

Learning from catastrophe

How recent outbreaks can help us improve public health



Global Food Safety: Solutions for Today and Tomorrow

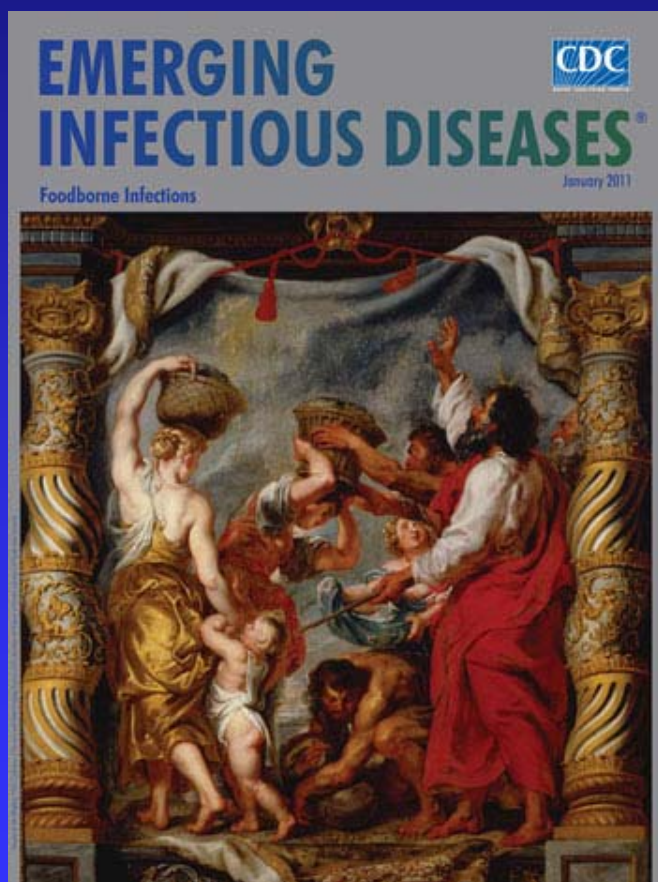
Dublin, Ireland

October 23, 2012

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Foodborne infections from contaminated foods: Common, costly and preventable



- Each year, 48 million people become sick (1 in 6 Americans), 128,000 are hospitalized, and 3,000 die
- 1,000 foodborne outbreaks reported annually
- Major pathogens: \$3 billion in health-related costs each year

Foodborne outbreak detection and investigation

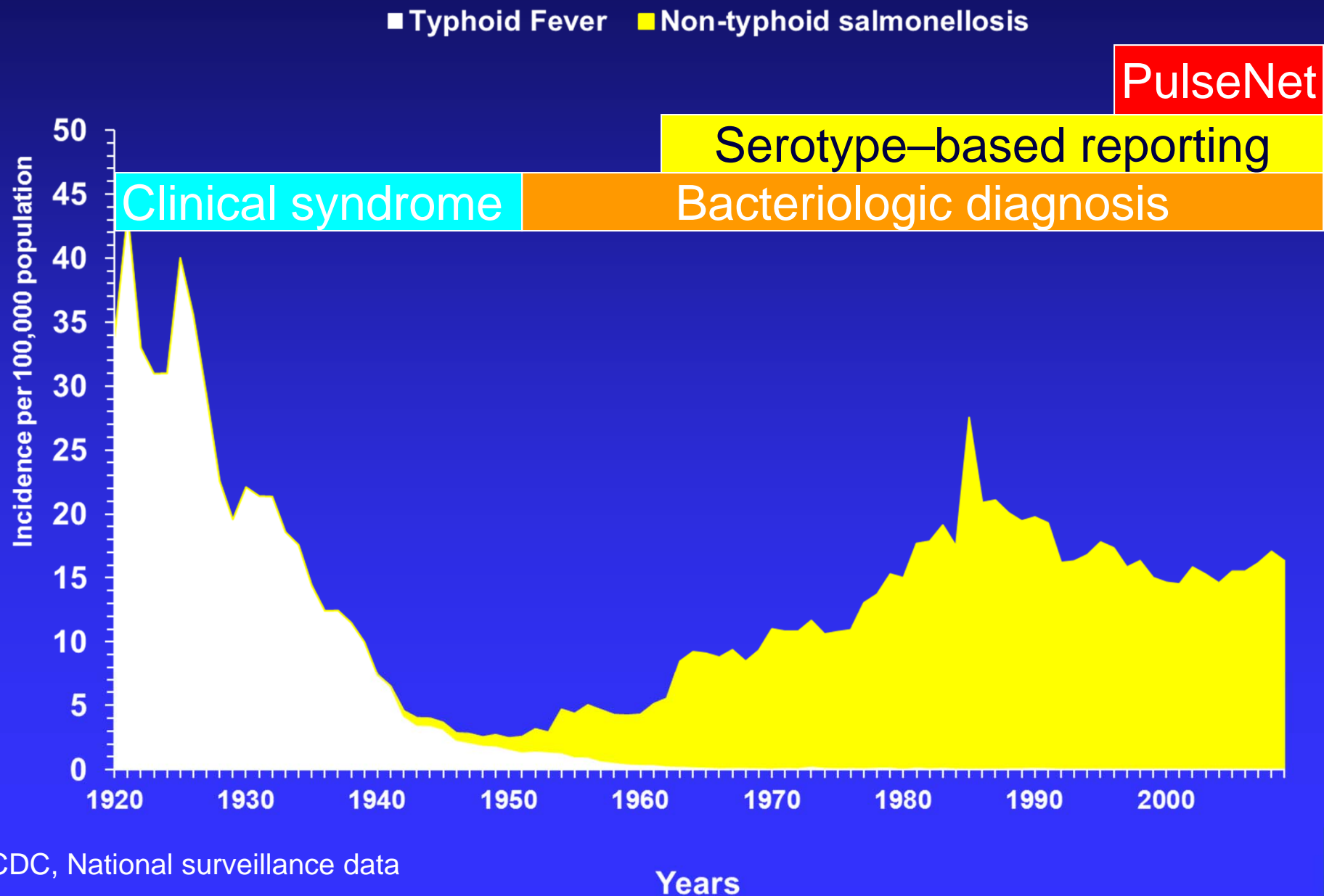
Standard methods for much of the 20C

- Local detection of large and obvious outbreaks of disease
- Identification of suspect food items by case interview
- Testing suspect food items in laboratory

- Outbreaks detected were limited to
 - Highly focal large outbreaks
 - Obvious associations with a particular food
 - Agents that can be identified in the food

- Misses the more dispersed outbreaks
- Ignores the “sporadic” cases
- Causes the misperception that foodborne disease is just a local problem, caused by bad foodhandling in the kitchen

Surveillance evolves from syndrome to molecular subtype: *Salmonella* infections in the United States, 1920-2009



PulseNet: National network for molecular surveillance of bacterial enteric infections



Standard method
Results in CDC database
All participants can see

Participants include:

- All state health departments
- City health departments
- FDA laboratories
- FSIS laboratories

50,000 bacteria/year from

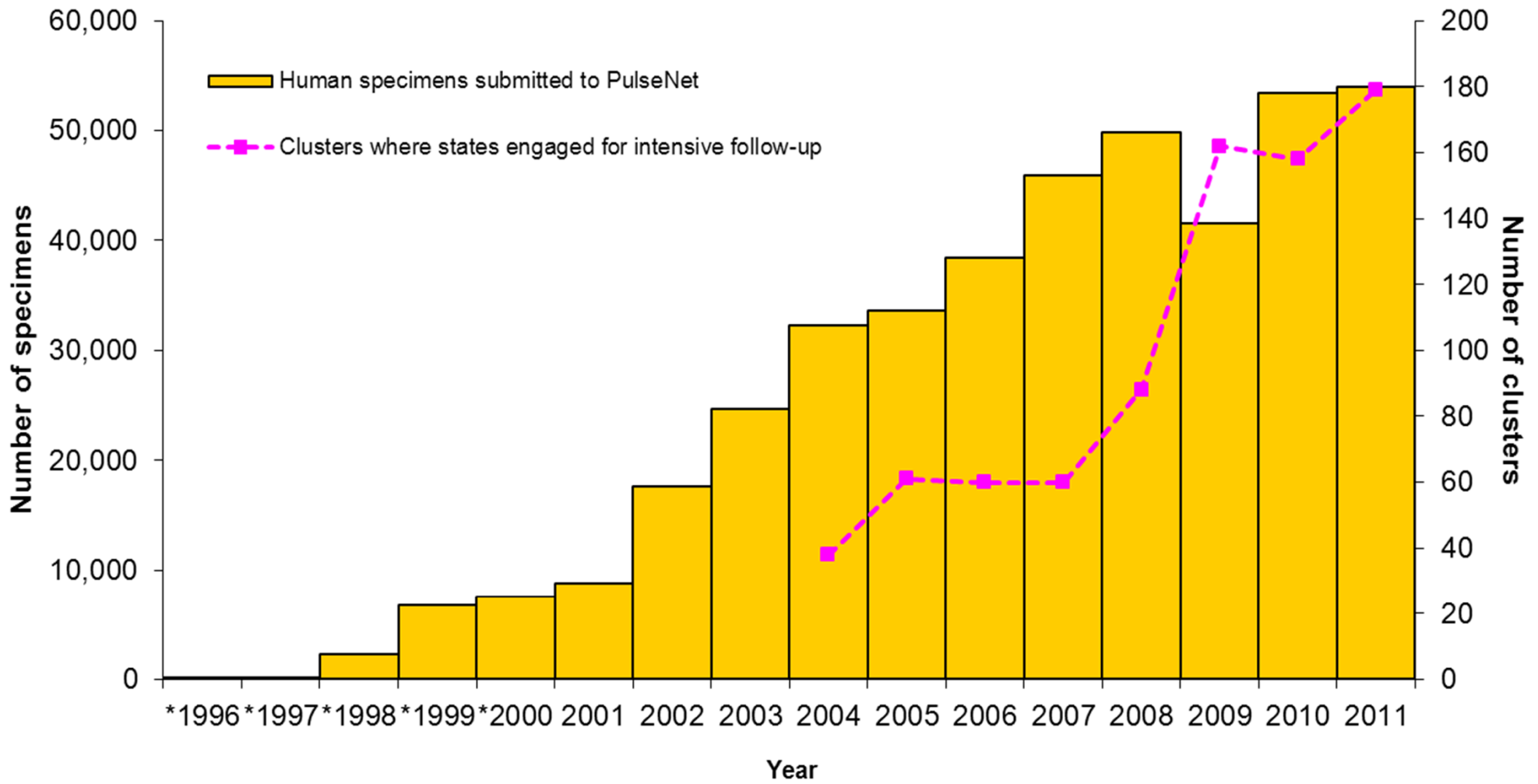
- ill people
- foods
- animals

Links with:

- PulseNet Canada
- VetNet (FSIS Salmonella)
- VoluntaryNet (food industry)

Hundreds of clusters/year

Bacterial isolates from humans uploaded to PulseNet USA, and identified multi-state clusters, 1996-2011†



† Data are preliminary and subject to change

* data type information may not be complete for these years

Expanded spectrum of foodborne disease outbreaks

Focal scenario

- Large number of cases in one jurisdiction
- Detected by affected group
- Local investigation
- Local food handling error
- Local solution

New dispersed scenario

- Small numbers of cases in many jurisdictions
- Detected by lab-based subtype surveillance
- Multi-state/-country investigation
- Industrial contamination event
- Broad implications

The new scenario makes coordination among multiple states, agencies, and countries more important

Outbreaks can teach many things

➤ New foodborne pathogens:

October 2008

Outbreak of *Arcobacter butzleri* infections

48 ill after wedding reception

3/5 had *A butzleri* by PCR

Associated with eating broasted chicken

(50% retail chicken had *A butzleri*)

➤ New food vehicles:

Outbreaks can teach many things

➤ New foodborne pathogens:

October 2008

Outbreak of *Arcobacter butzleri* infections

48 • May-June 2011

3/5 • Outbreak of *E. coli* O104:H4 STEC infections

As • Unusual strain: Aggregative STEC

(50 • 3,914 cases in 14 countries, 769 with HUS

• 42 deaths

• Linked to fenugreek sprouts

• Fenugreek seeds imported from Egypt

• No information on how they got contaminated

➤ New food vehicles:

Outbreaks can teach many things

➤ New foodborne pathogens:

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Outbreak of *Arcobacter butzleri* infection

48

- May-June 2011

3/5

- Outbreak of *E. coli* O104:H4

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- No information on how they grew

➤ New food vehicles:

15 foods identified since 2006 that were new to US

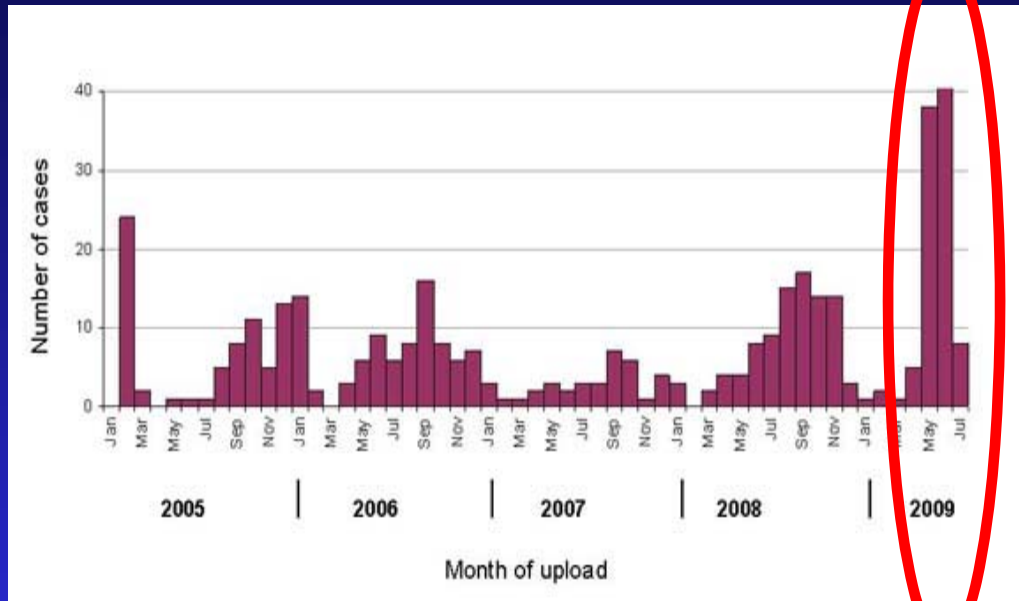
- Bagged spinach
- Carrot juice
- Peanut butter
- Broccoli powder on a snack food
- Dry dog food
- Frozen pot pies
- Canned chili sauce
- Hot peppers
- White and black pepper
- Raw cookie dough (flour?)
- Hazelnuts
- Fenugreek sprouts
- Papayas
- Pine nuts
- Raw scraped ground tuna (7 or 47% are imported)

The power of a network combining routine molecular subtyping and field epidemiology

➤ New window on foodborne outbreaks

- Direct control of ongoing outbreaks
- Drive prevention forward to prevent the next one
 - Identification of “new scenario” outbreaks
 - New food vehicles and pathogens
 - New insights into loci of contamination early in food production

E. coli O157 and ? – 2009



Cluster identified:

19 May, 2009: 17 cases with one rare pattern, from 13 states

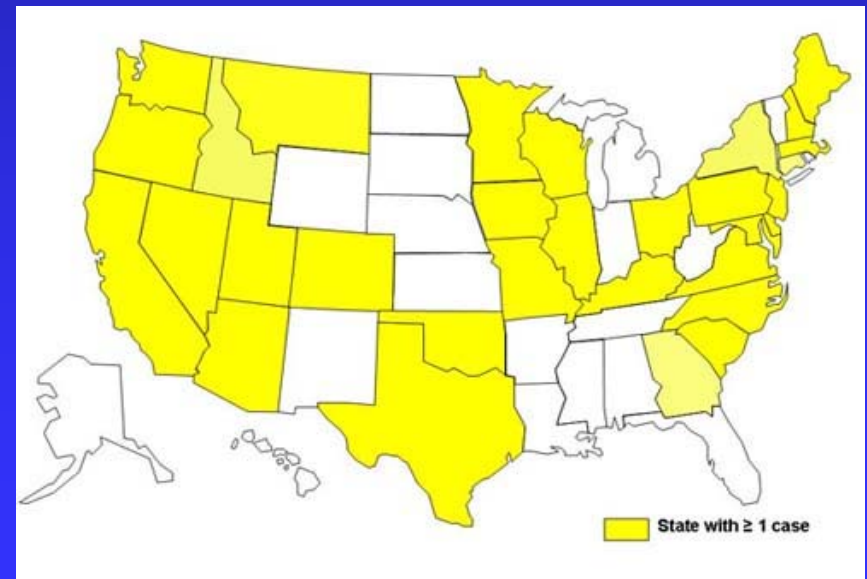
Began iterative interviews with a single interviewer

Pattern by month of upload
2005-2009 (as of July 31, 2009)

State of residence for 77 persons with outbreak pattern, Mar 1 -July 8, 2009

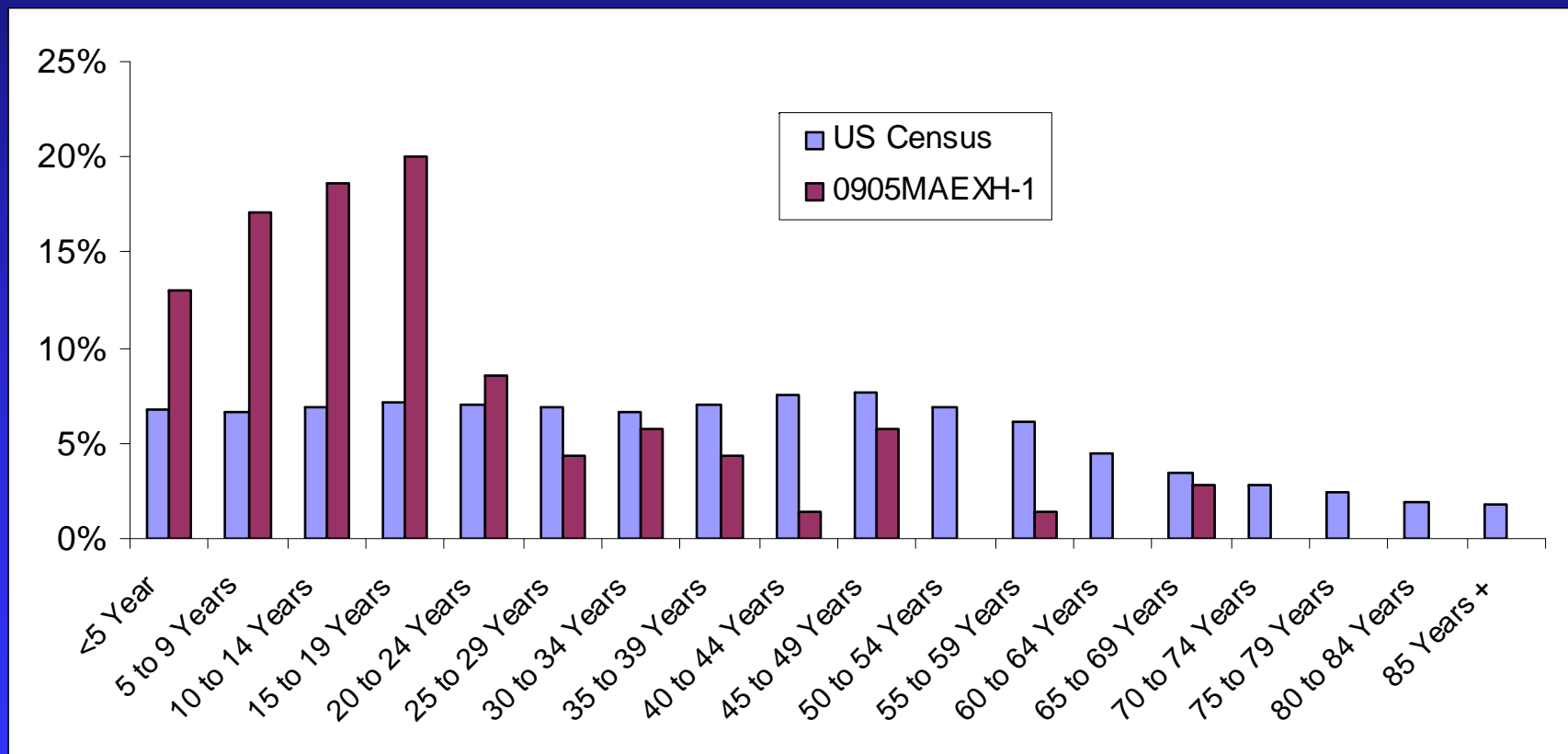
35 hospitalized

10 developed HUS, 0 deaths



E. coli O157 and ? – 2009

Distinctive age and sex profile
Median age = 15 years, 75% female



70 cases with outbreak PFGE pattern and MLVA pattern A or MLVA undetermined, by age

Data as of June 22, 2009. Preliminary and subject to change

E. coli O157:H7 and ? – 2009

- Analytic study comparing exposure to 20 items from hypothesis generating interviews for 7 days before illness
 - 36 cases defined by PFGE and MLVA
 - 36 other non-*E. coli* infections reported matched by age , gender and state
- 33 (94%) of 35 cases vs 4 (11%) of 36 controls reported eating raw cookie dough (matched odds ratio 41, $p < 0.001$)
- 31 of the 33 reported Brand A raw cookie dough, distributed nationwide, vs 0 of 4 controls
- New food practice – raw cookie dough as a snack

E. coli O157:H7 and cookie dough – 2009

- Traceback led to one plant: 40% of cookie dough in US
- June 18-19: Cookie dough production halted, 47 cookie dough products recalled
- Testing of 203 intact product samples: 1 + *E. coli* O157
- No source identified, company enhanced testing and reopened, with stronger consumer labeling
- January 2010: Company reported finding *E. coli* O157 twice in finished product (not shipped)
- Jan 2010: Company began using heat treated flour for cookie dough

E. coli O157:H7 and raw cookie dough

Lessons learned

- Single brand of raw cookie dough, distributed nationwide
- New food practice – raw cookie dough as a snack
- Outbreak would not have been identified without PulseNet
- Hypothesis came from single interviewer, open-ended interviews
- Multi-state case-control study rapidly implicated single brand (Using other reported enteric cases as controls)
- Control achieved without waiting for culture-positive product
- Intermittent low level contamination
- Possible source is raw wheat flour - Flour is not a sterile product
- Labeling “Do not eat raw dough or batter” is not enough

Salmonella Bareilly and ?

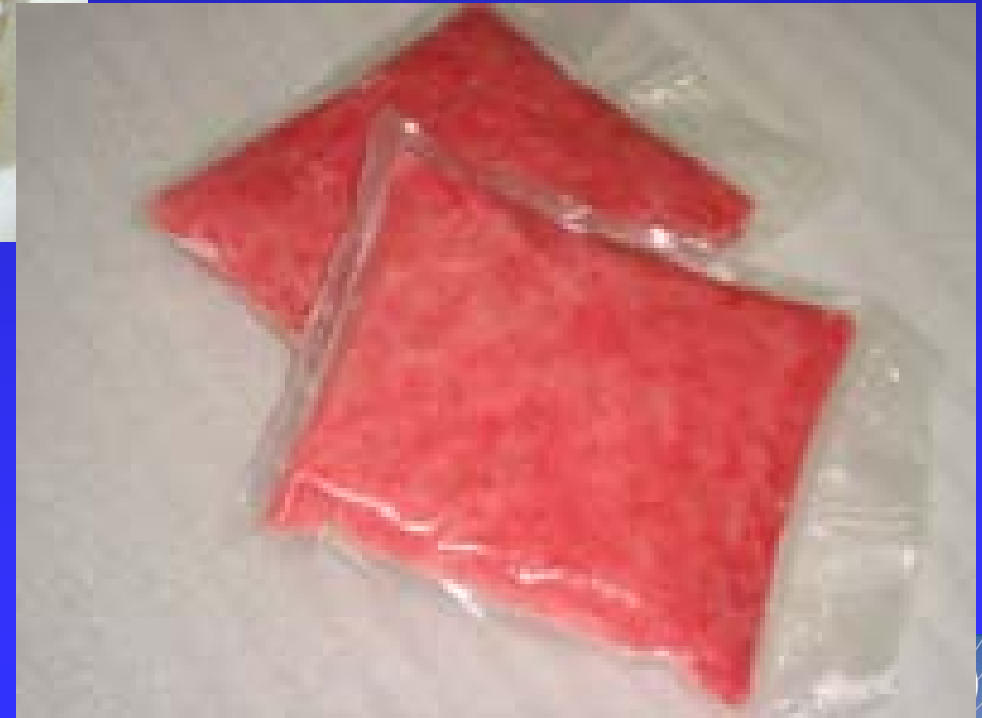
- March 4, 2012: New York State Health Department reports 4 people with same strain of Salmonella Bareilly
- 7 more from 6 other states in the PulseNet database
- Detailed interviews, as more cases reported:
 - 90% ate sushi in preceding week
 - vs 5% of general population
- What kind of sushi?
 - 81% ate spicy tuna rolls
 - vs 37% of all sushi orders at same restaurants
- What is a spicy tuna roll?

Salmonella Bareilly and spicy tuna roll



Rice
Noritake seaweed
Spicy sauce or mayonnaise
Sesame seeds
Raw minced tuna

OR
Raw tuna scrape
("Nakauchi scrape")
Frozen in 2 lb unmarked bags
All from Moon Fisheries, India

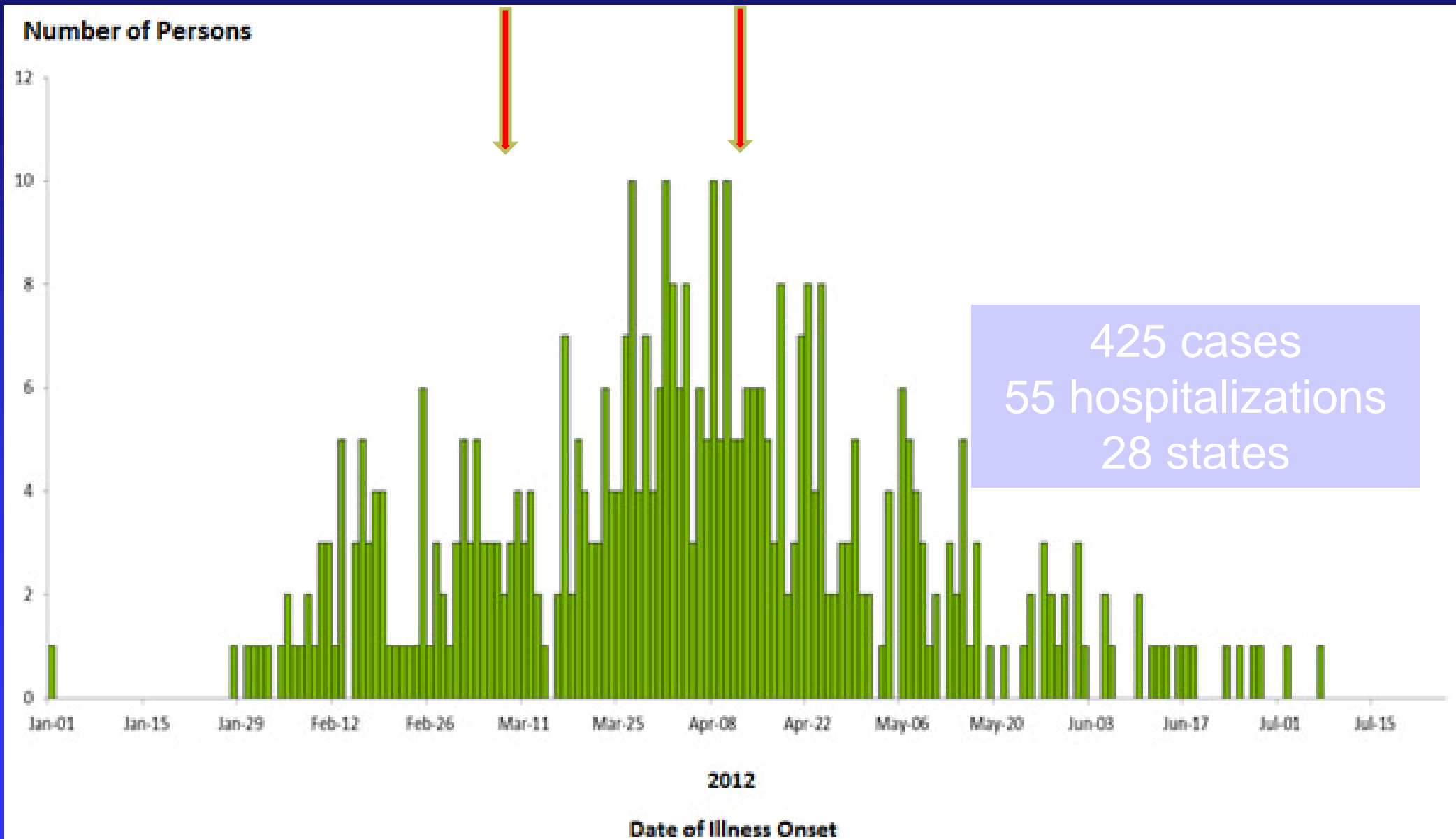


Salmonella Bareilly and raw tuna scrape

- Scraped by hand from yellow fin tuna carcasses
- April 13, 2012: Moon Marine International voluntarily recalled 3,000 tons of product
- April 19-24, 2012: FDA visited processing facility
 - No monitoring safety of water or ice, no effective cleaning procedures, visible product residue in many places, including on ceiling over processing area.
- 53 (96%) of 55 intact packages sampled yielded *Salmonella* – most Bareilly, some Nchanga
- Found 15 cases of *S* Nchanga infection in PulseNet - also fans of spicy tuna rolls

Salmonella Bareilly and raw tuna scrape - 2012

Detection Recall



Salmonella Bareilly and raw tuna scrape

Lessons learned

- One processor in another country source of large nationwide outbreak in US.
- New culinary practice – tuna scrape - a convenient short cut for sushi chefs
- Outbreak would probably not have been controlled without PulseNet
- Comparison of sushi order tickets critical to implicating one sushi type
- Visits to implicated restaurants, review and traceback of ingredients critical
- Control achieved without waiting for culture-positive product
- Outbreak could have continued indefinitely – 2 year shelf life of product
- Lack of effective HACCP or quality control
- Can this product ever be safe enough to consume raw (without irradiation)?

Surveillance for listeriosis in the United States

- 800 cases diagnosed each year (2.7/million/year*)
- Mortality 15%: ~ 120 deaths per year
- 1998: *Listeria* included in PulseNet
- 2004: “*Listeria* initiative” nationwide
 - Refer all clinical isolates to public health labs for PFGE subtyping in PulseNet system
 - Interview all cases with standardized exposure questionnaire

* FoodNet: CDC (2011) MMWR 60: 749-755

Listeria infections from cantaloupe - 2011

Information as of August 27, 2012

- September 2: Increase in *Listeria* infections reported to Colorado State Health department (7 in preceding week, vs 10 per year expected)
- September 6: PulseNet finds most had same PFGE pattern
- September 9: Standard interviews finds all cases ate cantaloupes, Colorado warns high risk inhabitants to avoid cantaloupe
- September 9: PulseNet finds 3 cases in neighboring states
- September 10, Inspection of Colorado farm identified by preliminary traceback of cantaloupes. Product sampled, learned cantaloupes went to ≥ 17 states

Listeria infections from cantaloupe – 2011

Information as of August 27, 2012

- September 12: 13 of 13 cases ate cantaloupe compared with 64% of controls (in *Listeria* Initiative database), including 2 cases outside of Colorado. ($p < 0.01$)
- September 12: CDC warns all high risk persons in US not to eat cantaloupe from one part of Colorado.
- September 14: Full traceback completed back to one farm. Cultures of cantaloupe in stores and on farm yield *L. mono.* Company recalls all cantaloupes at request of FDA.
- October 19: FDA reports investigation of farm showed
 - *Listeria* in packing shed, not in field
 - Poor sanitation in shed
 - Washing equipment in shed was carpeted and uncleanable, designed for potatoes, not cantaloupe
 - Warm wet cantaloupe placed into cold storage

Listeria infections from cantaloupe – 2011

Information as of August 27, 2012

- Ongoing surveillance: 5 different PFGE patterns both in patients and in cantaloupes
- Within 1 week of detection: Product implicated, local high risk population warned
- Within 10 days of detection: National risk identified, national warning issued
- Within 12 days of detection: Specific product recalled
- That was just the beginning (long incubation period)

Listeria infections from cantaloupe,

Information as of August 27, 2012

- 147 cases reported from 28 states
- 33 deaths and 1 miscarriage (CFR = 21%)
- 58% female
- Median age 78 years (range <1 – 96)
- 99% hospitalized
- 7 pregnancy-related cases, 1 miscarriage

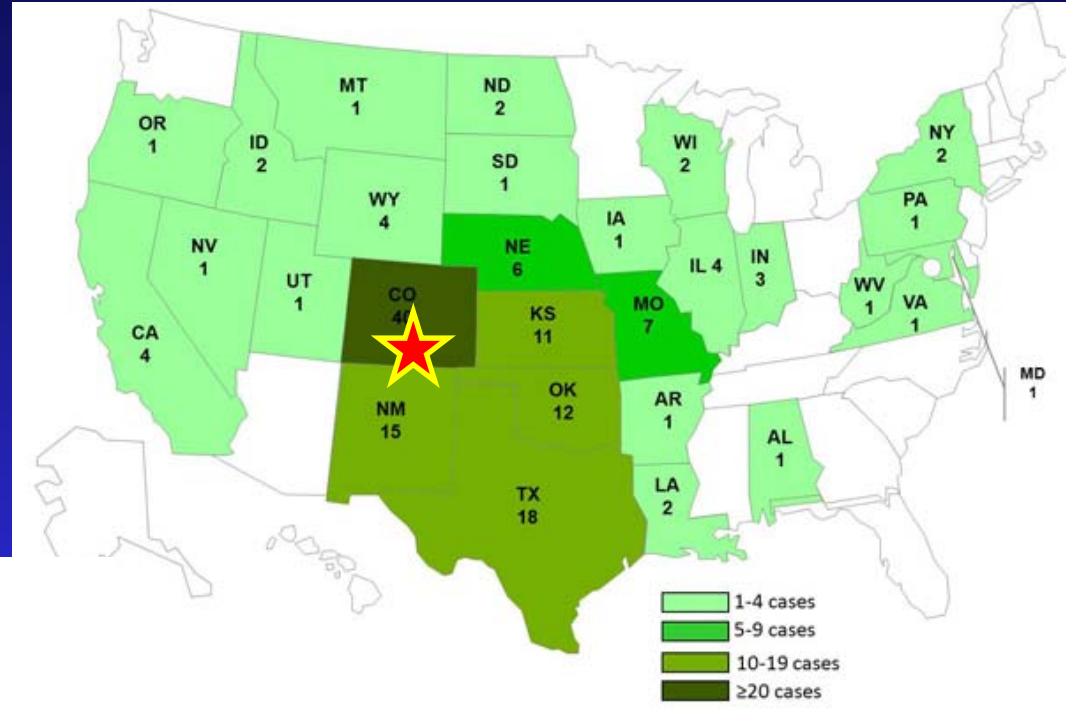
- Next largest listeriosis outbreak 1985, California, queso fresco with 142 cases, 28 deaths and 20 miscarriages

- More deaths than any foodborne outbreak since 1924:
Typhoid fever, raw oysters, ~1500 cases and ~150 deaths

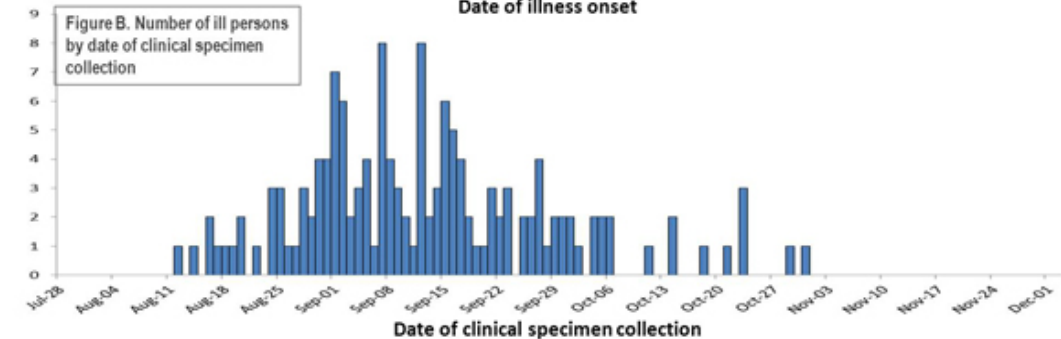
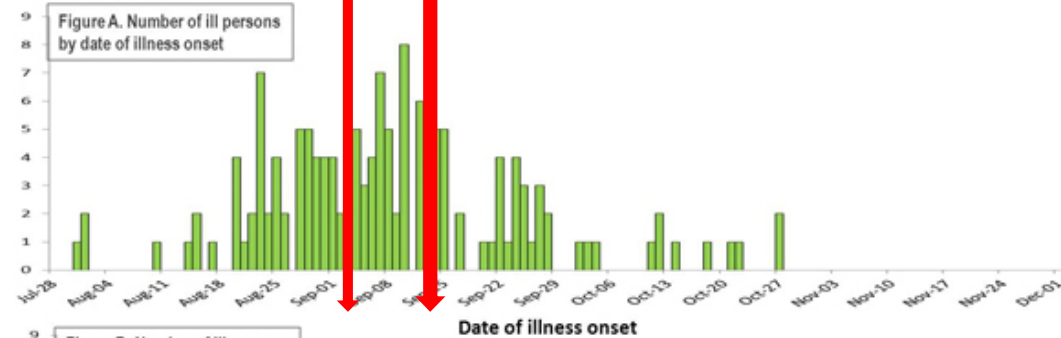
Listeria infections from cantaloupe from Jensen Farms - 2011

Detection

National warning



Number of Persons



Outbreak has a 2 month tail of cases after recall

* n= 142 for whom information was reported to CDC by 11am EDT on December 2, 2011

Listeria monocytogenes and cantaloupes - 2011

Lessons learned

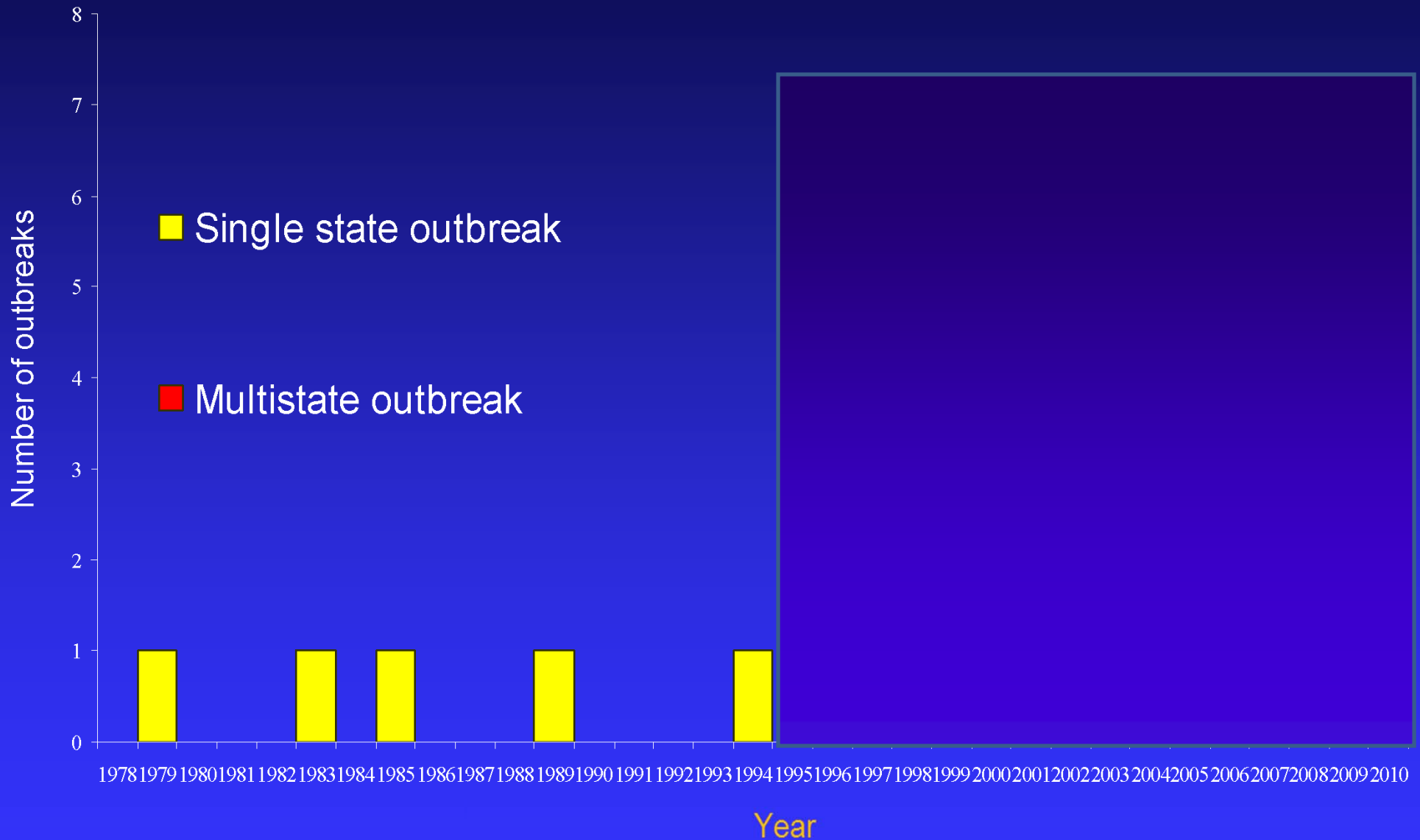
- First time a whole produce item is source of listeriosis in the US.
- Would not have been detected without PulseNet and standard interviews
- Rapid action stopped the outbreak and saved lives
 - Harvest and distribution halted
 - Prevented an estimated 36 cases and 8 deaths
 - Still most deadly foodborne outbreaks in 90 years
- Irregular processing equipment not in common use for cantaloupes
- Private third party auditor failed to identify the problem
- Produce industry largely unregulated in the US
- New regulations being drafted now

Detecting and investigating these outbreaks point to ways to protect public health

- None of these outbreaks would have been detected without improved surveillance
- One focal problem high in distribution chain -> widely disseminated disease
- New food vehicles and points of intervention clarified
 - New process controls
 - Human behavior matters: do not assume consumers or chefs follow instructions
- Next level = multinational networked improvements in surveillance and investigation, like PulseNet Europe
- Will accelerate global improvements in food safety

Reported outbreaks of listeriosis, 1978-2010

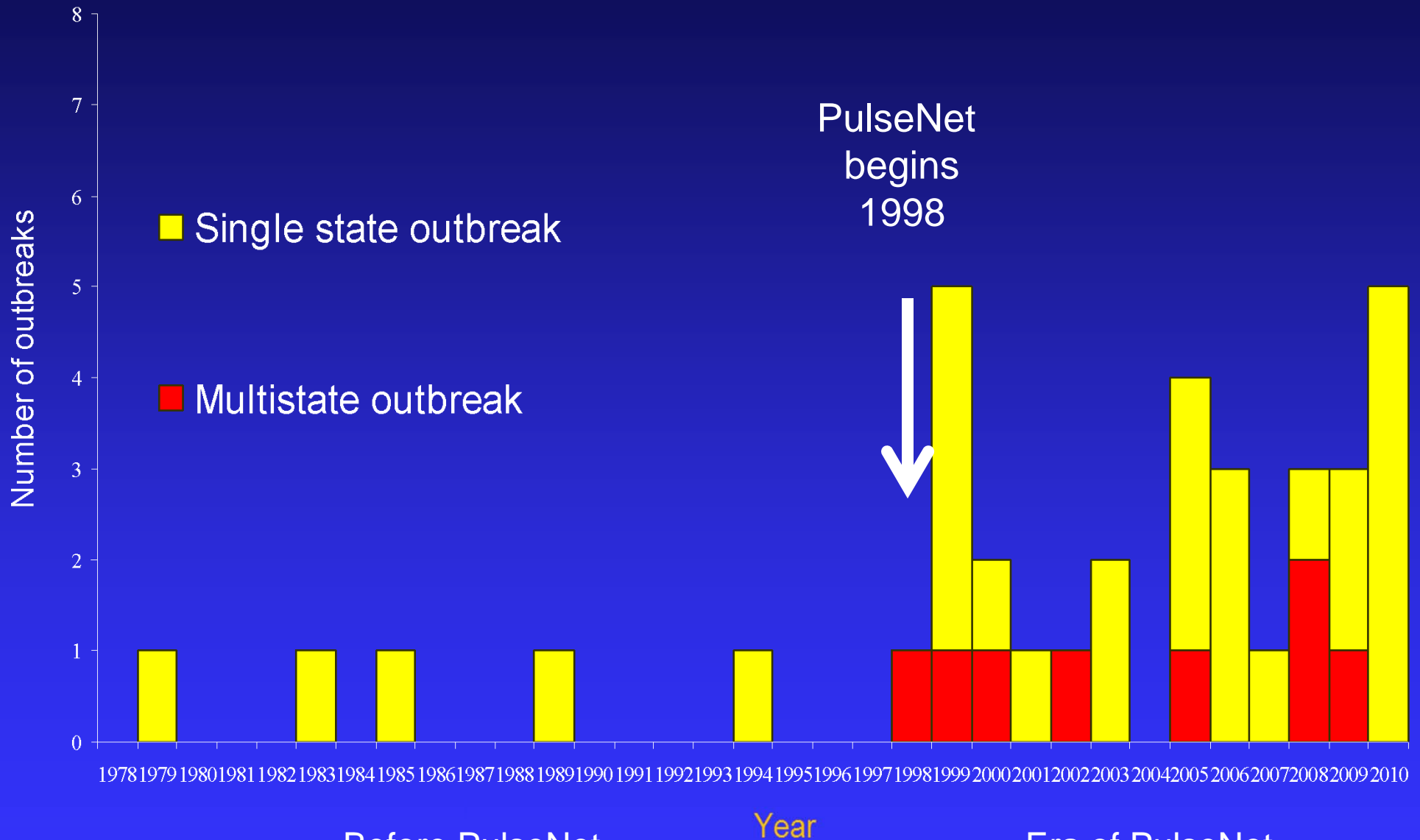
(from Foodborne Disease Outbreak Surveillance System)



Before PulseNet
1978-1997 (0.25 outbreaks/year)
Average 54 cases/outbreak

Reported outbreaks of listeriosis, 1978-2010

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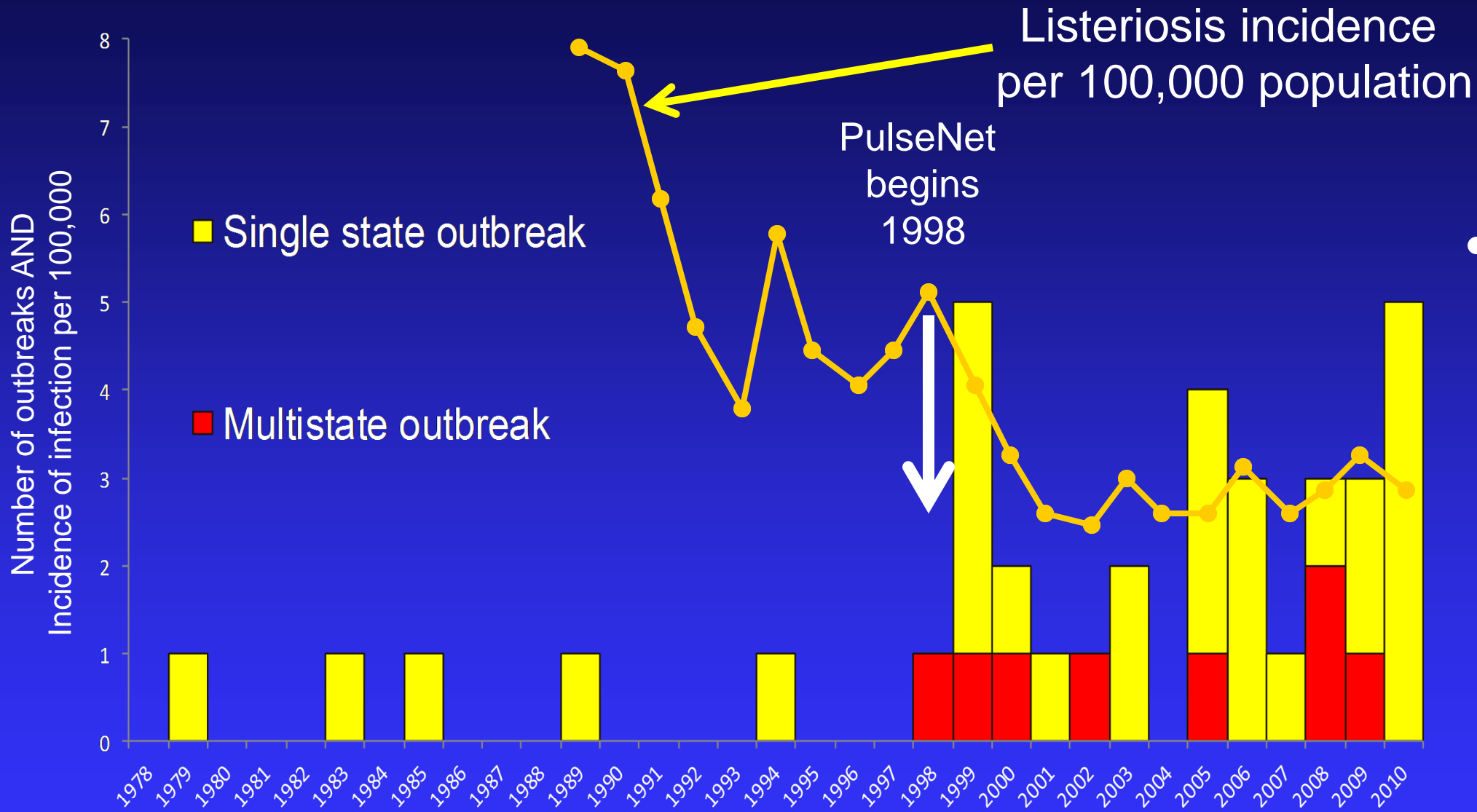


Before PulseNet
 1978-1997 (0.25 outbreaks/year)
 Average 54 cases/outbreak

Era of PulseNet
 1998-2010 (2.3 outbreaks/year)
 Average 19 cases/outbreak

Reported outbreaks of listeriosis, 1978-2010

(from Foodborne Disease Outbreak Surveillance System)



Before PulseNet
 1978-1997 (0.25 outbreaks/year)
 Average 54 cases/outbreak

Era of PulseNet
 1998-2010 (2.3 outbreaks/year)
 Average 19 cases/outbreak

Challenge #1 Expanding International Surveillance

- Safety depends on the public health and food safety systems of other countries
- Critical need for multi-national surveillance
- In outbreaks, need for trans-national cooperation and collaboration in investigation
- We occasionally find multi-continental outbreaks (and many more must exist)

- Some solutions:
 - PulseNet Europe
 - PulseNet International
 - WHO Global Foodborne Disease Network for training
 - TEPHINET: General epidemiological training consortium

Examples of multi-continental outbreaks

- 1995: *Salmonella* Stanley: Simultaneous outbreaks in Arizona, Michigan and Finland, traced to alfalfa sprouts, made from seeds imported from the Netherlands from an Italian broker
- 1994-5: *Salmonella* Agona: Cases in UK, Canada and US all traced to a “savory peanut snack” from Israel (was also leading cause of salmonellosis in Israel that year)
- 2001: *Salmonella* Typhimurium: Cases in Australia, Sweden, Canada and UK traced to helva (sesame seed product) from Turkey
- 2001: *Salmonella* Stanley: Cases in Australia, Canada, UK traced to peanuts from China
- 2009: Hepatitis A: Outbreaks in Australia, France both traced to semidried tomatoes exported from Turkey

It takes international collaboration to find them and solve them

Challenge #2: Dealing with the flood of clusters as subtype-based surveillance is implemented

- Often start by testing isolates within recognized outbreaks to assist investigation
- Then implement PulseNet for all “sporadic” cases – will increase number of suspect outbreaks detected 10 fold.
- Outbreaks detected are smaller and more dispersed
- Public health and food safety authorities need to be ready to investigate many more than they do now.

Challenge #3 New culture-independent diagnostic methods may eliminate the bacterial isolate

- Technological shift is occurring in diagnostic laboratories
- Use of rapid “dipstick” diagnostic tests increasing for enteric infections: *Campylobacter* stool EIA test, STEC ELISA
- Offers rapid presumptive diagnosis (with variable sens and spec)

- May mean that there is no isolate available to confirm a case:
 - Artifacts of method make complicate trend tracking
 - Lack of isolate means loss of serotyping and subtyping
 - Much less likely to detect dispersed outbreaks
 - Unable to track trends in antimicrobial resistance

- April 25-26, 2012 APHL/CDC Culture-Independent Diagnostics Forum: Charting a Path for Public Health

➤ Short-term: Preserve isolates

- Work with medical industry to make new tests compatible with public health needs
- Require/foster reflex culture of positive specimens
- Make reflex culture reimbursable
- Expand isolate recovery capacity for public health laboratories

➤ Longer-term: Develop culture-independent pathogen characterization methods

- Identify diagnostic /subtype/virulence targets for direct molecular detection
- Incorporate into new diagnostic test platforms

Foodborne diseases in the 21st century

- A continuing challenge to public health
- Better public health surveillance pushes change
- Finding problems means opportunity to prevent them
- Laboratory-based surveillance methods will change as we move to a post-isolate era
- We all depend on food safety systems in other countries
- Collaborative networks that cross borders
 - Use compatible surveillance methods
 - Detect and investigate multi-jurisdictional foodborne outbreaks
 - Translate lessons learned into better prevention everywhere



Thank you

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention



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Our websites

Our Programs:

FoodNet: www.cdc.gov/foodnet

PulseNet: www.cdc.gov/pulsenet

FoodCORE: www.cdc.gov/ncezid/dfwed/orpb/foodcore/index.html

Specific pathogens:

E. coli: www.cdc.gov/ecoli

Salmonella: www.cdc.gov/salmonella

Listeria: www.cdc.gov/listeria

Multistate foodborne outbreaks:

www.cdc.gov/outbreaknet/outbreaks.html

Foodborne burden of illness:

www.cdc.gov/foodborneburden

General information about foodborne diseases:

www.cdc.gov/foodsafety

www.foodsafety.gov



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