

# Evolving Process for Investigating Multistate Foodborne Outbreaks: CDC's Role

Matthew Wise, MPH, PhD

Outbreak Response and Prevention Branch

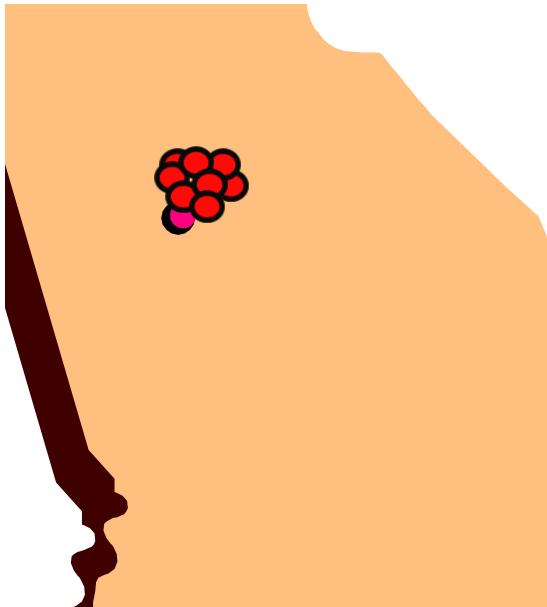
Division of Foodborne, Waterborne, and Environmental Diseases

Wisconsin Association for Food Protection Meeting

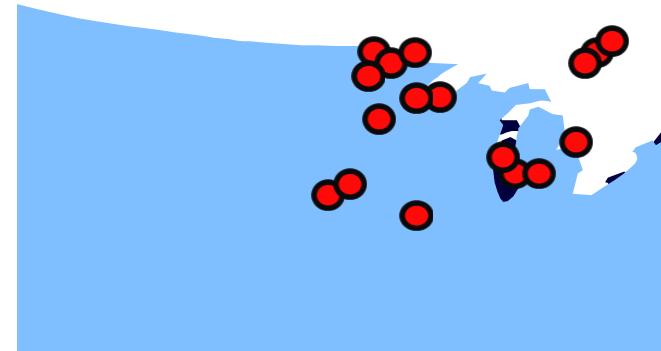
June 2019

# Background

# Foodborne Diseases in the United States: A Changing Landscape



“Classic” Foodborne Outbreak

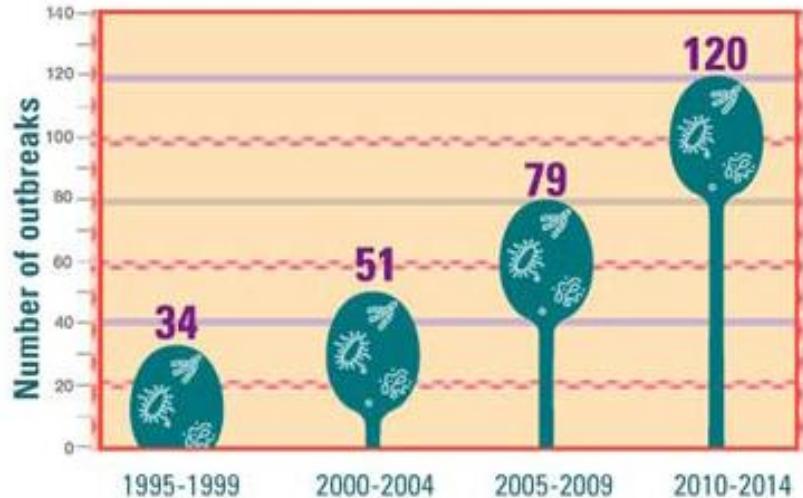


Disseminated Foodborne Outbreak

# Foodborne Disease Outbreaks in the United States: Importance of Multistate Outbreaks

More multistate outbreaks are being found

**Why?** Better methods to detect and investigate, and wider food distribution.



Multistate outbreaks: less common, but more serious

**Why?** The deadly germs *Salmonella*, *E. coli* and *Listeria* cause **91%** of multistate outbreaks.

**Only 3%** of all US foodborne outbreaks are multistate, but they cause more than their share of outbreak sicknesses, hospitalizations and deaths:



# Federal Roles in US Multistate Foodborne Outbreak Investigations

- CDC is the lead public health agency for multistate foodborne outbreaks
  - Disease surveillance and outbreak detection
  - Epidemiologic investigation (analyzing data from interviews of sick people)
- USDA (meat/poultry) and FDA (most other foods) are the lead regulatory agencies for multistate foodborne outbreaks
  - Traceback of suspected foods to their source
  - Food and environmental testing
  - Environmental assessments of farms and production facilities
  - Product recalls and actions



# State/Local Roles in US Multistate Foodborne Outbreak Investigations

- State and local health departments are ultimately responsible for the health of their residents
  - Some “centralized” states conduct interviews of ill people in outbreaks
  - Many states are “de-centralized” and local health departments are responsible for interviewing
- State and local also:
  - Detect and investigate localized outbreaks
  - Have authority over restaurants to conduct inspections and assessments
  - Collect records for traceback

*Almost all epidemiologic data in multistate outbreaks is collected by state/local jurisdictions, not CDC*

# Investigation Process

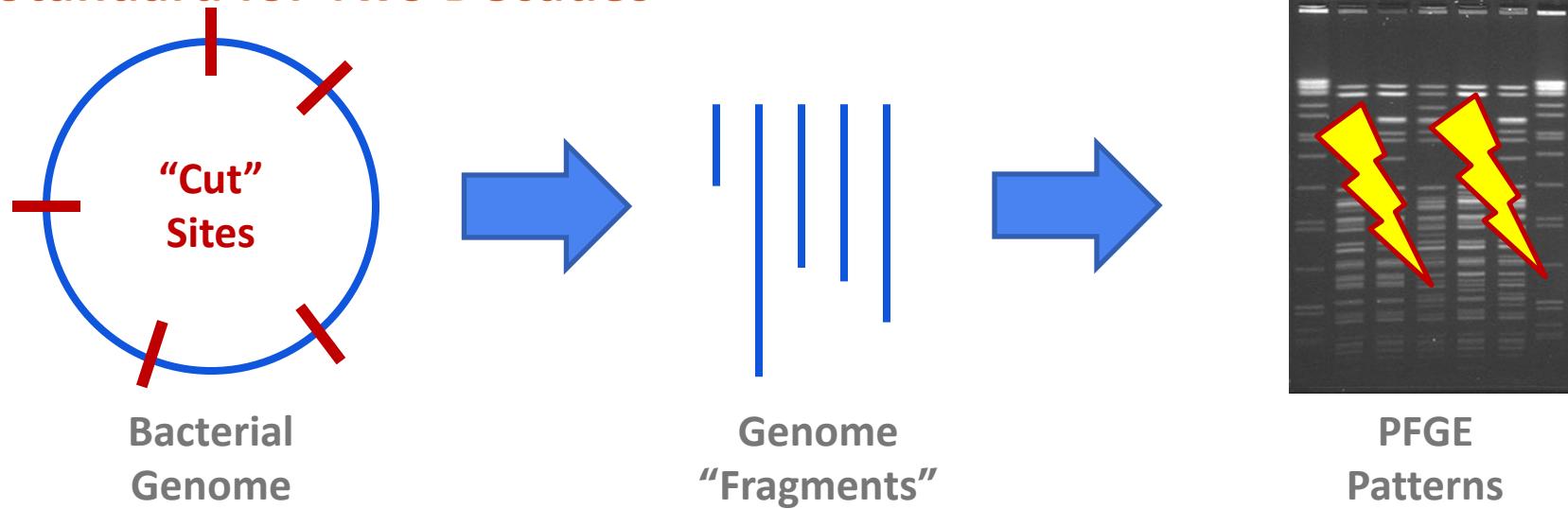
# Detecting Outbreaks with PulseNet

- Subtyping enteric bacteria is essential to identifying highly disseminated outbreaks
- PulseNet laboratory network established in 1996
  - Over 80 participating laboratories in the US
  - 60,000+ isolates subtyped annually
- Bacteria collected from ill people undergo DNA “fingerprinting” using several techniques



**Bacteria with the same “fingerprint” are more likely to come from a common source**

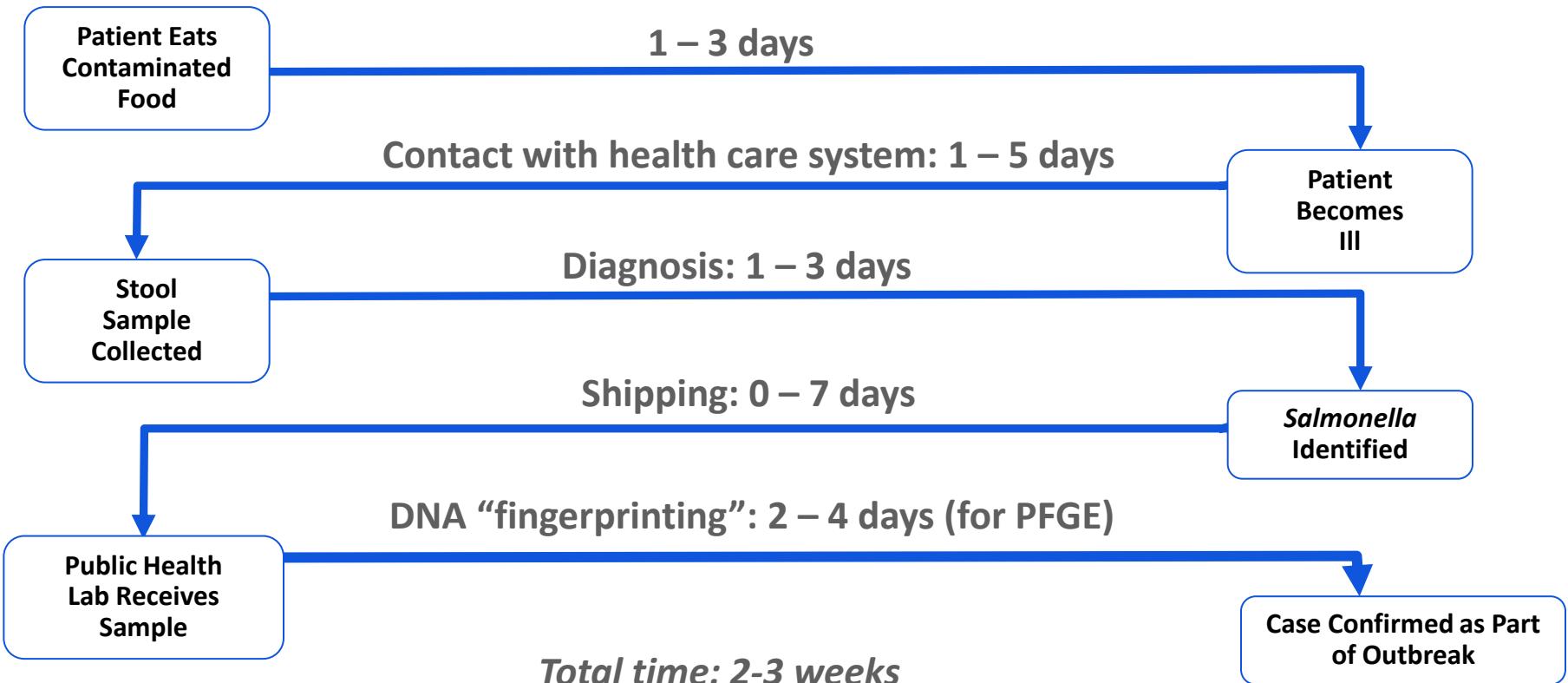
# Pulsed-Field Gel Electrophoresis (PFGE) Subtyping: PulseNet Standard for Two Decades



*PFGE provides a highly effective, but indirect comparison of the genomes of bacteria in outbreaks*

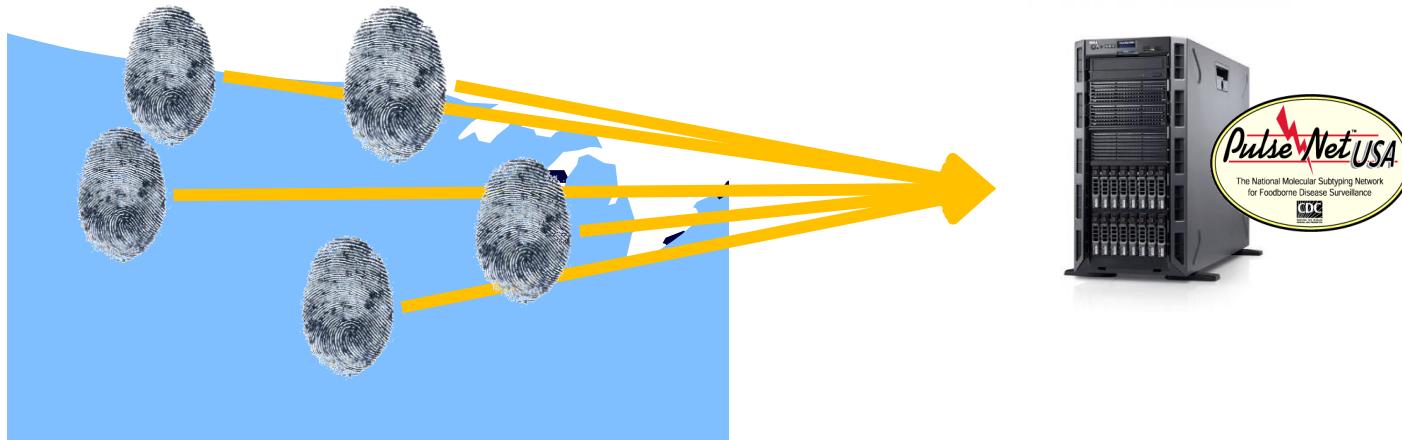
*Other lab workflows needed for serotype, virulence factors, etc.*

# Timeline for Reporting *E. coli* O157 Illnesses



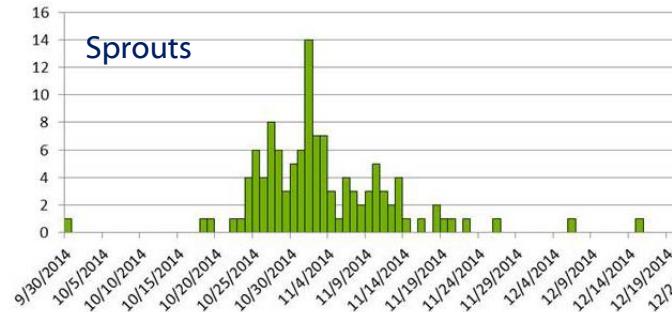
# Detecting Outbreaks with PulseNet

- Fingerprint data from illness-causing bacteria are transmitted to CDC
- Monitored for clusters of illnesses happening around the same time
- PulseNet notifies epidemiologists to investigate clusters

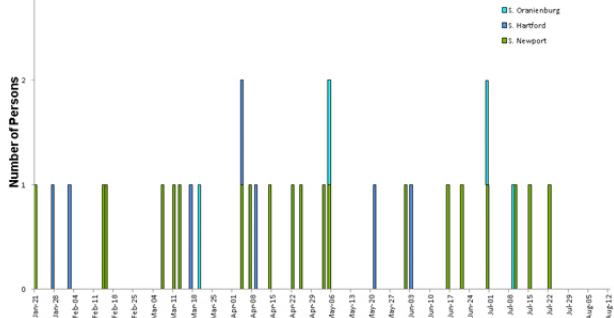


# Generating Hypotheses About the Source

- Demographics of ill people in the outbreak (age, sex, race/ethnicity)
- Geographic distribution
- Shape of the epidemic curve
  - Rapid ascent and descent?
  - Slow ascent and prolonged?
- Pathogen type and history

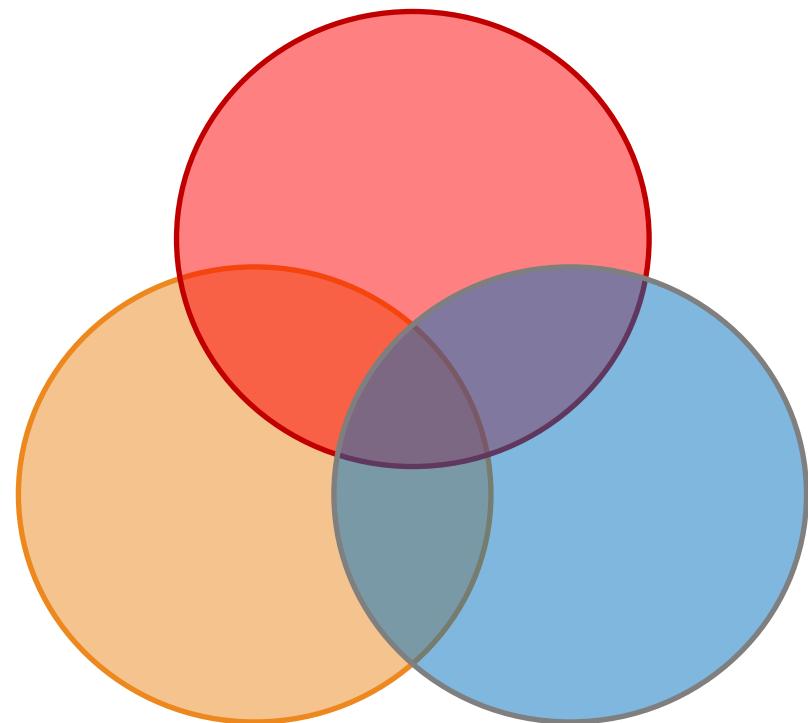


Chia seed powder



# Testing Hypotheses: How Do We Link a Food Item to Illness?

- Three types of evidence used:
  - Epidemiologic: link between illness and a specific food
  - Traceback: suspected food item links back to a common source of contamination
  - Environmental / Microbiologic: pathogen found in the food, farm or facility; inspectional findings

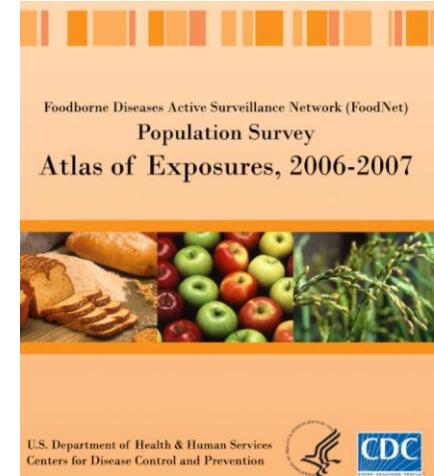


# Testing Hypotheses: Epidemiologic Evidence

- ***“Are ill people eating any foods more often than we would expect?”***
- What is done?
  - Ill people are asked about foods eaten before becoming sick, including types, brands, purchase locations, etc.
  - Other data used to corroborate reports (shopper cards, receipts)
  - Identify illness sub-clusters (multiple unrelated ill people with a common restaurant, event, institution exposure)
- Who's responsible?
  - CDC coordinates questionnaire development and analyzes data nationally
  - State/local health departments interview ill people

# Testing Hypotheses: Epidemiologic Evidence

- Compare food histories to available data sources
  - FoodNet Population Survey (2006-2008)
  - CDC database of interview data from past outbreaks
  - Industry/market share data when available
- Illness sub-clusters:
  - Identify common food items seen across different sub-clusters
  - Restaurant-based case-control and other studies
- Community-based case-case studies
  - Compare current outbreak to other sporadic enteric disease cases



# Testing Hypotheses: Traceback Evidence

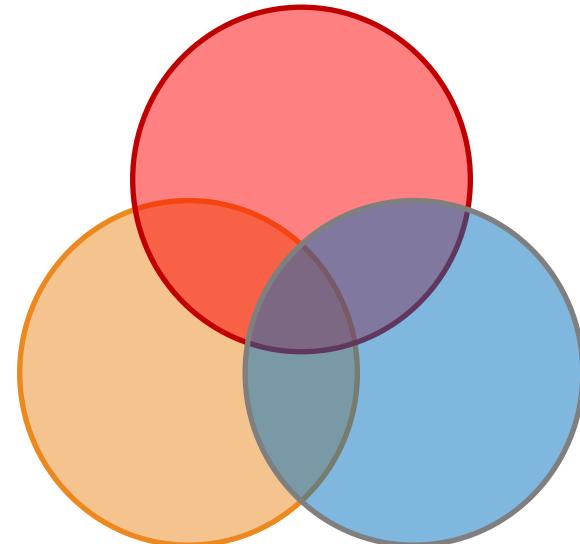
- *“Can most/all illnesses in the outbreak can be linked back to food coming from a common point of contamination?”*
- What is done?
  - Product names and lot numbers collected from case-patients, if available
  - Shopper card numbers and receipts document purchases
  - Records (invoices, bills of lading) obtained to trace foods to their source
- Who is responsible?
  - State/local health departments get pertinent case-patient information to regulatory agencies
  - State and/or federal regulatory agencies collect information further up the distribution chain to determine source

# Testing Hypotheses: Microbiologic Evidence

- *“Can the same bacteria that is making people sick be found in the food or production environment?”*
- What is done?
  - Testing leftover food items from patient homes / restaurants
  - Environmental and food sampling in the supply chain (e.g., farm, facility)
  - PulseNet/NCBI data examined for additional routine food/environmental samples
- Who is responsible?
  - State/local health departments collect leftover foods
  - Federal and state regulatory agencies test foods, conduct environmental assessments and sampling

# Testing Hypotheses: Interpretation

- Making the link between a company or food item and an outbreak is not taken lightly
  - Implications for government credibility
  - Financial and brand impact on industry/companies
- All lines of evidence must be evaluated in concert to make a determination about the link
  - Need to be fast and right
  - In some circumstances, may rely on only a single, strong line of evidence



# Taking Actions to Prevent More Illnesses

- Regulatory agencies have several tools to stop outbreaks
  - Product recalls
  - Facility closures
- Industry actions to stop the outbreak can include:
  - Issuing consumer warnings and product recalls
  - Defining the scope of the contamination event
  - Halting production and/or correcting processes
- CDC's role is to publicly communicate about the outbreak source
  - Providing specific, actionable advice
  - Disseminating recall information, especially for consumers

# Why CDC Communicates about Foodborne Outbreaks

## #1 REASON:

Specific source identified & public can take action

Other reasons CDC may communicate include:

- State health department(s) communicate
- High risk group involved
- Deaths, high hospitalization rate
- Misinformation circulating

# New Communications Tools



## Food Safety Alert

- Higher level of public health concern
- Higher specificity food item identified (e.g., brand, lot, etc.)
- Specific, actionable advice for consumers and retailers



## Investigation Notice

- Lower level of public health concern
- Lower specificity food item identified (e.g., general food item)
- General advice for consumers and retailers

# Message Accuracy & Consistency

- Decision to post a notice is made jointly with partners
  - State and local health departments
  - Regulatory agency
- Discussion of communication plan with implicated firm
- Content for web posting shared in advance before posting

Outbreak of *Salmonella* Infections Linked to Frozen Raw Tuna

Español (Spanish)



## Food Safety Alert

Posted April 16, 2019 at 4:45 PM ET

CDC, public health and regulatory officials in several states, and the [U.S. Food and Drug Administration](#) are investigating a multistate outbreak of *Salmonella* Newport infections linked to frozen, raw ground tuna supplied by Jensen Tuna.

### Advice to Consumers, Restaurants, and Retailers



#### Restaurants and retailers should not sell or serve recalled frozen, ground tuna from Jensen Tuna.

- On April 15, 2019, Jensen Tuna in Houma, Louisiana voluntarily [recalled](#) frozen ground tuna.
  - The recalled tuna was individually packaged in one-pound bags and sold in 20-pound boxes under lot numbers z266, z271, and z272.
  - Jensen Tuna distributed product to distributors in Connecticut, Illinois, Iowa, Minnesota, New York, North Dakota, and Washington. Recalled product might have been redistributed to additional states.
  - If restaurants and retailers do not know if the frozen ground tuna they have is recalled, contact the distributor. When in doubt, don't sell or serve it.
- Consumers who order sushi made with raw tuna, including "spicy tuna," should ask the restaurant or grocery store if the tuna is from Jensen Tuna. If you are not sure if the tuna has been recalled, do not eat it.
- Contact your health care provider if you think you may have become ill from eating raw tuna sushi.
- In general, people who are at higher risk for serious foodborne illness should not eat any [raw fish or raw shellfish](#). People at higher risk include children younger than 5 years, pregnant women, adults older than 65 years, and people with weakened immune systems.

### At A Glance

- [Reported Cases:](#) 13
- [States:](#) 7
- Hospitalizations: 2
- Deaths: 0
- Recall: Yes



# CDC Website

- Case count
- Affected states
- Symptoms
- Recall info
- Advice to consumers
- Photos of product
- Promoted via social media

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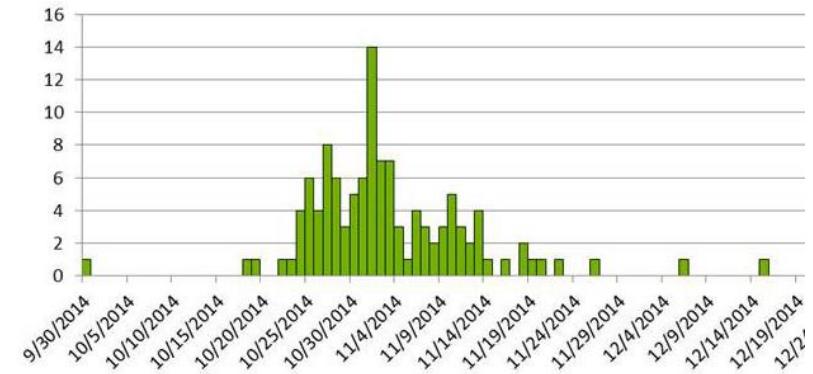
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# Confirming the Outbreak is Over

- Following regulatory or industry actions, CDC monitors for more illnesses to ensure the outbreak ends
- CDC will close an investigation after reports of illness either stop or return to “expected levels”
- Other information is considered
  - Reporting delays
  - Whether the source/extent of contamination was known/mitigated

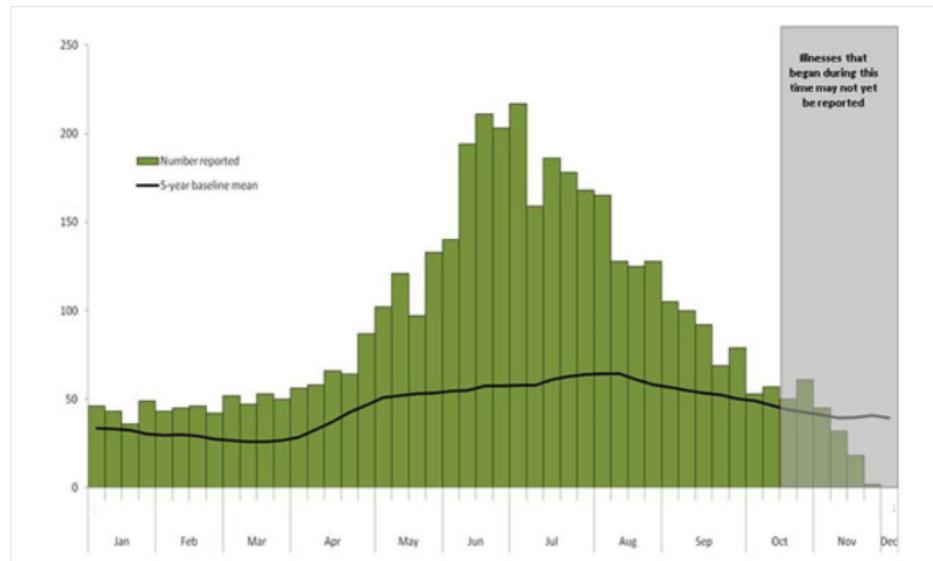


# Whole Genome Sequencing

# 2010 Outbreak of *Salmonella* Enteritidis Infections Linked to Shell Eggs

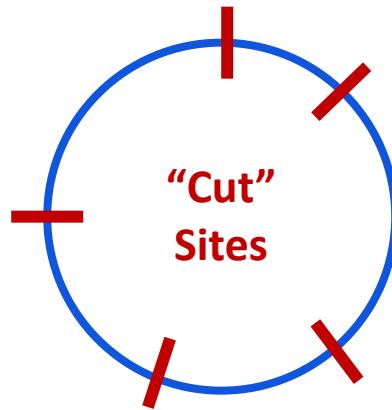


Number of *Salmonella* Enteritidis cases matching PFGE pattern JEGX01.0004 reported to PulseNet, United States, 2010\*

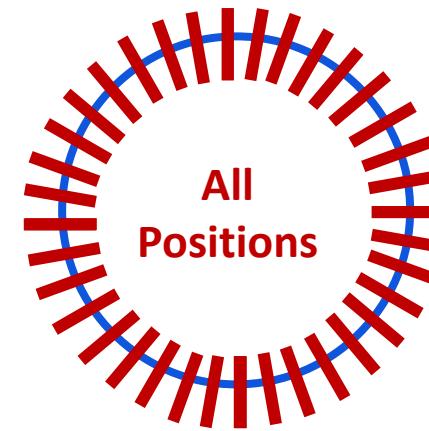


- Most common PFGE pattern in the PulseNet database
- 3,578 illnesses reported during the outbreak period
- 1,639 presumed to be unrelated “background” cases
- Complicated investigation into the source

# WGS Provides a Higher Resolution View of the Bacterial Genome



PFGE primarily gives genetic information via these cut sites

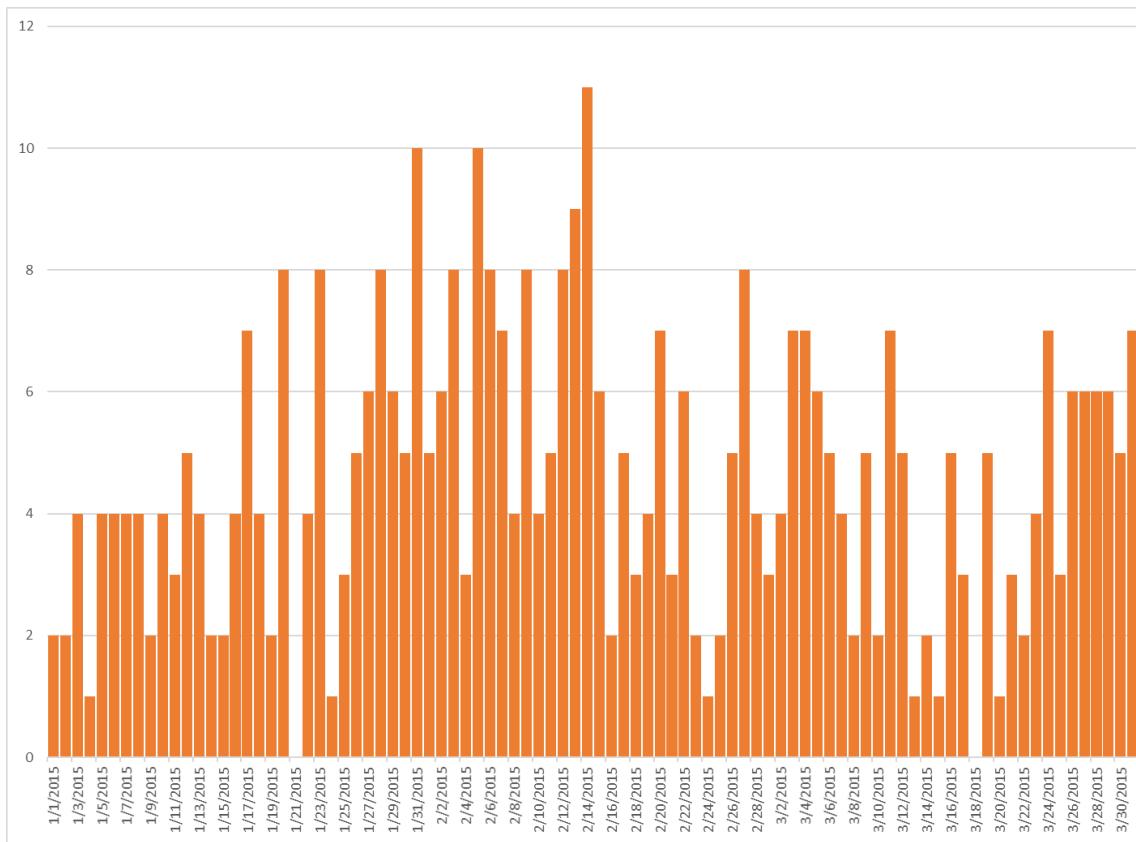


WGS has the ability to give us information at nearly every position in the bacterial genome

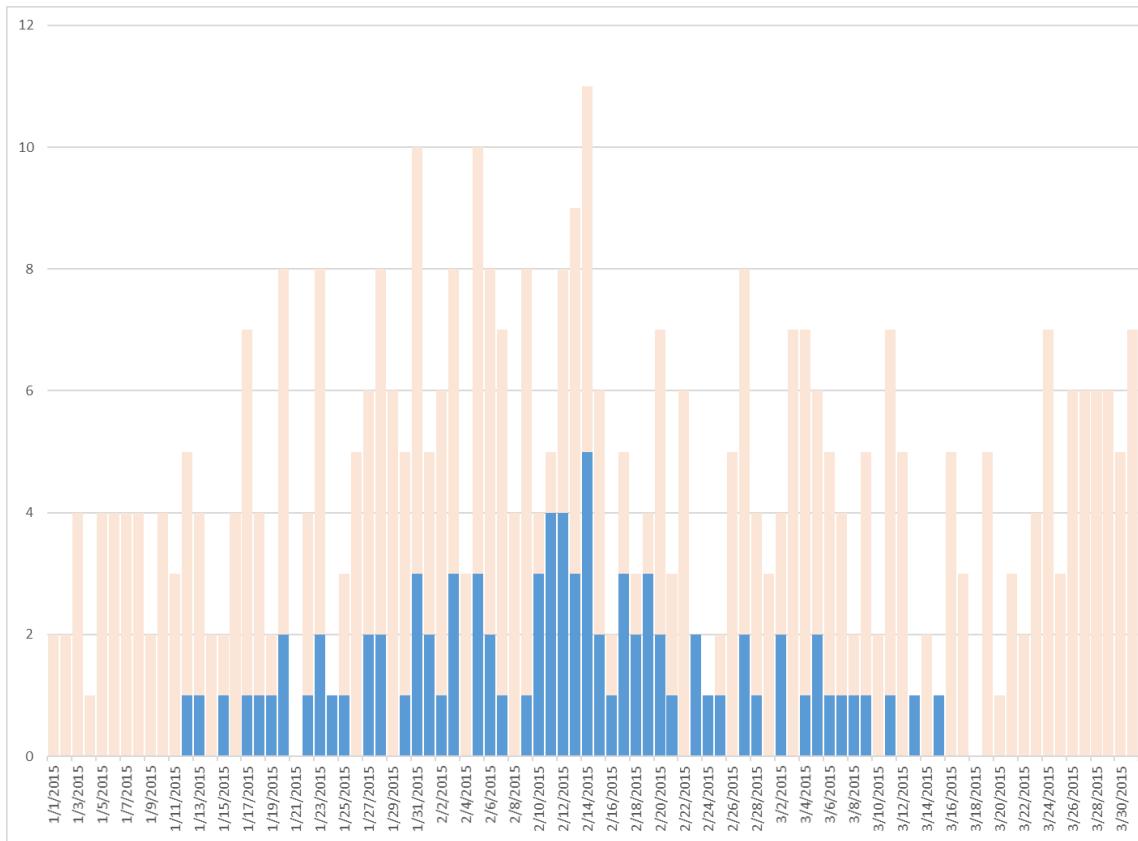
*Provides a much more direct and complete look at the genomes of bacteria in outbreaks*

*Resistance, serotype, etc. can be identified in one workflow*

# Hypothetical Contaminated Product Outbreak with “Background” Illnesses: PFGE View

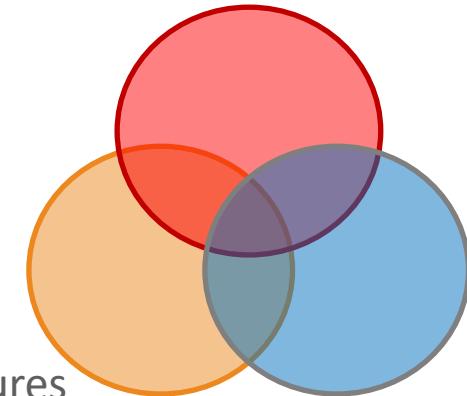


# Hypothetical Contaminated Product Outbreak with “Background” Illnesses: WGS View



# WGS Strengthens the Lines of Evidence Used to Link Outbreaks to a Food Source

- Epidemiologic evidence
  - Excludes unrelated illnesses from the analysis
  - Groups together seemingly unrelated illnesses, increasing power
- Tracing suspect foods to a common source of contamination
  - Helps ensure that traceback is performed on those exposures most likely to be linked to the exposure of interest
- Testing foods and the growing/production environment for pathogens
  - Increases the confidence that bacteria from people and foods are connected in some way



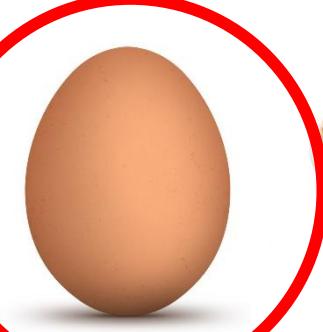
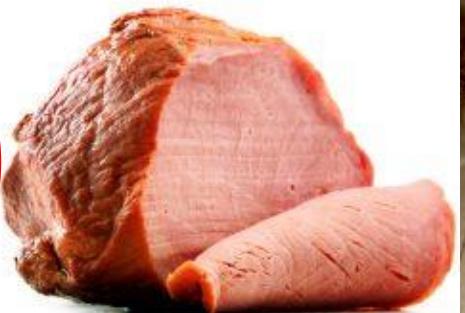
# WGS Impact Extends Beyond Just Improving Outbreak Investigations

- Spread of antimicrobial resistance genes/plasmids across multiple strains of bacteria
- Persistent sources of food contamination that result in consistent numbers of illnesses without a rapid rise in cases
- Recurrent outbreaks that link back to pathogen reservoirs in animals or the environment
- Better understanding the burden of illness attributable to certain food categories by combining genomic data with other data sources

# Full Implementation of WGS in PulseNet

- PulseNet is rapidly transitioning from PFGE to WGS
  - Already switched for *Listeria* and *Campylobacter*
  - Transition is happening during Summer 2019 for *Salmonella* and STEC
  - WGS data submitted to a publicly accessible database hosted by NIH
- This will require fundamental shifts in:
  - How outbreaks are defined and detected
  - The current processes for interagency, interdisciplinary, and private-public-academic collaboration
- Despite the advantages of WGS, it does not solve all problems
  - Multi-vehicle outbreaks with complex contamination routes

# Recent Outbreaks



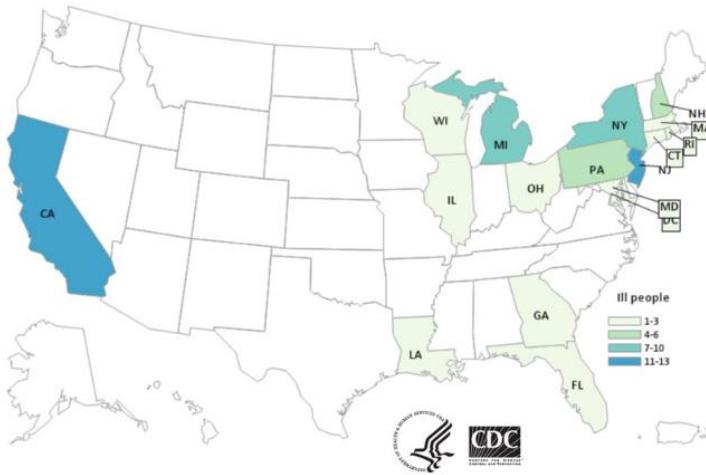
# Why Did 2018 Seem So Bad?

- Large number of outbreaks were solved in time to warn the public
  - Continued growth in state/local investigation capacity
  - Implementation of novel laboratory methods like whole genome sequencing
  - Year-to-year variation in finding and solving outbreaks (2017 was slow)
- Several of the outbreaks were large/severe and some resulted in broad consumer and industry advisories
- New communications tools developed for new types of investigations

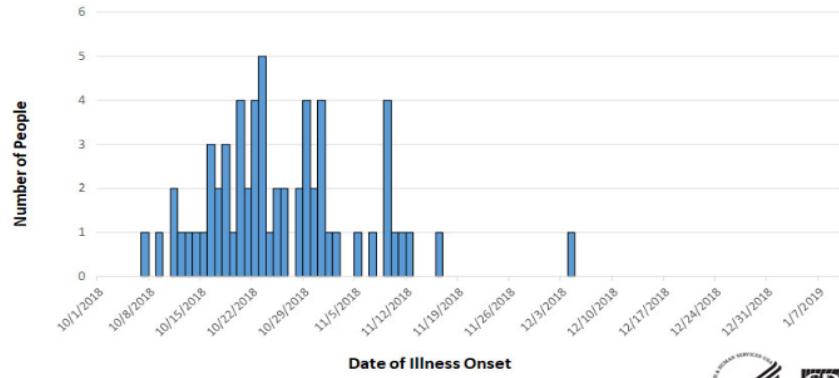


# Bi-National Outbreak of STEC O157 Linked to Romaine

People infected with the outbreak strain of *E. coli* O157:H7, by state of residence, as of January 9, 2019 (n=62)



People infected with the outbreak strain of *E. coli* O157:H7, by date of illness onset\*



\*n=62 for whom information was reported as of January 9, 2019. Some illness onset dates have been estimated from other reported information.



- California farms and cooling facilities identified in traceback were investigated
- Water and sediment samples analyzed from these locations
- *E. coli* O157:H7 highly related by WGS to the outbreak strain found in an agricultural water reservoir

# A History of Outbreaks with this Strain



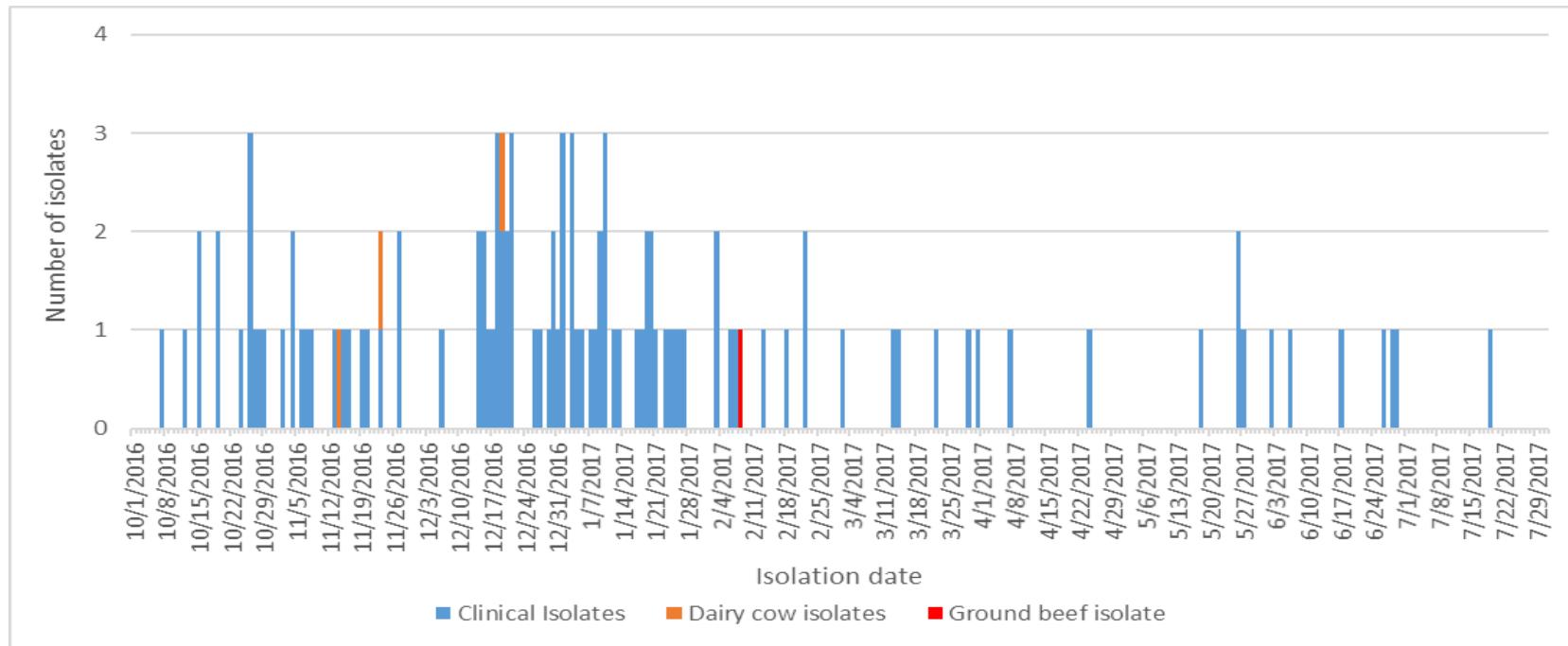
# **Investigation of *Salmonella* Newport Infections, 2016–2017**

- In 2016, CDC began investigating illnesses caused by *Salmonella* Newport with PFGE relatively common PFGE pattern
- WGS was used to better determine which illnesses to investigate
  - WGS broke the PFGE-defined cluster up into what looked like multiple outbreaks
  - Separate investigations were conducted into each of the illness clusters

# Outbreak of *Salmonella* Newport Infections Linked to Ground Beef, 2016–2017

- WGS identified 106 illnesses from 21 states caused by a nearly identical *Salmonella* Newport strain
  - Majority of cases from southwest United States
  - 52/65 (80%) reported eating ground beef at home
- The same *Salmonella* Newport strain (by WGS) was also found in ground beef and cattle during the same time period
  - 4 dairy cattle from a single state
  - Ground beef collected from an ill person's home (removed from its original packaging)

# Outbreak of *Salmonella* Newport Infections Linked to Ground Beef, 2016–2017



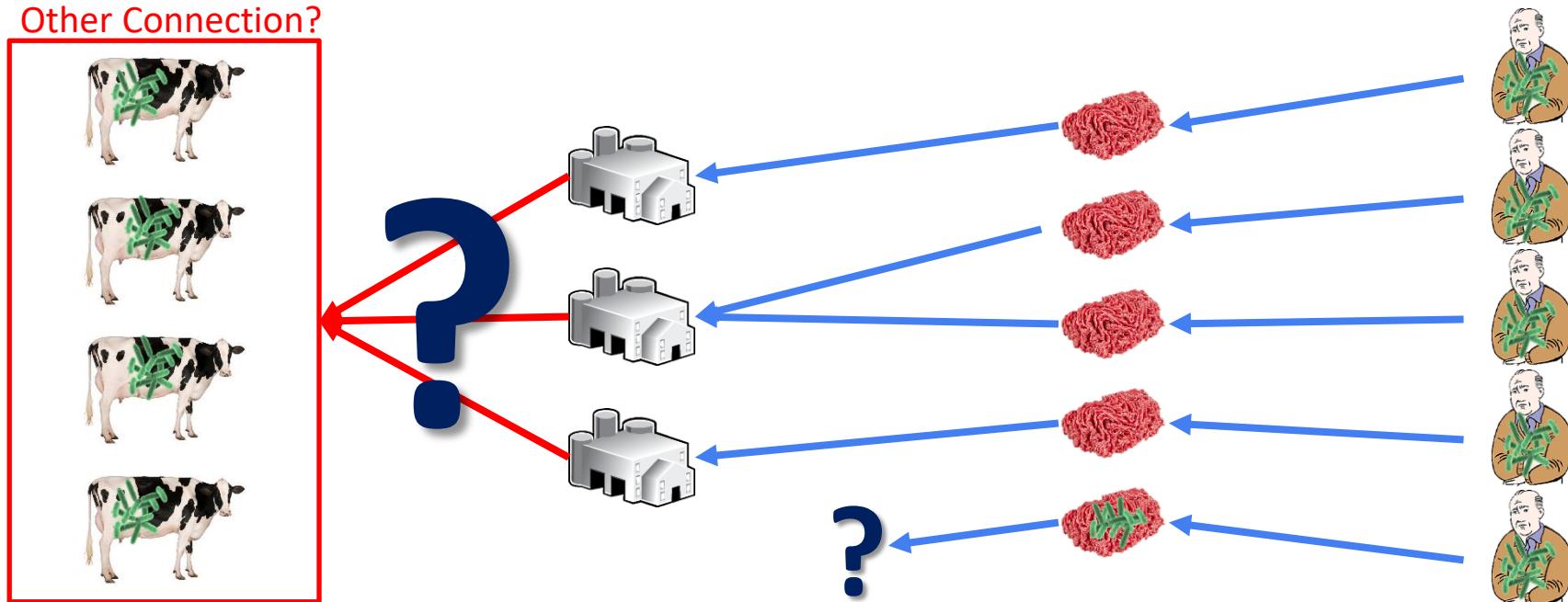
# **Outbreak of *Salmonella* Newport Infections Linked to Ground Beef, 2016–2017**

- USDA-FSIS performed traceback on ground beef exposures reported by ill people
  - Identified 20+ slaughter/processing establishments from 3 corporations predominantly
  - Due to limited purchase and other traceback evidence, common production lot not identified, precluding product recall
- Further, a direct pathway linking dairy cows to slaughter facilities to ill people in the outbreak could not be established
  - Complex traceback from consumers to slaughter establishments
  - Difficulty obtaining information on whether New Mexico dairy cows connected to any slaughter establishments identified in traceback

# Closely Related *Salmonella* Identified Throughout the Production Chain

Single Farm?

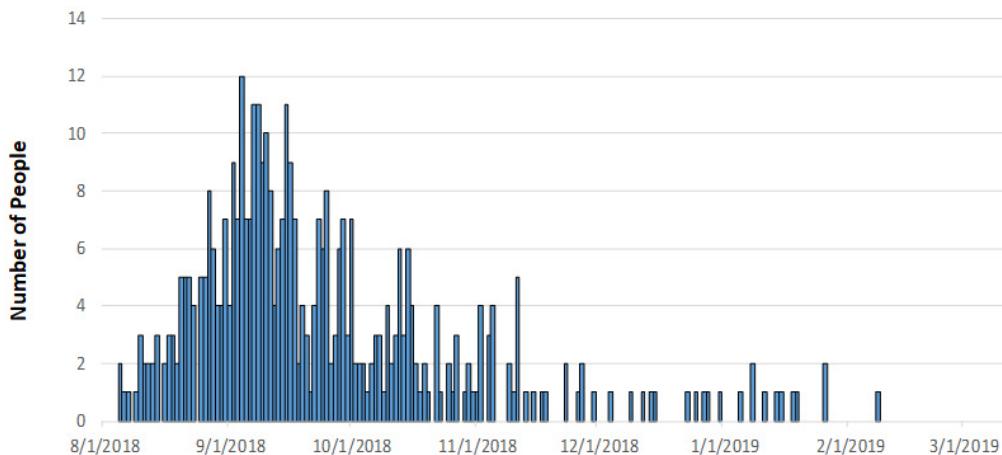
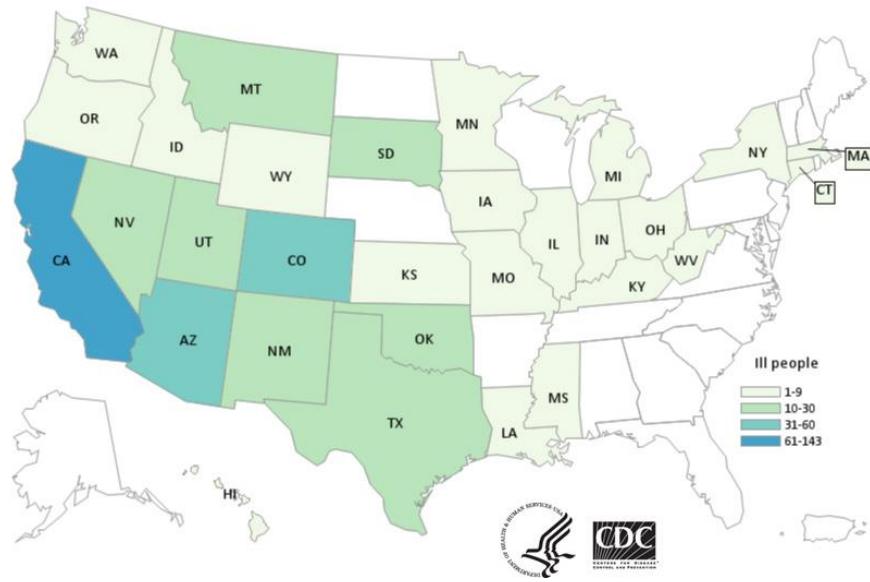
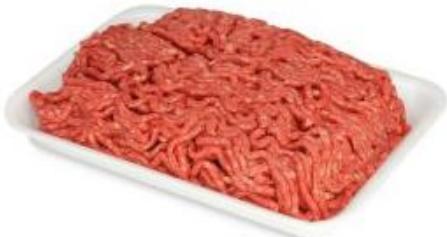
Other Connection?



*No contributing factors identified that might have led to the outbreak*

# Re-Emergence in 2018-2019

- 403 illnesses in 30 states
  - 117 people hospitalized
- This time, FSIS traceback converged on a slaughter facility
  - 12 million pounds of beef recalled



# Lessons Learned and Remaining Questions

- We are seeing this pattern of outbreak over and over again
  - Beef
  - Chicken
  - Turkey
- How can we find ways to understand the root cause of these that are acceptable to industry, agriculture, and public health?
- Had we gotten to the bottom of what happened in 2016-2017, could these illnesses have been prevented?

# Outbreak of Listeriosis Linked to Deli-Sliced Meats and Cheeses

- 8 hospitalizations from 2016-2019, including one death
- CDC investigated in 2017 but did not find a common source

The CDC's announcement Wednesday also comes as Consumer Reports is analyzing the results of our own testing of counter-sliced deli meat. One of our samples of turkey, purchased from a deli in New York City, contained a strain of listeria similar to the one involved in this current outbreak

Then Consumer Reports sent its findings to the CDC late in 2018, as well as to the New York City's Department of Health and Mental Hygiene, because the bacteria poses serious risks—especially to pregnant women, older people, and other vulnerable groups.

The CDC found that the listeria in CR's deli meat sample was closely related genetically to the listeria that previously made people sick, according to Brittany Behm, spokesperson for the agency. Two additional illnesses were reported since the sample was collected, she added.

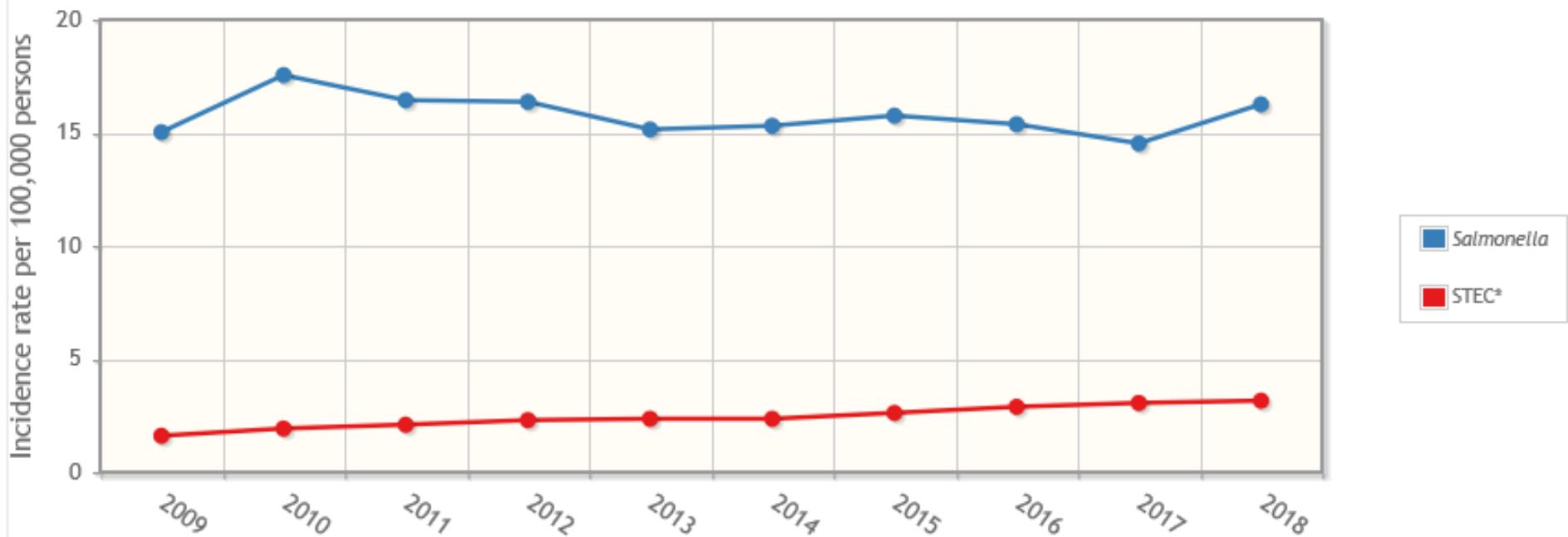


# Conclusions

# Industry Involvement in Investigation Process

- Industry plays a critical role in multistate foodborne outbreaks
  - Hypothesis generation: early consultation with industry experts can help narrow down suspects based on the timing and geographic distribution of illnesses
  - Hypothesis testing: providing traceback data or sharing isolates from food/environmental testing can help confirm or refute a hypothesis
  - Pinpointing the cause: working with regulatory agencies to scope contamination events and identify/correct the cause of contamination
  - Stopping the outbreak: recall contaminated products and reach out to customers and consumers
  - Sharing lessons: disseminating information learned during an outbreak and/or recall to others in industry

# No Improvements in Incidence of *Salmonella* and STEC Infections Since 2009



# Recognized Outbreaks Are Currently a Small Fraction of All Foodborne Illnesses

- Only about 12% of all *Salmonella*, STEC, and *Listeria* illnesses reported to PulseNet are associated with a potential outbreak
- The vast majority of illnesses do not have a known or suspected cause (the “baseline”)
- WGS will allow us to move beyond just acute outbreaks to find where the major sources of illness are

