
Public Health Surveillance is a Pre-Requisite for Effective Food Control Programs

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Surveillance and Food Control

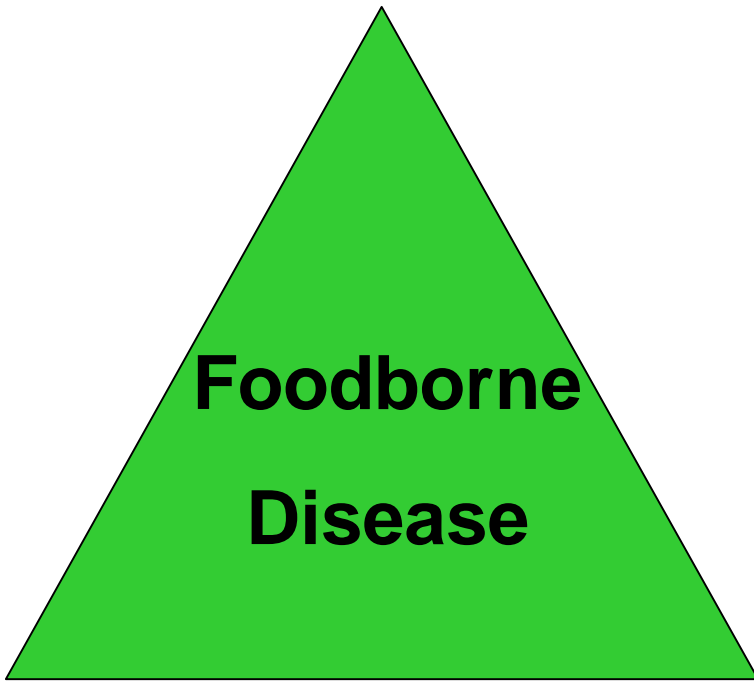
- Public health surveillance
 - Goals of foodborne disease surveillance
 - Role of epidemiology in food control
 - Examples-what we can do to improve surveillance
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Public Health Surveillance

- *“Public health surveillance is the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health event for use in public health action to reduce morbidity and mortality and to improve health.”*
CDC, 2001.
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Environment



Agent

Host



Burden of Foodborne Illnesses in the United States

Known Pathogens

Illnesses	14,000,000
Hospitalizations	60,000
Deaths	1,800

Unknown Pathogens

Illnesses	62,000,000
Hospitalizations	263,000
Deaths	3,400

Total

Illnesses	76,000,000
Hospitalizations	323,000
Deaths	5,200

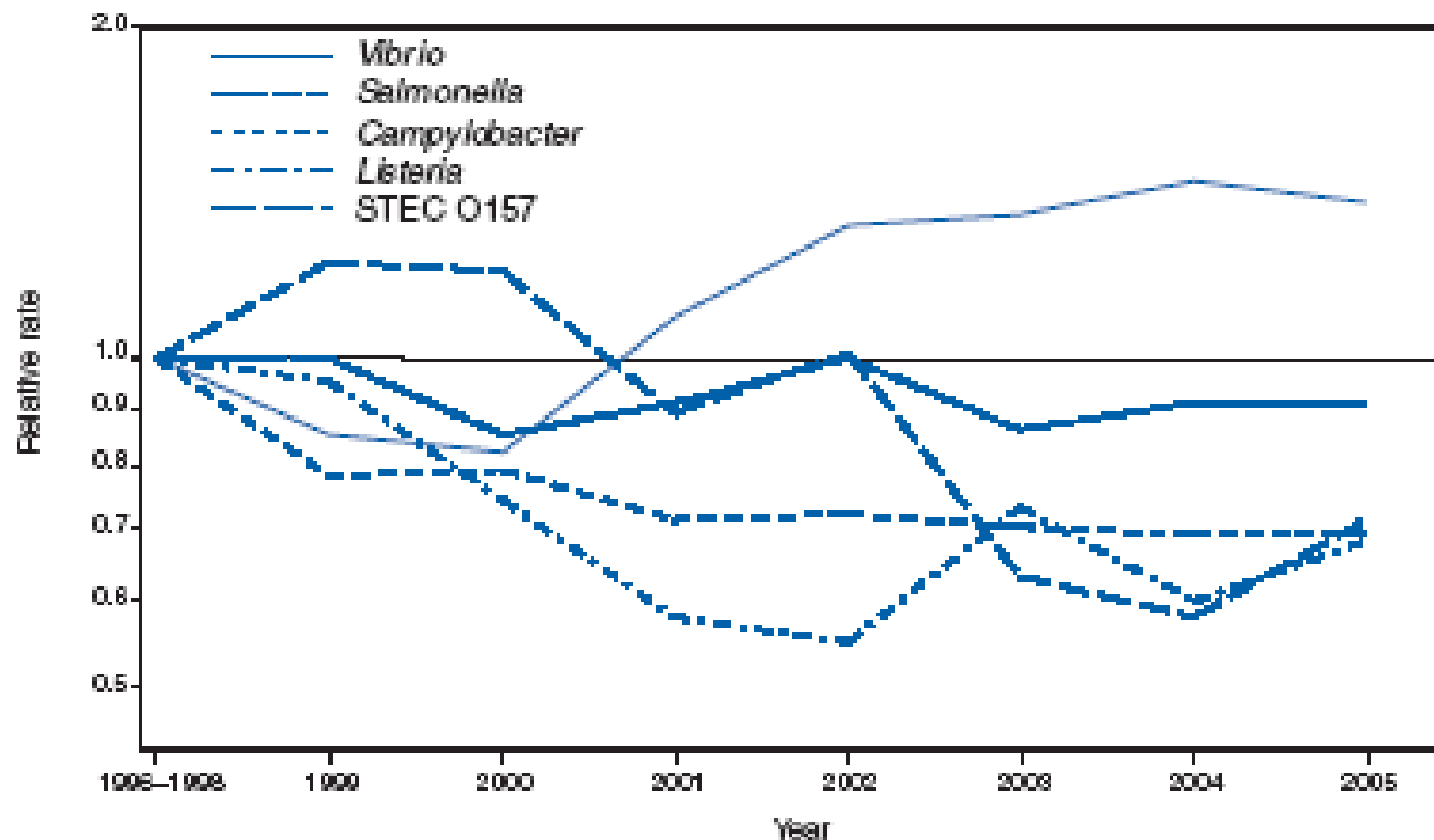
Mead, et al 1999

FoodNet Active Surveillance Network





FIGURE 1. Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with *Campylobacter*, STEC* O157, *Listeria*, *Salmonella*, and *Vibrio*, by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2005



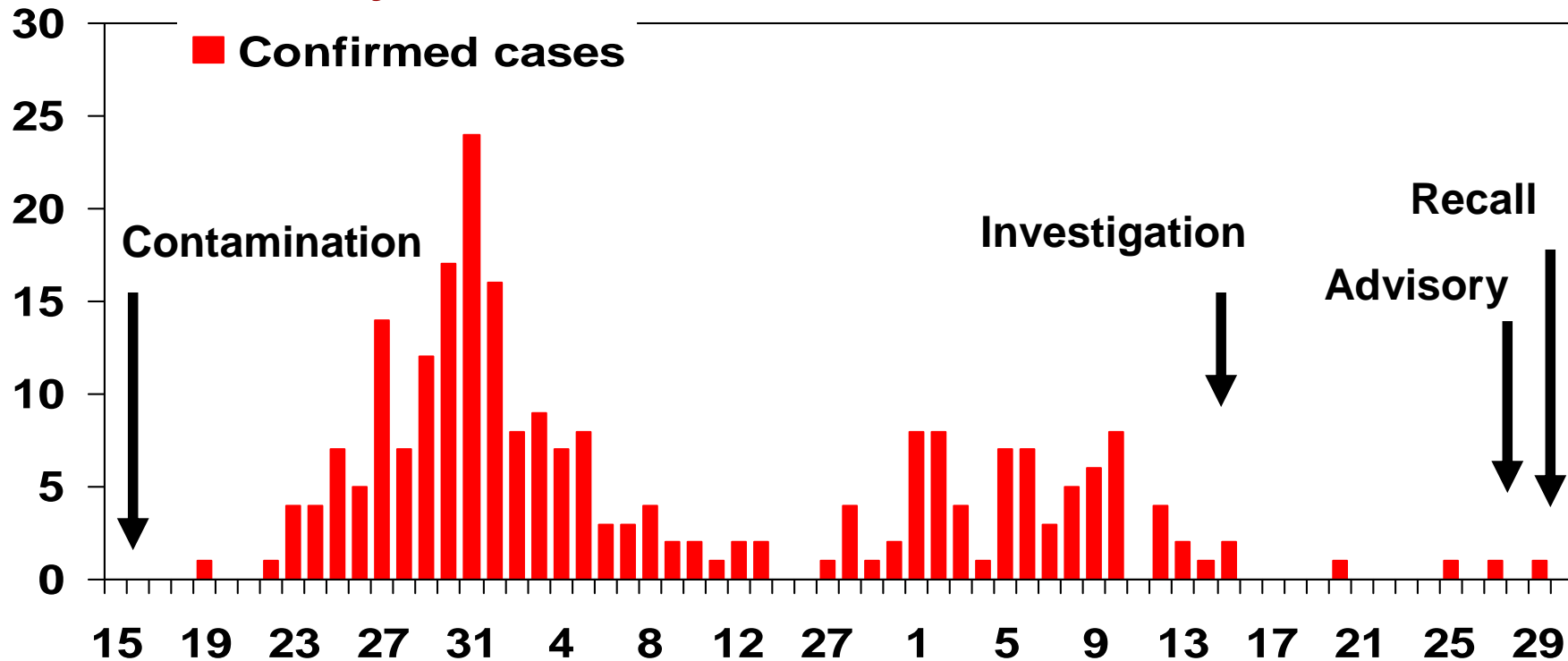
* Shiga toxin-producing *Escherichia coli*.

Goals of Foodborne Disease Surveillance

- The overall goal of a foodborne outbreak investigation is to rapidly obtain sufficient information to implement specific interventions to abate the outbreak.
 - In this regard, how surveillance systems are organized to detect outbreaks, and how outbreaks are investigated may limit our ability to prevent outbreak-associated illnesses.
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E. coli O157:H7 Associated with Fresh Bagged Spinach, 2006

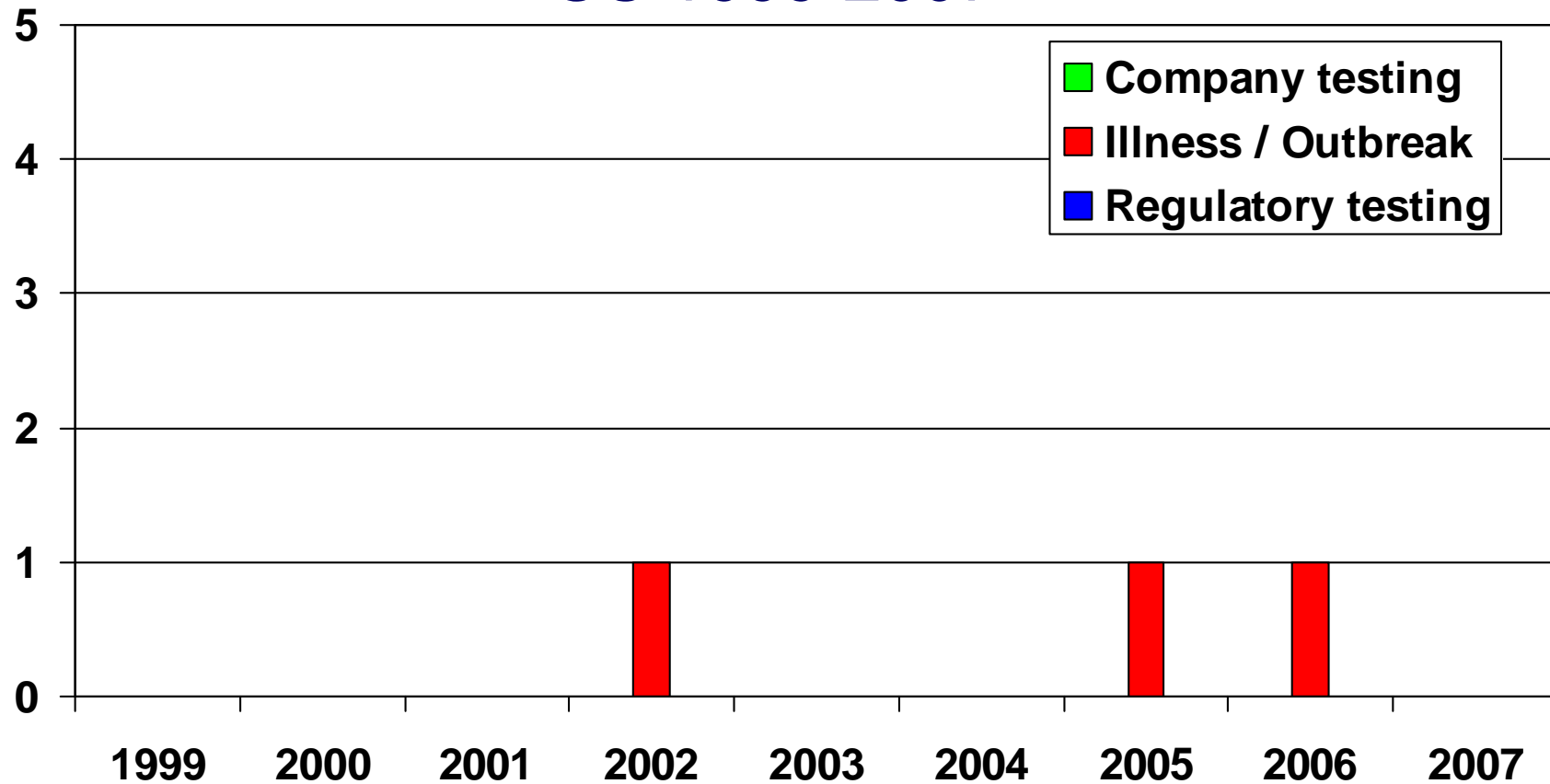
30 days from contamination to intervention



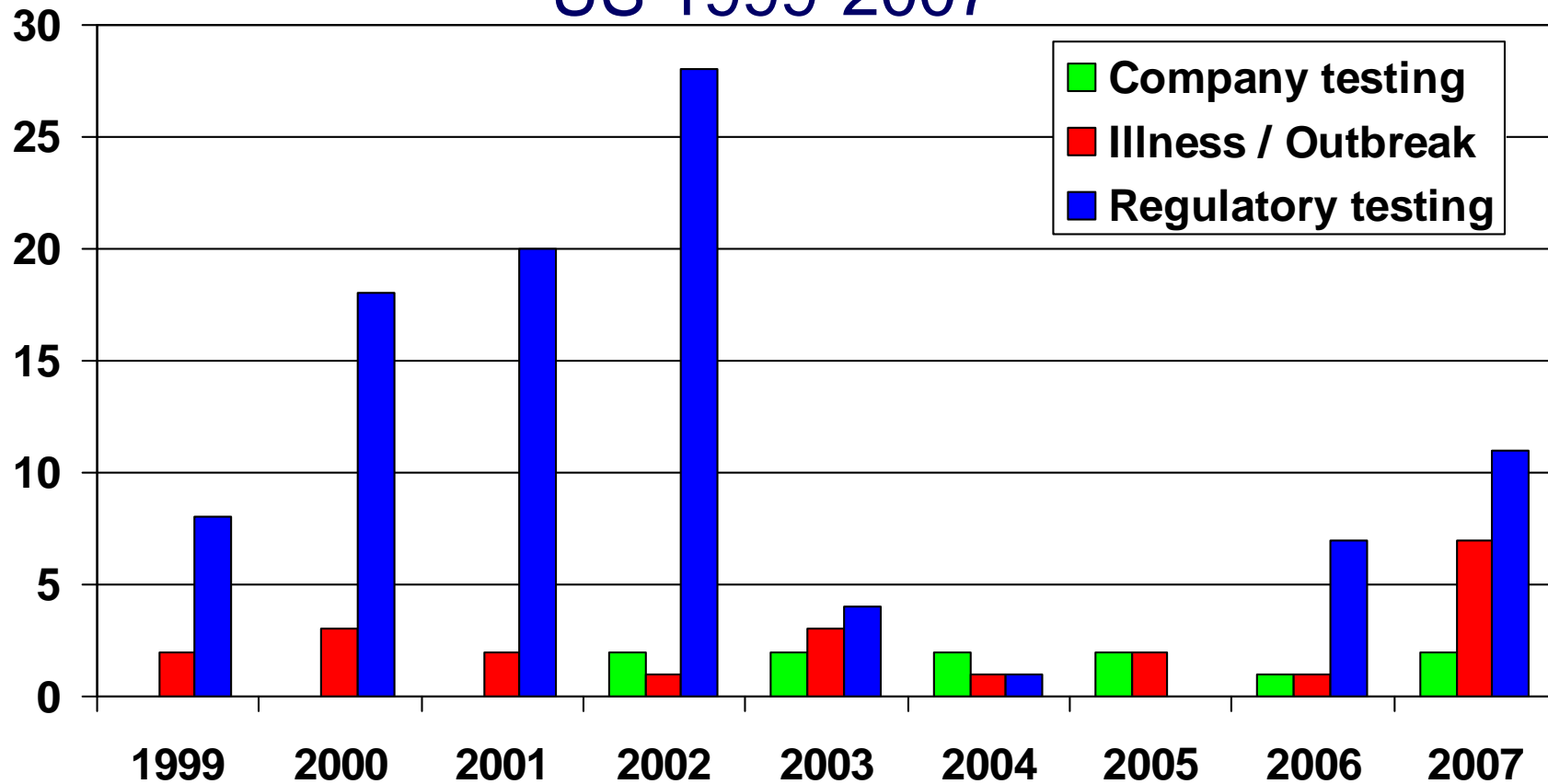
Median Intervals (days) and Range (by state) from Onset of Symptoms to Timeline Event

Timeline Event	<i>Salmonella</i>	<i>E. coli</i> O157
Collection of stool sample	4 (2, 4)	3 (2, 6)
Case report from clinician to health department	9 (8, 11)	7 (6, 7)
Submission of isolate to public health laboratory	10 (8, 11)	8 (5, 9)
Case interview	14 (14, 22)	12 (9, 16)
PFGE subtyping	18 (15, 28)	15 (11, 22)

Initiation of Recall of FDA-Regulated Product Contaminated with *E. coli* O157:H7, US 1999-2007



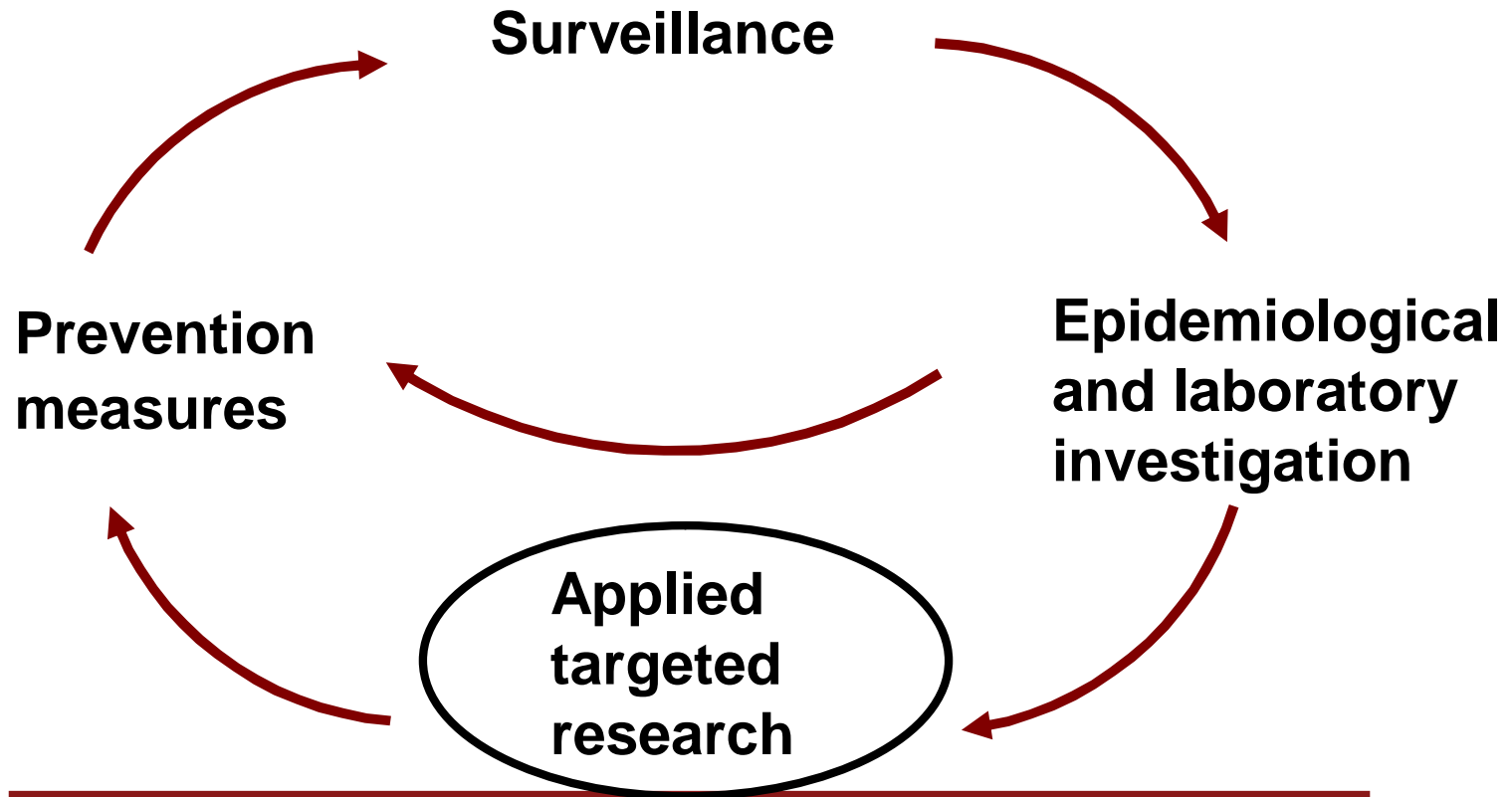
Initiation of Recall of FSIS-Regulated Product Contaminated with *E. coli* O157:H7, US 1999-2007



Goals of Foodborne Disease Surveillance

- Secondary goals of outbreak investigations include identifying the agent, vehicle, source of contamination, and factors contributing to the occurrence of the outbreak.
 - Identifying these factors are critical for identifying new hazards, evaluating the effectiveness of existing control measures, and developing new prevention methods.
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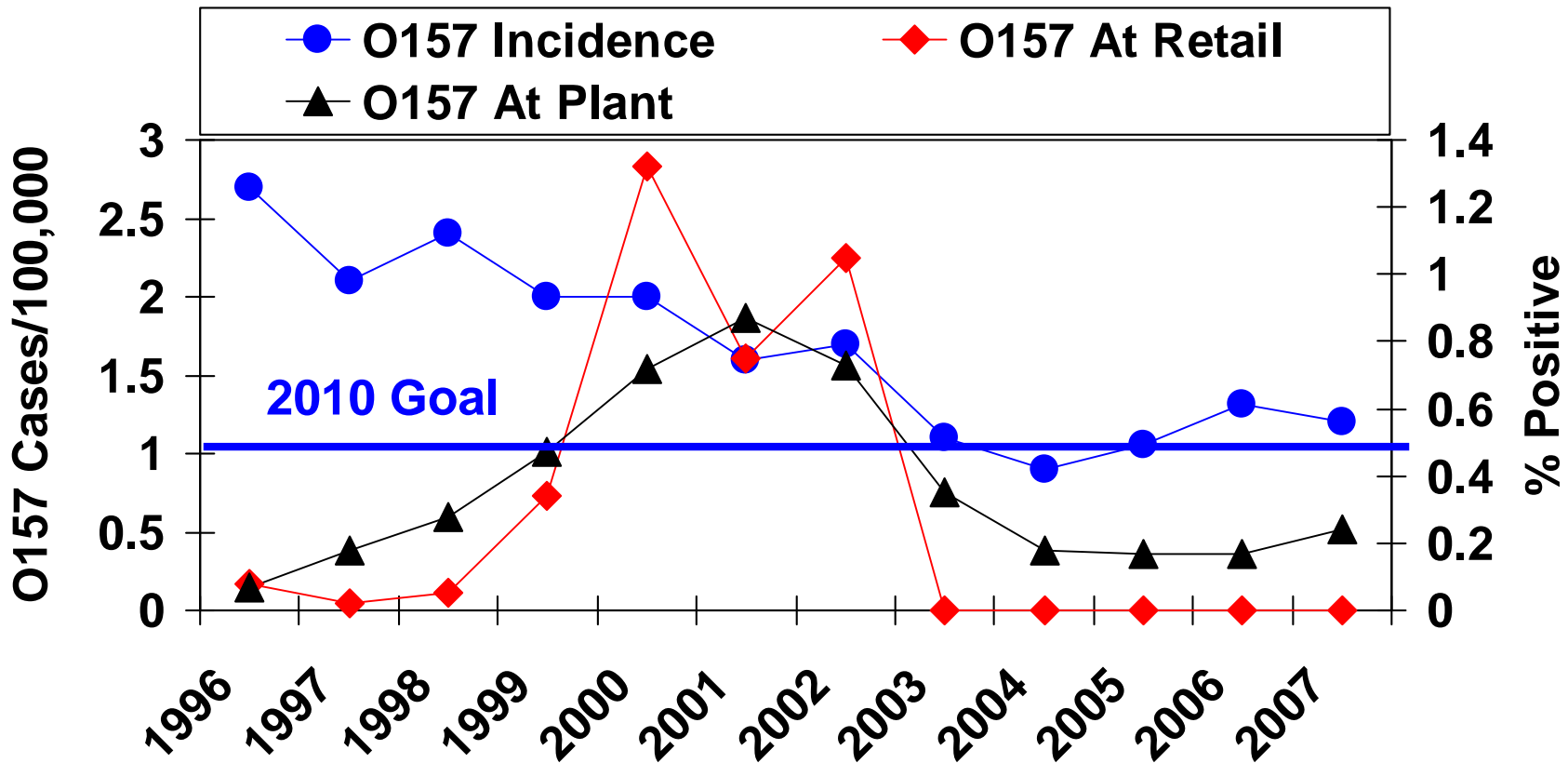
The Cycle of Public Health Prevention



Epidemiology in Food Control

- Methods to abate specific hazards, such as *E. coli* O157:H7 contamination of ground beef can be developed solely based on knowledge of the agent and the characteristics of the food system.
 - Public health surveillance is needed to monitor the effectiveness of control measures on a population basis.
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E. coli O157:H7 in Ground Beef and Incidence of O157 in FoodNet, 1996-2007



USDA Microbiological Testing Program/ FoodNet

Epidemiology in Food Control

- Monitoring systems in place at a plant level may not be sufficiently sensitive to prevent the release of large quantities of contaminated product.
 - Humans are the ultimate bio-assay for this type of contamination, and epidemiology is the tool we need to detect it.
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Schwan's Ice-Cream Associated Outbreak; 1994



Microbiologic Investigation: Ice Cream and Environmental

- **266 unopened products, 32 production dates**
 - **8 positive for SE, 1 positive for *S. Thompson***
 - **SE positive products from 4 production dates**
 - **Phage typing on 5 isolates: all were type 8**
 - **Environmental samples: All negative**
-

Concentration of *S. Enteritidis* in Ice Cream

Date	Most probable number per g	Most probable number per 65 g (1/2 cup)
8/25	<0.003	<0.2
8/25	0.093	6.0
8/26	0.093	6.0
9/12	<0.003	<0.2

Source of Contamination

Tanker loads pre-mix after eggs	Number case products	Number control products	Odds ratio*
0 %	2	6	Reference
1-24%	7	17	1.2
25-50%	5	9	1.7
51-100%	7	3	7.0
Total	21	35	

*Chi-square test for trend, $p=0.02$

Role of Epidemiology in Food Control

- Prioritize food safety interventions
- Identify new hazards
- Provide feedback on effectiveness of food safety systems

The Role of Foodhandlers in Restaurant Outbreaks of Salmonella

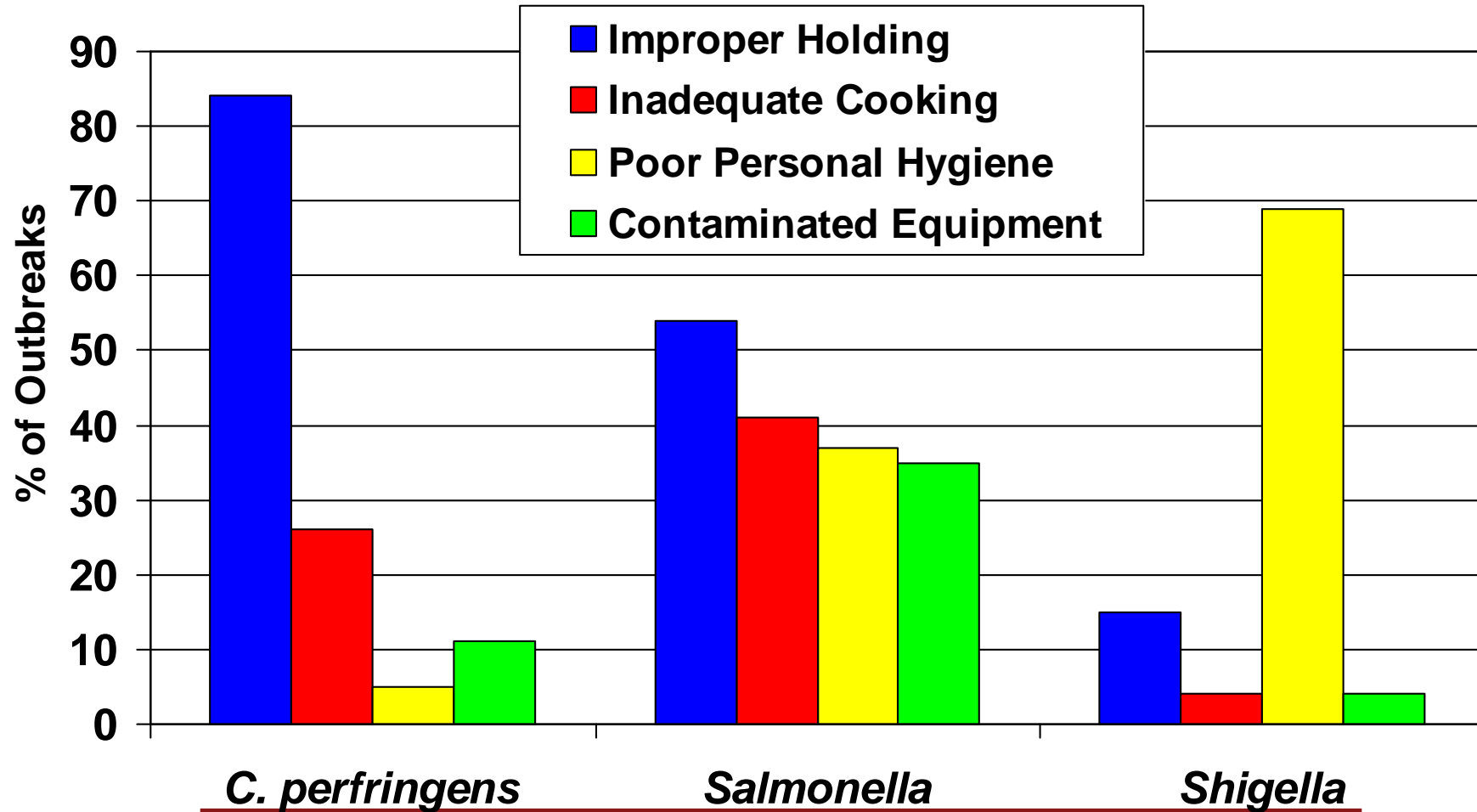
- 23 restaurant outbreaks of Salmonella in MN 1995-2003
- Median duration 21 days (1-517 days)
- Foodworkers infected with outbreak strain in 19 (83%)
 - 12% (129 of 1,033) positive for Salmonella
 - 53% of 64 of 121 Salmonella-positive reported no recent gastrointestinal illness
 - Median duration of Salmonella shedding was 16 days
- Environmental samples positive in 4 (33%) of 12 outbreaks
 - Associated with longer duration (187 days vs 26 days) and higher proportion of infected workers (22% vs 8%)

EHS-NET Evaluation of Outbreak and Nonoutbreak Restaurants

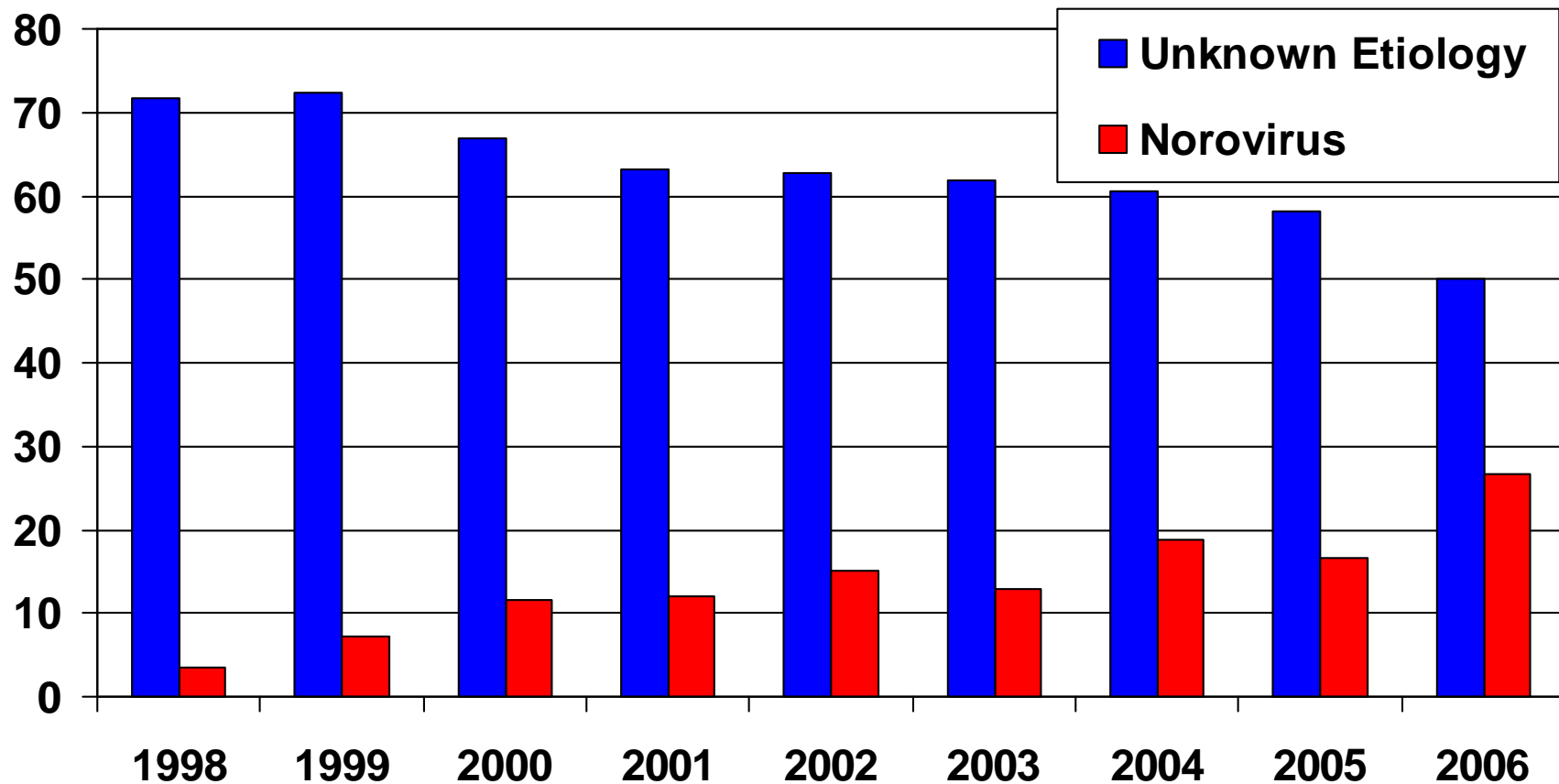
- 22 outbreak and 347 nonoutbreak restaurants evaluated by EHSNET, 2002-2003
- Norovirus most common pathogen (42%)
- Handling of food by infected person (65%) and bare-hand contact with food (35%) most common factors
- Presence of certified kitchen manager major difference
 - 32% of outbreak
 - 71% of nonoutbreak restaurants
- Certified kitchen manager reduced bare-hand contact with food, but not role of infected foodworkers

Bias or Biological Plausibility?

Contributing Factors Identified for Outbreaks in Restaurants



Percentage of Outbreaks Caused by Norovirus or Unknown Etiology, US, 1998-2006





**What people think about
when they think about
noroviruses**



What people *should* think about when they think about noroviruses



Estimated Norovirus Infections Among Restaurant Employees

- Employees **12 million**
- Diarrheal illness rate **(0.79 per person/year)**
- Illnesses among restaurant employees **9 million**
- % of GI illnesses due to norovirus **(11%)**
- Norovirus among restaurant employees **990,000**
- Foodworkers who work while ill **(5%)**
- Norovirus infected restaurant employees who work while ill **>50,000**
- Average no. ill per outbreak in a restaurant **31**
- Estimated illnesses attributable to ill employees
~1,550,000 (15-20% of all foodborne norovirus)



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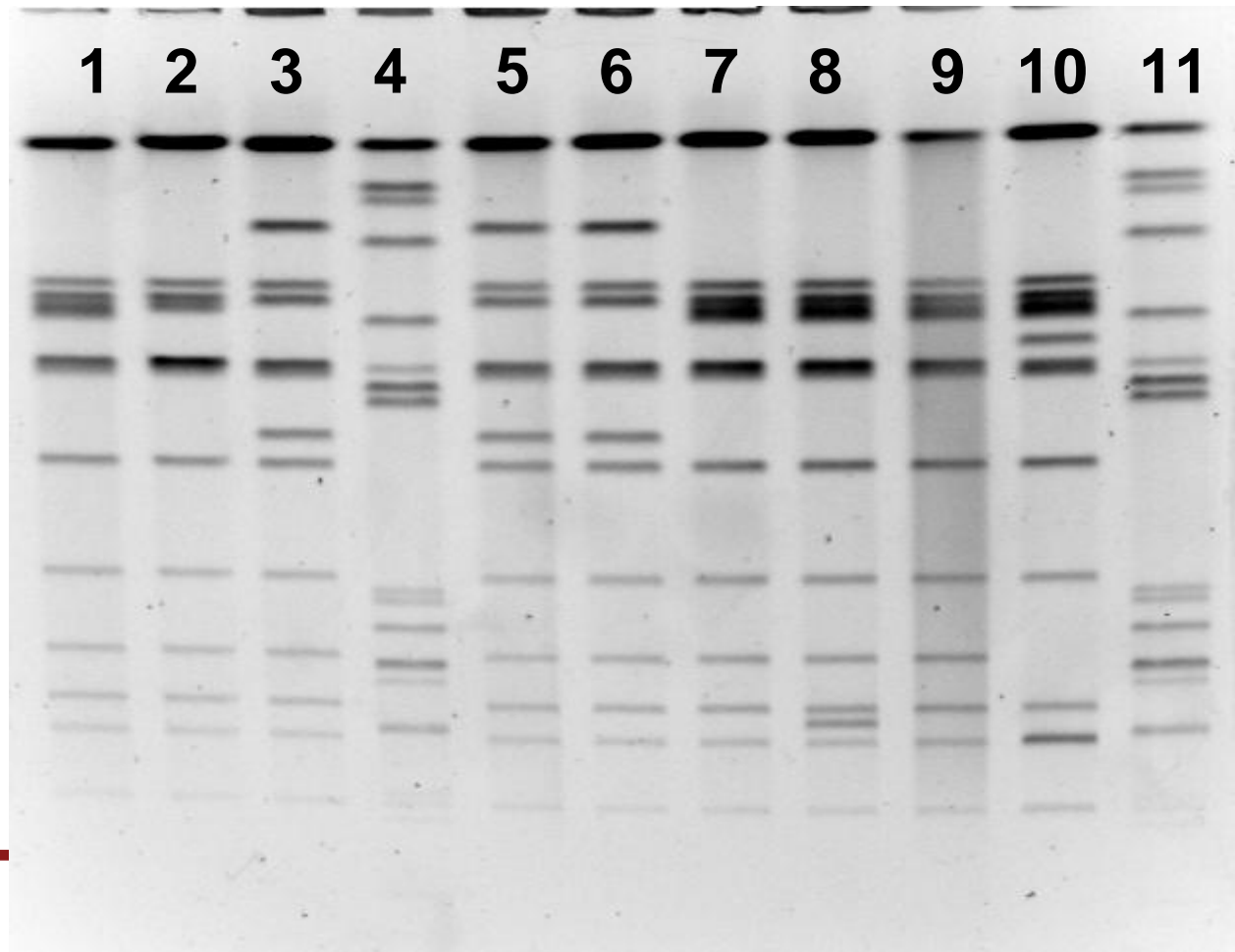
Key Foodborne Disease Prevention Messages



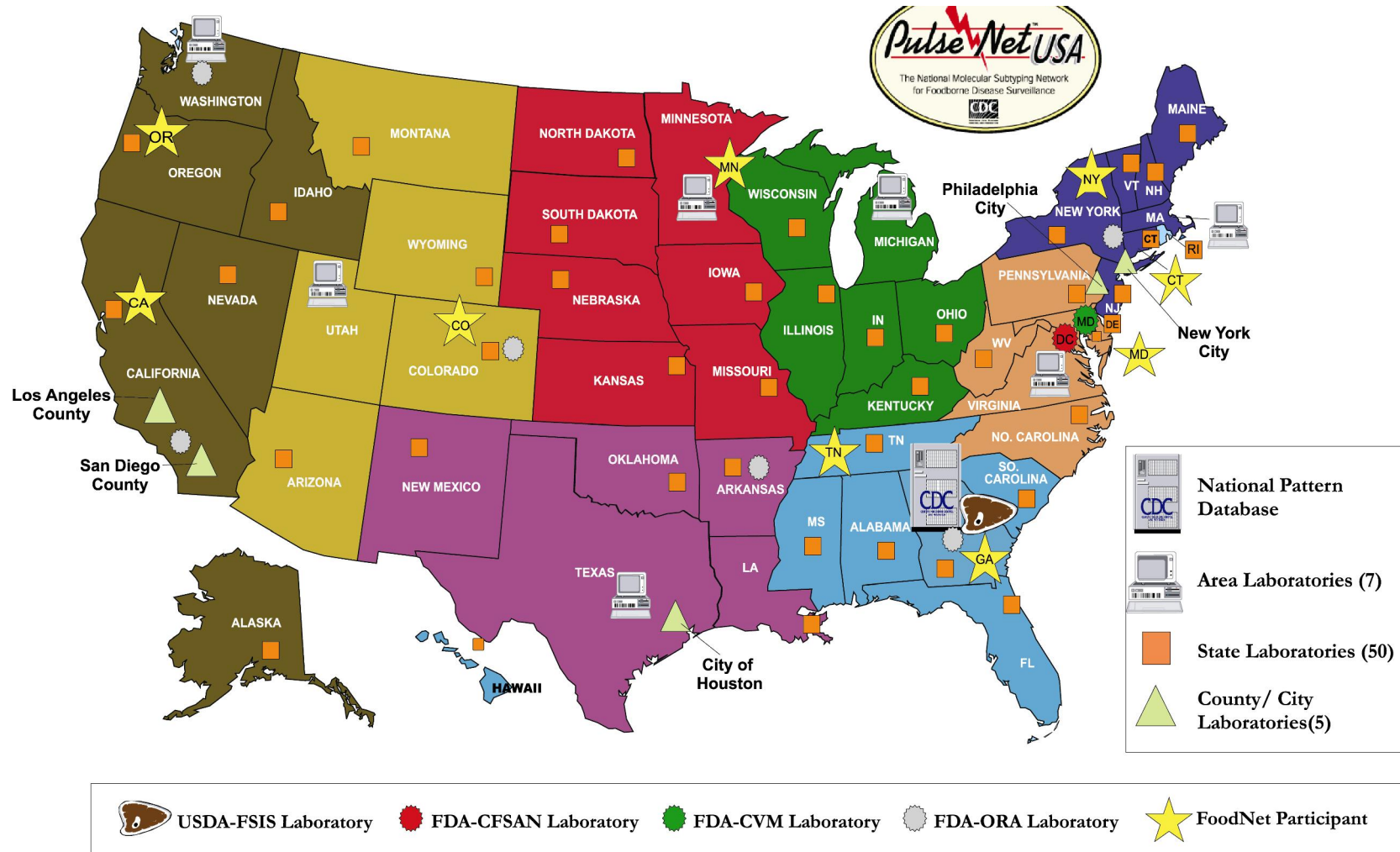
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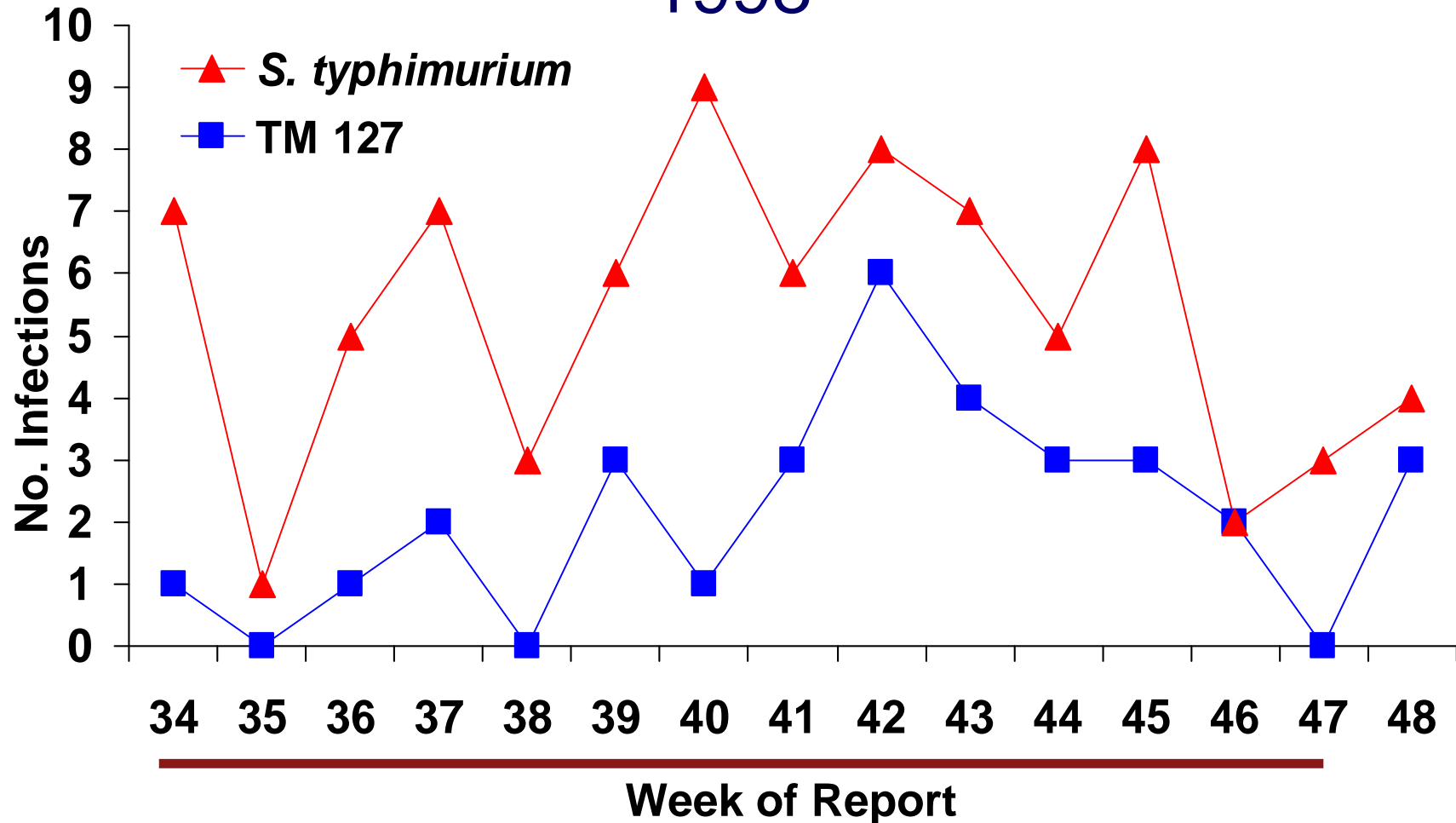
Molecular Subtype-Specific Surveillance by PFGE



The Most Important Foodborne Disease Epidemiology Tool Developed in My Lifetime



Salmonella typhimurium Infections, by PFGE Type and Week of Onset, Minnesota 1998



Consumption of Maple Leaf Farms Chicken Kiev, Among Cases and Matched Controls, Minnesota

- **11 (73%) of 15 cases,**
- **0 (0%) of 9 controls**

Ate Maple Leaf Farms Chicken Kiev

Matched OR=undefined; $p < 0.001$



Chicken Breast KIEV

Boneless Breaded Breast of Chicken with Rib Meat
Stuffed with Seasoned Butter & Chives

Specially Cut and Shaped

MICROWAVEABLE
READY TO COOK
NO MSG

Keep Frozen
Serving Suggestion

NET WT. 6 OZ. (170g)

Consumption of Any Chicken Among Cases and Matched Controls, Minnesota

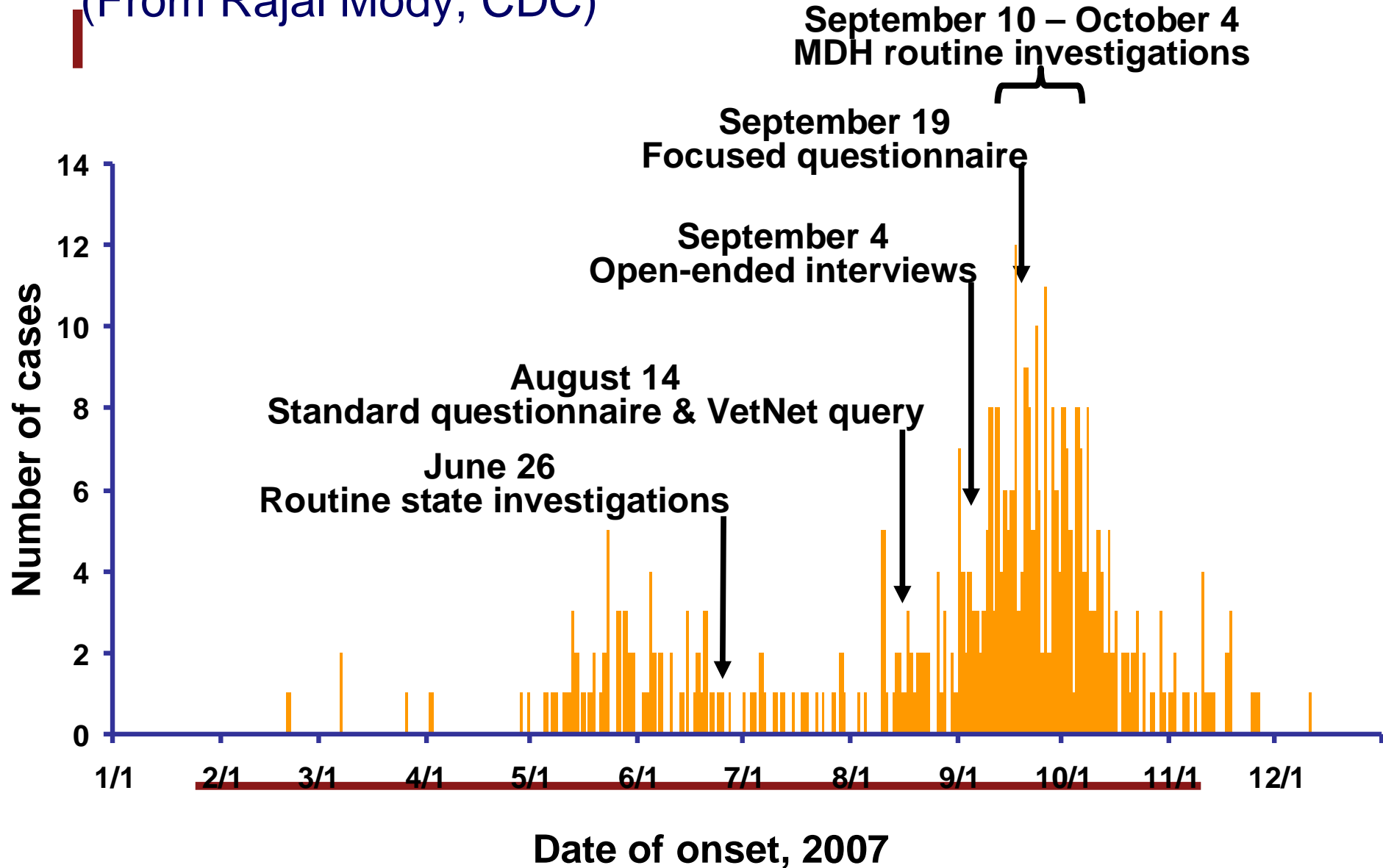
- **14 (93%) of 15 cases,**
 - **7 (78%) of 9 controls**
- Ate any chicken**

Matched OR=undefined; p=0.4



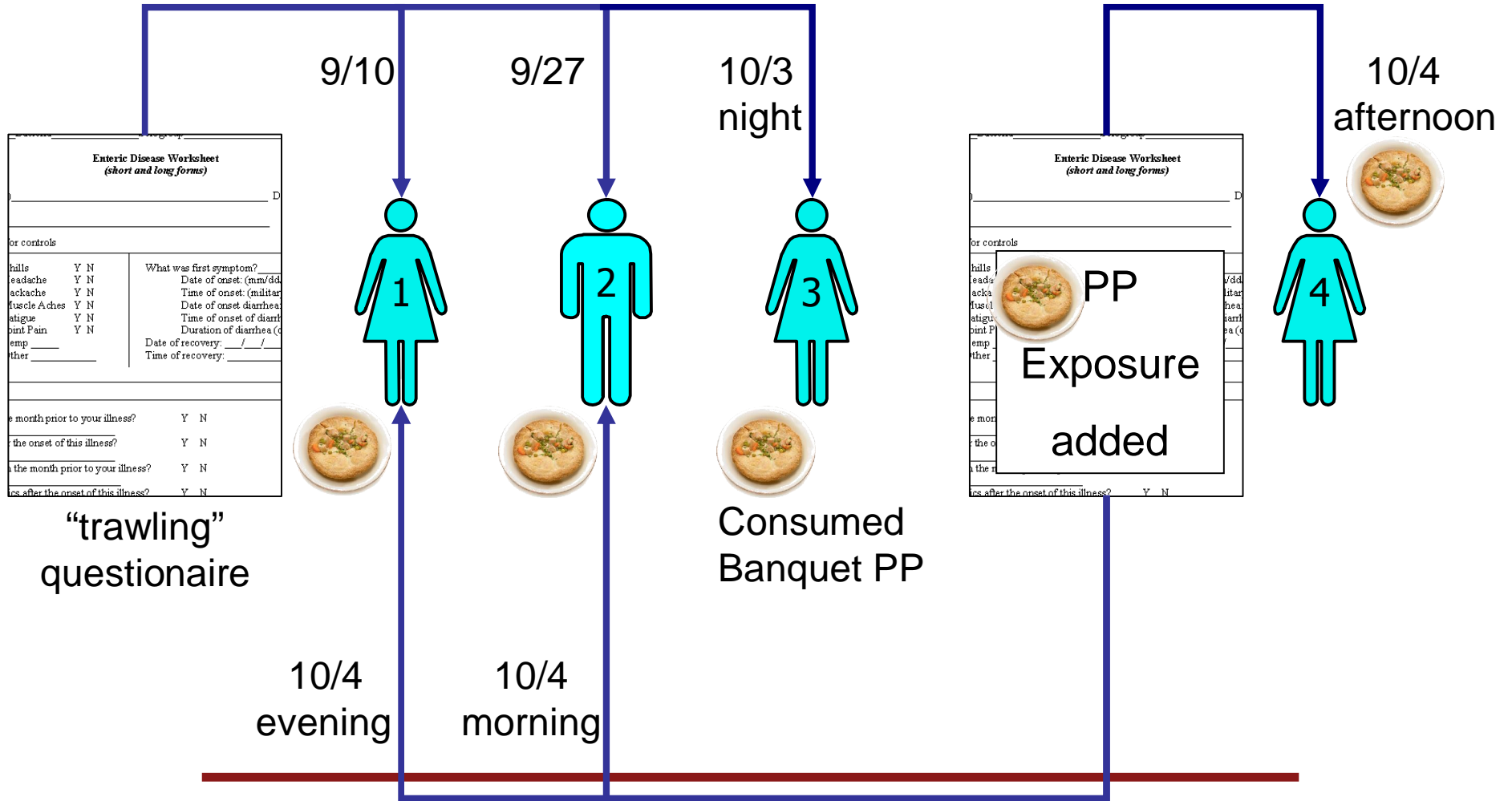
Salmonella 1,4,5,12:i:- Outbreak

(From Rajal Mody, CDC)



Dynamic Cluster Investigation-Pot Pies

Initial trawling questionnaire interview date



Re-interviewed cases about frozen foods and pot pies

Team Diarrhea



The Council to Improve Foodborne Outbreak Response (CIFOR)

- CIFOR is a multidisciplinary working group convened to increase collaboration across the country and across relevant areas of expertise in order to reduce the burden of foodborne illness in the United States.
- The Council of State and Territorial Epidemiologists (CSTE) and the National Association of County and City Health Officials (NACCHO) are co-chairing CIFOR with support from the Centers for Disease Control and Prevention (CDC).
- CIFOR is actively exploring methods to evaluate and

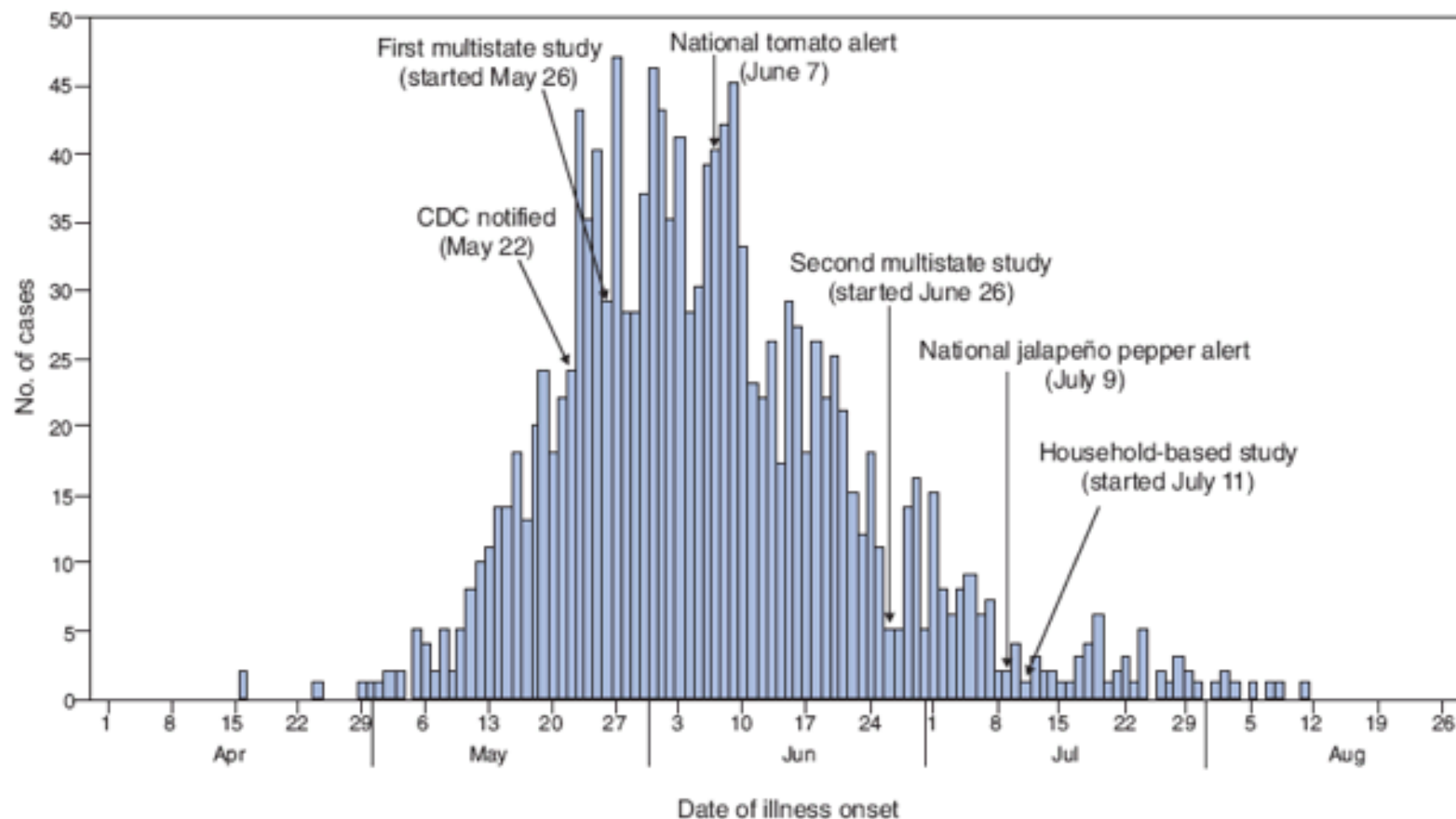
CIFOR

The Council to Improve Foodborne Outbreak Response

Conclusion

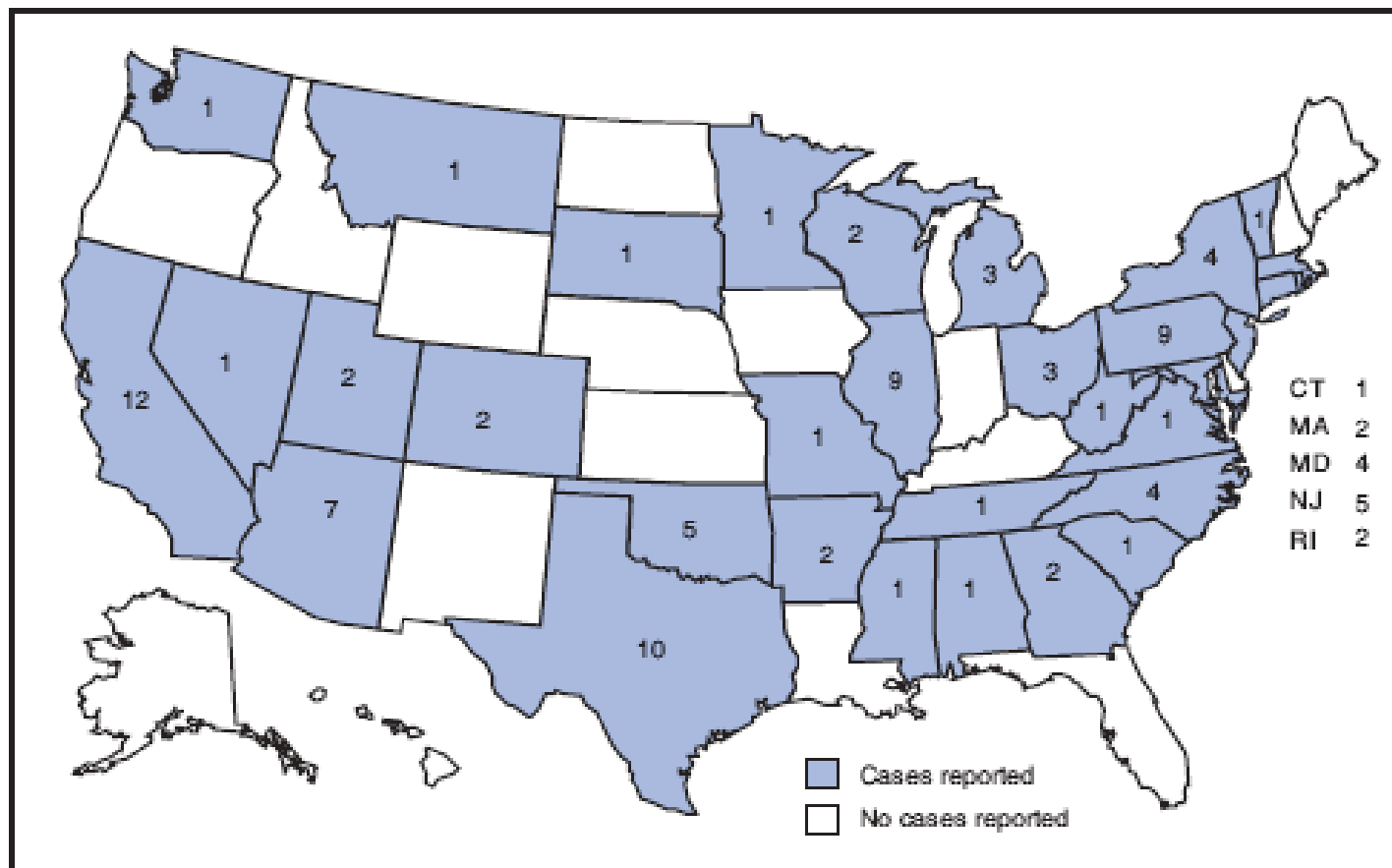
- The unique ability of public health surveillance to identify new hazards, and provide population-based evaluation of the effectiveness of control measures makes it a prerequisite for effective food control programs, and a primary tool for food control research.
 - Improving public health surveillance for foodborne diseases will require considerable investments at multiple levels. However, such investments are critical to the improvement of our food safety systems.
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FIGURE 2. Number of laboratory-confirmed cases (n = 1,414) of *Salmonella* Saintpaul (outbreak strain), by date of illness onset — United States, 2008*



* Includes cases with onset information received as of August 25, 2008. Some illness onset dates (n = 366) were estimated by subtracting 3 days from the specimen date. Illness that began during July 29–August 25 might not yet be reported.

FIGURE 2. Number* of human *Salmonella* Paratyphi B var. Java cases having isolates with a pulsed-field gel electrophoresis *Xba*I pattern indistinguishable from the outbreak strain, by state — United States, May 4, 2007–January 18, 2008



* N = 103.

TABLE. Number and percentage of exposures to *Salmonella* Saintpaul among case patients and controls in seven case-control studies, by implicated food item/exposure — United States, 2008

Study (start date) and food item/exposure	Cases		Controls		Odds ratio	(95% CI*)
	No.	(%)	No.	(%)		
First multistate study (May 26)						
Raw tomatoes	42/48	(88)	67/104	(64)	6.7 ^{†‡}	(1.9–36.0)
	42/48	(88)	67/104	(64)	5.6 ^{§¶}	(1.6–30.3)
Tortillas	39/47	(83)	69/104	(66)	2.8 ^{†‡}	(1.0–10.0)
Salsa	27/48	(56)	47/104	(45)	1.7 ^{†‡}	(0.8–3.8)
Guacamole	16/50	(32)	26/103	(25)	1.6 ^{†‡}	(0.7–3.5)
First Texas restaurant (June 20)						
Salsa	41/43	(95)	8/29	(28)	62.3 ^{**}	(12.4–632.1)
Texas restaurant chain (June 24)						
Salsa	32/32	(100)	49/58	(85)	7.5 ^{**}	(1.1–undefined)
Second multistate study (June 26)						
Eating at a Mexican-style restaurant	68/138	(49)	64/278	(23)	4.6 ^{†‡‡}	(2.1–undefined)
Pico de gallo	35/127	(28)	26/257	(10)	4.0 ^{†‡‡}	(1.5–17.8)
Corn tortilla	51/126	(40)	67/251	(27)	2.3 ^{†‡‡}	(1.2–5.0)
Salsa	60/130	(46)	73/245	(30)	2.1 ^{†‡‡}	(1.1–3.9)
Minnesota restaurant (June 30)						
Jalapeño pepper	17/19	(89)	8/73	(11)	62.0 ^{**}	(12.0–321.0)
North Carolina restaurant (July 17)						
Guacamole	4/4	(100)	42/113	(37)	8.7 ^{**}	(1.1–undefined)
Household-based study (July 11)						
Jalapeño pepper	26/41	(63)	42/107	(40)	2.9 ^{†‡}	(1.2–7.6)
Serrano pepper	9/41	(22)	9/107	(8)	3.0 ^{†‡}	(0.9–9.6)

* Confidence interval.

† Univariate analysis.

‡ Matched analysis.

§ Adjusted for consumption of tortillas in the week before illness onset.

** Multivariate analysis.

†† Adjusted for sex, Hispanic ethnicity, and additional age variation.