



# Foodborne Diseases Active Surveillance Network

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# Presentation Outline

- Overview of FoodNet
- Preliminary 2006 FoodNet Data
- Update on FoodNet Activities

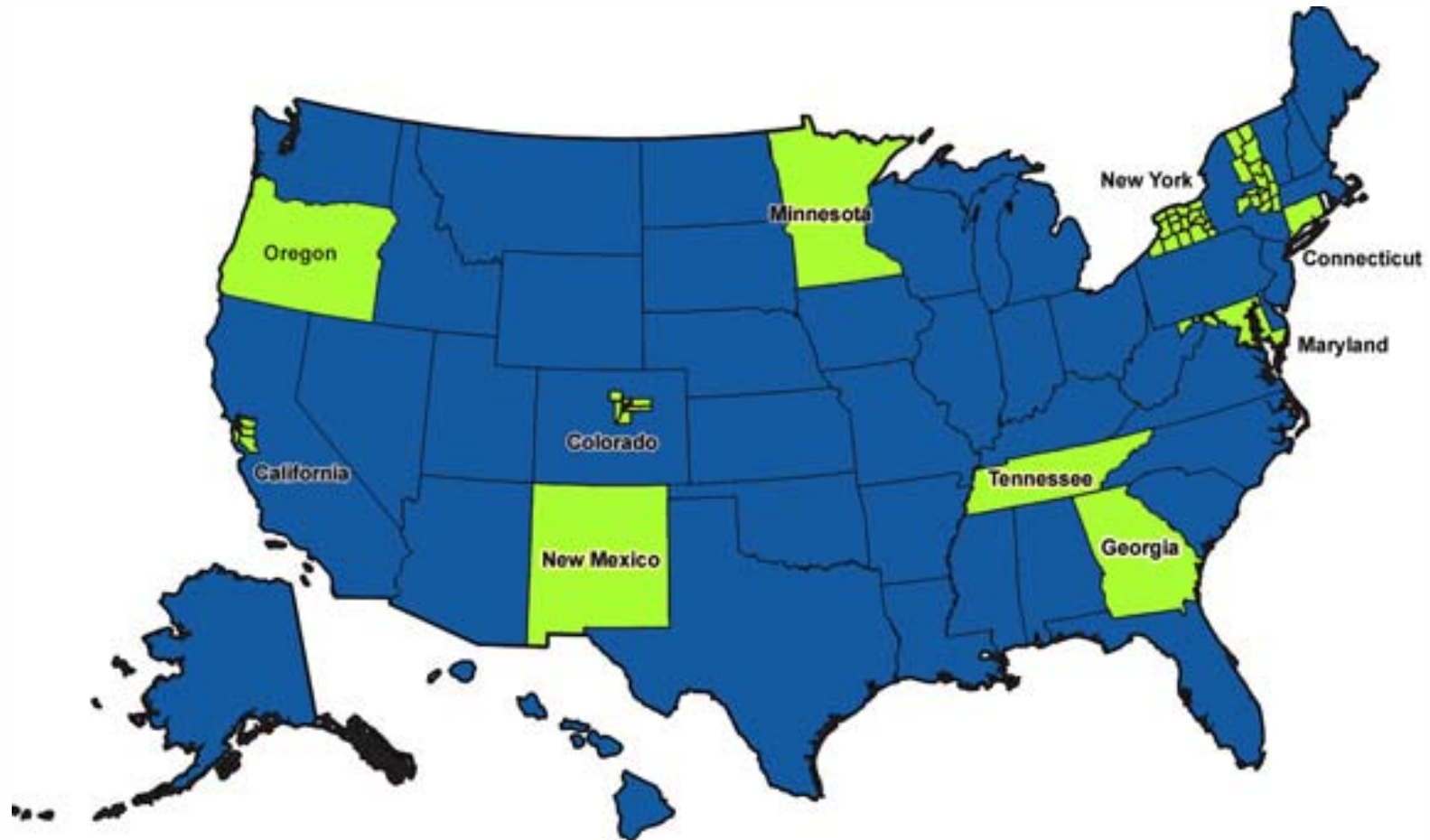
# Overview of FoodNet

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# What is FoodNet?

- Foodborne Diseases Active Surveillance Network
- Established in 1996
- Principal foodborne disease component of Emerging Infections Program
- CDC, USDA-FSIS, FDA, and 10 participating state health departments

# FoodNet Sites 2006



45 million (15% of U.S. population)

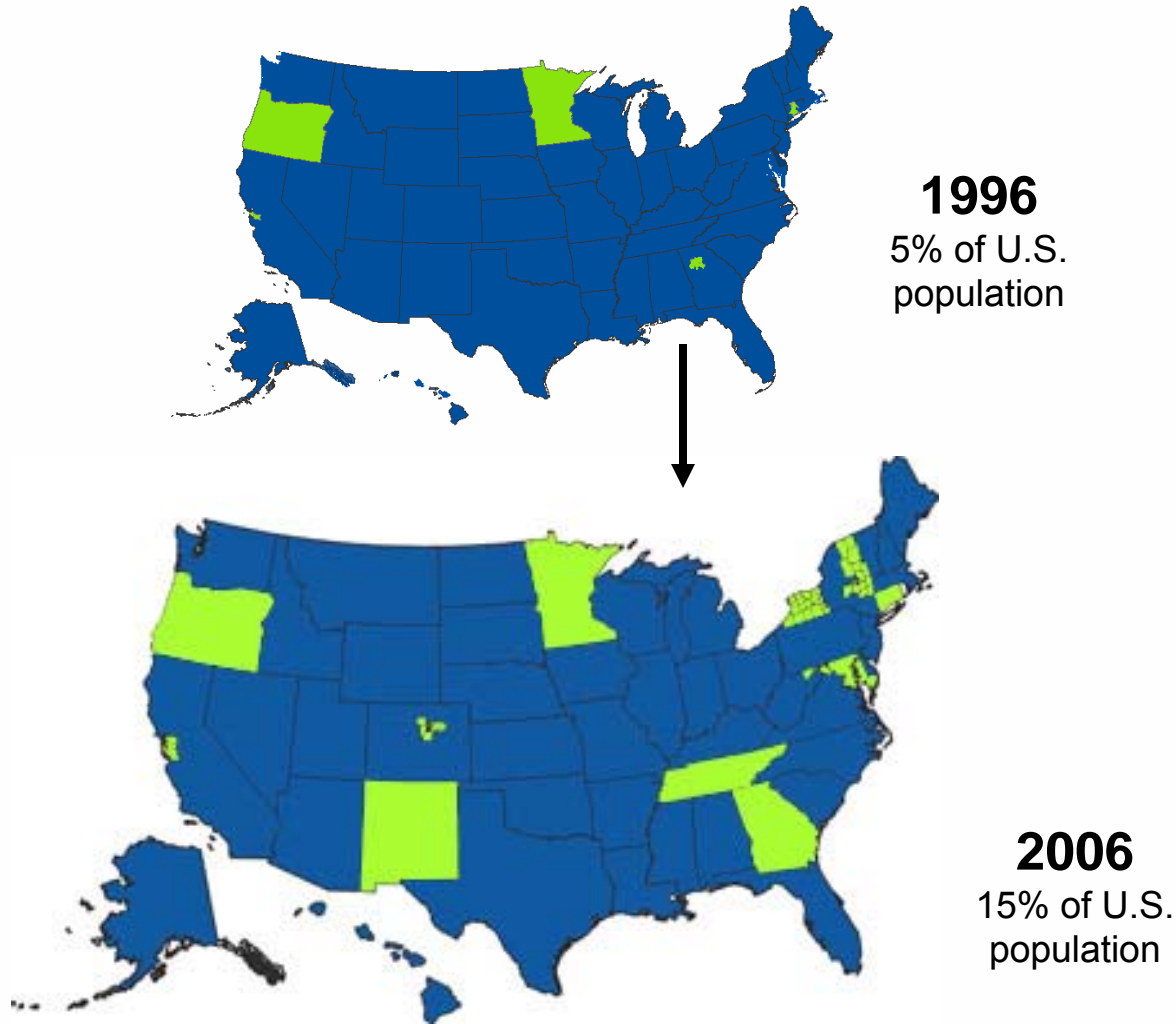
# FoodNet Objectives

1. **Determine the burden** of foodborne illness in the United States
2. **Monitor trends in the burden** of specific foodborne illness over time
3. **Attribute the burden** of foodborne illness to specific foods and settings
4. **Develop and assess interventions** to reduce the burden of foodborne illness

# FoodNet Surveillance

- Active surveillance for laboratory-confirmed infections at >650 clinical laboratories
  - *Salmonella, Shigella, Campylobacter*, Shiga-toxin producing *E. coli*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Vibrio*, *Cryptosporidium* and *Cyclospora*
  - Since 2004, data on outbreak-associated infections
- Active surveillance for hemolytic uremic syndrome among pediatric nephrologists, with hospital discharge review

# FoodNet Catchment Area



| Year | Population (millions) |
|------|-----------------------|
| 1996 | 14.3                  |
| 1997 | 16.1                  |
| 1998 | 20.7                  |
| 1999 | 25.9                  |
| 2000 | 30.5                  |
| 2001 | 64.1                  |
| 2002 | 38.0                  |
| 2003 | 41.5                  |
| 2004 | 44.1                  |
| 2005 | 44.9                  |

# Monitoring trends over time

- Measuring change in incidence compared to 1996-1998 baseline
- Use negative binomial regression model to account for:
  - Increase in number of participating sites
  - Site-to-site variation in incidence

# Preliminary 2006 FoodNet Data

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# 2005 Results

## Declines:

- *Campylobacter*
- *E. coli* O157
- *Listeria*
- *Shigella*
- *Yersinia*

## Little change:

- *Salmonella*

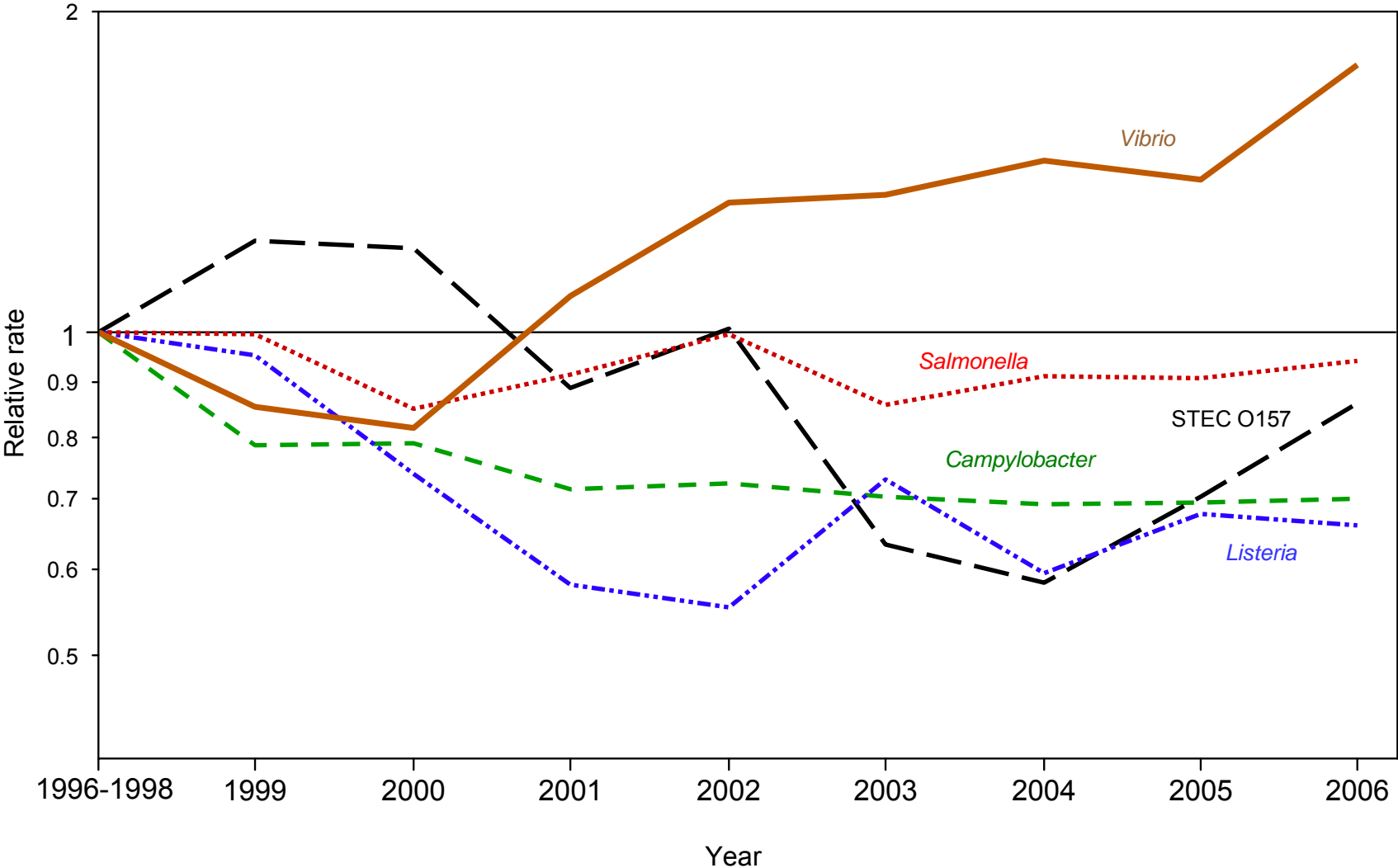
## Increase:

- *Vibrio*

# What has changed in 2006?

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**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



# Summary of 2006 data

## Declines:

- *Campylobacter*
- *Listeria*
- *Shigella*
- *Yersinia*

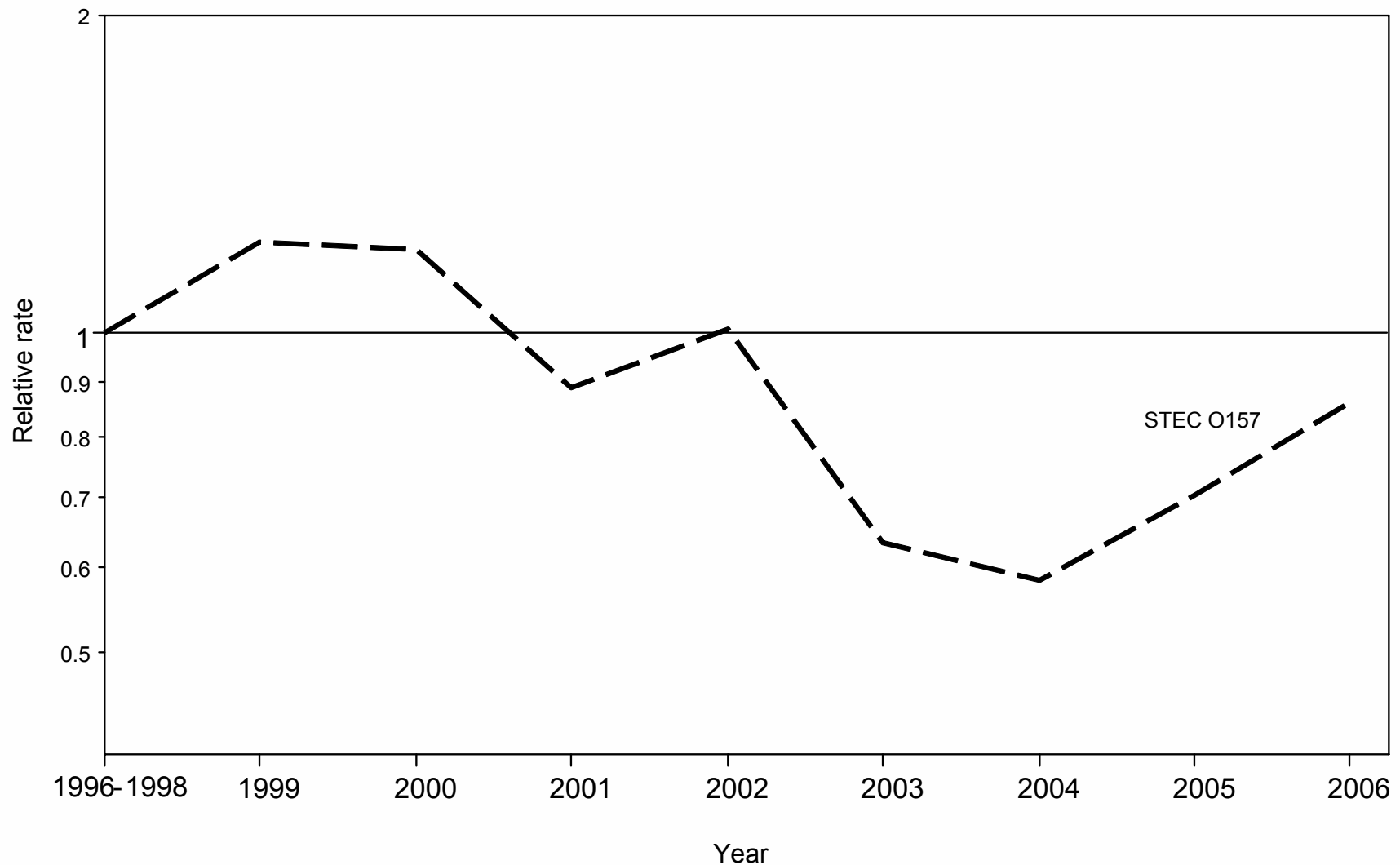
## Little change:

- *Salmonella*
- *E. coli O157*

## Increase:

- *Vibrio*

## Relative rates compared with 1996—1998 baseline period of laboratory-diagnosed cases of infection with STEC O157, by year



# Trend in *E. coli* O157

- Decline in *E. coli* O157 infections 2003-2004, not sustained 2005-2006
  - Compared to 1996-1998 baseline, *E. coli* O157 not statistically significantly different in 2006
  - Decline 14% (95% CI: 5% increase to 30% decrease)
- Similar trend in FSIS data on *E. coli* O157 contamination of ground beef
  - Decline 2003-2004, stable 2004-2006

# Outbreak-Associated *E. coli* O157 Infections

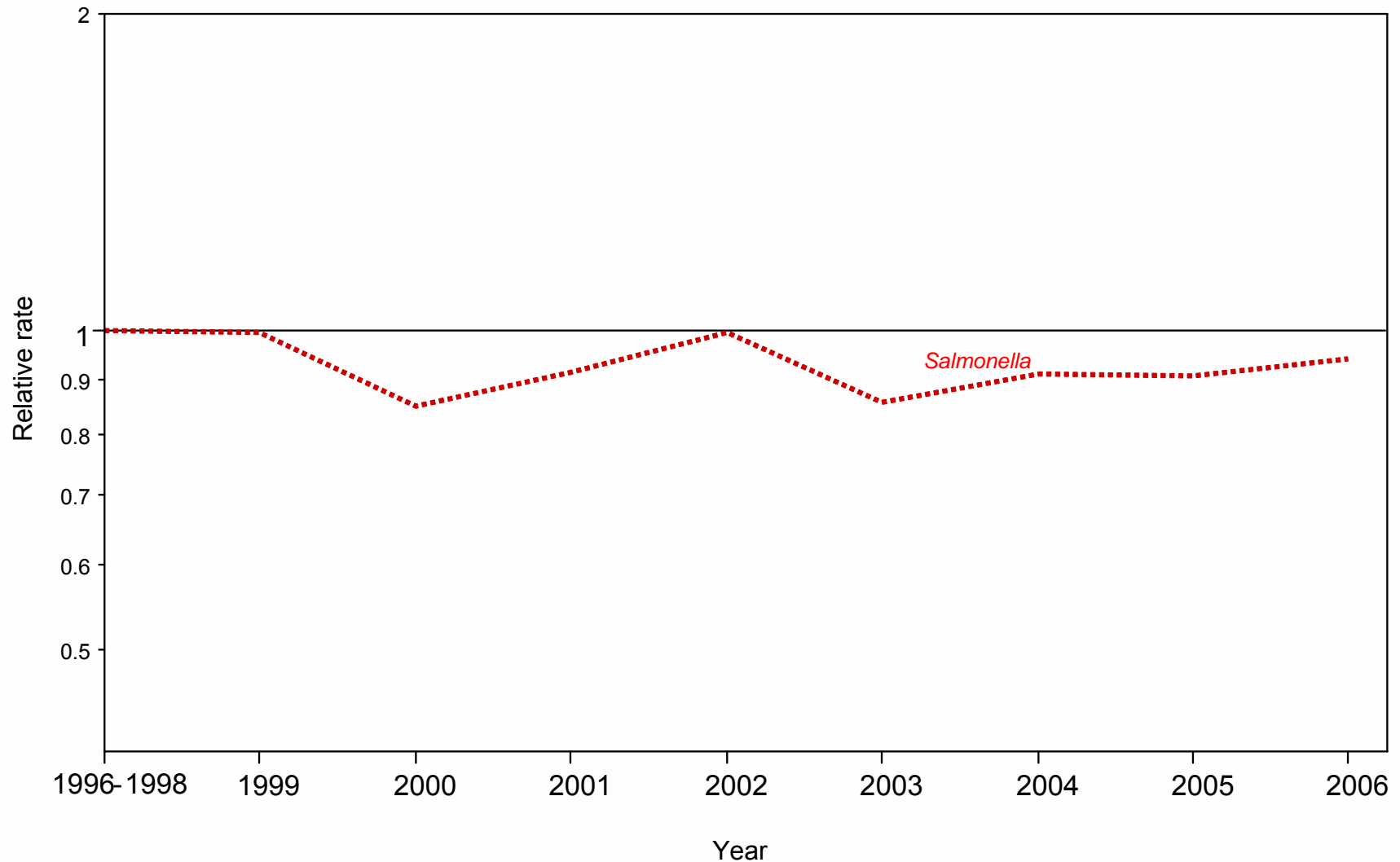
| <b>Year</b> | <b>All <i>E. coli</i> O157</b> | <b>Outbreak-associated</b> | <b>Outbreak-associated (%)</b> |
|-------------|--------------------------------|----------------------------|--------------------------------|
| 2004        | 402                            | 36                         | 9                              |
| 2005        | 473                            | 107                        | 23                             |
| 2006        | 590                            | 88                         | 15                             |

- Three large, produce-associated multistate outbreaks in 2006
  - Bagged fresh spinach
  - Lettuce in two fast-food chains

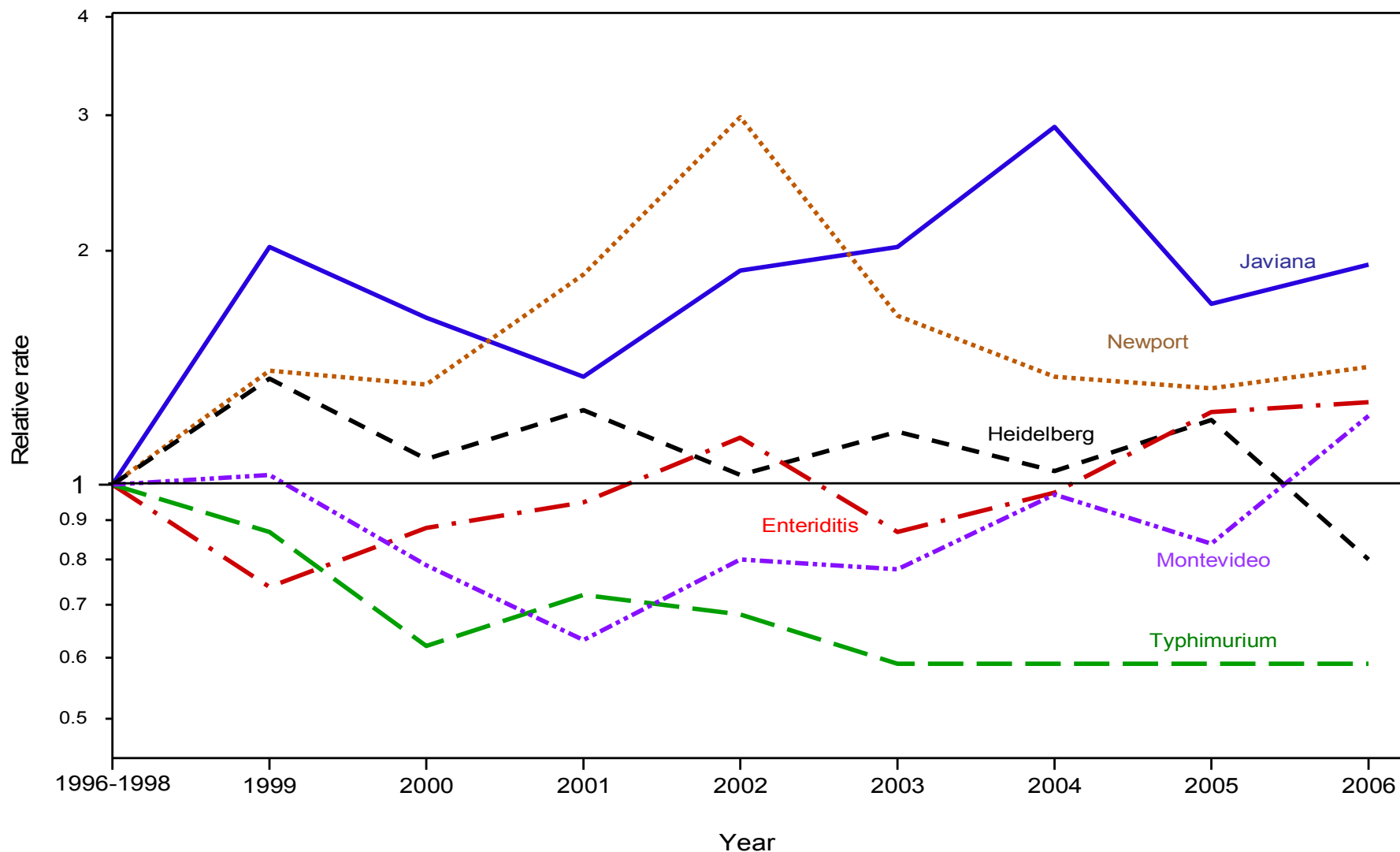
# Healthy People 2010 Objectives

|                     | Cases per 100,000 |                |
|---------------------|-------------------|----------------|
| Pathogen            | 2006              | 2010 Objective |
| <i>E. coli</i> O157 | 1.31              | 1.00           |

## Relative rates compared with 1996—1998 baseline period of laboratory-diagnosed cases of infection with *Salmonella*, by year



**Figure 2.** Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with the six most commonly isolated *Salmonella* serotypes, by year



# Trends in *Salmonella*

- Compared to 1996-1998 baseline, *Salmonella* not statistically significantly different in 2006
  - Only the incidence of *S. Typhimurium* decreased, and most of that decrease was prior to 2000
- FSIS data shows increase in frequency of *Salmonella* (particularly SE) in chicken-broiler carcasses from 2000-2005
  - 2006 FSIS initiative to reduce *Salmonella* in poultry and other meat

# Outbreak-Associated *Salmonella* Infections

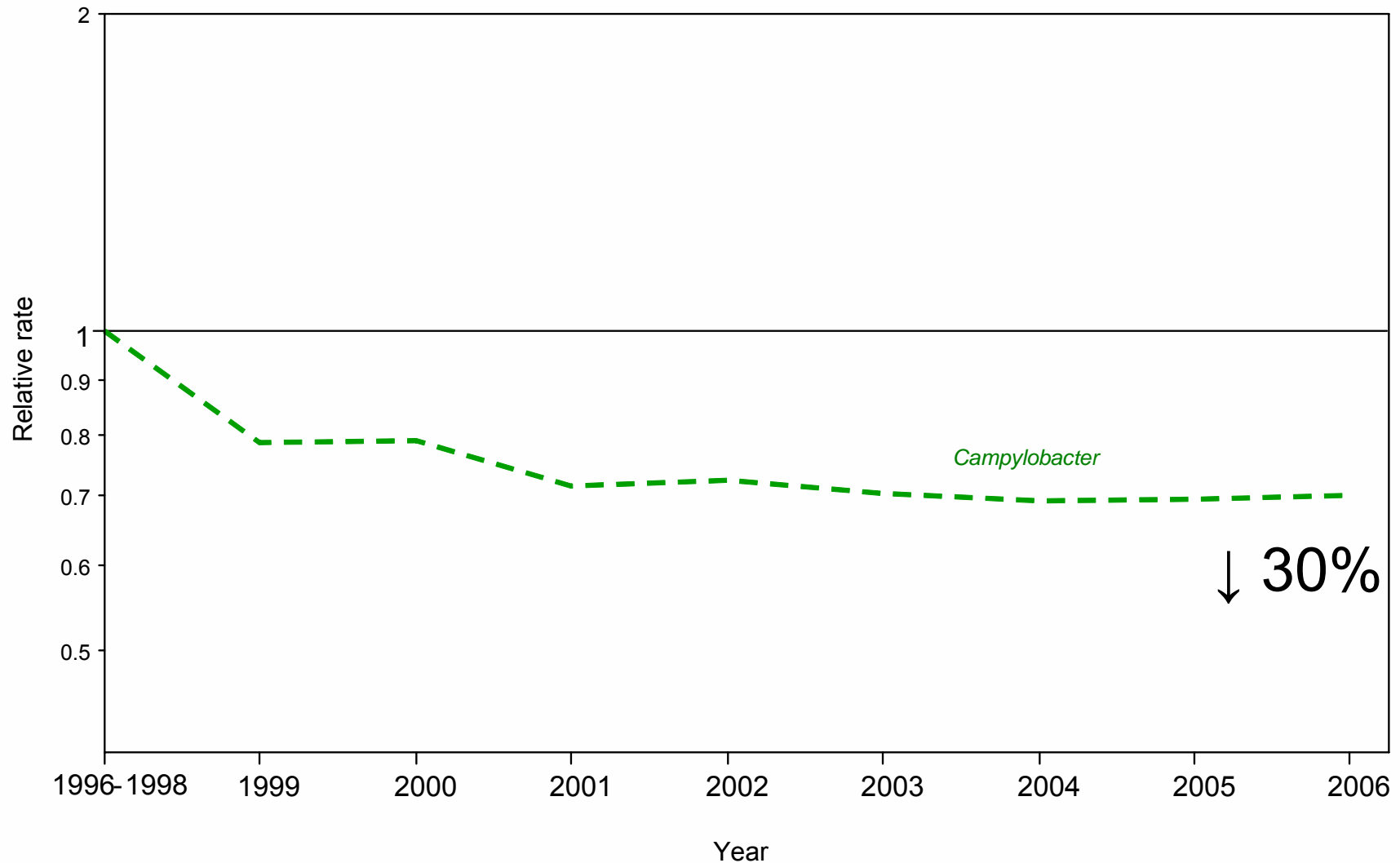
| <b>Year</b> | <b>All <i>Salmonella</i></b> | <b>Outbreak-associated</b> | <b>Percentage outbreak-associated</b> |
|-------------|------------------------------|----------------------------|---------------------------------------|
| 2004        | 6,498                        | 352                        | 5.4                                   |
| 2005        | 6,505                        | 296                        | 4.6                                   |
| 2006        | 6,655                        | 404                        | 6.1                                   |

- Two large, tomato-associated multistate outbreaks in 2006
  - *S. Newport*
  - *S. Typhimurium*

# Healthy People 2010 Objectives

|                   | Cases per 100,000 |                |
|-------------------|-------------------|----------------|
| Pathogen          | 2006              | 2010 Objective |
| <i>Salmonella</i> | 14.81             | 6.80           |

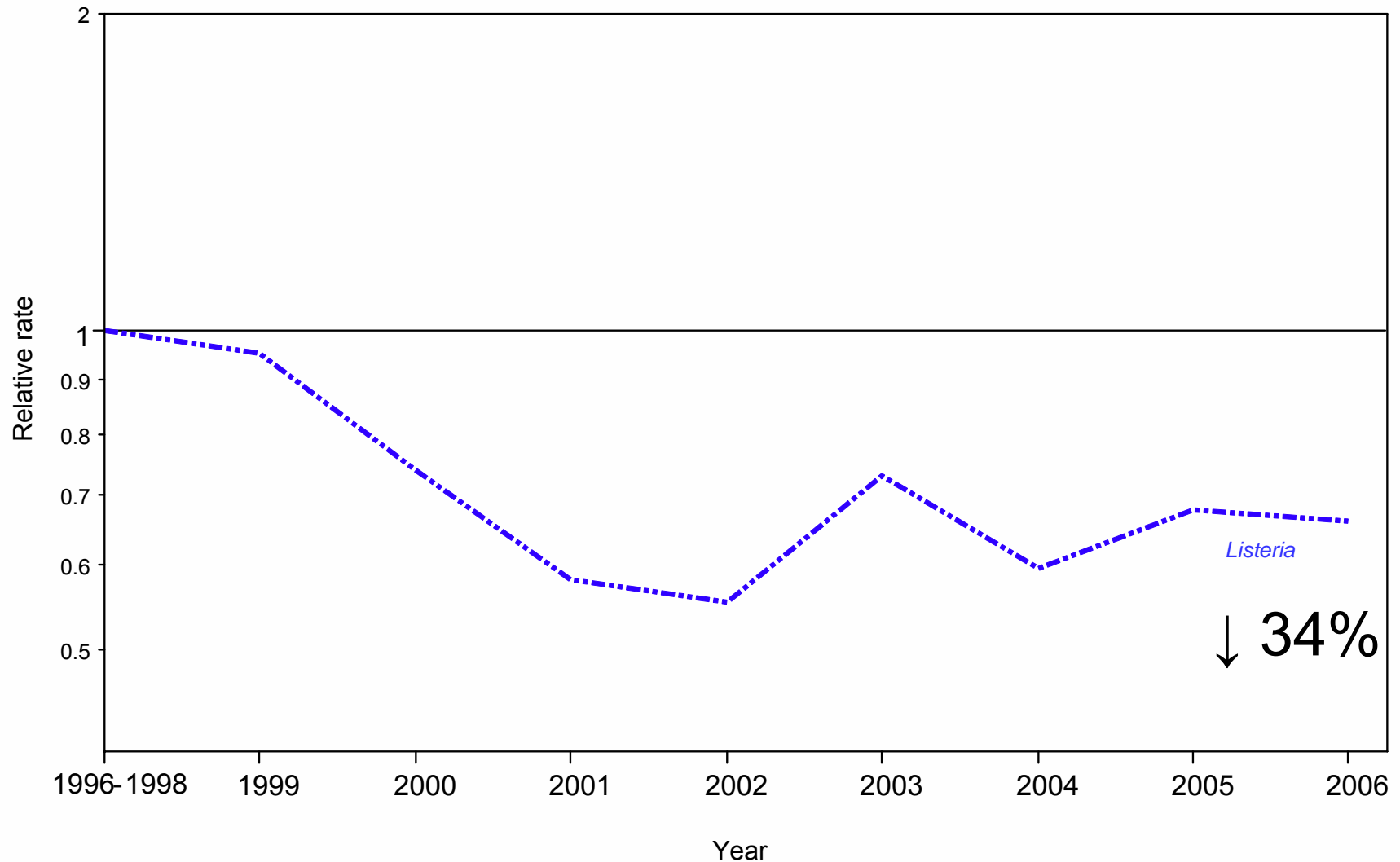
Relative rates compared with 1996—1998 baseline period of laboratory-diagnosed cases of infection with *Campylobacter*, by year



# Healthy People 2010 Objectives

|                      | Cases per 100,000 |                |
|----------------------|-------------------|----------------|
| Pathogen             | 2006              | 2010 Objective |
| <i>Campylobacter</i> | 12.71             | 12.30          |

## Relative rates compared with 1996—1998 baseline period of laboratory-diagnosed cases of infection with *Listeria*, by year



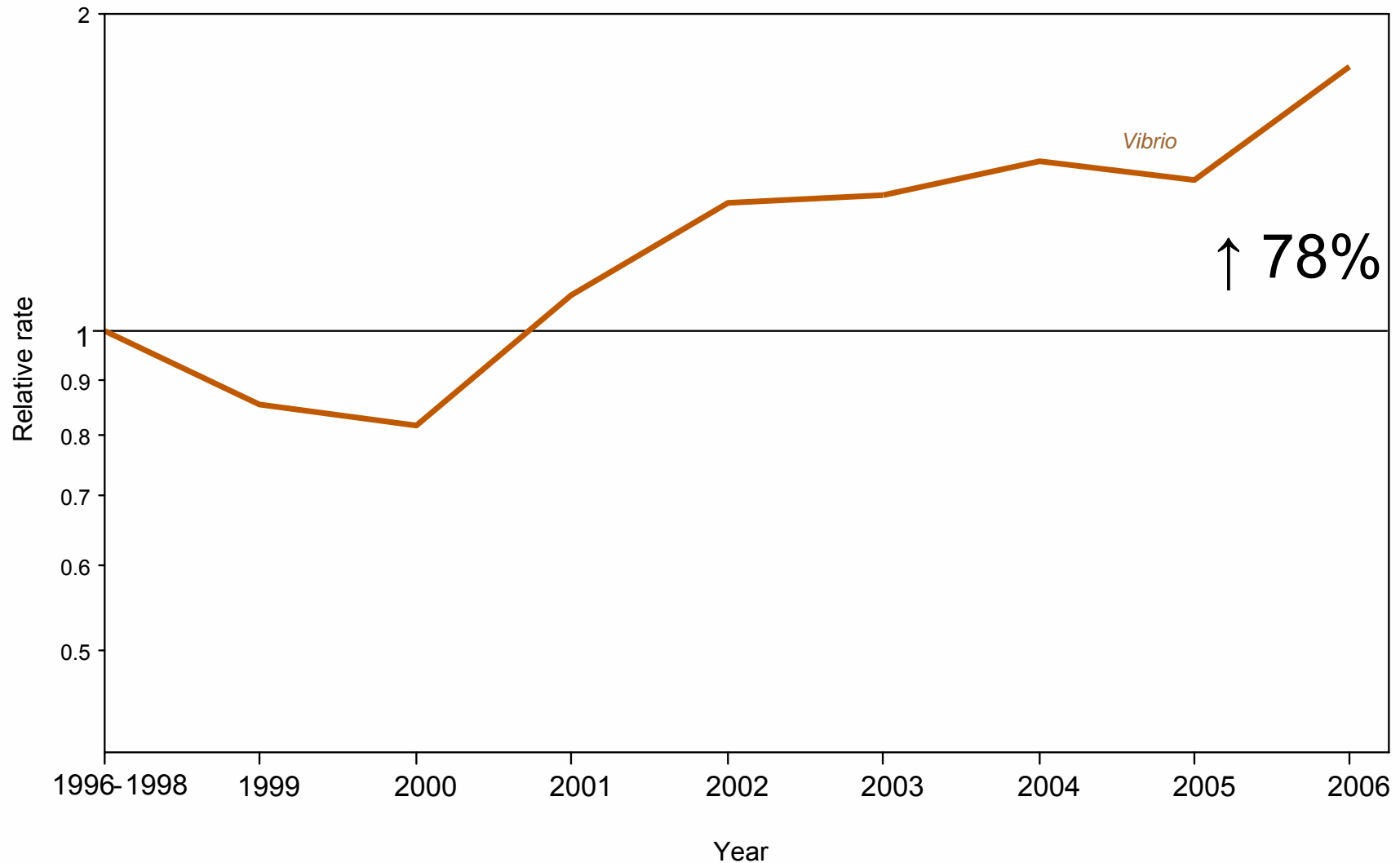
# Healthy People 2010\* Objectives

|                 | Cases per 100,000 |                |
|-----------------|-------------------|----------------|
| Pathogen        | 2006              | 2005 Objective |
| <i>Listeria</i> | 0.31              | 0.25           |

\*Changed to 2005

- Voetsch et al. (2007) Reduction in the incidence of invasive listeriosis in Foodborne Diseases Active Surveillance Network Sites, 1996-2003. *Clin Infect Dis* 44:513-520.

**Relative rates compared with 1996—1998 baseline period of laboratory-diagnosed cases of infection with *Vibrio*, by year**



# Trend in *Vibrio*

- Incidence in 2006 increased to highest level since FoodNet began active surveillance
- Infections associated with consumption of raw seafood, particularly oysters
- Additional measures needed to reduce
  - Contamination of seafood
  - Consumption of contaminated raw seafood

# Summary of FoodNet Trends

- Incidence of *Campylobacter* and *Listeria* has declined
- Little change in incidence of *E. coli* O157 and *Salmonella*
- *Vibrio* infections have increased
- Further measures are needed to prevent foodborne illness and meet Healthy People 2010 Objectives

# Update on FoodNet Activities

- *E. coli* O157
- *Salmonella*
- *Campylobacter*
- Other Activities
  - Burden of illness estimates
  - Population Survey
  - *C. difficile* enhanced surveillance

# *E. coli* O157

# Attribution

- FoodNet sporadic case-control studies conducted in 1996 and 1999
  - Eating pink hamburgers, farm exposure, cattle exposure, drinking untreated surface water, and eating at a table-service restaurant
- Priority at 2007 FoodNet Vision Meeting
  - 3<sup>rd</sup> *E. coli* O157 case-control study?
  - FoodNet sites routinely interview *E. coli* O157 cases
    - Review and standardize some key questions

# Blending project

***e.g. E. coli O157:H7***

- FoodNet sporadic case-control study
  - 15% due to eating pink hamburgers
  - 8% due to visiting a farm
- Summary of outbreaks\*
  - 20% due to eating hamburgers
  - 4% due to animal contact

***\*Rangel et al. EID 11:603-9, 2005***

# *E. coli* O157:H7 Cohort Study

- Launched January 2006
- Determine risk of developing HUS associated with antibiotic exposure, microbiological and clinical characteristics
- Patients interviews, chart reviews, and isolate typing (including PFGE, *eae* and Stx genes, suscept testing)
- Status: 529 eligible; 336 enrolled

# Genomics Study

- Patients enrolled in *E.coli* O157 cohort study
- Objectives to:
  - Determine host factors contribute to the HUS among patients with *E. coli* O157
  - Characterize genes known to be involved in non-infectious HUS using SNP analysis
- DNA from mouthwash samples
- Status: TN enrolled 19; sites awaiting IRB approval

# *Salmonella*

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# Attribution

- *Salmonella* attribution project comparing subtypes from humans and animal-food groups
  - Application of Danish Attribution model
  - Working group lead by USDA-FSIS
- 1st iteration presented at FoodNet Vision Meeting in March 2007
  - Validation and further exploration of the model priority for 2007

# Sporadic Case-control study

- Most recent study launched January 2007
- Sporadic infections due to *S. Javiana*,  
*S. Infantis*, *S. I 4*, [5], 12:i:-
- Objective to identify behavioral, dietary,  
medical risk factors
  - Serotypes selected due to increases in  
prevalence, lack of info on reservoirs and risk  
factors
- Status: 60 eligible; 27 enrolled

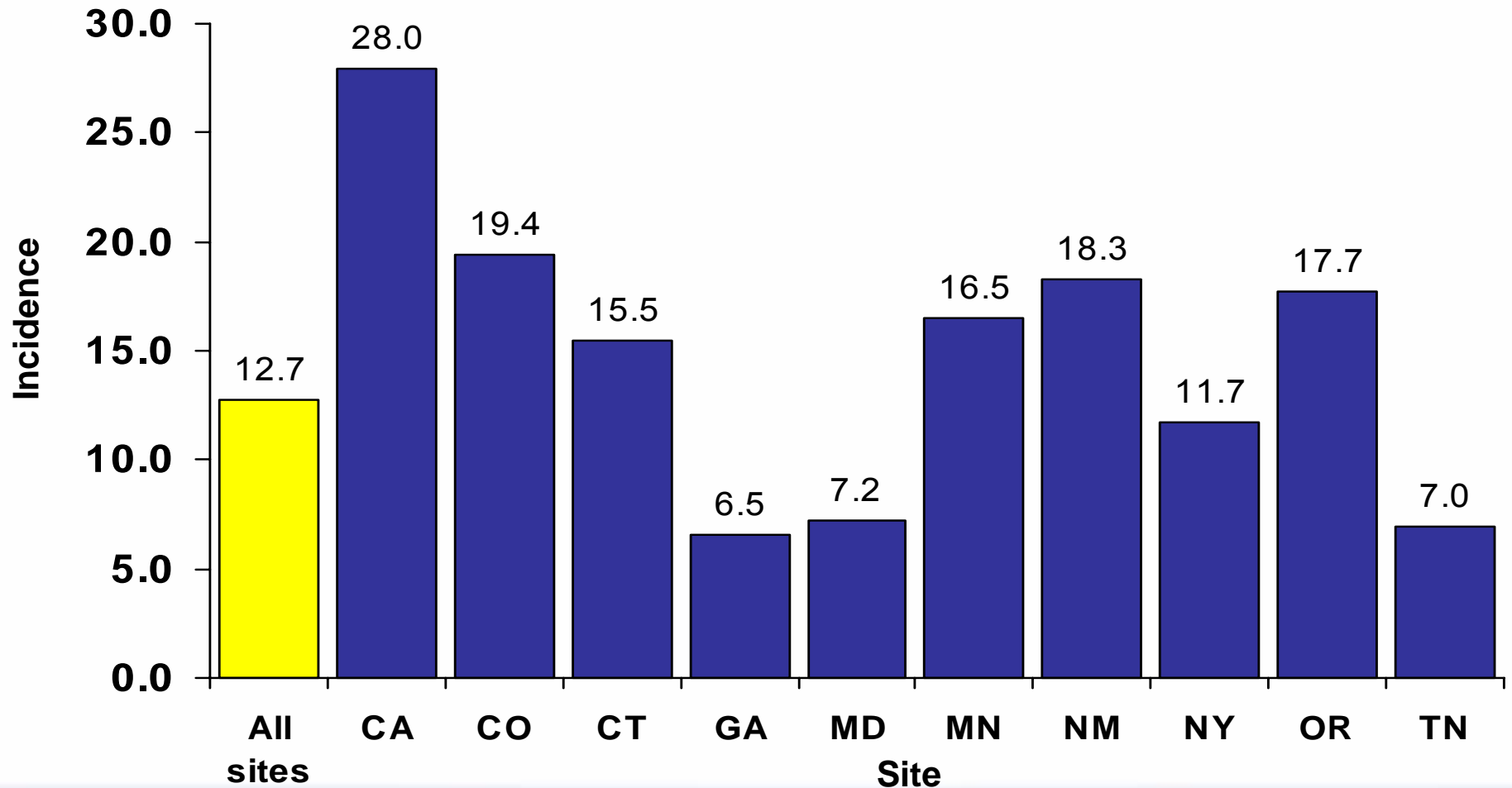
# Clinical Outcomes Study

- Launched January 2006 (2-year study)
- Determine and compare severity of clinical outcomes among infections with pansusceptible and multi-drug resistant non-typhi *Salmonella*
- Status: 804 eligible; 546 enrolled

# *Campylobacter*

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# Incidence of *Campylobacter* per 100,000 persons in FoodNet, 2005



# *Campylobacter* Laboratory Survey

- 582 clinical diagnostic laboratories serving 9 sites in catchment area
- Preliminary descriptive analysis complete
  - Perform onsite testing for *Campy*: 97%
  - Conduct routine *Campy* testing: 90%
  - Draft manuscript circulating to co-authors
- Analytic analysis ongoing
  - Link FoodNet incidence with laboratory methods for isolation

# Grocery Store Sampling of Chicken

- Pilot phase launched October 2006
- Prevalence on chicken does not correlate with incidence of infection
  - 53% in CA vs. 5% in TN in 2003
- Quantify *Campy* on retail chicken products in CA and TN
  - USDA-ARS laboratory perform quantification
- Low recovery: pilot phase extended
  - Reviewing protocol to link with FSIS baseline (whole carcass)

# Other Activities

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# Burden of illness estimates

- Revising estimate overall burden of foodborne disease
- Plan to estimate
  - Cost and economic impact
  - Disability Adjusted Life Years (DALYs)

# Population survey

- Fifth cycle in progress (ends April 2007)
- Information collected on:
  - Diarrhea, vomiting
  - Health-seeking behavior
  - Consumption of produce, dairy and meats

## ***C. difficile* enhanced surveillance**

- Epidemic strain causing illness in community?
- In 2006, 3-month surveillance in FoodNet sites
- Identify community-onset CDAD
  - Toxin-positive cases with no known hospitalization in the 3 months prior to specimen collection
  - Isolates tested by PFGE, toxinotyping, deletion analysis of *tcdC*, detection of binary toxin, antimicrobial susceptibility

# *Clostridium difficile*

- Anaerobic, spore-forming bacteria
- Produces two toxins (A and B)
  - Some strains produce additional binary toxin
- *Clostridium difficile*-associated disease (CDAD)
- Most common cause of antimicrobial-associated diarrhea
- Little is known about *Clostridium difficile* in the community

# Laboratory testing

- CDAD diagnosed in clinical laboratories by detection of toxin
  - Rapid toxin detection kits available
- Anaerobic isolation of *Clostridium difficile* from stool specimen
  - Labor intensive
  - Not routinely done by clinical laboratories

# *Clostridium difficile*

- Historically causes outbreaks in hospitals
- Isolates
  - Toxinotype 0
  - Variety of PFGE patterns
  - Usually do not produce binary toxin
  - “Hospital” strains

# *Clostridium difficile*

- Numerous outbreaks in hospitals with increased severity of illness
- Isolates
  - Toxinotype III
  - PFGE North American pattern 1 (NAP1)
  - Binary toxin
  - Deletion in *tcdC*
  - “Epidemic” strain
- “Epidemic” strain caused severe community onset CDAD
  - No apparent contact with healthcare facilities
  - No prior use of antimicrobials



# *Clostridium difficile*

- Cause of diarrheal illness in animals
  - Pigs, calves, horses, dogs
- *Clostridium difficile* isolated from chicken and pork in U.S. and Canada
- Isolates
  - Toxinotype V
  - Binary toxin
  - Deletion in toxin regulatory gene *tcdC*
  - “Animal” strains
- “Animal strains” are a rare cause of human infections

# Public health research questions

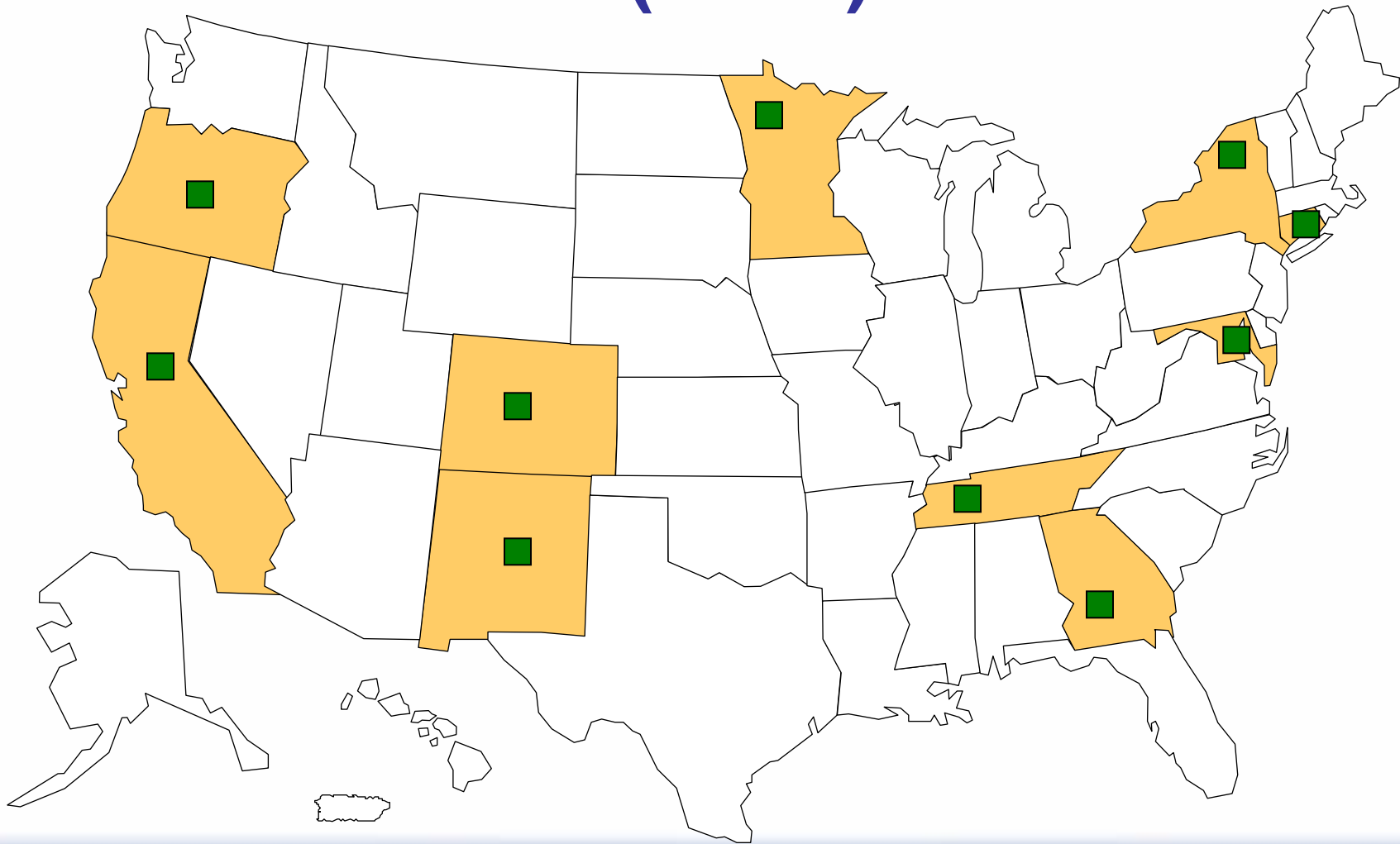
- Since people can be infected with *Clostridium difficile* outside of healthcare facilities
  - What proportion of patients with CDAD have illness onset in community?
  - What strains cause CDAD in the community?
- *Clostridium difficile* pilot study
  - Enhanced surveillance for community-onset CDAD in FoodNet sites

## ***C. difficile* enhanced surveillance**

- Identified 175 cases of community-onset *C. difficile* associated disease
  - 104 (59%) culture positive
  - 92 (88%) confirmed and characterized by CDC
    - Epidemic strain (III, NAP1): 15 (16%)
    - Strain 0 (hosp-assoc): 48 (52%)
    - Strain V (assoc w/ animal disease): 9 (10%)

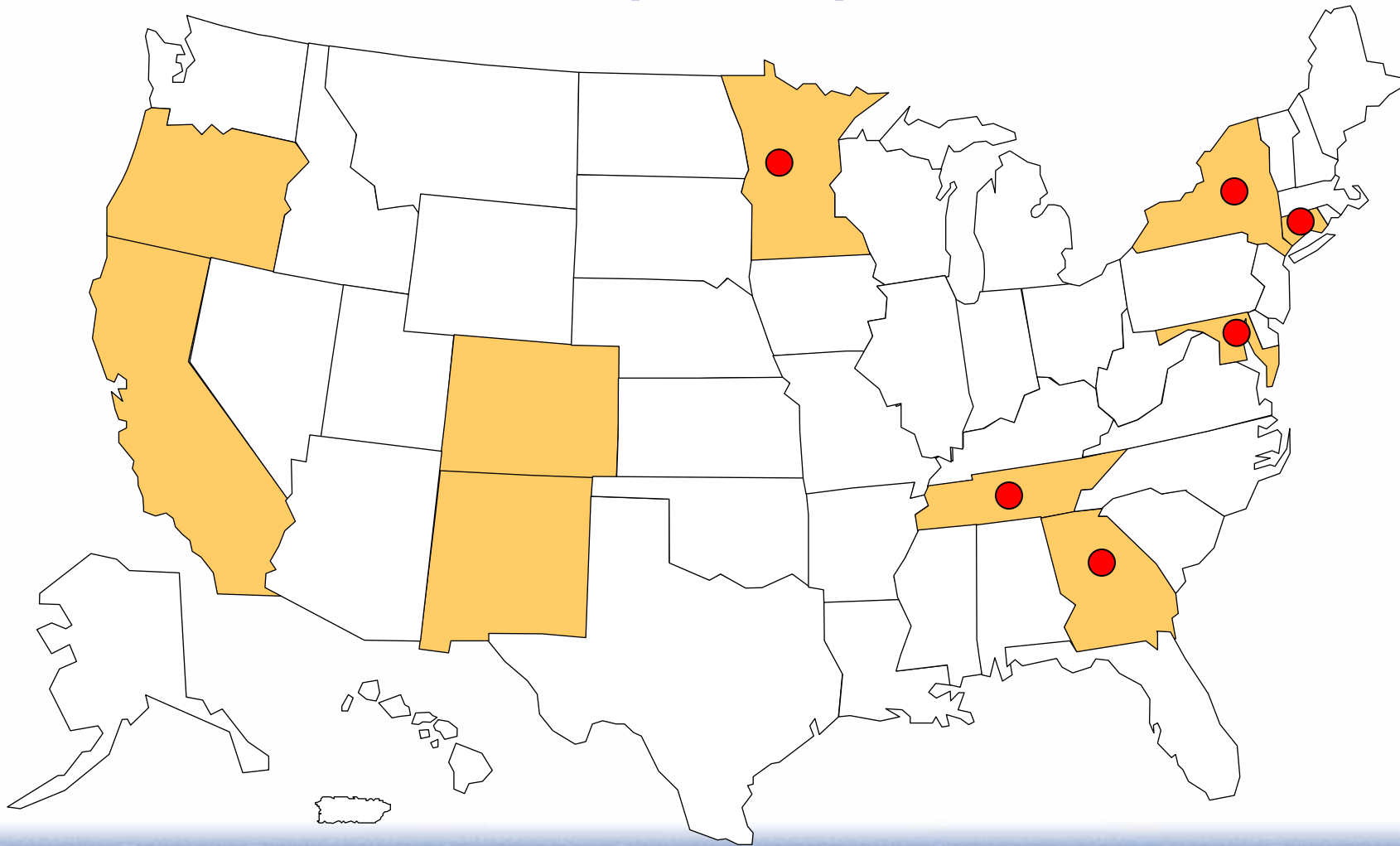
# *Clostridium difficile* strains FoodNet (N=92)

■ "Hospital" strains



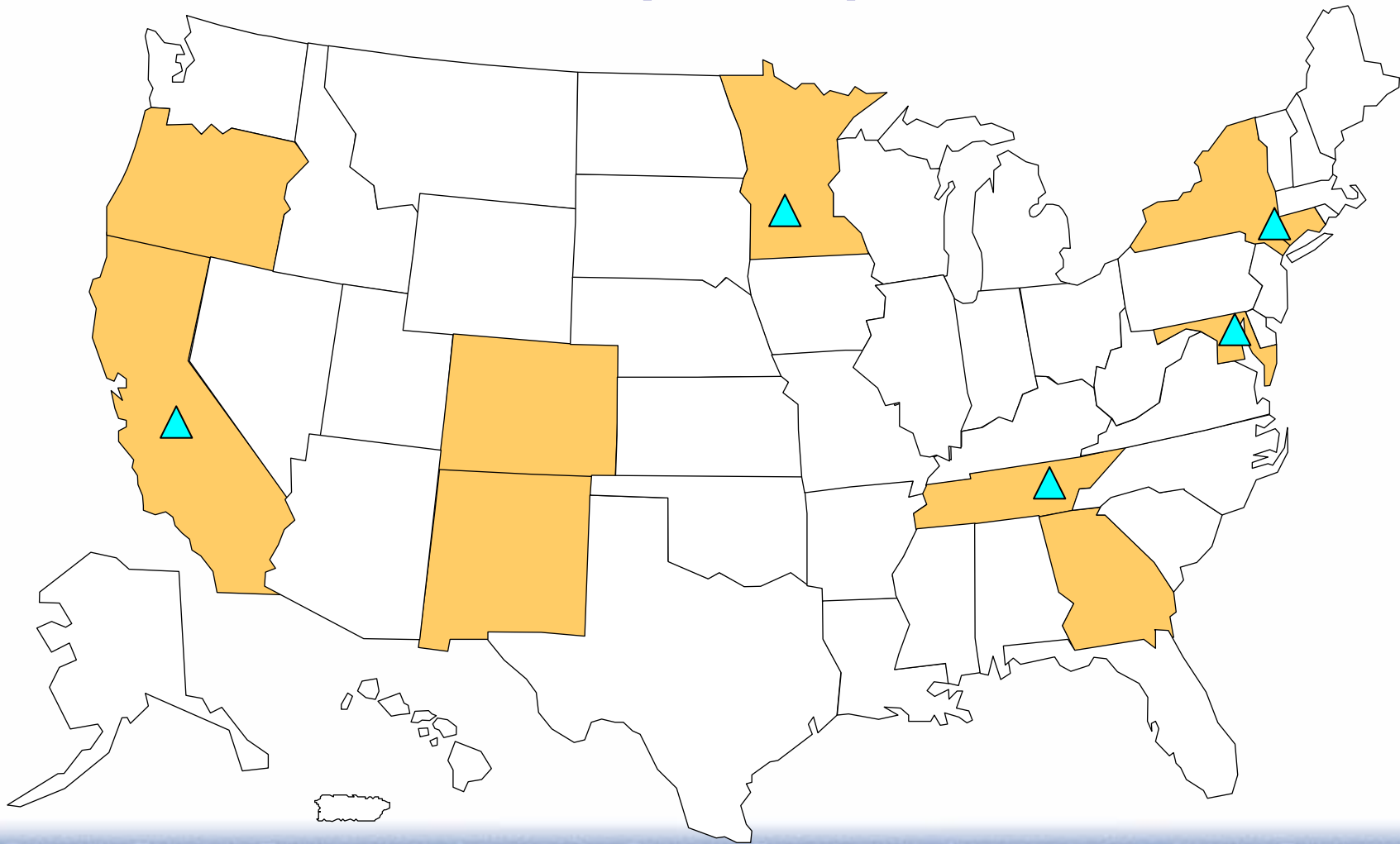
# *Clostridium difficile* strains FoodNet (N=92)

● "Epidemic" strain



# *Clostridium difficile* strains FoodNet (N=92)

▲ “Animal” strains



# Limitations

- Patients with healthcare facility contact but who did not stay overnight in a healthcare facility were not excluded
  - May have acquired CDAD in healthcare facility
- Patients were not interviewed, the definition of community-onset CDAD was based only on medical record review
  - Cannot rule out undetected healthcare facility contact

# Further research

- Sources of community-onset CDAD
  - Prospective case-control study proposed
    - Focus on identifying behavioral, dietary, and medical risk factors
  - Intriguing questions:
    - Is food a source of “animal” strains of *Clostridium difficile* infections for humans?
    - Is food a source of the “epidemic” strain of *Clostridium difficile* infections for humans?

# FoodNet provides

- Stable surveillance for a variety of pathogens and syndromes
  - Report card on the food safety system of the U.S., used by public health, regulatory agencies and industry
- Critical data for updating overall burden estimates
- Platform for attributing burden to specific foods
- Mechanism for rapid institution of surveillance of new and emerging enteric pathogens

# FoodNet Working Group

## 2006

### CDC

Frederick Angulo  
Heather Bair-Brake  
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Susan Brooks  
Claudia Crandall  
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Sharon Hurd  
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Aristea Kinney

Mona Mandour  
Laurin Mank  
Ruthanne Marcus  
Patricia Mshar  
Quyen Phan  
Charles Welles

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Jennifer Gillespie  
Tameka Hayes  
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Matthew Johns  
Susan Lance  
Paul Malpiedi  
Pat Martell-Cleary  
Mahin Park  
Christina Payne  
Kate Phillips  
Lynett Poventud  
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Susan Ray  
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Melissa  
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Kirsten Larson  
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Amber Starn  
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Carlota Medus  
Joni Scheftel  
Brian Lee  
Stephanie Wedel  
John Besser  
Dawn Kaehler  
Stephen Swanson  
Theresa Weber

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Lisa Butler  
Karen Johnson  
Joanne Keefe  
Sarah Lathrop  
Kathy Villa

### New York

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Hwa-Gan Chang  
Nellie Dumas  
Dina Hoefer  
Jillian Karr  
Dale Morse  
David Nicholas  
Candace  
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Tim Root  
Dianna  
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Glenda Smith  
Perry Smith  
Nancy Spina  
Shelley Zansky

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Paul Cieslak  
Emilio DeBess

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James Mack  
Melissa Plantenga  
Beletshachew Shiferaw  
Janie Tierheimer  
Rob Vega

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Amanda Ingram  
Timothy Jones  
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Marcy McMillian

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Myra Gardner  
David Goldman  
Jane Harman  
Kristin Holt  
Lynn Larsen  
Priscilla Levine

### USDA-FSIS (con't)

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Nisha Oatman  
Heather H. Quesenberry  
Bonnie Rose  
Bernard Salamone  
Carl Schroeder  
Scott Seys  
Reuben Varghese  
Patricia White

### FDA-CFSAN

Jack Guzewish  
Patrick McCarthy  
Eileen Parish  
Clifford Purdy

### FDA-CVM

David White



# Thank you!

<http://www.cdc.gov/foodnet>

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**An epidemic hospital strain as a  
cause of community-onset  
*Clostridium difficile*-associated  
disease: FoodNet pilot study, 2006**



# *Clostridium difficile*

- Isolates can be subtyped by:
  - Pulsed-field gel electrophoresis (PFGE)
- Isolates also characterized by toxinotyping
  - Polymerase-chain reaction (PCR)
  - More than 20 toxinotypes have been identified
- Isolates further distinguished by
  - Production of a binary toxin
  - Deletion of the toxin regulatory gene (*tcdC*)

# Objectives

- Isolate *Clostridium difficile* from stool specimens from patients with community-onset CDAD
- Characterize the isolates causing community-onset CDAD

# Goal

- Collect 100 isolates from patients with community-onset CDAD

# Methods

- Three month period in 2006
- Participating clinical laboratory
  - Routinely tested stool specimens from patients with diarrhea for *Clostridium difficile* toxin
- Epidemiologist reviewed medical records for history of overnight stay in healthcare facility
- Participating culturing laboratory
  - Cultured *Clostridium difficile* toxin positive stool specimens from patients with community-onset CDAD

# Case definition

## Community-onset CDAD

- A patient with diarrheal illness
- Sought medical care
- *Clostridium difficile* toxin positive stool specimen
- No overnight stay in healthcare facility in the 3 months prior to illness onset based upon medical record review

# Community-onset CDAD

- Participating culturing laboratories cultured stool specimens for *Clostridium difficile*
- Presumed *Clostridium difficile* isolates sent to DHQP at CDC
  - Confirmation
  - Strain characterization
    - PFGE
    - Toxinotyping

# Results

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# Laboratory testing

1571 *Clostridium difficile* toxin positive stool samples collected

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175 Community-onset CDAD (medical record review)

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104 Presumed *Clostridium difficile* isolates

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175 Community-onset CDAD (medical record review)

104 Presumed *Clostridium difficile* isolates

92 Isolates received and confirmed at CDC

# Isolates (n=92) from patients with community-onset CDAD

|                                    |          |
|------------------------------------|----------|
| “Hospital” strains (toxinotype 0)  | 48 (52%) |
| “Epidemic” strain (toxinotype III) | 15 (16%) |
| “Animal” strains (toxinotype V)    | 9 (10%)  |
| Six other toxinotypes              | 20 (22%) |

# Demographic information of the 92 patients

|            | “Hospital”<br>strains | “Epidemic”<br>strain | “Animal”<br>strains |
|------------|-----------------------|----------------------|---------------------|
| Median age | 57 yr                 | 60 yr                | 74 yr               |
| Female     | 60%                   | 53%                  | 67%                 |

# PFGE characterization of the 92 *Clostridium difficile* isolates from patients with community-onset CDAD

“Hospital”  
strains (n=48)

“Epidemic”  
strain (n=15)

“Animal”  
strains (n=9)

10% NAP2

100 % NAP1

66% NAP 7

10% NAP3

34% unnamed

19% NAP4

8% NAP6

52% unnamed

# Conclusion

- Community-onset CDAD caused by genetically diverse *Clostridium difficile* strains
  - “Hospital” strains
  - “Epidemic” strain
  - “Animal” strains
- Animal strains caused illness in humans in the community
- Consider *Clostridium difficile* as cause of diarrhea in the community

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**Disclaimer:** The findings and conclusions in this presentation are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention