

Foodborne and Other GI Outbreaks

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Objectives

1. Review the causes of foodborne and other GI outbreaks, the epidemiology, pathogenesis, and clinical presentations.
2. Describe the laboratory diagnosis of these outbreaks.
3. Discuss the role of the CDC and how they track these outbreaks.

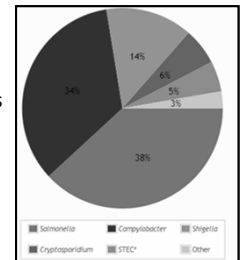
Increased 114% in 2016 vs 2013–2015



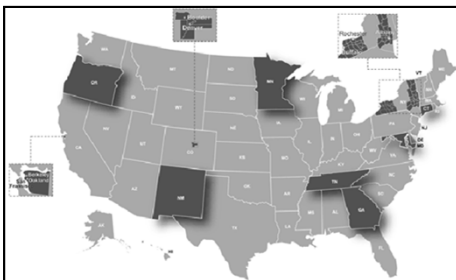
CDC estimates 48 million people get sick, 128,000 are hospitalized, and 3,000 die from foodborne diseases each year in the United States.

More Likely To Get A Foodborne Illness

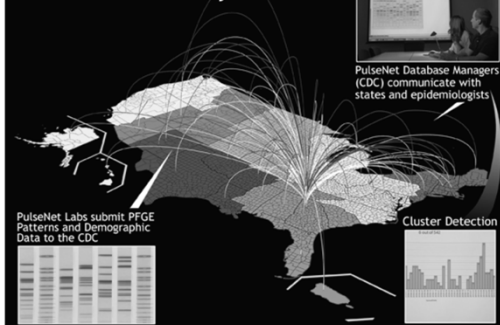
- Children younger than 5
- Adults 65 and older
- People with weakened immune systems
 - Cancer
 - HIV/AIDS
 - Diabetes
- Pregnant women




FoodNet



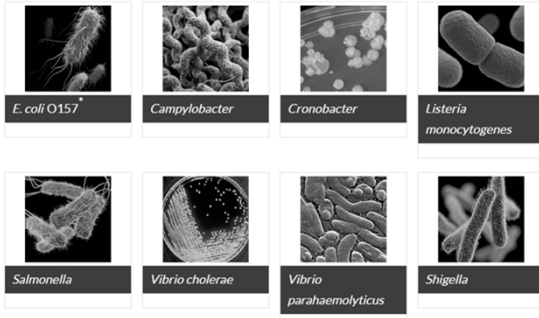
PulseNet Laboratory Network



PulseNet



- National laboratory network
- Began in 1996
- Connects foodborne illness cases to detect outbreaks
- DNA fingerprinting to detect thousands of local and multistate outbreaks
- Improved our food safety systems by early ID
- Find the source
- Alert the public sooner
- Identify gaps in food safety systems
- 83 laboratories in seven regions
- PulseNet International




E. coli O157 *Campylobacter* *Cronobacter* *Listeria monocytogenes*

Salmonella *Vibrio cholerae* *Vibrio parahaemolyticus* *Shigella*

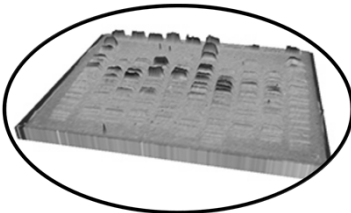
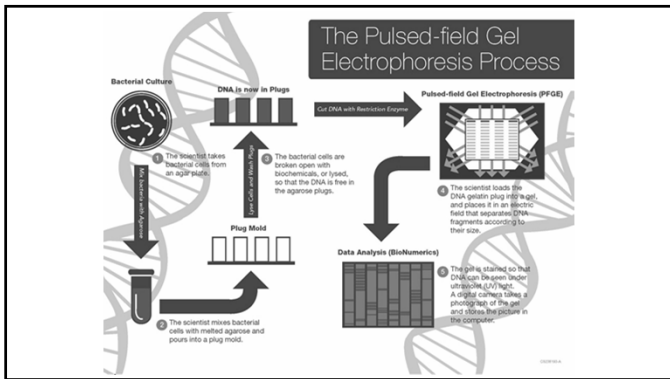
Not Just Food

- Identified outbreaks cause by bacteria from:
 - Pet turtles
 - Hedgehogs
 - Animals at petting zoos
 - Rodents
 - Reptiles
 - Animal feed
 - Recreational water: lakes, pools, streams
 - Laboratories!




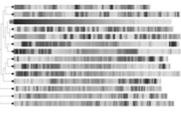
Pulsed-field Gel Electrophoresis (PFGE)

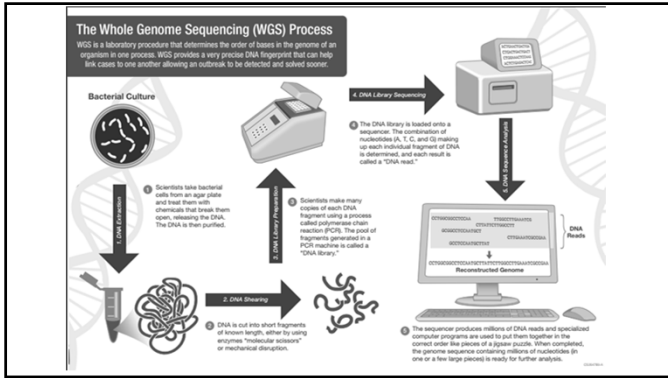
- Current "gold standard" fingerprinting method

Whole Genome Sequencing

- Transitioning in 2018
- Complete marker map with resolution at nucleotide level
- Direct testing of genetic relatedness
- Get data, enter into free online databases: Illumina's BaseSpace Sequence Hub or Galaxy web-based platform



Foodborne Diseases Centers for Outbreak Response Enhancement (FoodCORE)

- 10 centers participate
- 18% of population
- 58 million people
- Develop new methods
- Focused on *Salmonella*, Shiga toxin-producing *E. coli*, and *Listeria*

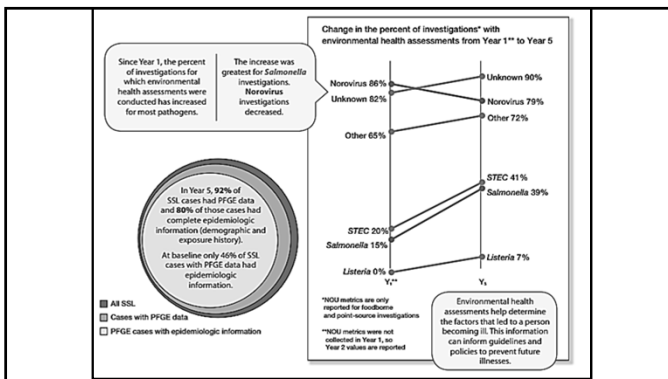
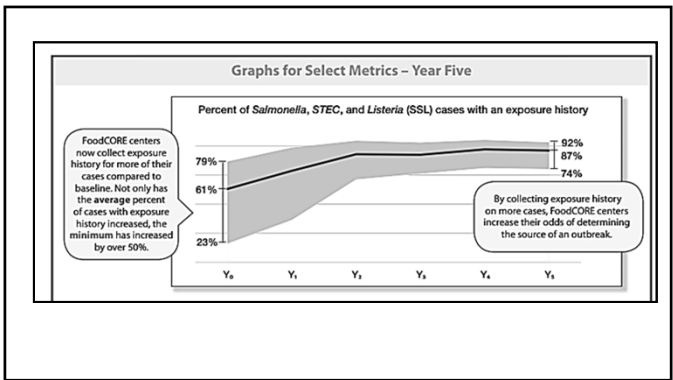
How much faster are CIDTs?

CIDTs: 1-8 hours

Culture: > 2 days (plus 1 to get PFGE pattern)

FoodCore Successes

- New sampling method to test *Campylobacter* in raw milk in Utah
- Splash pads *Salmonella* outbreaks in Tennessee
- NYC using restaurant reviews from Yelp
- Wisconsin lake outdoor rec area norovirus
- 2-year mysterious *Salmonella* outbreak in queso fresco in Utah

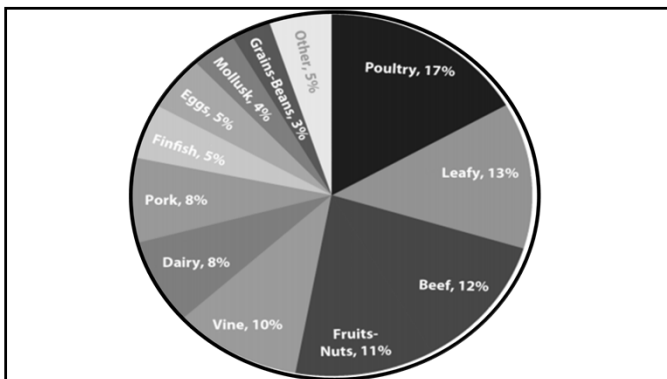
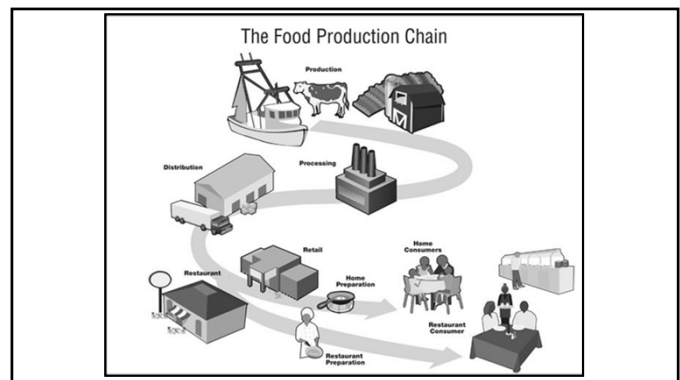
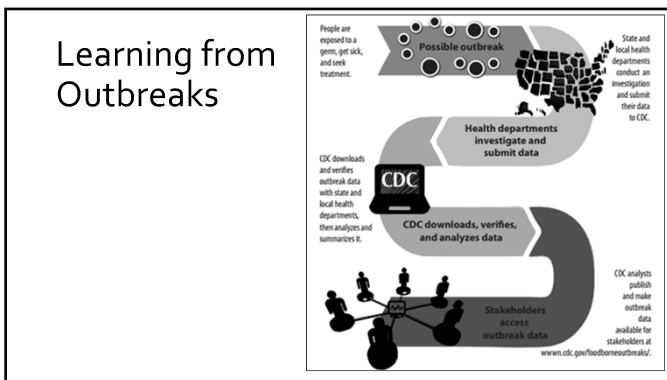
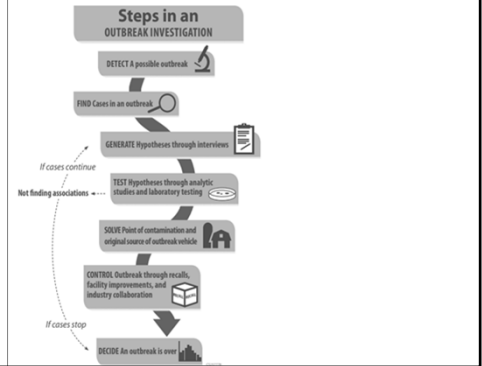


SEDRIC: System for Enteric Disease Response, Investigation, and Coordination


Sharing Data in Real Time to Solve Outbreaks Faster



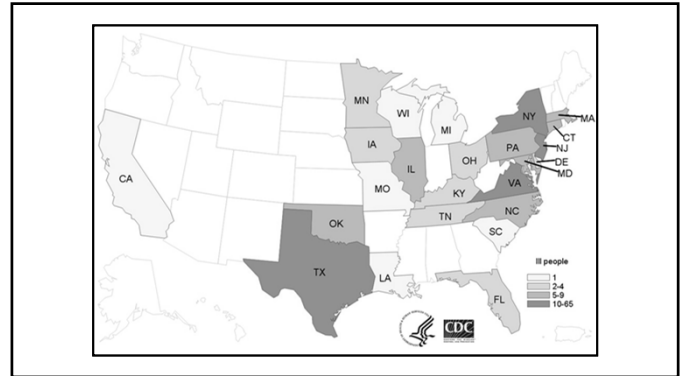
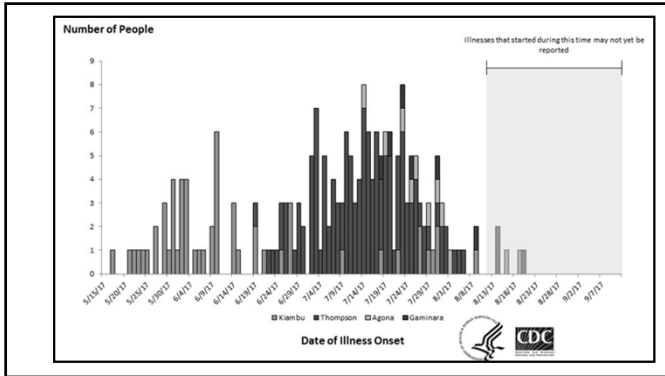
- Integrate multiple surveillance data sources in real time
- Visualize outbreak data rapidly in one place
- Provide a secure platform for partner collaboration
- Manage a repository of historic surveillance and outbreak data.



Papayas Summer 2017

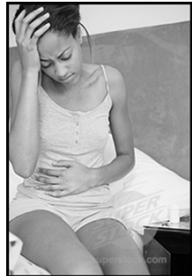


- *Salmonella*: Kiambu, Thompson, Agona, and Gaminara
- Case Count: 210
- States: 24
- Deaths: 1
- Hospitalizations: 67
- Maradol papayas
- Carica de Campeche farm in Mexico
- Same strain found in papayas and ill people




Symptoms and Pathogenesis

- Diarrhea
- Fever
- Abdominal cramps
- Lasts 4 to 7 days
- Most recover without treatment
- May spread to bloodstream
- Can cause death unless treated promptly




Salmonella enterica Epidemiology

- 1.4 million infections/year in US
- Physician's office visits/year = 168,000
- Hospitalized = 15,000/year
- Mortality 400/year – Immunocompromised, elderly, and infants
- <5% reported
- Adults and older children don't seek medical attention
- Seldom cultured if patient seen




Epidemiology

- Ingesting contaminated food
- Rarely waterborne
- Food appears and smells normal
- Animals: chickens, cattle, pigs, shellfish
- 1986-1999, 841 outbreaks with 371 with confirmed source
- 80% associated with eggs



Precautions

- Eggs may look and smell normal
- Use pasteurized eggs and egg products
- Keep eggs refrigerated at 40°F (4°C) or colder
- Discard cracked or dirty eggs
- Wash hands and items that came into contact with raw eggs
- Cook eggs until both the yolk and white are firm-- 160°F (71°C)



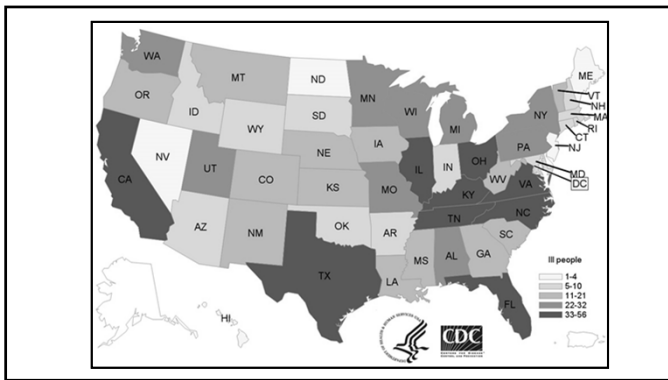
Salmonella Oranienburg Infections Linked to Shell Eggs

- Good Earth Egg Company
- November 9, 2016
- Case Count: 8
- States: 3
- Deaths: 0
- Hospitalizations: 2



Salmonella Infections Linked to Live Poultry in Backyard Flocks

- 8 multistate outbreaks
- January to September 2016
- Case Count: 961
- States: 48 & DC
- Deaths: 1
- Hospitalizations: 215
- 254 (28%) ill people were children 5 years or younger



Live Poultry Outbreak



- 74% linked to contact with live poultry (chicks and ducklings)
- Multiple hatcheries
- Live baby poultry from feed supply stores, Internet sites, hatcheries, and friends
- Why? to produce eggs, learn about agriculture, as a hobby, for fun, keep as pets, or give as Easter gifts
- Also contact in someone else's home, work, or school
- Laboratory testing isolated 5 of the outbreak strains

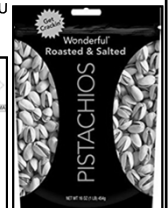
Poultry

- Small animals such as chicks, ducklings, mice, and baby turtles common vehicles
 - Small enough to handle
 - Carry salmonella
- 2 ways to minimize risk:
 - Aggressive handwashing
 - Choosing other pets
- Fashionable to have backyard poultry
- Variety of serotypes typical of contaminated poultry feed



Salmonella Montevideo and Senftenberg Linked to Pistachios

- Wonderful, Paramount Farms, and Trader Joe's
- Sold nationwide and in Canada, Mexico, and Peru
- January 3 to March 25, 2016
- Case Count: 11
- States: 9
- Deaths: 0
- Hospitalizations: 2



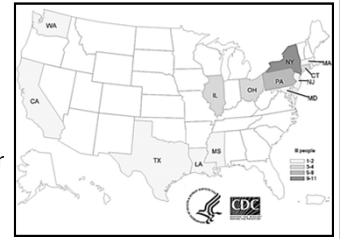
Salmonella in Labs

- 69% worked in a lab
- Reported risky behaviors:
 - Not wearing gloves or lab coats
 - Not washing hands
 - Using the same writing utensils and notebooks outside of the laboratory



Salmonella Agbeni Infections Linked to Pet Turtles, 2017

- Mar 2 to 3 Aug 2017
- 37 people
- 16 hospitalized
- 0 deaths
- 12 -- 5 years of age or younger
- Street vendors, flea markets, gifts
- Sale prohibited in 1975



Turtles

- 6% of U.S. cases
- 90% carry Salmonella
- Breeding farms promote transmission
- Attempts to treat turtles, turtle eggs, and turtle breeding ponds unsuccessful
- Resulted in a high prevalence of antibiotic resistance
- Shedding might be intermittent and stress related
- Determining if free of bacteria is difficult



- Turtles handled differently than snakes or iguanas
- Water in habitats
- Only 20% aware



Salmonella in Reptiles

- 7.3 million reptile pets in U.S.
- 9 of 10 reptiles infected
- 93,000 cases associated with reptiles
- Treatment of reptiles unsuccessful



Salmonella Virchow in Organic Shake & Meal Products

- Garden of Life RAW Meal
- April 2016
- Case Count: 33
- States: 23
- Deaths: 0
- Hospitalizations: 6

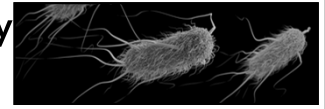


Shiga toxin-producing *Escherichia coli* O157:H7 Infections Linked to Beef

- Adams Farm Slaughterhouse
- October 2016
- Case Count: 11
- States: 5
- Deaths: 0
- Hospitalizations: 7
- HUS: 1



STEC Epidemiology



- Occurs sporadically or in small to large outbreaks
- Infectious dose low, so infections can spread person-to-person
- Seen in schools, long-term care facilities, families, and day care centers
- Case fatality rate in U.S. nursing homes: 16-35%

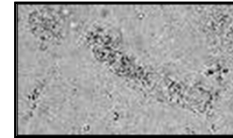
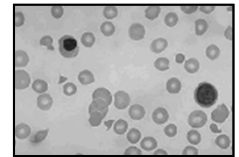
STEC Damage

- Attaches to terminal bowel and does not invade
- Toxin causes structural damage to epithelial cell membrane
 - Inflammation
 - Bleeding
- Complications
- Hemolytic uremic syndrome (HUS)
 - Occurs in ~10% infected
 - Most common in children 1-5 years of age
 - 4-10% of HUS patients die
- Thrombotic thrombocytopenia purpura (TTP) in adults



Hemolytic Uremic Syndrome

- One week following diarrhea with Shiga-like toxin producing *Escherichia coli*
- Symptoms: pallor, edema, and oliguria
 - Microangiopathic hemolytic anemia
 - Thrombocytopenia
 - Acute renal dysfunction



Shiga toxin-producing *Escherichia coli* Infections Linked to Flour

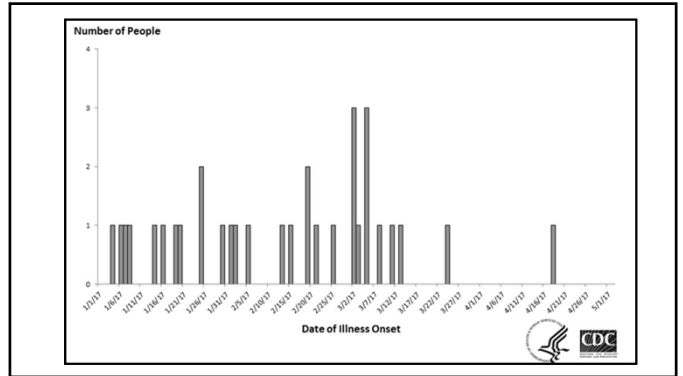
- December 21, 2015 to September 5, 2016
- General Mills facility in Kansas City
- Case Count: 63
- States: 24
- Deaths: 0
- Hospitalizations: 17
- FDA isolated STEC O121 in open samples of flour in homes




Shiga toxin-producing *Escherichia coli* O157:H7

- I.M. Healthy Brand SoyNut Butter
- Several products recalled
- Case Count: 32
- States: 12
- Deaths: 0
- Hospitalizations: 12
- 81% under age 18


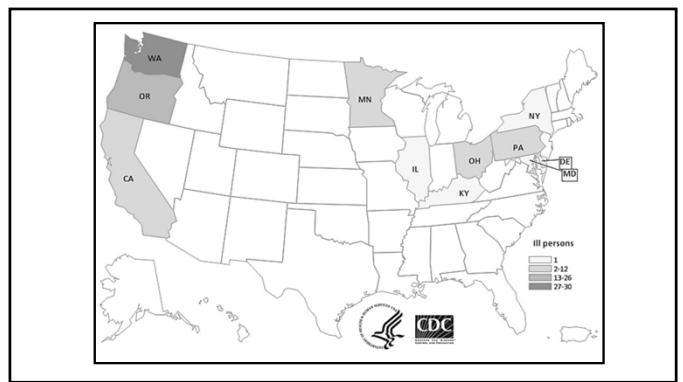




Shiga toxin-producing *Escherichia coli* O26 Infections Linked to Chipotle Mexican Grill Restaurants




- **Initial, Larger Outbreak**
 - Case Count: 55
 - States: 11
 - Deaths: 0
 - Hospitalizations: 21
- **Second, Smaller Outbreak**
 - Case Count: 5
 - States: 3
 - Deaths: 0
 - Hospitalizations: 1

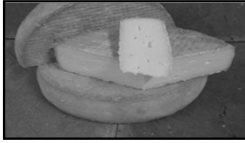
Shiga toxin-producing *Escherichia coli* O157 Alfalfa Sprouts

- Jack & The Green Sprouts--January 2016
- Case Count: 11
- States: 2 MN & WI
- Deaths: 0
- Hospitalizations: 2
- HUS: 0



Multistate Outbreak of Listeriosis

- March 10, 2017 Vulto Creamery
- 8 people all hospitalized
- 2 died
- 1 newborn
- Leftover cheeses from the home of the deceased person
- Strain of *Listeria* was identified as Ouleout cheese
- 3 intact wheels had outbreak strain of *Listeria*



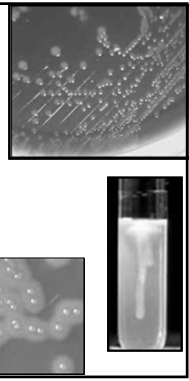
Listeria monocytogenes

- Gram-positive, non-spore-forming rods
- Widespread in nature
- Infects wide variety of animals
- Human exposure limited
- Transient colonization occurs without disease



Listeria monocytogenes Clinical Infections

- Adults
 - Septicemia/meningitis in compromised/elderly
 - Mild flu-like syndrome in pregnant women
 - Can be fatal to fetus
- Neonatal
 - Early onset from intrauterine transmission results in sepsis; high mortality rate
 - Late onset manifests as meningitis; lower mortality rate



Listeriosis Linked to Frozen Vegetables

- July 2016
- CRF Frozen Foods: All Frozen Vegetable and Fruit
- Case Count: 9
- States: 4
- Deaths: 3
- Hospitalizations: 9



Listeriosis Linked to Blue Bell Creameries Products

- 2015
- Case Count: 10
- States: 4
- Deaths: 3
- Hospitalizations: 10



LISTERIA AND BLUE BELL ICE CREAM
Contaminated production facilities and illnesses linked to Blue Bell Creameries

CDC recommends that people not eat, serve, or sell any recalled Blue Bell brand products. This complicated investigation of a listeria outbreak involved serious illnesses from 2010 through 2015 linked to two Blue Bell production facilities.

Arizona
1 case linked to ice cream made in Oklahoma facility

Kansas
3 cases in one hospital linked to ice cream made in Texas facility, resulting in 3 deaths

Oklahoma
1 case linked to ice cream made in Oklahoma facility
Listeria found in ice cream products and in Oklahoma facility where they were made

Texas
2 cases in separate hospitals linked to ice cream made in Oklahoma facility
Listeria found in ice cream products made in Texas facility

Alabama
Listeria found in Alabama facility
No cases linked to Alabama facility

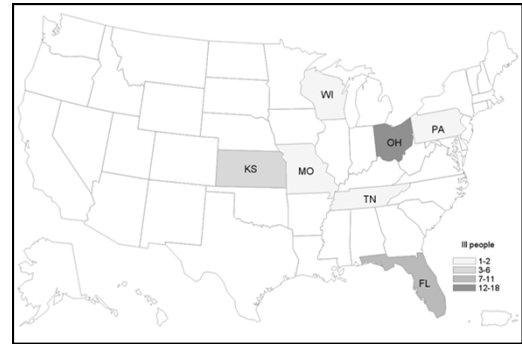
Human (blue dot)
Alabama Blue Bell production facility
Texas Blue Bell production facility
Oklahoma Blue Bell production facility
..... Illness(es) linked to Texas facility
..... Illness(es) linked to Oklahoma facility

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
Learn more: www.cdc.gov/listeria/bluebell



Multistate Outbreak Of *Campylobacter* Infections

- Petland pet stores (80)
- Cases: 39
- States: 7
- Hospitalized: 9
- Deaths: 0
- 12 Petland employees
- Puppy mill animals



Campylobacter Epidemiology

- Raw or undercooked poultry or meat
- Raw milk
- Cross-contamination
- Asymptomatic animals
- Bloody diarrhea, vomiting and fever
- Most recover in a week
- 20-75% of animals carriers
- ~6% of human cases associated with dogs



Hepatitis A

- Frozen strawberries imported from Egypt
- Smoothies from Tropical Smoothie Café
- 143 people
- 9 states
- 56 hospitalized
- No deaths
- Symptoms from 15 to 50 days after exposure
- Not everyone will experience symptoms



Symptoms of Hepatitis A

- Mild flu-like symptoms
- Yellow eyes or skin
- Abdominal pain
- Pale stools
- Dark urine
- CDC recommends providing post exposure prophylaxis (PEP) for unvaccinated people



Other Hepatitis A Outbreaks

- August 15, 2016 raw scallops served at Genki Sushi restaurants on the islands of Oahu and Kauai
 - 74 people hospitalized
- Pomegranate seeds from Turkey at Costco
 - 165 people were confirmed to have become ill
 - 71 (44%) hospitalized
 - 3/31/2013 – 7/26/2013



Hepatitis A Vaccine



- All children at age 1 year
- Travelers to countries that have high rates
- Family members and caregivers of recent adoptees from countries where hepatitis A is common
- Men who have sexual contact with other men
- Users of injection and non-injection illegal drugs
- People with chronic liver disease
- People who are treated with clotting-factor concentrates
- People who work with hepatitis A infected animals or in a hepatitis A research laboratory

Norovirus

- 19-21 million cases
- 400,000 ED visits
- 56-71,000 hospitalizations
- 570-800 deaths

Quick Stats: U.S. Outbreaks of Diarrhea and Vomiting, 2009–2013

61%
61% of outbreaks of diarrhea or vomiting are spread by having direct contact (like shaking hands) with an infected person or touching a contaminated surface and then touching your mouth.

#1
Norovirus is the #1 cause of diarrhea or vomiting outbreaks spread by direct contact with an infected person or touching a contaminated surface.

3 out of 4
3 out of 4 norovirus outbreaks occur in long-term care facilities like nursing homes. Elderly residents are more likely to get very sick or die from norovirus.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

CaliciNet
National Norovirus Outbreak Network

CaliciNet: Participating States

Etymology (from CaliciNet)

Genus	Species	Serotype	Confirmed or Suspected	Other Characteristics	Detected In*	# Lab Confirmed Cases
Norovirus	Genogroup II	GI.4 Den Haag (2006)	Confirmed	Imported from CaliciNet		6

* State laboratories certified (n = 28 + DC)
State laboratories pending certification (n = 1)
State laboratories submitting to CMVSC (n = 21)
FDA Seafood Laboratory

Norovirus Reporting in CaliciNet

Genotype Distribution of Norovirus Outbreaks
September 1, 2016 – August 18, 2017 (n=668)

Genotype	Percentage
GI.4 Den Haag	51%
GI.2	19%
GI.1	6%
GI.7	6%
GI.6	5%
GI.5	3%
GI.3	3%
GI.8	2%
GI.9	2%
GI.10	2%
GI.11	2%
GI.12	2%
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GI.97	2%
GI.98	2%
GI.99	2%
GI.100	2%

SINGLE KNOWN CAUSES OF FOODBORNE ILLNESS OUTBREAKS, U.S., 2009-2012

Cause	Percentage
Norovirus	48%
Bacteria	46%
Chemicals/Toxins	6%
Parasites	1%
Other	1%

How You Get Norovirus From People or Surfaces

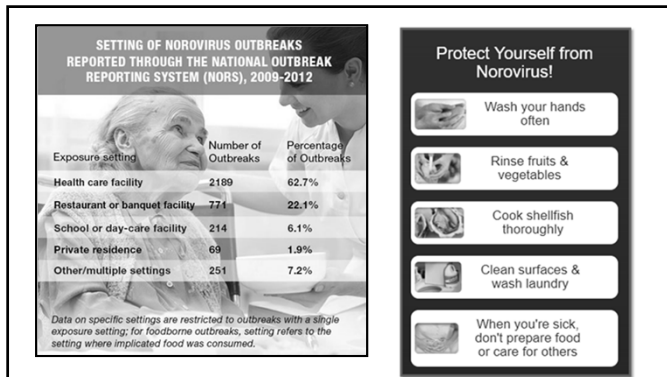
• **PREVING CARE**: Norovirus spreads when a person gets poop or vomit from an infected person in their mouth.

• **SHARING TOYS**: Norovirus spreads when a person gets poop or vomit from an infected person in their mouth.

• **TOUCHING YOUR MOUTH**: Norovirus spreads when a person gets poop or vomit from an infected person in their mouth.

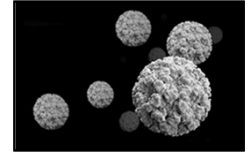
• **TOUCHING CONTAMINATED SURFACES**: Norovirus spreads when a person gets poop or vomit from an infected person in their mouth.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention



Noroviruses

- Group of non-enveloped, single-stranded RNA viruses
- Cause acute gastroenteritis
- Family Caliciviridae that includes sapoviruses
- 6 recognized norovirus genogroups
- 3 (GI, GII, and GIV) affect humans
- >25 different genotypes



Symptoms

- Acute-onset of vomiting
- Watery, non-bloody diarrhea with abdominal cramps
- Nausea
- Some have low-grade fever, headaches, and myalgias
- Dehydration most common complication
- Symptoms last 24 to 72 hours
- Young children, older adults, and people with compromised immune systems: severe dehydration, hospitalization, and death



Aquatic Facility–Associated Outbreaks of Cryptosporidiosis

- Alabama, Arizona, and Ohio, 2016
- 1st U.S. molecularly based surveillance system for parasitic disease
- Can cause profuse, watery diarrhea
- Lasts 2–3 weeks in immunocompetent patients
- Life-threatening wasting and malabsorption in immunocompromised patients
- Increased dramatically in recent years



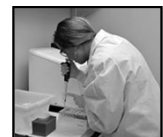
Transmission

- Ingestion of contaminated recreational water, drinking water, or food
- Following contact with infected persons or animals (preweaned bovine calves)
- 13 (54%) of 24 states reported 32 aquatic facility–associated cryptosporidiosis outbreaks in 2016
- 2-10 days incubation period
- Can live for days even in well-maintained pools

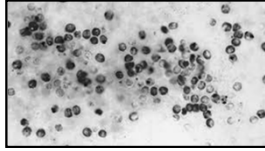


CryptoNet

- Established 2010
- Data can be used to optimize evidence-based prevention strategies
- Not swimming when ill with diarrhea is key to prevention
- Genotyping (18S PCR-RFLP) to determine *Cryptosporidium* species
- gp60 PCR and sequencing to determine subtype



Alabama



- 35 cases
- Visited aquatic facility
- 23 outbreak-associated cases
- 3 laboratory- and CryptoNet confirmed *Cryptosporidium* infection
- Filter backwash and water samples directly from the facility's aquatic venues negative
- Facility operation and maintenance in compliance with local standards
- Facility operators hyperchlorinated the aquatic venues to achieve 3- \log_{10} (99.9%) inactivation

Arizona



- Players on a Coconino County Little League team and families
- 36 (71%) of 51 persons ill 6–7 days after visiting a Maricopa County aquatic facility
- 352 laboratory-confirmed cryptosporidiosis cases statewide
- Of 317 interviewed patients, 204 (64%) reported recreational water exposure at 86 public aquatic venues
- 43 (17%) reported swimming while symptomatic at 1 venue (range = 1–3)

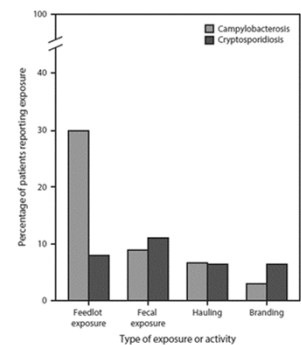
Ohio



- 399 cryptosporidiosis cases annually statewide
- 2016 incidence increased to 1,940
- 10 (4.2%) of 24 cryptosporidiosis outbreaks associated with aquatic venues
- Identified by CryptoNet as the *C. hominis* IdA19 subtype, rarely identified in U.S.
- 5 from university sports team's members and a sixth specimen from a patient with no epidemiologic link visiting the same waterpark
- Reclassified 26 cases in the university sports team as part of the waterpark-associated outbreak

Nebraska Study

- 2005-2015



Discussion



- Identifying *C. hominis* indicates a human source
- Most *Cryptosporidium* species indistinguishable by traditional diagnostic tests (microscopy or immunoassays)
- Cyanuric acid substantially delays chlorine inactivation of *Cryptosporidium*
- Diarrheal event worse
- Hyperchlorination rules by CDC

Time to Kill or Inactivate Organisms in Chlorinated Water

Organism	Time
<i>E. coli</i> O157:H7	Less than 1 minute
Hepatitis A Virus	About 16 minutes
<i>Giardia</i>	About 45 minutes
<i>Cryptosporidium</i>	About 15,300 minutes or 10.6 days

Prevention of Recreational Water Infections



- Don't swim while ill with diarrhea
- Cryptosporidiosis patients don't swim for additional 2 weeks after diarrhea has resolved
- Don't swallow water
- Keep ears as dry as possible and dry ears thoroughly
- Don't swim when you have open wounds

Prevention of Foodborne Illness

4 STEPS TO FOOD SAFETY



- <https://www.youtube.com/watch?v=zEoypKtFuWQ&feature=youtu.be>

Prevention of Foodborne Illness

- People who are more likely to get food poisoning should not eat the following:
 - Undercooked or raw animal products (such as meat, poultry, eggs, or seafood)
 - Raw or lightly cooked sprouts
 - Unpasteurized (raw) milk and juices
 - Soft cheese (such as queso fresco), unless it is labeled as made with pasteurized milk



Kitchen Sink

- Wash your hands for **20 seconds** with soap and running water.
- Wash fruits and vegetables before peeling.
- Do not wash meat, poultry, or eggs.



Cutting Board and Utensils

- Use separate cutting boards, plates, and knives for produce and for raw meat, poultry, seafood, and eggs.
- Clean with hot, soapy water or in dishwasher (if dishwasher-safe) after each use.



Thermometer

- Use a food thermometer to make sure food cooked in the oven, stove or on the grill reaches a temperature hot enough to kill germs.
 - All poultry, including ground: **165°F**
 - Ground beef, pork, lamb, and veal: **160°F**
 - Beef, pork, lamb, and veal chops, roasts and steaks: **145°F**
 - Fish: **145°F**



Microwave

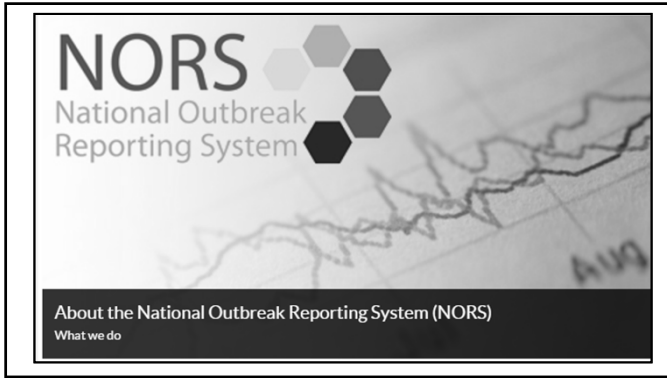
- Know your microwave's wattage.
 - Check inside the door, owner's manual, or manufacturer's website. Lower wattage means longer cooking time.
- Follow recommended cooking and standing times, to allow for additional cooking after microwaving stops.
- When reheating, use a food thermometer to make sure food reaches 165°F.



Refrigerator


- Keep your refrigerator between 40°F and 32°F, and your freezer at 0°F or below.
- Refrigerate fruits, vegetables, milk, eggs, and meats within 2 hours; (1 hour if the temperature is 90°F or higher).
- Store raw meat on the bottom shelf away from fresh produce and ready-to-eat food.
- Throw out foods left unrefrigerated for over 2 hours.
- Thaw or marinate foods in the refrigerator.





How to Report a Foodborne Illness

- Contact your local health department
- Ask to speak with the environmental health specialist or sanitarian
- Refer to your state health department website to find more information



Questions?

