# From Table to Toilet:

# How Foodborne Outbreaks Influence the Path of Public Health Investigations

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# Overview

- Foodborne illness surveillance
- Detecting outbreaks
- Steps in an outbreak investigation
- Key players in outbreak investigations
- Examples

# Session Goals

- Understand public health surveillance of foodborne illness
- Understand methods of outbreak investigation
- Understand how information collected during case interview is used during outbreak investigations

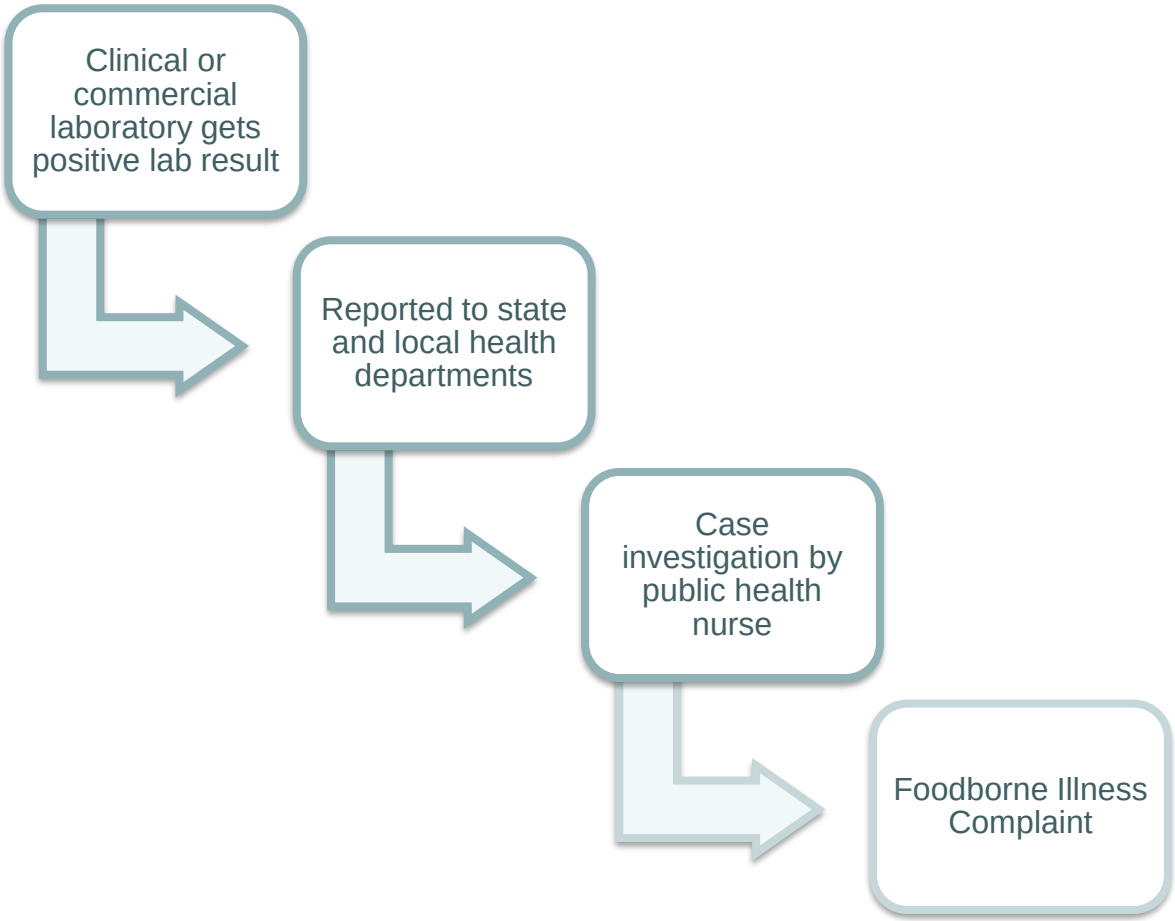
# Foodborne Illness Surveillance

Certain infectious diseases are required to be reported by clinical laboratories and clinicians to LBOHs and DPH (105 CMR 300):

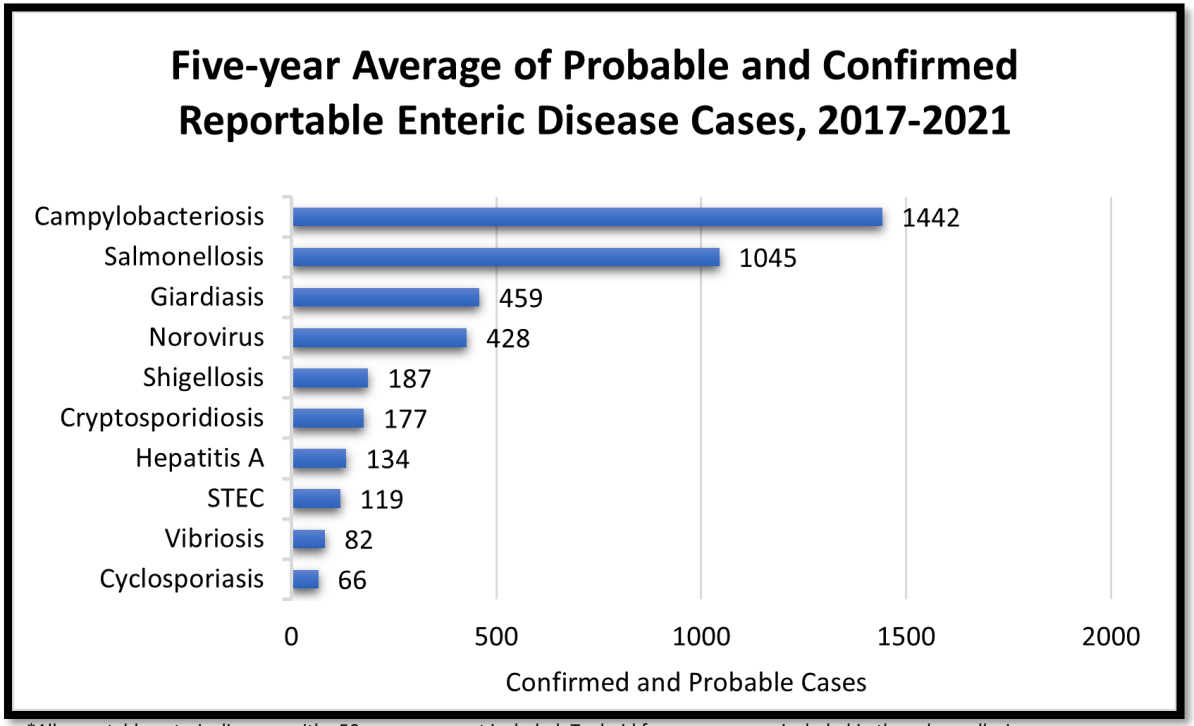
| Reportable by clinical labs | Reportable by clinicians |
|---|---|
| • ☎ *Clostridium botulinum* ⇨🖹<br>• *Campylobacter* sp. ⇨🖹<br>• *Cryptosporidium* sp.<br>• *Cyclospora cayetanensis*<br>• *Entamoeba histolytica*<br>• *Giardia* sp.<br>• Hepatitis A virus<br>• *Listeria* sp. ⇨🖹<br>• Noroviruses<br>• *Salmonella* sp. (non *typhi*)<br>• ☎ *Salmonella typhi* ⇨🖹<br>• Shiga-toxin producing organisms, including *E. coli* O157:H7 ⇨🖹<br>• *Shigella* sp. ⇨🖹<br>• *Vibrio* sp. ⇨🖹<br>• *Yersinia* sp. ⇨🖹 | • ☎ Any cluster/outbreak of illness, not limited to foodborne illness<br>• ☎ Botulism<br>• ☎ Cholera<br>• ☎ Foodborne illness due to toxins (including mushroom toxins, ciguatera toxins, scombrotoxin, tetrodotoxin, paralytic shellfish toxin and amnesic shellfish toxin, staphylococcus enterotoxin and others)<br>• ☎ Hemolytic uremic syndrome<br>• ☎ Hepatitis A (IgM+ only)<br>• ☎ Typhoid Fever |

⇨🖹 Isolates should be submitted to the State Public Health Laboratory
☎ Report immediately by phone

# Foodborne Illness Surveillance

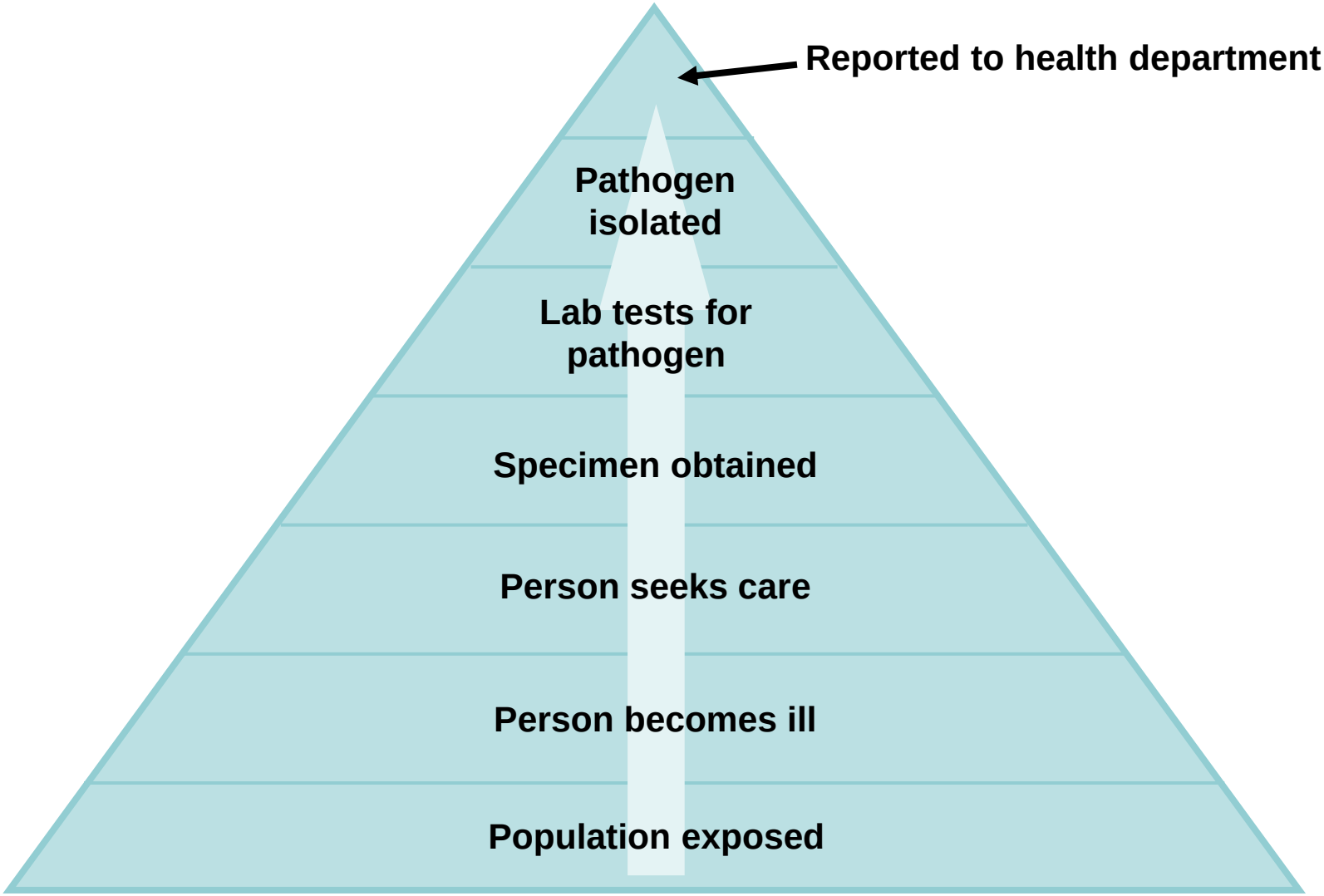


# Enteric Disease in Massachusetts




*All reportable enteric diseases with <50 cases were not included. Typhoid fever cases were included in the salmonellosis case count. Massachusetts Department of Public Health, Bureau of Infectious Disease and Laboratory Sciences. Data are current as of 5/18/2022 and may be subject to change.

# Foodborne Illness Surveillance



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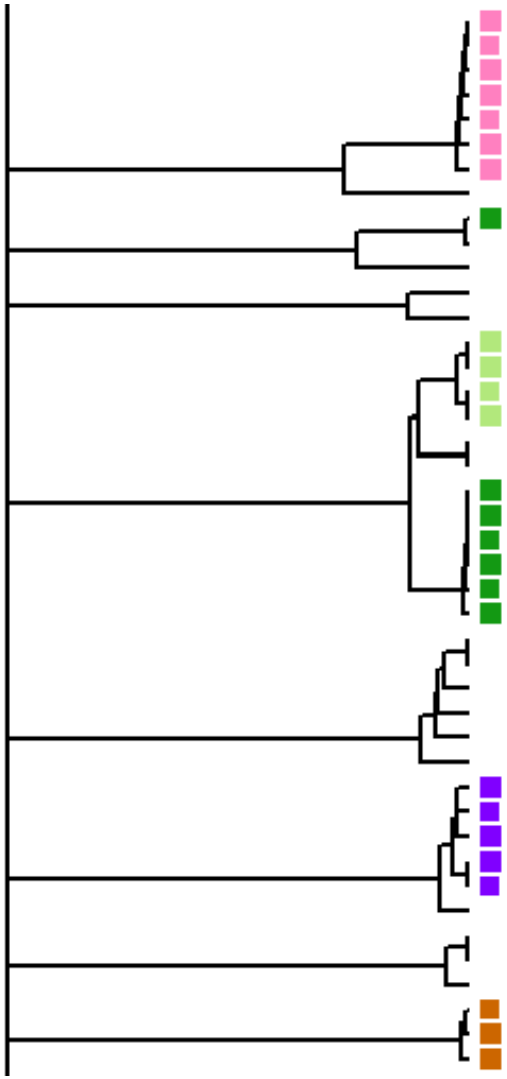
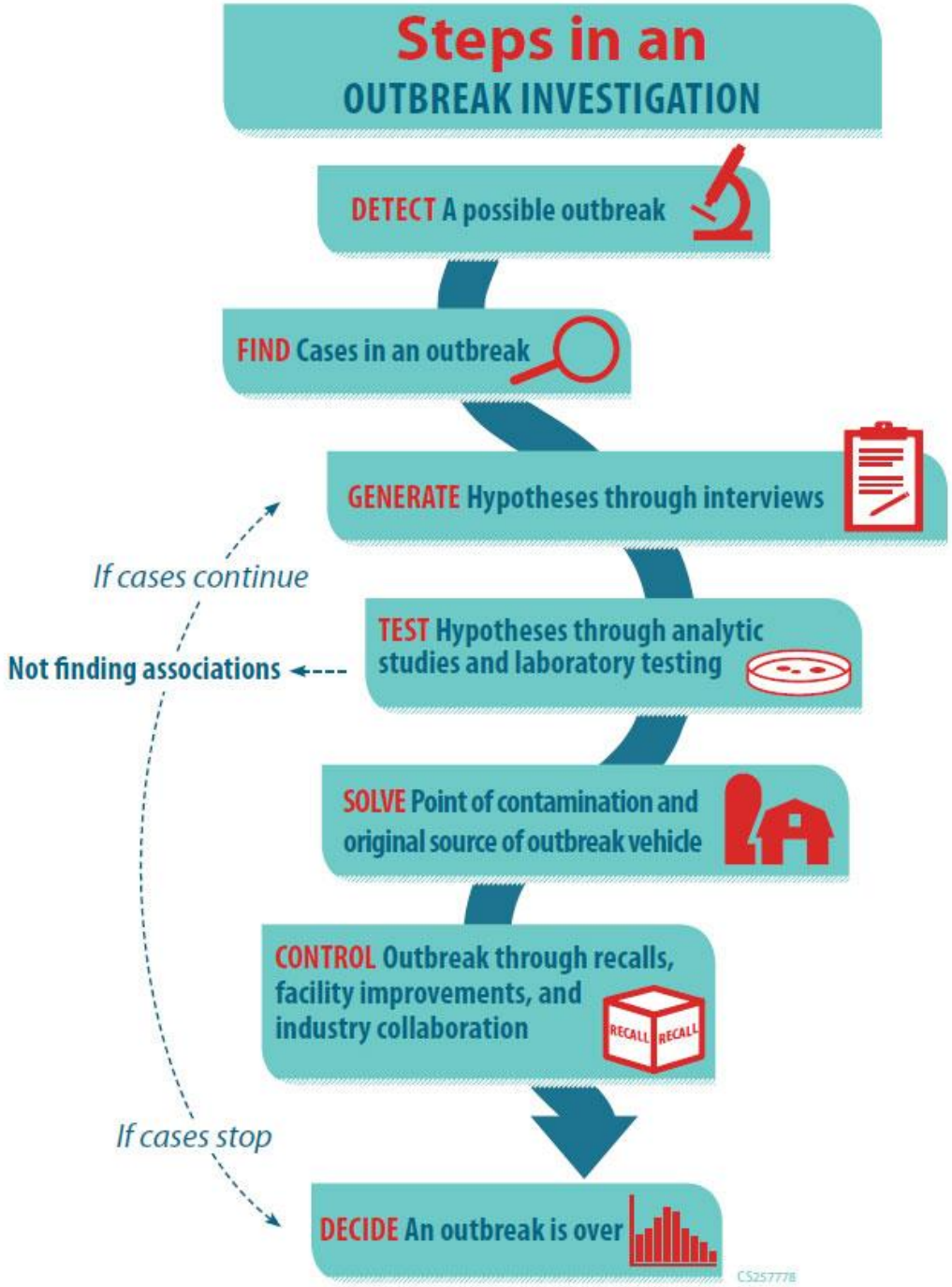
# Whole Genome Sequencing (WGS)



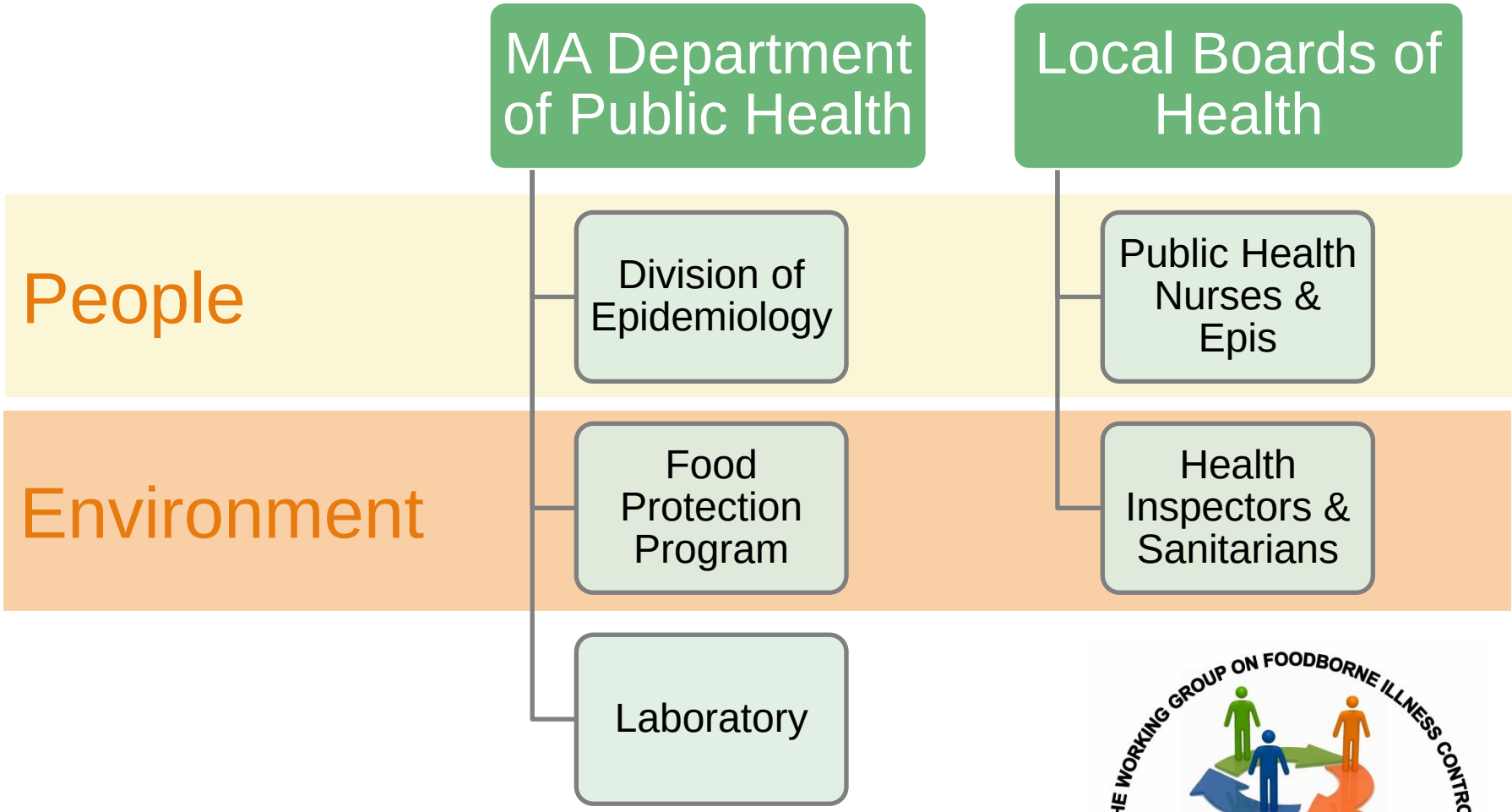
- For over 20 years, the MA State Public Health Lab (MA SPHL) has been an active member of the CDC's national foodborne disease surveillance network, PulseNet.
- PulseNet laboratories traditionally performed Pulsed-field gel electrophoresis (PFGE), a DNA fingerprinting method as the primary method for foodborne disease surveillance
- In 2019, MA SPHL retired PFGE and transitioned to Whole Genome Sequencing (WGS).
- WGS allows us to characterize and identify clusters of foodborne pathogens at a much higher resolution than was possible using PFGE by comparing allele (gene) and SNP (nucleotide) differences between isolates.

# Detecting outbreaks

- Routine case investigation
- WGS clusters
- Calls from ill individuals, medical providers, or establishments
- Routine analysis of reported cases to identify unusual geographic increases and common exposures


Steps in an
OUTBREAK INVESTIGATION
DETECT A possible outbreak
FIND Cases in an outbreak
GENERATE Hypotheses through interviews
If cases continue
TEST Hypotheses through analytic studies and laboratory testing
Not finding associations
SOLVE Point of contamination and original source of outbreak vehicle
CONTROL Outbreak through recalls, facility improvements, and industry collaboration
RECALL
RECALL
If cases stop
DECIDE An outbreak is over
CS257778

# Who is involved in surveillance and outbreak investigation in MA?



Outbreak #1

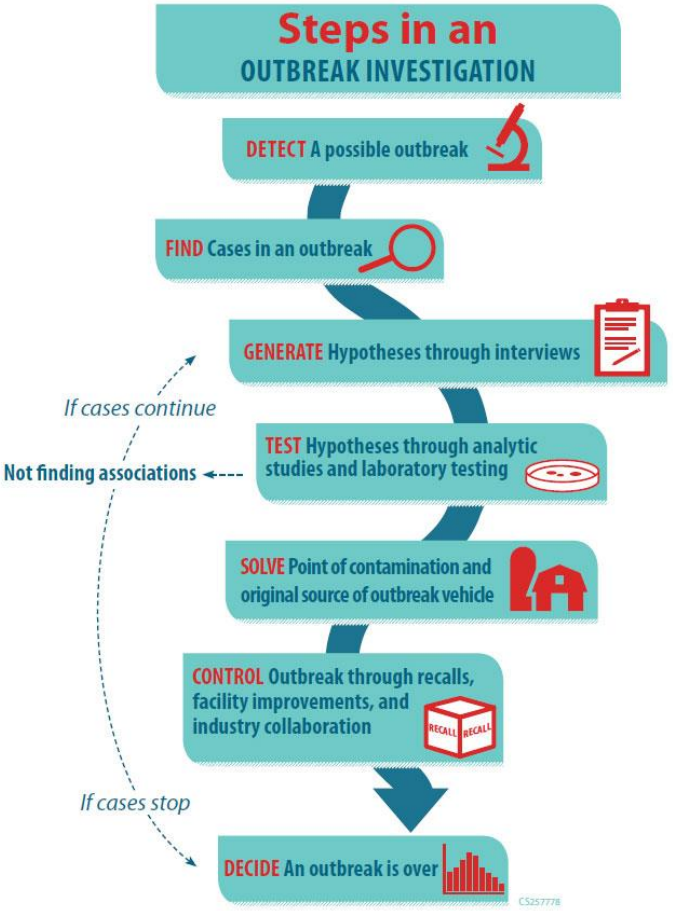
# *SALMONELLA* AT A DINER

## Outbreak #1: *SALMONELLA* AT A DINER

# Detection of Outbreak

- July 18, 2019
- LBOH reported two cases that ate at the same diner; Division of Epidemiology identified a third
- One case related by WGS to a recently closed national outbreak of *Salmonella* Reading associated with turkey
- Two cases reported eating turkey at the diner
- Diner uses same brand of turkey implicated in national outbreak

# What would you do next?



# Next Steps

- Epi/Public Health Nurse (PHN)
  - Additional case finding
- Environmental Investigation/LBOH
  - Review turkey preparation
  - National Environmental Assessment Reporting System (NEARS)
- Laboratory
  - Identification of additional genetically related case isolates
  - Food handler specimens – 33 tested

# Summary

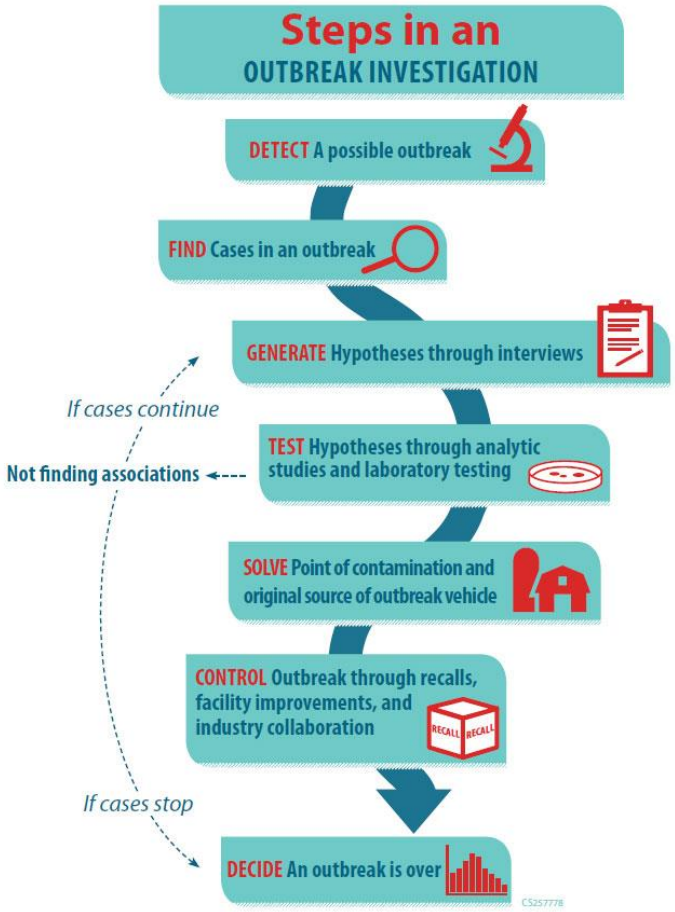
- Total 8 cases from May to July 2019
  - 7 patrons; 1 food handler
  - 5 ate turkey, 1 ate corned beef (cut on same slicer as turkey), 1 dined regularly but detailed food history unknown
- Undercooked turkey, contaminated slicer

## Outbreak #1A: *SALMONELLA* AT A DINER Take 2

# …Three months later

- Fast forward 3 months to October 22, 2019
- MA SPHL notified Division of Epidemiology of 3 genetically similar isolates; also similar to prior outbreak
- Same geographic area as Outbreak #1

# What would you do next?



# Next Steps

- Epi/PHN
  - Additional case finding
- Environmental/LBOH
  - Inspection, NEARS
- Laboratory
  - Additional case finding
  - Environmental swabs
  - Food handler specimens – 33 tested

# Summary

- Total 5 cases with illness onsets from October 5-21, 2019
  - 4 patrons: 3 turkey, 1 corned beef
  - 1 employee who regularly ate at diner
- Turkey likely vehicle

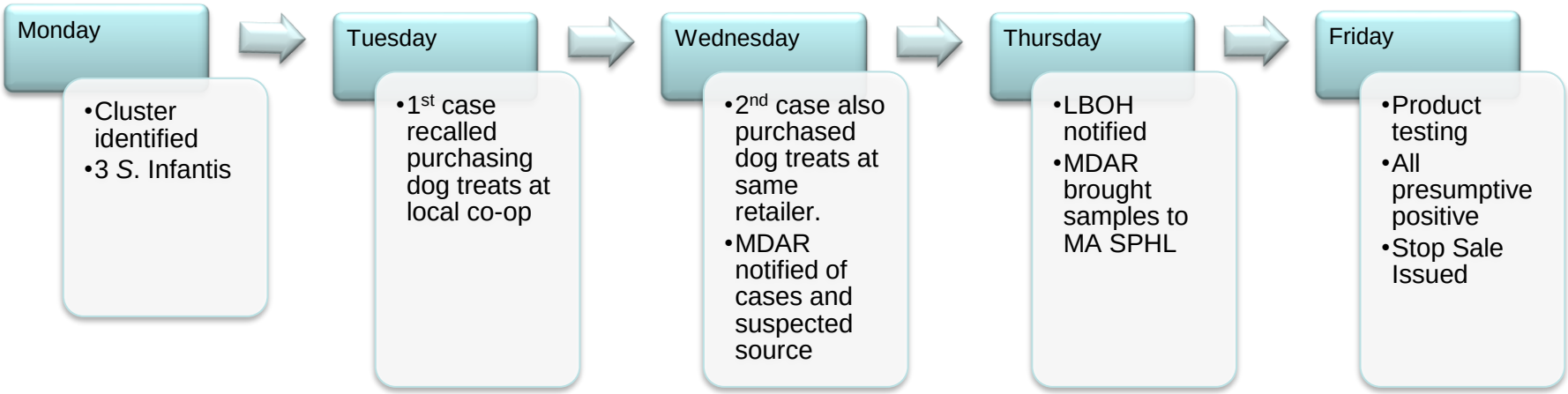
Outbreak #2:

# WGS CLUSTER OF *SALMONELLA*

## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Outbreak Timeline

## Week 1: Monday 2/7 – Friday 2/11/2022

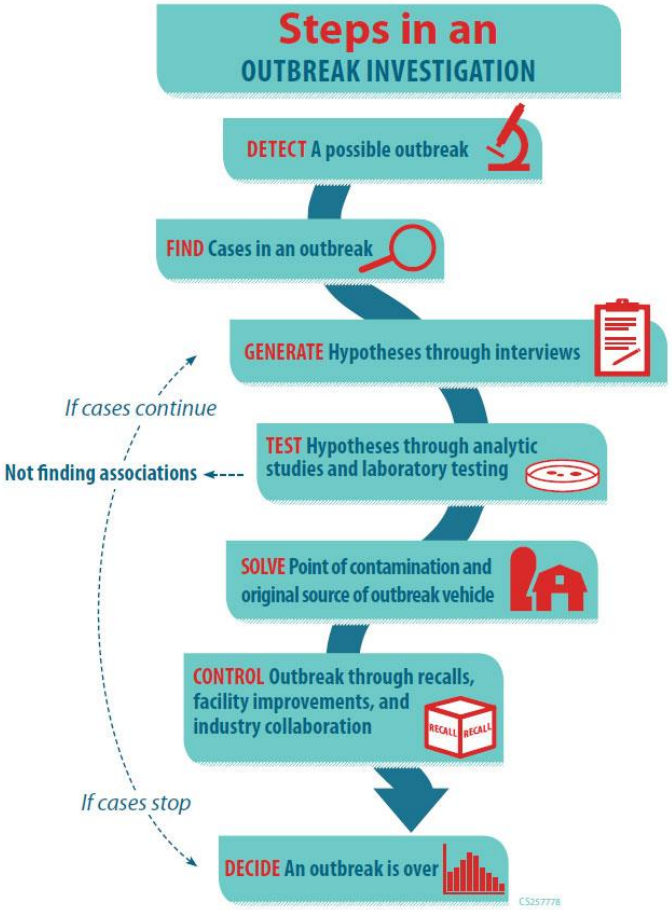



Highlights:

- Essex County/case investigations w/LBOHs
- Common product and purchase location identified
- Samples collected, tested, resulted
- Stop Sale Order

MDAR = Massachusetts Department of Agricultural Resources

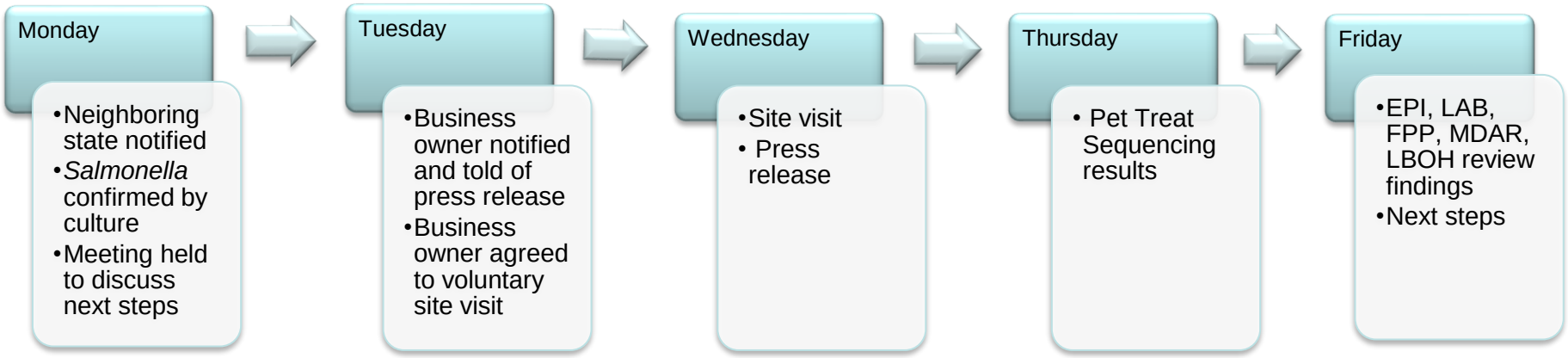
# What would you do next?



## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Outbreak Timeline

### Week 2: Monday 2/14 - Friday 2/18/2022




Highlights:

- *Salmonella* found in all samples
- Notifications
- Site visit
- Press Release

# Chicken chip production process

- Purchases 40-pound packages of fresh chicken breasts from wholesale retailer
- Trims chicken, divides into ~10 lb packages, and freezes in chest freezer
- 10-pound packages of frozen chicken are briefly microwaved to separate, then sliced (frozen and raw) on a deli slicer
- Sliced chicken is placed in food dehydrators for 30 hours at 160°F

# Chicken chip production process

- Chicken chips are stored in large plastic containers until ready to package
- A homemade PVC and wood chute is used to get treats into bags

# Chicken chip production process

- Slicer is taken apart and cleaned between products (chicken, beef liver, sweet potato)
  - Slicer parts washed in sink then sprayed with quaternary sanitizer
- Dehydrator racks are power washed outside then sprayed with quaternary sanitizer

## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Sequencing results of sampled dog treats

**Thursday, February 17**

- Sequencing of dog treat isolates completed. Three serotypes were identified among the four samples tested

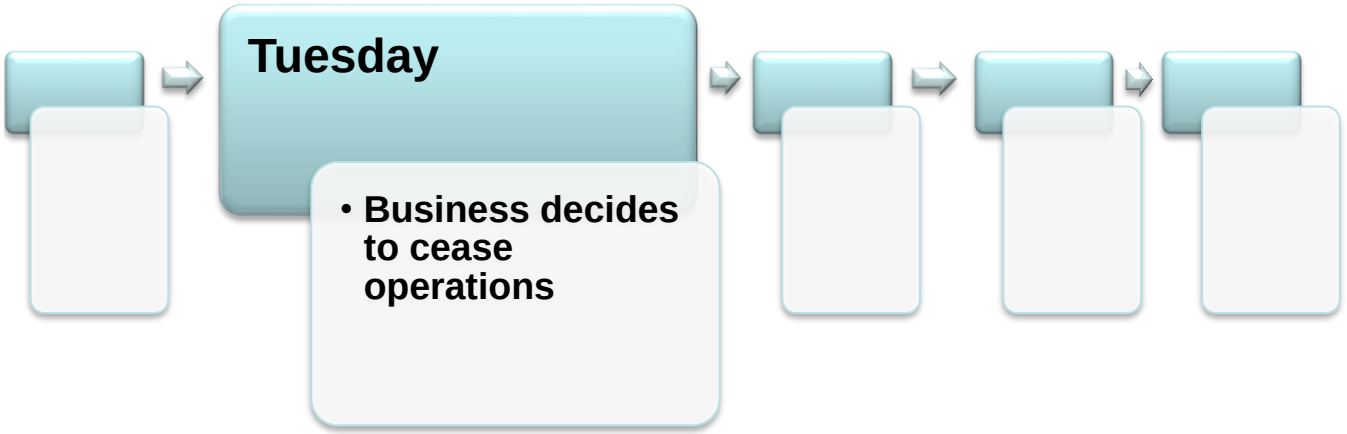
| Source | Product | *Salmonella* serovar | WGS Results |
|---|---|---|---|
| Unopened Samples from Local Co-Op | Chicken chips | Infantis | Related to clinical isolates (9-14 allele differences) |
| | Beef liver chips | Typhimurium | 7-11 allele differences between two product samples |
| | Sweet potato chips | | |
| Sample from case's home | Mixed chicken and sweet potato chips | Schwarzengrund | |

- Non-outbreak *Salmonella* Typhimurium and Schwarzengrund isolates were compared against historical isolates in PulseNet

## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Outbreak Timeline

Week 3: Monday 2/21 – Friday 2/25/2022



## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Historical Case Finding

| | ***S.* Typhimurium** | ***S.* Schwarzengrund** |
|---|---|---|
| **Source of pet treat isolate(s)** | Unopened bags of beef liver chips and sweet potato chips | Opened, mixed bag of chicken and sweet potato treats chips from a case's home |
| **Clinical isolates related by WGS to treat isolate(s)** | • 5 isolates 1-9 allele difference<br>• Prior PFGE cluster of 13 isolates 7-12 allele difference | 8 isolates 11-21 allele difference from sampled treats |
| **Timespan of clinical isolates** | January 2016 – May 2019 | July 2017 – April 2021 |
| **Demographics** | 89% from Essex County | 100% from Essex County |
| **Historic case investigation findings** | 14 out of 16 (88%) with a case investigation completed at the time of infection reported owning a dog | 4 out of 7 (57%) with a risk history available were dog owners (risk history not obtained for 1 individual without a clear onset) |
| **Result of 2022 follow-up** | 6 out of 8 (75%) reinterviewed cases reported exposure to implicated treats | 4 out of 5 (80%) reinterviewed cases (4 known dog owners and the individual with no risk history originally collected) reported exposure to implicated treats |

## OUTBREAK #2: WGS CLUSTER OF *SALMONELLA*

# Summary

- 2022 Outbreak, 3 cases
- WGS instrumental in linking this 2022 outbreak to historical cases spanning 2016-2021; suggesting production of contaminated treats resulting in human illness for years prior to identification by public health
- Fragmented regulatory responsibilities within multiple state and local agencies highlighted challenges for small-scale pet treat/food manufacturers

A one-health approach is essential when conducting enteric case and cluster investigations

- Given the close interaction of humans with dogs and their food, and increases in dog ownership over the past decade, ascertaining exposure to pet and pet food should be a priority of public health investigations

Outbreak #3:

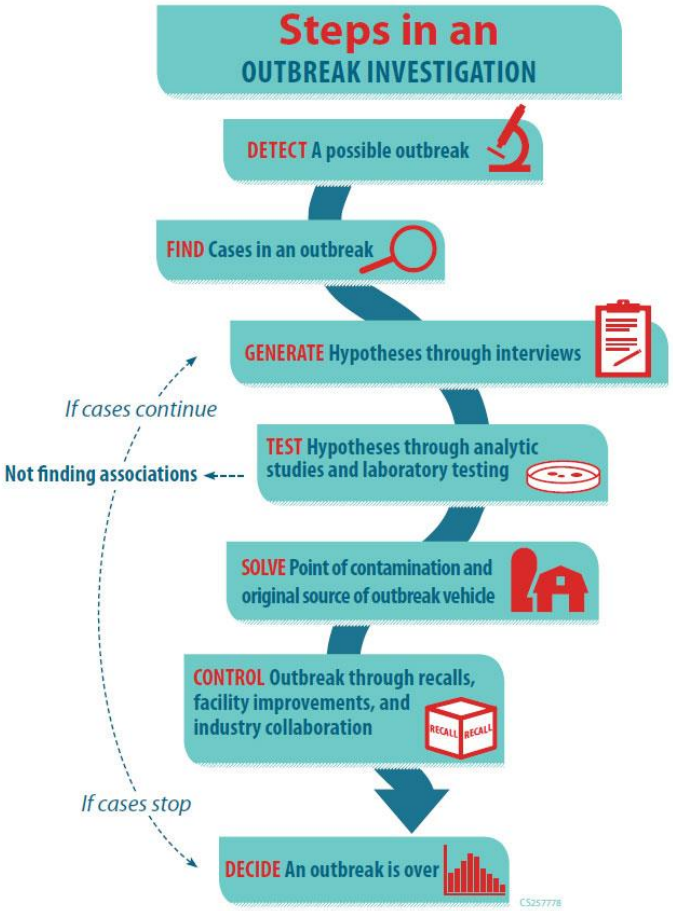
# *CAMPYLOBACTER* AT A GOLF TOURNAMENT

## OUTBREAK #3: *CAMPYLOBACTER* AT A GOLF TOURNAMENT

# LBOH Notification

- June 7, 2022: LBOH notified Division of Epidemiology
  - Anonymous calls reporting GI illness after 6/1 golf tournament
  - Call from golf club manager; also receiving reports of illness
- Working Group on Foodborne Illness Control notified

# What would you do next?



## OUTBREAK #3: *CAMPYLOBACTER* AT A GOLF TOURNAMENT

# Next Steps

- EPI/PHN
  - Case finding, social media
  - Analytic Study/survey attendees
- Environmental/LBOH
  - Inspections, NEARS, menu review
- LAB
  - Food handler stool specimens
  - Food sampling
  - WGS analysis

# Results: Analytic Study

- Electronic survey developed by EPI, sent out by the club to 97 tournament attendees
- 80/97 responded 82%!
- 46/80 met case definition 58%!

## OUTBREAK #3: *CAMPYLOBACTER* AT A GOLF TOURNAMENT

# Analytic Study Survey Tool

Golf Tournament Guest Survey

Food History

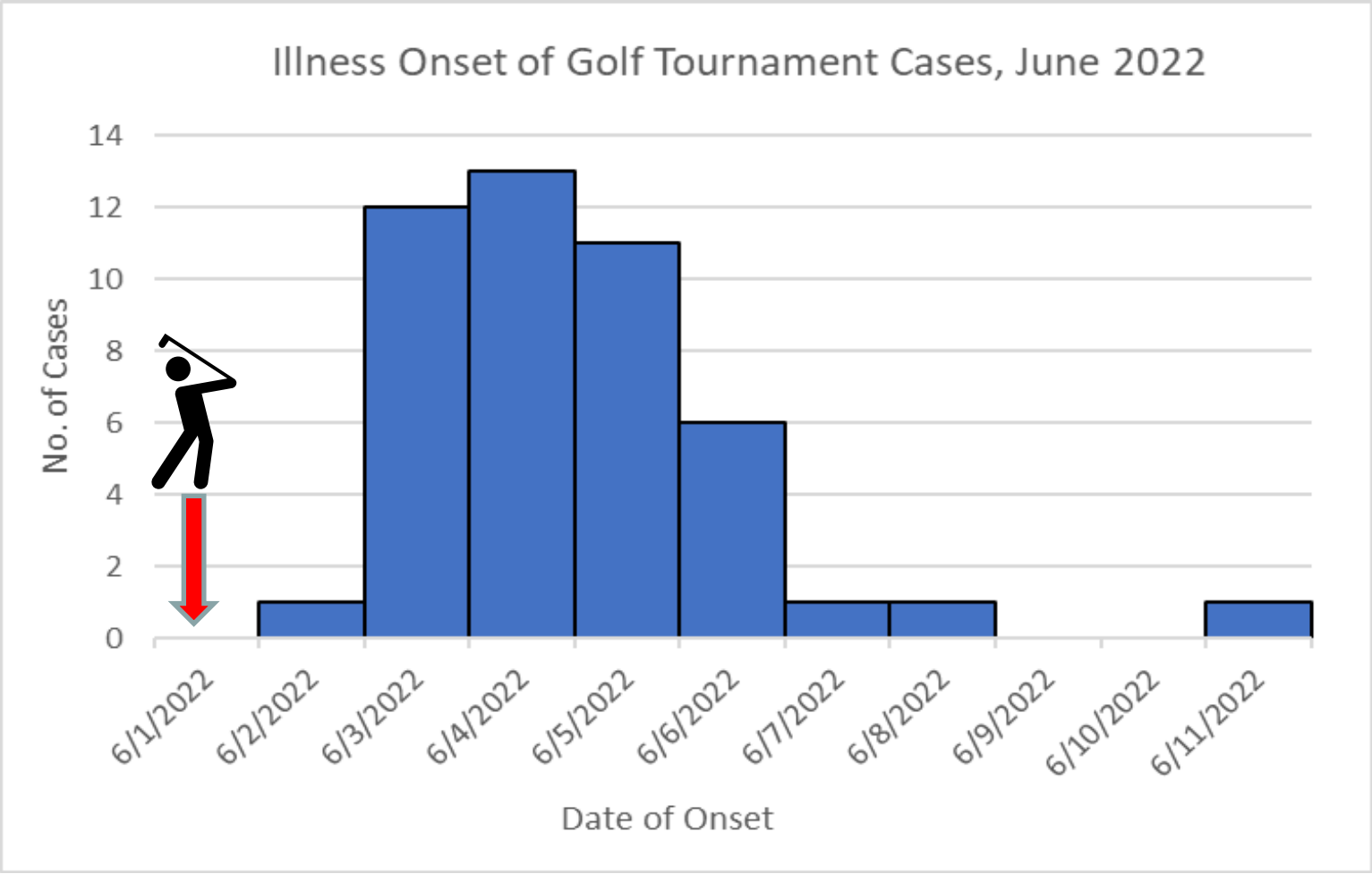
* 9. Please select all of the lunch food items you consumed at on June 1st:

| | Yes | No | Cannot recall |
|---|---|---|---|
| Smoked pork Banh Mi sandwich | ○ | ○ | ○ |
| Fried shrimp basket | ○ | ○ | ○ |
| Pickled vegetables | ○ | ○ | ○ |
| Potato salad | ○ | ○ | ○ |
| Chocolate mousse cup | ○ | ○ | ○ |

Please indicate any other lunch items, including beverages, not listed above that you consumed on June 1st, 2022 at Golf Tournament.

## OUTBREAK #3: *CAMPYLOBACTER* AT A GOLF TOURNAMENT

# Epidemic curve of illness onset among survey respondents, (n=46)



## OUTBREAK #3: *CAMPYLOBACTER* AT A GOLF TOURNAMENT

# Relative Risks of Food Exposures at Lunch

| | Ate | | | | Didn't Eat | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Exposure** | **Ill** | **Not Ill** | **Total** | **Attack Rate** | **Ill** | **Not Ill** | **Total** | **Attack Rate** | **Relative Risk** | **P value** |
| Any Lunch | 45 | 22 | 67 | 67.16% | 1 | 5 | 6 | 16.67% | 4.03 | 0.023554 |
| Smoked Pork Banh Mi | 39 | 14 | 53 | 73.58% | 1 | 12 | 13 | 7.69% | 9.57 | 0.000019 |
| Shrimp | 34 | 12 | 46 | 73.91% | 4 | 14 | 18 | 22.22% | 3.33 | 0.000217 |
| Pickled Vegetables | 20 | 8 | 28 | 71.43% | 16 | 16 | 32 | 50.00% | 1.43 | 0.090969 |
| Potato Salad | 30 | 18 | 48 | 62.50% | 12 | 6 | 18 | 66.67% | 0.94 | 0.753983 |
| Mousse | 19 | 3 | 22 | 86.36% | 19 | 23 | 42 | 45.24% | 1.91 | 0.001289 |

Yellow denotes statistical significance ($\alpha = 0.05$)

# Results: Environmental and Lab

- Environmental:
  - 6/7/2022 LBOH site visit
  - 6/9/2022 LBOH completes NEARS
  - 6/10/2022 LBOH initiates stool specimen collection
  - 6/16/2022 LBOH site visit, HACCP
- Laboratory:
  - Tested 12 food handlers, all negative for *Campylobacter*
  - Food tested negative for *Campylobacter*

# Summary

- LBOH identified outbreak
- 46 outbreak cases/ 6 laboratory confirmed for *Campylobacter* from different towns; all participated in the same golf tournament
- Analytic study identified likely food
  - Sandwich containing chicken liver pate; a known high-risk food

# Summary

- Studies have shown 77% of retail chicken livers are contaminated with *Campylobacter*
- Usually contaminated on both the surface and in the internal tissues
  - Requires longer cooking time than is commonly practiced

# Required reporting of outbreaks

- LBOH notification to MDPH
  - Suspected clusters or outbreaks of enteric illness are immediately reportable by the LBOH to MDPH
  - Definition of cluster: An increase in the usual frequency of illness in a given area or among a specific population over a particular period of time
    - Examples:
      - Multiple undiagnosed individuals reporting GI illness after event of shared dining experience
      - More than one case of campylobacteriosis reporting dining at the same restaurant during their incubation period
  - Notify MDPH at 617-983-6800

# Outbreak Detection Summary

- Outbreaks 1 and 1A: *Salmonella* at a diner
  - LBOH routine case investigation and WGS
- Outbreak 2: *Salmonella* in pet treats
  - WGS
- Outbreak 3: *Campylobacter* at a Golf Club
  - Complaints to LBOH and Golf Club

# QUESTIONS?

# THANK YOU!

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