

# Developments in Foodborne Disease Epidemiology: Update from the Centers for Disease Control and Prevention

125<sup>th</sup> Annual Educational Conference (virtual)  
Association of Food and Drug Officials

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# Tremendous ongoing efforts during COVID-19 Pandemic

- Extraordinary efforts in many agencies, companies, universities, communities
- Today is day 527 of CDC COVID-19 Emergency Response
  - State and local health authorities working largely on pandemic response
  - Thousands of CDC staff also involved: ~ 1/3 of division at any given moment
  - Support local, state, tribal health departments to investigate focal outbreaks, promote prevention measures, testing, and vaccination efforts
  - Now our lab is ramping up sequencing of mRNA in specimens nationwide
- Website: COVID Data Tracker summarizes of up-to-date surveillance information
- COVID Data Tracker Weekly Review – [subscribe](#) to this weekly summary

— COVID DATA TRACKER WEEKLY REVIEW 

# Foodborne illnesses in the United States

- Each year, 48 million people become sick, 128,000 are hospitalized, and 3,000 die
- Estimated annual cost of foodborne illness: \$15.6 billion
- Prevention: Understanding transmission well enough to prevent it
- Actions by regulators, public health, industry, consumers
- Progress driven by foodborne outbreaks and attribution studies, that lead to further research, changes in industry practices and regulatory policies
- 1996-2007: Important progress was made, especially with interventions at slaughter for meat and poultry, and along the supply chain for eggs
- Since then, less general progress has been made in reducing incidence
- **Further efforts needed, including pre-harvest interventions**

# Food Safety Activities at CDC

- Conduct national surveillance for infections often transmitted by food
- Detect, investigate and control outbreaks to stop them and prevent future illness
- Drive illness prevention policy with data, analyses, and partnerships
- Innovate by applying advanced technologies to improve surveillance and to address diagnostic challenges
- Support state and local health departments, global and other partners to fulfill their primary roles in addressing the above goals

# Surveillance and investigation are multi-agency efforts

## Caregivers and clinical labs

- Make the diagnoses, and report the specific illnesses

## Local and State health departments

- Receive reports of specific diseases, and interview patients
- Subtype pathogens in public health labs
- Investigate and control events within the state
- Lead many ongoing monitoring and prevention activities

## CDC

- Primary national public health agency
- Conduct national disease surveillance and multistate outbreak detection and investigation

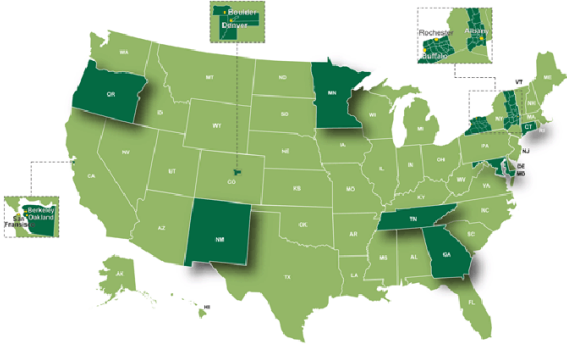
## FDA (most foods) USDA/FSIS (meat, poultry, egg products)

- In outbreaks, trace suspected foods back to source
- Assess production and processing facilities
- Maintain ongoing prevention and monitoring efforts

# The changing landscape of food

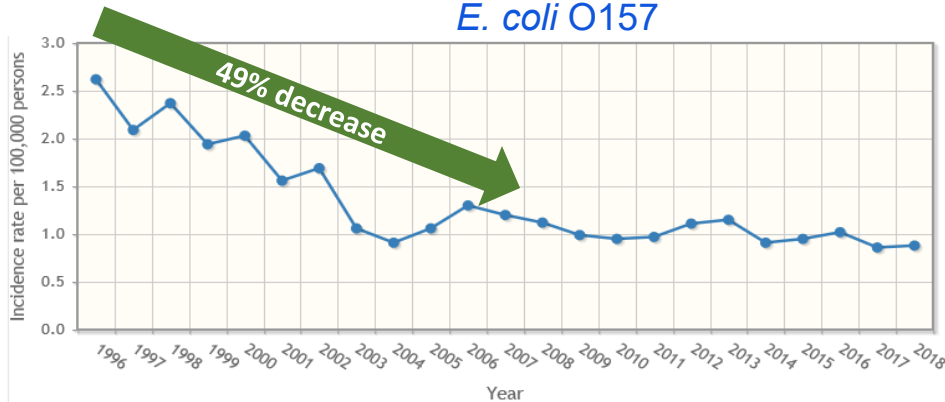
- The landscape is constantly changing
  - New foods
  - Changing food sources with globalized economy
  - Changing consumer habits, and demands
  - Emerging pathogens
  - COVID-19 pandemic
- The methods we use for surveillance are also changing
- The problems we find depend on the surveillance tools we use

# Incidence of diagnosed cases, by pathogen — FoodNet

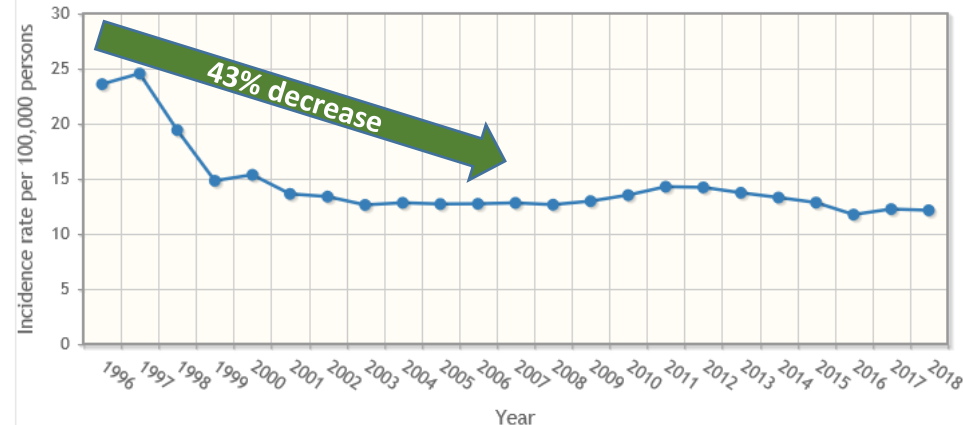


- Active surveillance, part of CDC's Emerging Infections Program
- Culture-confirmed illnesses per 100,000 population
- Collaboration among CDC, 10 FoodNet sites, FDA, USDA/FSIS
- 8 infections often spread through food
- Reliable and up-to-date data on illness trends online for 1996 – 2019

*E. coli* O157

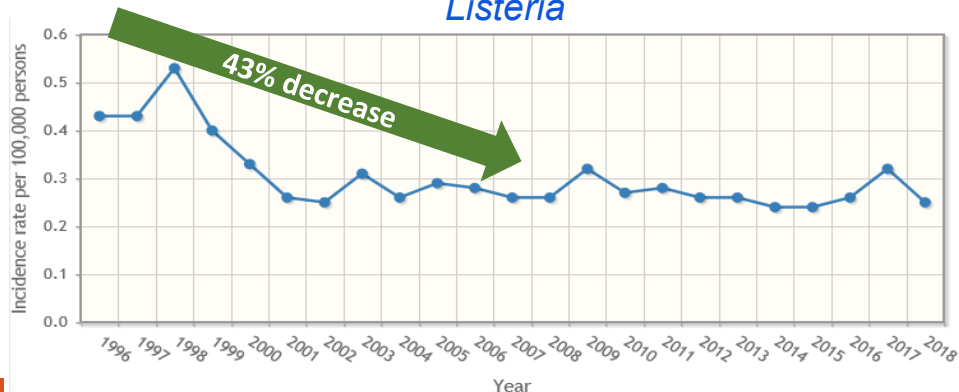


*Campylobacter*

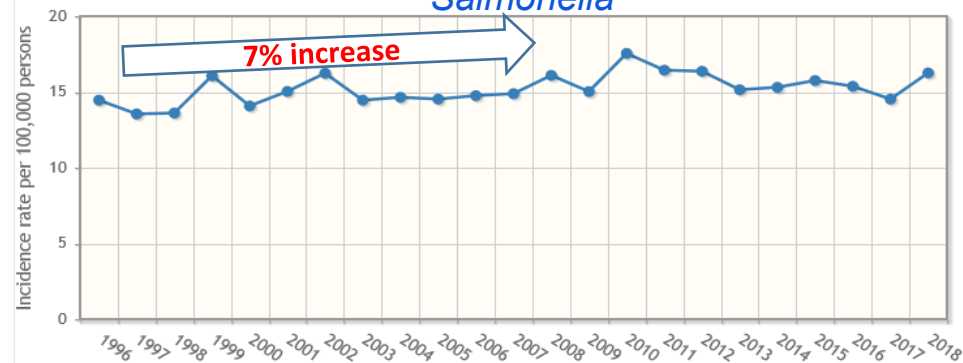


■ Culture-Confirmed only

*Listeria*



*Salmonella*





# Food Safety Goals for 2030

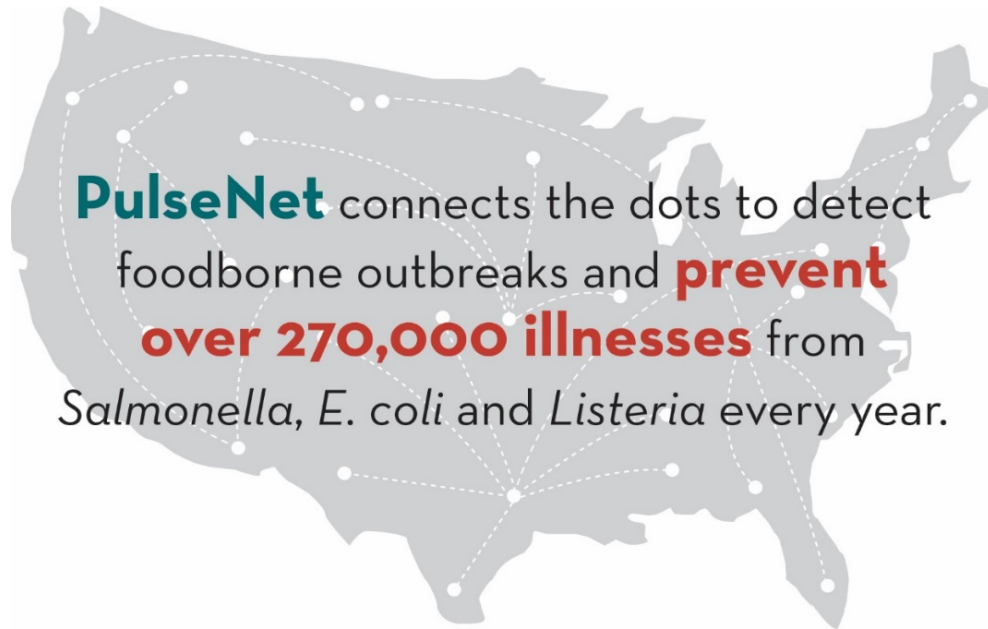
- Healthy People 2030: From baseline in 2015-2017:
  - 20% reduction in Shiga–toxin producing *E. coli* infections
  - 25% reduction in *Salmonella* infections
  - 33% reduction in *Campylobacter* infections
  - 40% reduction in *Listeria monocytogenes* infections



# Expanding efforts at CDC to meet Food Safety Goals

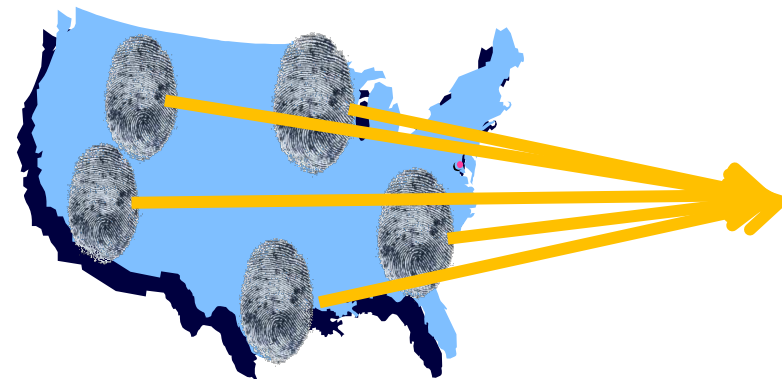
- Make surveillance and investigations more powerful
  - Implement whole genome sequencing for routine PulseNet subtyping
  - Detect and control outbreaks we may be missing now
  - Identify emerging problems
- Analyze our surveillance more to help target interventions
  - Attribute illnesses to specific food categories
  - Account for changing diagnostic tests that affect surveillance
- Stay on the cutting edge as new laboratory diagnostic methods arise.
  - The challenge of culture-independent diagnostic tests
  - Metagenomic tools for public health are coming
- Make our information and assessments rapidly available

# PulseNet 1996-2021: National network for molecular, now sequence-based surveillance of bacterial enteric infections



- Public health labs test clinical isolates using standardized sequencing methods
- Data from pathogens are transmitted to a centralized database
- Monitor for clusters of illnesses with the same genetic “fingerprint”
- Investigate ~200 multistate clusters annually

- 87 labs participate:
  - State and city health departments
  - FDA & USDA laboratories
- Since 2019, shifted to whole genome sequencing: 50,000 per year



# Continuous investment and improvement in public health laboratories

- Whole genome sequencing now routine in public health laboratories to
  - find and investigate dispersed outbreaks
  - improve source attribution of sporadic cases
  - track success of control measures
  - predict serotype and antimicrobial resistance from sequence
- Expanding IT infrastructure: access to greater computing power
- Clinical labs are adopting “culture-independent diagnostic tests”
- Public health labs still need to isolates for WGS
- Someone needs to culture the positive specimens - This falls more and more on public health labs
- **This summer: Piloting a new metagenomic approach to getting *Salmonella* sequences from fecal samples in two state public health labs**

# New landscape of bacterial foodborne outbreaks revealed by whole genome sequencing

- Finding more outbreaks, finding them while they are smaller
  - Identifying familiar and new sources
- Developing better source attribution models for sporadic cases of common serotypes
- Identifying events that fall between acute outbreaks and the background
  - **Re-occurring** (*E. coli* O157 in Romaine lettuce)
  - **Emerging** and spreading (*Salmonella* Infantis and poultry)
  - **Persisting** over several years (Resident strains of *Listeria*)
  - These are “**REP** strains” defined by WGS
- Using this information to guide upstream source investigations and target new prevention strategies, including vaccinating food animals

# Two successes in *Salmonella* prevention for two formerly common serotypes, 1996-2019



■ Heidelberg



*S. Heidelberg* declined **93%**  
from 1.07/100,000 in 1999  
to 0.08/100,000 in 2019

*S. Typhimurium* declined **70%**  
from 4.26/100,000 in 1998  
to 1.27/100,000 in 2019

■ Typhimurium



From FoodNet Fast: [cdc.gov/foodnetfast](https://cdc.gov/foodnetfast)

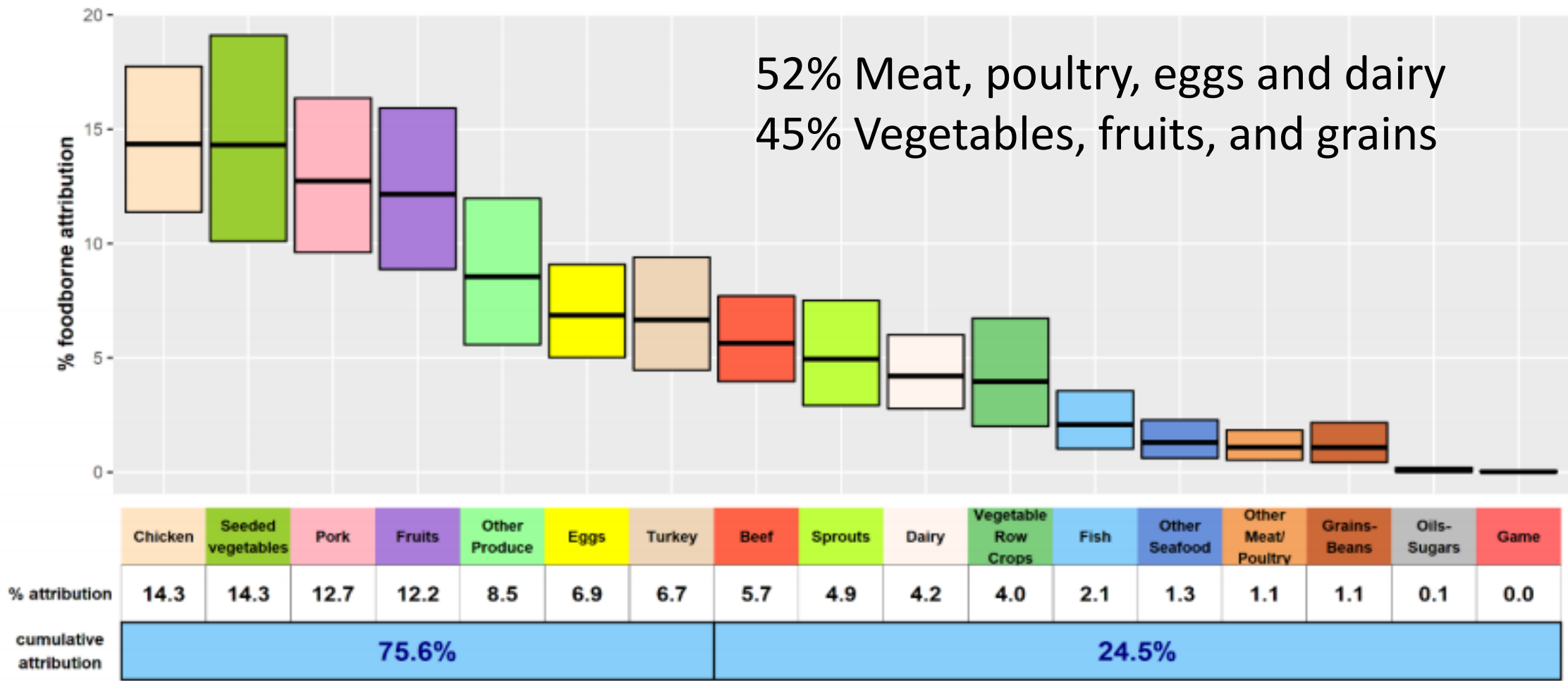
# Using attribution to help target interventions



- Interagency Food Safety Analytics Consortium (IFSAC): CDC, FDA, FSIS work together to summarize information on sources of foodborne infections
- Have constructed a model based on reported foodborne outbreaks over the last 18 years, giving more weight to most recent 5 years
- Attributed cases of illness across 17 major food categories, by pathogen
- Most recent summary based on 1998 – 2018
- Repeat and update annually

# What are the food sources of salmonellosis? Attribution using food vehicles in outbreaks – U.S., 1998 - 2018

Salmonella



IFSAC 2018 Report

[www.cdc.gov/foodsafety/ifsac/annual-reports.html](http://www.cdc.gov/foodsafety/ifsac/annual-reports.html)



# Summary of biggest targets for prevention



## ■ FDA regulated foods

- Fresh produce: *Salmonella* and STEC\*
  - Leafy greens and STEC\*
  - Seeded vegetables and *Salmonella*
- Eggs: *Salmonella*
- Cheese and other RTE foods: *Listeria*
- Shellfish and *Vibrio* infections

## ■ FSIS regulated foods

- Chicken: *Salmonella* and *Campylobacter*
- Ground beef: *Salmonella* and STEC\*
- Pork: *Salmonella* and *Yersinia*

\*Shiga toxin–producing *E. coli*, such as *E. coli* O157

# Impacts of COVID-19 pandemic are wide-ranging

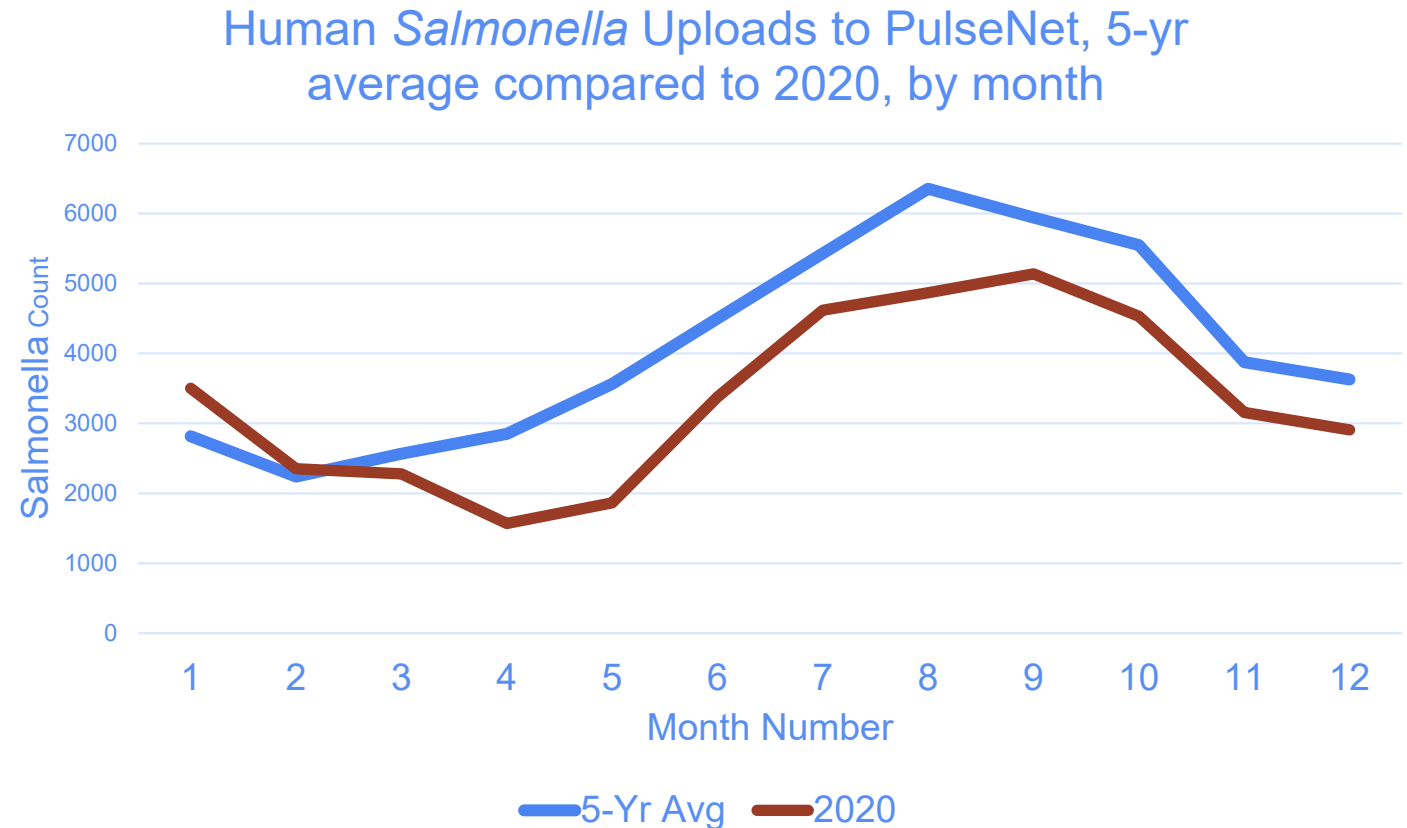
- Many changes in food sector, though no evidence of transmission via food
  - Pandemic impact on food production and processing workers
    - Control with regular testing, making distancing, other measures
    - Opportunity to vaccinate workforce; incentives needed
  - Restaurant closed, cancelled catering events
  - Groceries and meals delivered to homes, surge in home cooking
  - Now phased re-opening
- Public health efforts slowed
  - Local and state resources focused on COVID-19 response
  - Inspections complicated by COVID-19
  - Delayed CDC updates for FoodNet, National Outbreak Reporting System, National Antimicrobial Resistance Monitoring System
- Fewer reports of many types of illnesses

# Impact of COVID-19 Pandemic of PulseNet Surveillance

- Early in March 2020: Sequence submissions dropped to 50% of expected
- Slowly recovered to 70-80% of expected
- Parallel to decreases in ER visits for any reason
- Did illnesses actually decrease in 2020?



- Major changes in food practices
- Major change in health care seeking
- Halt to international travel
- Still detected outbreaks



# 12 major multistate foodborne outbreaks of 2020 – 2021

- |                         |                       |                               |
|-------------------------|-----------------------|-------------------------------|
| ■ <i>S. Newport</i>     | 1127 cases, 48 states | Red Onions (+515 in Canada)   |
| ■ <i>S. Enteritidis</i> | 101 cases, 17 states  | Peaches (+57 in Canada)       |
| ■ <i>S. Stanley</i>     | 55 cases, 12 states   | Wood ear mushrooms (imported) |
| ■ <i>L. mono</i>        | 36 cases, 31 states   | Enoki mushrooms (imported)    |
| ■ <i>L. mono</i>        | 12 cases, 4 states    | Deli meats                    |
| ■ <i>L. mono</i>        | 7 cases, 4 states     | Hispanic style cheeses        |
| ■ STEC O103             | 51 cases, 4 states    | Clover sprouts                |
| ■ STEC O157             | 32 cases, 12 states   | ? Source                      |
| ■ STEC O157             | 40 cases, 19 states   | Leafy greens                  |
| ■ STEC O157             | 18 cases, 9 states    | ? Source (retail romaine +)   |
| ■ STEC O157             | 16 cases, 15 states   | Under Investigation           |
| ■ <i>Cyclospora</i>     | 701 cases, 14 states  | Bagged salad mix              |

# 12 major multistate enteric outbreaks of 2020 – 2021

## Three were caused by REP strains

- |                         |                       |  |
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| ■ STEC O103             | 51 cases, 4 states    | Clover sprouts <b>rel to 2019 outbreak</b> |
| ■ STEC O157             | 32 cases, 12 states   | ? Source <b>rel to 2018 CAZ clade</b>      |
| ■ STEC O157             | 40 cases, 19 states   | Leafy greens <b>SMS clade</b>              |
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# 12 major multistate enteric outbreaks of 2020 – 2021

## Four were from unusual or novel food sources

|   |                       |                       |                             |                  |
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# Novel food contamination events need to be better understood so they can be controlled

- Imported mushrooms dehydrated or fresh, are sometimes not ready to eat
  - Often eaten uncooked in US, but routinely cooked in country of origin
  - Need for warning labels? Irradiation?
- *Salmonella* Newport and red onions
  - Extraordinary size of event
  - Traced back to four fields
  - Ultimate source of contamination undetermined
- *Salmonella* Enteritidis and fresh peaches
  - Did contamination occur while fruit still on trees?
  - Should we consider “Aeolian” transmission?
  - Proximity to upwind sources?



Aeolus  
God of the winds



# Foodborne disease prevention in the 21st century: An evolving public health approach

- WGS is used in every state now, can be used for more pathogens
- Whole genome sequence-based surveillance is a major step forward:
  - More precise subtyping, plus enhanced patient interviews and traceback
  - More outbreaks and sources detected and controlled
  - Improved source attribution for sporadic cases
  - Systematic approach to repeating, emerging and persisting strains (REP Strains)
- A bridge to the future, when public health will have culture-independent tools that provide all needed information directly from a patient sample
- Define more targets for prevention, finding and correcting food safety gaps
- **Empower public health, regulators, industry, and consumers to drive down incidence of foodborne infections**

# Thank you

For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [www.cdc.gov](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.

