FDOSS
- NARMS
- NNDSS
- NVEAIS
- CaliciNet
- LEDS
- COVIS
- PulseNet
...and connections between systems

- FoodNet
- PulseNet
- NARMS
- NNDSS
- FDOSS
- LEDS
- CaliciNet
- NVEAIS
- COVIS
- Foodborne Disease Outbreak Surveillance System
- Cholera and Other Vibrio Illness Surveillance System
- National Antimicrobial Resistance Monitoring System for Enteric Bacteria
- National Molecular Subtyping Network for Foodborne Disease Surveillance
- National Voluntary Environmental Assessment Information System
- Laboratory-based Enteric Disease Surveillance
- Foodborne Diseases Active Surveillance Network
- National Notifiable Diseases Surveillance System
- National Electronic Norovirus Outbreak Network
“That’s been one of my mantras — focus and simplicity. Simple can be harder than complex...once you get there, you can move mountains.”

-Steve Jobs
A *Smart phone Analogy*
Surveillance systems are like “apps” – each has a different purpose

http://www.cdc.gov/foodborneburden/surveillance-systems.html
Major Foodborne Illness Surveillance Systems

Main Categories

I. National case surveillance
II. Sentinel site case surveillance
III. Outbreak surveillance
Major Foodborne Illness Surveillance Systems
Main Categories

I. National case surveillance (reports from all states)
II. Sentinel site case surveillance
III. Outbreaks
Major Foodborne Illness Surveillance Systems

I. National Case Surveillance

Basic case surveillance
- National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet)
- National Notifiable Disease Surveillance System (NNDSS)
- Laboratory-based Enteric Disease Surveillance (LEDS)
- National Antimicrobial Resistance Monitoring System (NARMS)

Detailed case surveillance
- Listeria Initiative
- Botulism
- Cholera and other Vibrio Surveillance System (COVIS)
Major Foodborne Illness Surveillance Systems

National Case Surveillance

Basic case surveillance
- National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet)
- National Notifiable Disease Surveillance System (NNDSS)
- Laboratory-based Enteric Disease Surveillance (LEDS)
- National Antimicrobial Resistance Monitoring System (NARMS)

Detailed case surveillance
A large outbreak in one place may be obvious
An outbreak with persons in many places may be difficult to detect, unless

- we test the bacteria from many persons, and
- find that they are infected with the same strain
PulseNet and Molecular Subtyping: the Hubble Telescope of Foodborne Disease Prevention

In 1995, the Hubble Space Telescope found distant galaxies and star clusters never seen before.

In 1996, PulseNet was launched.
Developed: 1996

Because: After the 1993 *E. coli* O157 outbreak from hamburgers made 726 people sick and killed 4 children, more clinical labs began testing ill people for *E. coli*, and finding plenty. Health departments did not have subtype data to help determine which illnesses were linked by a common food source. Congress provided funds to improve surveillance.

Now: National network of public health and food regulatory agency laboratories that perform standardized molecular subtyping (“fingerprinting”) of foodborne disease-causing bacteria.

**PulseNet**

Connects cases of illness nationwide to quickly identify outbreaks, including many that would otherwise not be detected.
87 labs in the PulseNet USA network

- CDC PulseNet headquarters
- ★ Regional labs
- ▲ Local and secondary state labs
- ● Federal labs

PulseNet USA: The National Molecular Subtyping Network for Foodborne Disease Surveillance
Electronic Data Transmission

Public health laboratories

PFGE patterns

National database at CDC
PulseNet Data Analysis Involves Searching for Clusters

- PulseNet teams at CDC and in states search for similar patterns
- When a cluster is identified, they report it to epidemiologists

Cluster of same pattern
Human Specimen Isolates Uploaded to PulseNet USA 1996-2010

Most patterns are from *Salmonella*, then *E. coli*, then *Listeria*. PFGE is pulsed-field gel electrophoresis; some data are preliminary.
Detecting Outbreaks

- Multistate outbreaks detected more frequently
- Each year, >150 national or multistate and >1,000 state and local investigations
- Since 2006, 13 newly recognized food vehicles that can transmit pathogens

Data from Foodborne Disease Outbreak Surveillance System
13 New Vehicles for Illness, 2006 - 2011

- Bagged spinach
- Carrot juice
- Peanut butter
- Broccoli powder on a snack food
- Dog food
- Pot pies
- Canned chili sauce
- Hot peppers
- White pepper
- Raw cookie dough
- Whole, raw papaya
- Hazelnuts
- Pine nuts
13 New Vehicles for Illness, 2006 - 2011
Data Sources: PulseNet, OutbreakNet, Foodborne Disease Outbreak Surveillance System

- Bagged spinach
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Major Foodborne Illness Surveillance Systems

I. National Case Surveillance

Basic case surveillance

- National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet)
- National Notifiable Disease Surveillance System (NNDSS)
- Laboratory-based Enteric Disease Surveillance (LEDS)
- National Antimicrobial Resistance Monitoring System (NARMS)

Detailed case surveillance

- Listeria Initiative

[Diagram showing PulseNet, NNDSS-LEDS, NARMS, and Listeria Initiative]
We use NNDSS and LEDS to Answer Questions Like These...

- Are *E. coli* O157 infections more common in certain regions?  *Yes, the north*

- Are some *Salmonella* serotypes much more common in some regions?  *Yes, Newport and some others are much more common in the southeast*

- Do states with an Egg Quality Assurance Program have fewer people sick with *Salmonella* serotype Enteritidis?  *Yes*
We use NNDSS and LEDS to Answer Questions Like These…
(continued)

- Since cholera broke out in Haiti, how many people have been diagnosed with cholera in the US linked to that outbreak? 41
- What kinds of foods most often cause botulism in the mainland US? *Home-canned asparagus, peppers, and green beans*
- Where are US travelers most likely to get typhoid fever? *India*
- Are some pregnant women more likely to get *Listeria* infection than others? *Yes, Hispanics are more likely*
National Notifiable Diseases Surveillance System

NNDSS

Tracks notifiable infectious diseases

Developed: 1878

Because: Congress required reports of cholera, smallpox, plague, and yellow fever (other diseases added later).

Now: Health care and laboratory professionals are required by state law to report cases of certain diseases to health departments, who report to CDC.
Laboratory-based Enteric Disease Surveillance

LEDS

Collects laboratory data, eg, serotype, on *Campylobacter, E. coli, Shigella, and Salmonella*

**Developed:** National *Salmonella* serotype surveillance began in 1963

**Because:** Serotyping is needed to track trends and detect outbreaks, in synergy with PulseNet.

**Now:** State public health labs send serotype data (with patient age, sex, residence) electronically to CDC.

**Decreased partly because**
- built sewage treatment facilities
- disinfected drinking water
- stopped harvesting oysters near sewers
- pasteurized milk

**Increased partly because**
- concentrated animal feeding operations
- factory farms

CDC, National Notifiable Disease Surveillance System
Major Foodborne Illness Surveillance Systems

I. National Case Surveillance

Basic case surveillance

- National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet)
- National Notifiable Disease Surveillance System (NNDSS)
- Laboratory-based Enteric Disease Surveillance (LEDS)
- National Antimicrobial Resistance Monitoring System (NARMS)

Detailed case surveillance
Developed: 1996

Because: FDA’s Center for Veterinary Medicine approved a drug for poultry in the same class as the human drug “cipro.” CDC wanted to track whether human pathogens carried by poultry would become resistant to “cipro.”

Now: CDC collaborates with FDA and USDA to monitor resistance among bacteria isolated from humans, retail meat, and animal carcasses.
Three “Arms” of NARMS

- **Human isolates**
- **Retail meats**
- **Animals at slaughter**

**Agencies involved**
- CDC: Center for Veterinary Medicine
- FDA
- USDA
How does NARMS work?

- **Human**
  - CDC tests for resistance
    - a subset of all isolates of *Salmonella* and *E. coli* from all states
    - a subset of all isolates of *Campylobacter* from 10 states
    - all outbreak isolates received of *Salmonella, E. coli, Campylobacter* (many not sent)

- **Retail meat**
  - FDA tests for resistance packages from grocery stores in 11 states of
    - ground turkey
    - chicken breast
    - ground beef
    - pork chops
  - FDA also determines PFGE pattern (sends pattern to PulseNet)

- **Animals at slaughter**
  - USDA tests *Salmonella* from cattle, chickens, turkeys, and swine in slaughter plants
We use NARMS to Answer Questions Like These...

- Does antimicrobial resistance in *Salmonella* vary by serotype? *Yes*

- Has resistance to the antibiotic ceftriaxone increased in any *Salmonella* serotype? *Yes, for example, resistance in serotype Heidelberg increased from 5% in 2003 to 21% in 2009*

- Are resistant *Salmonella* strains more commonly isolated from patient’s blood than susceptible strains? *Yes*

1986: Ciprofloxacin approved for humans

1989-90: Pilot Study showed no resistance

1995: Fluoroquinolone approved for poultry

2005: FDA withdrew approval for fluoroquinolones for poultry
“A Big Victory for Public Health”

FDA decision to withdraw the use of Baytril in poultry

In a landmark decision, U.S. Food and Drug Administration (FDA) recently ordered the removal of Baytril, an enrofloxacin, from use in domestic poultry. This decision was made despite significant opposition from the pharmaceutical industry and other interests. Public health data, including substantial contributions from FoodNet and the National Antimicrobial Resistance Monitoring System (NARMS), showed convincing evidence of the harmful effects to humans associated with Baytril usage in poultry. The Union of Concerned Scientists called this ruling a “big victory for public health”.

Please refer to the letter on the reverse side of this page from Dr. Frederick Angulo, Chief of FoodNet/NARMS Unit and Dr. Tom Chiller, Chief of NARMS, expressing their gratitude to our laboratory and public health partners who have assisted with the collection of FoodNet data that greatly impacted the outcome of this decision. Recent FoodNet publications that provided the scientific basis for the ruling include:


YOU ARE THE NEXT CLASS OF DRUG-RESISTANT BACTERIA. AS HUMANS CONTINUE TO ABUSE AND OVERUSE ANTIBIOTICS, YOUR RANKS WILL SWELL. SO, GO OUT THERE AND MUTATE! AND REMEMBER: THAT WHICH DOES NOT KILL US MAKES US STRONGER!!
Major Foodborne Illness Surveillance Systems

I. National Case Surveillance

Basic case surveillance

Detailed case surveillance

- Listeria Initiative
- Botulism
- Cholera and other Vibrio Surveillance System (COVIS)
Developed: 2004

Because: To quickly generate hypotheses for *Listeria* clusters and outbreaks and obtain appropriate controls for rapid case-control analyses.

Now: CDC asks states to interview all cases with a standard form that asks about foods. When PulseNet detects a cluster, CDC compares food exposures among *Listeria* patients in the cluster and not in the cluster to identify suspect foods.
Multistate Outbreak of Listeriosis Associated with Jensen Farms Cantaloupe — United States, August–September 2011

Listeriosis is caused by *Listeria monocytogenes*, a gram-negative bacillus common in the environment and acquired primarily through consumption of contaminated food. It causes a spectrum of illness, ranging from febrile gastroenteritis to invasive disease, including sepsis and meningitis. Systemic invasive listeriosis occurs predominantly in older persons with impaired immune systems. Listeriosis in pregnant women is typically a mild “flu-like” illness, but can result in serious disease in the newborn (intrapartum or neonatal listeriosis) or the fetus (symptomatic listeriosis).

**Listeriosis (Listeria infection)**

Listeriosis, a serious infection usually caused by eating food contaminated with the bacterium *Listeria monocytogenes*, is an important public health problem in the United States. The disease primarily affects older adults, pregnant women, newborns, and adults with weakened immune systems. However, rarely, persons without these risk factors can also be affected. The risk may be reduced by recommendations for safe food preparation, consumption, and storage.

Multistate Outbreak of Listeriosis, September 2011

The Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA) are investigating a multistate outbreak of listeriosis in coordination with state and local health departments, including the Colorado Department of Public Health and Environment. The outbreak started in the late summer. Collaborative investigations by local, state, and federal public health and regulatory agencies indicate the source of the outbreak is whole cantaloupe grown at Jensen Farms’ production fields in Granada, Colorado.

Latest update
Major Foodborne Illness Surveillance Systems

Main Categories

I. National case surveillance

II. Sentinel site case surveillance
   (in just 10 sites)

III. Outbreak surveillance
Foodborne Disease Active Surveillance Network

FoodNet

Reports trends in foodborne infections and tracks the impact of food safety policies nationally

Developed: 1995

Because: After the 1993 hamburger outbreak, UDA’s Food Safety Inspection Service began a modern meat inspection system. They needed to tell Congress if *E. coli* O157 infections were being prevented. They gave funds to CDC.

Now: Conducts surveillance for 9 infections and hemolytic uremic syndrome (HUS), working closely with 10 state health departments and other federal agencies.
FoodNet Sentinel Sites, 2011
46 million people (15% of US population)

10 sites: CT, GA, MD, MN, NM, OR, TN, and counties in CA, CO, NY
FoodNet Surveillance

- **Active surveillance to capture data from clinical laboratories on laboratory-confirmed infections of**
  - *Campylobacter*
  - *Cryptosporidium*
  - *Cyclospora*
  - *Listeria*
  - *Salmonella*
  - *Shigella*
  - Shiga toxin-producing *E. coli (STEC)*, including O157
  - *Yersinia enterocolitica*
  - *Vibrio*
  - and hemolytic uremic syndrome
What was the major data source for new estimates?
Making Food Safer to Eat
Reducing contamination from the farm to the table

1 in 6
About 1 in 6 (or 48 million) people gets sick each year from contaminated food.

50%
E. coli O157 infections have decreased almost in half.

Each year, roughly 1 in 6 people in the US gets sick from eating contaminated food. The 1,000 or more reported outbreaks that happen each year reveal familiar culprits—Salmonella and other common germs. We know that reducing contamination works. During the past 15 years, a dangerous type of E. coli infection, responsible for the recall of millions of pounds of ground beef, has been cut almost in half. Yet during that same time, Salmonella infection, which causes more hospitalizations and deaths than any other type of germ found in food and $365 million in direct medical costs, has climbed. Each year, millions
How do we track trends to focus prevention?

*E. coli* O157 infections have been cut almost in half since 1997, but *Salmonella* remains unchanged.

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*Change in *E. coli* O157 and *Salmonella* infection, 1996-2010*

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Rate (cases/100,000 population)</th>
<th>2010</th>
<th>2020 Objective</th>
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MMWR, June 2011
## Progress Toward Healthy People 2020 Objectives

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MMWR, 2011
Characteristics of Some Major Pathogens

- **Escherichia coli O157**
  - Major reservoir: cattle
  - Transmission: food, water, person-to-person, animal contact
  - Virulence factors: Shiga toxins, adherence factors
  - Incubation period: 3-4d
  - Illness:
    - usually local (intestine)
    - systemic: kidney failure

- **Campylobacter jejuni**
  - Major reservoir: poultry
  - Transmission: food, water
  - Incubation period: 4d
  - Illness: almost always local (intestine)
Characteristics of Some Major Pathogens
(continued)

- **Listeria monocytogenes**
  - Reservoir: animals, soil, factories
  - Transmission: food
  - Incubation period: 1-3 weeks
  - Illness: systemic (bloodstream, meningitis)

- **Salmonella**
  - Reservoir: all animals
  - Transmission: food, water, animal contact, person-to-person
  - Incubation: 8-48h
  - Illness
    - usually local (intestine)
    - sometimes systemic (bloodstream, meningitis, joint infection, etc)
Major Foodborne Illness Surveillance Systems

Major Categories

I. National case surveillance

II. Sentinel site case surveillance

III. Outbreaks

CDC Enteric Disease Surveillance:
- PulseNet
- FoodNet
- NNDSS-LEDS
- FDOSS
- NARMS
- CaliciNet
- Listeria Initiative
- NVEAIS
Foodborne Disease Outbreak Surveillance System
FDOSS

Captures outbreak data on agents, foods, and settings responsible for illness

Developed: 1973

Because: Outbreaks are the major way we learn what foods are causing illness and how to prevent it.

Now: States report hundreds of outbreaks each year through the National Outbreak Reporting System (NORS). The data is used to determine pathogen-food combinations to target for prevention.
We use FDOSS to Answer Questions Like These…

- Which pathogens cause the most reported foodborne disease outbreaks? 
  *Norovirus and Salmonella*

- What is the most common food source for norovirus outbreaks? 
  *Raw foods, such as leafy greens*

- What foods are most often linked to outbreaks caused by *Clostridium perfringens*? 
  *Land animal foods, such as beef, pork, and poultry*

- Is beef still the most common food source for *E. coli* O157 outbreaks? 
  *Yes*
Some Recent US Multistate Bacterial Outbreaks, 2006-2011 (n=39)

2006 – *E. coli* O157 & bagged spinach
2006 – *E. coli* O157 & shredded lettuce
  (restaurant chain A)
2006 – *E. coli* O157 & shredded lettuce
  (restaurant chain B)
2006 – Botulism & pasteurized carrot juice
2006 – *Salmonella* & fresh tomatoes
2007 – *E. coli* O157 & frozen pizza
2007 – *Salmonella* & peanut butter
2007 – *Salmonella* & a snack food
2007 – *Salmonella* & dry dog food
2007 – *Salmonella* & microwaveable pot pies
2007 – *Salmonella* & dry puffed breakfast cereal
2007 – *E. coli* O157 & ground beef
2007 – Botulism & canned chili sauce
2008 – *Salmonella* & cantaloupe
2008 – *E. coli* O157 & ground beef
2008 – *Salmonella* & peppers
2009 – *Salmonella* & peanut butter-containing foods
2009 – *Salmonella* & imported white and black pepper

2009 – *Salmonella* & alfalfa sprouts
2009 – *E. coli* O157 & prepackaged cookie dough
2009 – Multidrug resistant *Salmonella* & ground beef (x2)
2009 – *E. coli* O157 & blade tenderized steaks
2009 – *Salmonella* & salami made with contaminated pepper
2010 – *E. coli* O145 & shredded Romaine lettuce
2010 – *Salmonella* & alfalfa sprouts
2010 – *Salmonella Typhi* & frozen mamey fruit pulp
2010 – *Salmonella* & frozen meals
2010 – *Salmonella* & shell eggs
2010 – *Salmonella* & alfalfa sprouts
2011 – *E. coli* O157 & hazelnuts
2011 – *Salmonella* & cantaloupe
2011 – *E. coli* O157 & Lebanon bologna
2011 – Multidrug resistant *Salmonella* & turkey burgers
2011 – *Salmonella* & alfalfa/spicy sprouts
2011 – *Salmonella* & whole, imported papayas
2011 – Multidrug resistant *Salmonella* & ground turkey
2011 – *Listeria* & cantaloupe
2011 – *Salmonella* & imported pine nuts
Where do Outbreaks Occur?

- Of 5,696 foodborne outbreaks in 2004-2008
  - 68 (1%) were multistate
  - 165 (3%) were multicounty in 1 state
  - 5,463 (96%) were in 1 county

- Conclusion: All public health is local
What can we learn in an outbreak?

Prevention from the Farm to the Table
Lessons learned from Salmonella outbreaks

Production
Muddy eggs, 2010: Chicken and feed contamination results in 55,000 eggs recalled. Cause: Salmonella Enteritidis (SE).
Prevention
Require preventative controls for egg producers, such as testing chickens from suppliers with SE control programs, testing poultry houses for SE, and setting temperature requirements for storing and transporting eggs.

Manufacturing
Poultry slaughterers to pet breaks, 2009: Preventing plant contamination results in many birds-causing illnesses in 40 states. Cause: Salmonella Enteritidis.
Prevention
Keep facilities clean, separate raw and processed foods, ensure that steps to reduce contamination work.

Distribution and Delivery
Cattle feed lots, 2008: Trucks hauling live cattle, truck drivers, total 20,000,000 pounds. Cause: Salmonella Enteritidis (SE).
Prevention
Clean and disinfect trucks between loads, keep cold environments at correct temperatures; trucks, equipment, and storage.

Preparation and Consumption (Retail/Store)
Ground beef, 2005: Poor kitchen practices cause food to be undercooked and cross-contaminated. Cause: Salmonella Newport.
Prevention
Cook chicken and meats thoroughly, separate raw and cooked foods, rail and certificate managers in food safety in all restaurants.

Preparation and Consumption (Restaurant/Server)
Prevention
Make sure handling instructions are clear and correct, use food thermometers, ensure food handlers wash hands before handling food.

Preparation and Consumption (Entertainment/Server)
Prevention
Make sure handling instructions are clear and correct, use food thermometers, ensure food handlers wash hands before handling food.

Prevention
Tickled chicken, 2011: 10,000 lbs of ground chicken recalled following illness in 30 states. Cause: Salmonella Heidelberg.
Prevention
Empty perishable food safety strategies to isolate Salmonella in animals, prevent contamination at slaughter, reduce contamination of ground product from non-animal sources, ensure that steps to reduce contamination work.
Foodborne Disease Outbreak Surveillance

CDC collects reports of foodborne outbreaks due to enteric bacterial, viral, parasitic, and chemical agents. State, local, and territorial public health agencies report these outbreaks to the Foodborne Disease Outbreak Surveillance System through the National Outbreak Reporting System (NORS). The CDC surveillance team conducts analyses of these data to improve understanding of the human health impact of foodborne outbreaks and the pathogens, foods, settings, and contributing factors (for example, food not kept at the right temperature) involved in these outbreaks. Starting in 2009, the system has also included modules for reporting enteric disease outbreaks transmitted through water, person-to-person contact, or direct contact with animals. The data transmission tool that preceded NORS was called the electronic Foodborne Outbreak Reporting System (eFORS) from 1998-2008. 

Data: For data on foodborne outbreaks, the Foodborne Outbreak Online Database (FOOD) can be searched.

Data on foodborne outbreaks:
Foodborne Outbreak Online Database (FOOD) is an annual listing of foodborne disease outbreaks in the United States (1998–2009) which has been designed to allow the public direct access to information on foodborne outbreaks reported to CDC. Most outbreaks are reported to the system by the state, local, territorial, or tribal health department that conducted the outbreak.
Surveillance for Foodborne Disease Outbreaks --- United States, 2008

Weekly
September 9, 2011 / 60(35):1197-1202

Foodborne agents cause an estimated 48 million illnesses annually in the United States, including 9.4 million illnesses from known pathogen.

Since 1992, CDC has defined a foodborne disease outbreak as the occurrence of two or more similar illnesses resulting from ingestion of a common food, drink, or food handler.

This report includes outbreaks in which the first illness occurred in 2008 and were reported to CDC by June 20, 2011. Data requested for each outbreak include the number of illnesses, hospitalizations, and deaths; the etiologic agent (confirmed or suspected); the implicated food or foods; the setting of food preparation and consumption; CDC classification of outbreaks; and demographic data on those affected.

Public health officials from 47 states, the District of Columbia, and Puerto Rico reported 1,034 outbreaks, multistate outbreaks involving three or more states, and foodborne disease outbreaks involving food products from food establishments in a total of 15 outbreak commodities or types of implicated foods, and settings where transmission occurred. Public health professionals can use this information to target prevention efforts against pathogens and foods that cause the most foodborne disease outbreaks.

http://www.cdc.gov/outbreaknet/surveillance_data.html
The Foodborne Outbreak Online Database (FOOD)

Choose search criteria

<table>
<thead>
<tr>
<th>Year</th>
<th>State</th>
<th>Etiology (Genus Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>Alabama</td>
<td>(Not Reported)</td>
</tr>
<tr>
<td>1999</td>
<td>Alaska</td>
<td>Banquet facility</td>
</tr>
<tr>
<td>1999</td>
<td>Arizona</td>
<td>Camp</td>
</tr>
<tr>
<td>2000</td>
<td>Arkansas</td>
<td>Caterer</td>
</tr>
<tr>
<td>2001</td>
<td>California</td>
<td>Church, temple, religious location</td>
</tr>
<tr>
<td>2002</td>
<td>New York</td>
<td>Day care center</td>
</tr>
<tr>
<td>2003</td>
<td>Colorado</td>
<td>Fair, festival, other temp or mobile services</td>
</tr>
<tr>
<td>2004</td>
<td>Connecticut</td>
<td>Foodservice</td>
</tr>
</tbody>
</table>

Disclaimer: This site was developed by the Centers for Disease Control and Prevention (CDC) to make Foodborne Disease Outbreak Surveillance System data more available to the public and stakeholders. The FOOD tool is intended to be used for limited and simple descriptive summary of outbreak data. Data obtained from this tool are an extract of reported data and therefore should not be considered completely representative of the findings in investigations of all outbreaks reported. CDC uses more detailed information for its analyses of the causes and risk factors of foodborne disease outbreaks. Please see the FOOD FAQ for more information and limitations of the data.

Table is populated based on the following criteria:

http://www.cdc.gov/foodborneoutbreaks/
Foodborne Disease Outbreaks, 1973–2009

~500 outbreaks/year

~1,200 outbreaks/year

1998: improved surveillance

All data from Foodborne Disease Outbreak Surveillance System. Color of bars indicates improvements in data reporting systems.
Current Hierarchical Scheme for Grouping Foods Into Commodities

- All Food
  - Aquatic
    - Fish
    - Shellfish
  - Land
    - Dairy
    - Eggs
    - Meat-poultry
  - Plant
    - Grains-beans
    - Oils-sugars
    - Produce
      - Fruits-nuts
      - Vegetables
        - Fungi
        - Leafy
        - Root
        - Sprout
        - Vine-stalk

- Meat
  - Beef
  - Game
  - Pork
- Poultry

Represent 17 individual commodities
Commodity groups
Attributing Outbreak-Associated Illnesses to Foods

Outbreak surveillance provides data for determining what foods are major causes of illness.


Data from Foodborne Disease Outbreak Surveillance System.
CDC and Industry Have a Track Record of Collaboration in Outbreaks

- CDC has often communicated directly with industry during outbreak investigations
  - industry has often collaborated with CDC to pinpoint the source of the problem
- Industry has sometimes funded related lab studies suggested by CDC
  - e.g., potato industry funded lab study after a botulism outbreak traced to skordalia dip
  - e.g., sprout seed supplier funded lab study after first big outbreak, to evaluate effect of *Salmonella* contamination of seeds
- Careful, collaborative outbreak investigations save industry money by pinpointing the source of contamination
  - so control measures clear
Come check out our stool samples.
A Smart phone Analogy
Surveillance systems are like “apps” – each has a different purpose

PulseNet
NNDSS-LEDS
NARMS
Listeria Initiative
FoodNet
FDOSS
CaliciNet
NVEAIS

http://www.cdc.gov/foodborneburden/surveillance-systems.html
Cycle of Foodborne Disease Control and Prevention

Surveillance

Prevention Measures

Epidemiologic Investigation

Applied Research
Developing new tools
More, faster, better…

- Integrate surveillance data sources
- Rapidly visualize outbreak data
- Increase speed and completeness of case interviews
- Provide secure platform for collaboration
- Facilitate knowledge management
Gaps: Challenges for Surveillance

- Resources for foodborne disease surveillance and response have eroded
- Transition to electronic reporting and data integration is at early stage
- Culture-independent tests do not provide necessary public health information
- No recent surveys on rates of diarrhea, care-seeking, and foods consumed
- No organized surveillance for pathogens in foods
- Little or no surveillance for some pathogens, e.g., *Toxoplasma*, norovirus
Some Results of Gaps

- **Data**
  - on occurrence of some culture-confirmed illnesses are not captured
  - are incomplete and have errors
  - come too slowly
  - are not well linked

- **Outbreaks**
  - not detected (at all or quickly)
  - insufficient data to implicate source (at all or quickly)
Vision for Surveillance

- Molecular tests are developed that provide information for public health as well as patient care.
- Data from every pathogen-confirmed illness and every outbreak is captured.
- IT system links data from many surveillance systems.
- Food industry becomes a real partner in public health.
- Timely, reliable data on incidence, trends, and implicated foods is available to all.
Some Possible Steps for Achieving the Vision

- Build on models that work, eg, FoodNet, PulseNet
- Expand partnerships, eg, clinical labs, food industry, academia, consumer groups
- Create “best practices” guidelines for reporting
- Continue to do more with less
We must not see any person as an abstraction. Instead, we must see in every person a universe with its own secrets, ... treasures, ... anguish, and with some measure of triumph.

-Elie Wiesel
Thank You

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA  30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov    Web: http://www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
Listeria Outbreak from Cantaloupe, July – December, 2011

Information as of December 8, 2011

- Detected by Colorado health department
- 146 ill
  - 139 not pregnancy-related
    - most >60 years old
    - 30 died (48-96 years old)
  - 7 pregnancy-related
    - 1 miscarriage
- 58% female
- Illness began July 31 - October 21
- Ill persons live in 28 states
  - 40 in Colorado
  - 18 in Texas
- Outbreak caused by 4 strains of Listeria
- Cantaloupe from Jensen Farms in Colorado
SURVEILLANCE SYSTEMS
Developed: 1973

Because: To quickly identify food products, especially those distributed commercially, that could cause more cases

Now: CDC controls release of antitoxin to assure that public health authorities learn about possible cases. CDC collects data on all botulism cases.
Developed: 2009
Because: Norovirus is responsible for most foodborne illnesses in the United States.
Now: By comparing norovirus DNA sequences, State and local public health laboratories can determine which clusters of illnesses are part of the same outbreak. They can also identify new strains.
Cholera and Other Vibrio Illness Surveillance System

**COVIS**

Tracks cholera and other *Vibrio* infections

**Developed:** 1878 for cholera, 1988 for other *Vibrio*

**Because:** Need to prevent deaths from consumption of seafood

**Now:** Health officials collect clinical data, history of consumption of seafood and of exposure to seawater, and also conduct tracebacks of implicated oysters.
Developed: 1973

Because: Outbreaks are the major way we learn what foods are causing illness and how to prevent it.

Now: States report hundreds of outbreaks each year through the National Outbreak Reporting System (NORS). The data is used to determine pathogen-food combinations to target for prevention.
Developed: 1995

Because: After the 1993 hamburger outbreak, UDA’s Food Safety Inspection Service began a modern meat inspection system. They needed to tell Congress if *E. coli* O157 infections were being prevented. They gave funds to CDC.

Now: Conducts surveillance for 9 infections and hemolytic uremic syndrome (HUS), working closely with 10 state health departments and other federal agencies.
**Laboratory-based Enteric Disease Surveillance (LEDS)**

Collects laboratory data, eg, serotype, on *Campylobacter, E. coli, Shigella, and Salmonella*.

**Developed:** National *Salmonella* serotype surveillance began in 1963.

**Because:** Serotyping is needed to track trends and detect outbreaks, in synergy with PulseNet.

**Now:** State public health labs send serotype data (with patient age, sex, residence) electronically to CDC.
Developed: 2004

Because: To quickly generate hypotheses for *Listeria* clusters and outbreaks and obtain appropriate controls for rapid case-control analyses.

Now: CDC asks participating states to interview all cases with a standard form that asks about foods. When PulseNet detects a cluster, CDC compares food exposures among *Listeria* patients in the cluster and not in the cluster to identify suspect foods.
National Antimicrobial Resistance Monitoring System for Enteric Bacteria

NARMS

Monitors antimicrobial resistance among enteric bacteria isolated from humans

Developed: 1996

Because: FDA’s Center for Veterinary Medicine approved a drug for poultry in the same class as the human drug “cipro.” CDC wanted to track whether human pathogens carried by poultry would become resistant to “cipro.”

Now: CDC collaborates with FDA and USDA to monitor resistance among bacteria isolated from humans, retail meat, and animal carcasses.
National Notifiable Diseases Surveillance System
NNDSS

Tracks notifiable infectious diseases

Developed: 1878

Because: Congress required reports of cholera, smallpox, plague, and yellow fever (other diseases added later).

Now: Health care and laboratory professionals are required by state law to report cases of certain diseases to health departments, who report to CDC.
Developed: from the EHS-Net Foodborne Outbreak Study, 2000-2010

Because: Need to address the environmental causes of foodborne disease.

Now: Intended to provide food safety program managers with an information resource to fill the gap on contributing factors and environmental antecedents of foodborne illness outbreak prevention activities. Launch: 2012

National Voluntary Environmental Assessment Information System
NVEAIS

Tracks environmental factors that contribute to foodborne illness
Developed: 1996

Because: After the 1993 *E. coli* O157 outbreak in hamburgers made 726 people sick and killed 4 children, more clinical labs began testing for *E. coli*, and health departments were flooded with reports of illness.

Now: National network of public health and food regulatory agency laboratories that perform standardized molecular subtyping ("fingerprinting") of foodborne disease-causing bacteria.

PulseNet Connects cases of illness nationwide to identify outbreaks that would otherwise go undetected.

National Molecular Subtyping Network for Foodborne Disease Surveillance

PulseNet

![PulseNet logo](image-url)
Developed: 1900, with electronic data collected since the 1970s

Because: Originally to detect outbreaks.

Now: Participating health departments collect clinical, laboratory, and epidemiologic data, including travel and vaccination status. This informs CDC’s recommendations for travelers.