

Non-O157 STECs: What do we know and what are the issues?

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Death in CCC due to STEC O21

- Severe disease and death can occur with non-O157 STEC infection, even in an adult
- Lab results included no demographic information delaying public health follow up
- Fecal broth forwarded to PH appropriately in this case; but still delay in serotyping; not a common non-O157 serogroup
- Difficult to implicate a source with a single case unless food testing positive or cluster identified
- How should public health follow up be conducted while waiting for final lab results?

Outline of Today's Talk

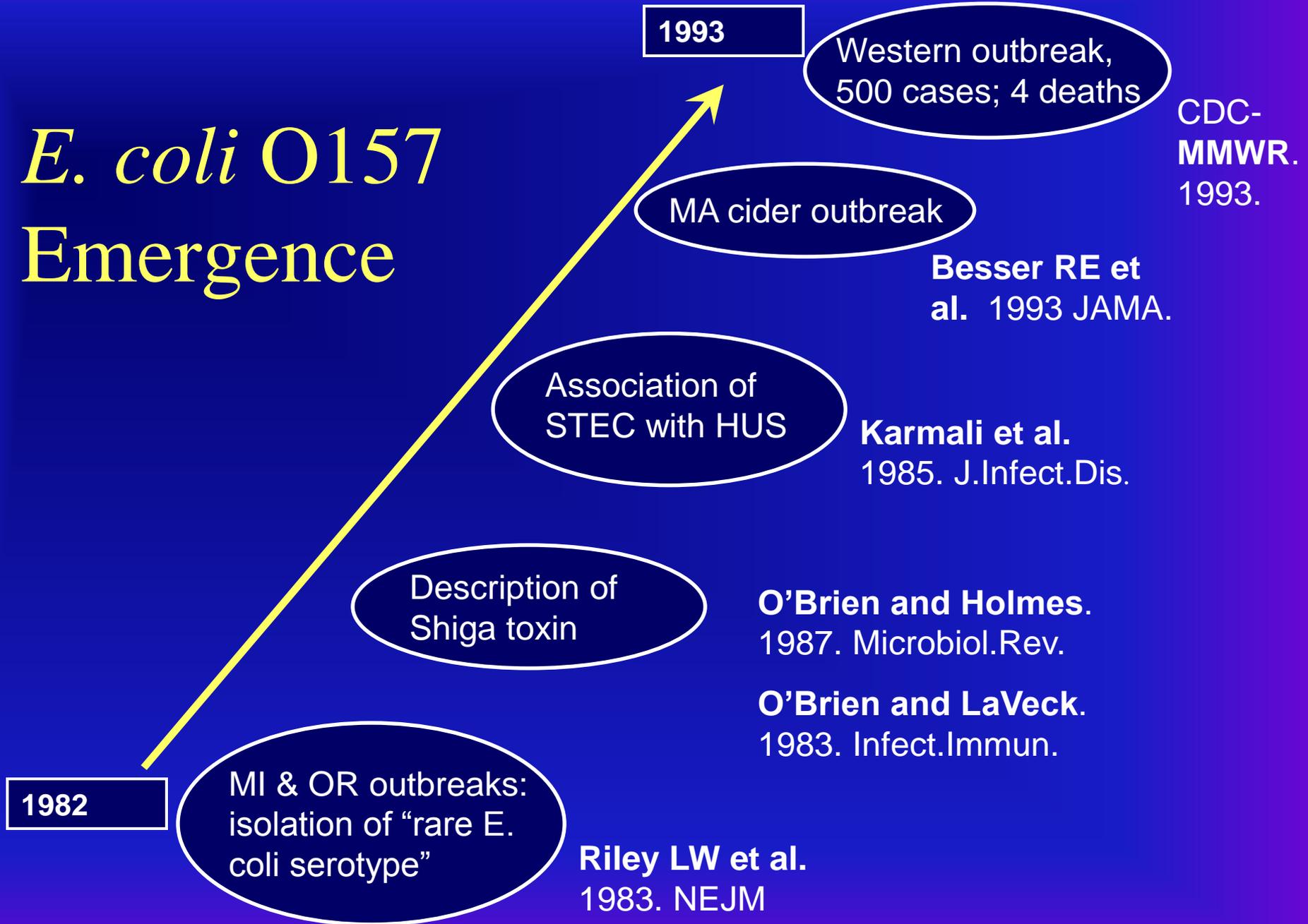
- O157 STEC emergence and epidemiology
- Non-O157 STEC emergence and epidemiology
- Non-O157 STEC in Connecticut and Minnesota
- Non-O157 STEC in California
- What do we know and what are the issues?

***E. coli* that cause human gastrointestinal illness**

- **Shiga Toxin-producing *E. coli* (STEC), also called Enterohemorrhagic *E. coli* (EHEC)**
 - ***E. coli* O157 serogroup**
 - **Non-O157 serogroups (~250 to date; >100 associated with illness)**
- **Enteropathogenic (EPEC)**
- **Enterotoxigenic (ETEC)**
- **Enteroinvasive (EIEC)**
- **Other types, less well characterized**



E. coli O157 Emergence



E. Coli O157 : H7

Disease:

Abdominal cramps, diarrhea (bloody and non-bloody), vomiting, H.U.S., death

Diagnosis:

Stool culture (Sorbitol-MacConkey agar), serotyping, Shiga toxin EIA

Treatment:

Supportive

E. coli O157 : H7

EPIDEMIOLOGY

Foodborne: undercooked ground beef, raw milk, dry-cured salami, unpasteurized apple juice / cider, lettuce, alfalfa sprouts

Waterborne: recreational, municipal

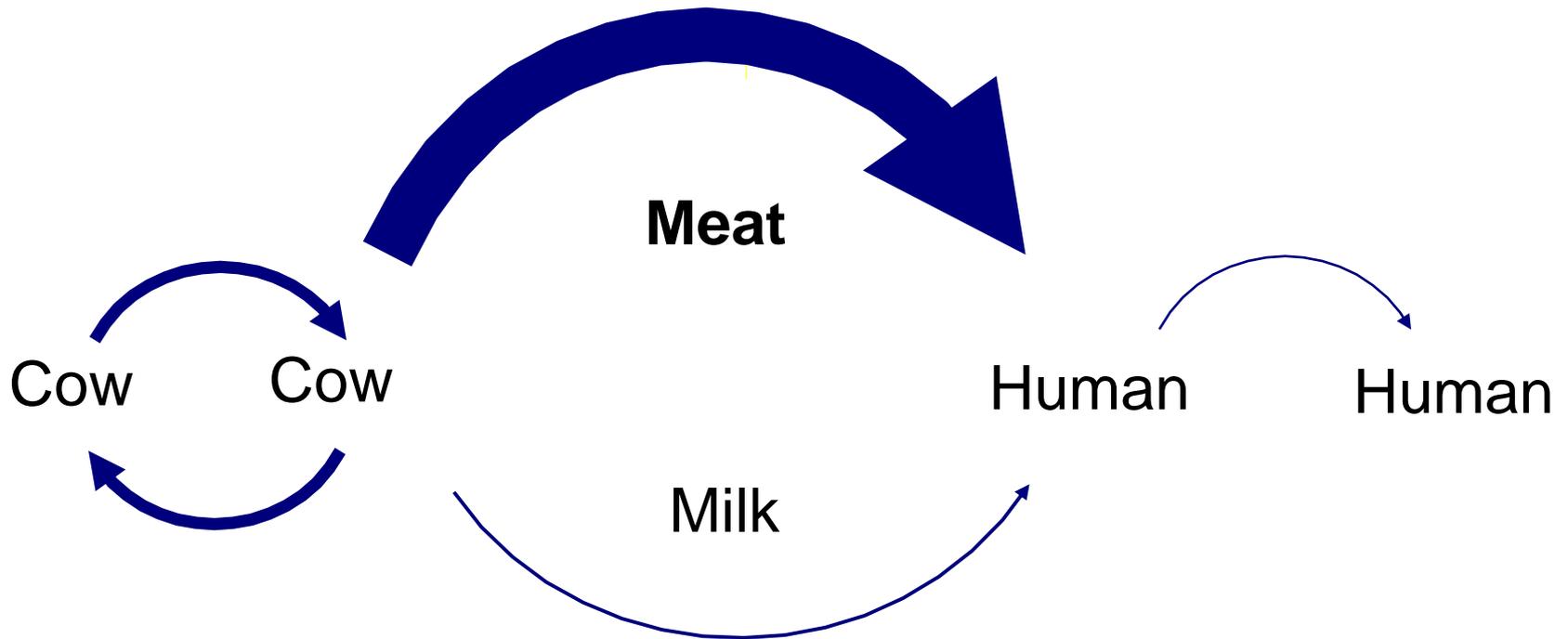
Person-to-person: intrafamilial, day care centers, nursing homes

Others: contact with farm animals at fairs, petting zoos, farms

Animals are the reservoirs for STEC

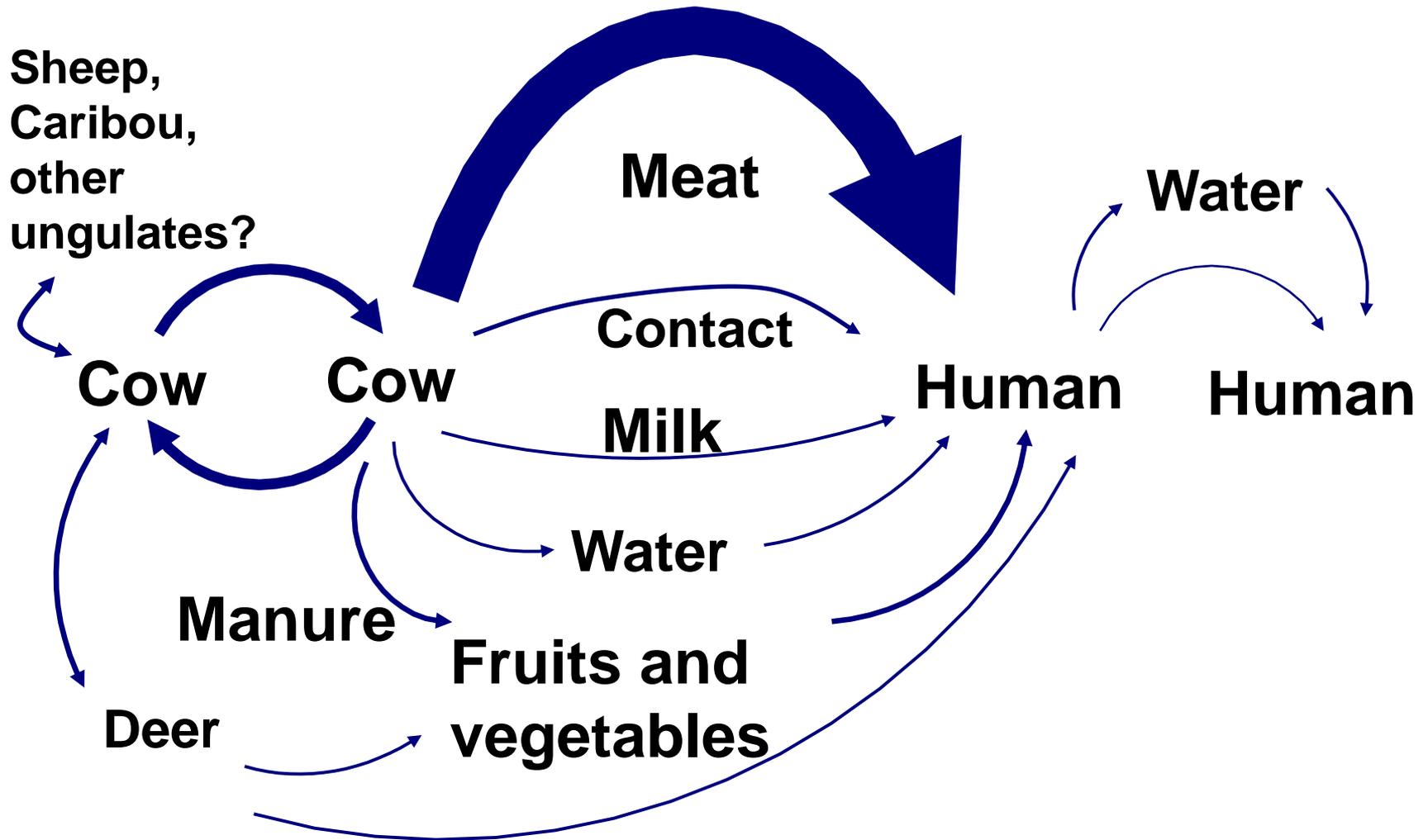
- Cattle
- Other ruminants (deer, sheep, goats, ...)
- Other animals
 - especially those who have contact with cattle

E. coli O157:H7 foodborne transmission The 1988 model



E. coli O157:H7 foodborne transmission

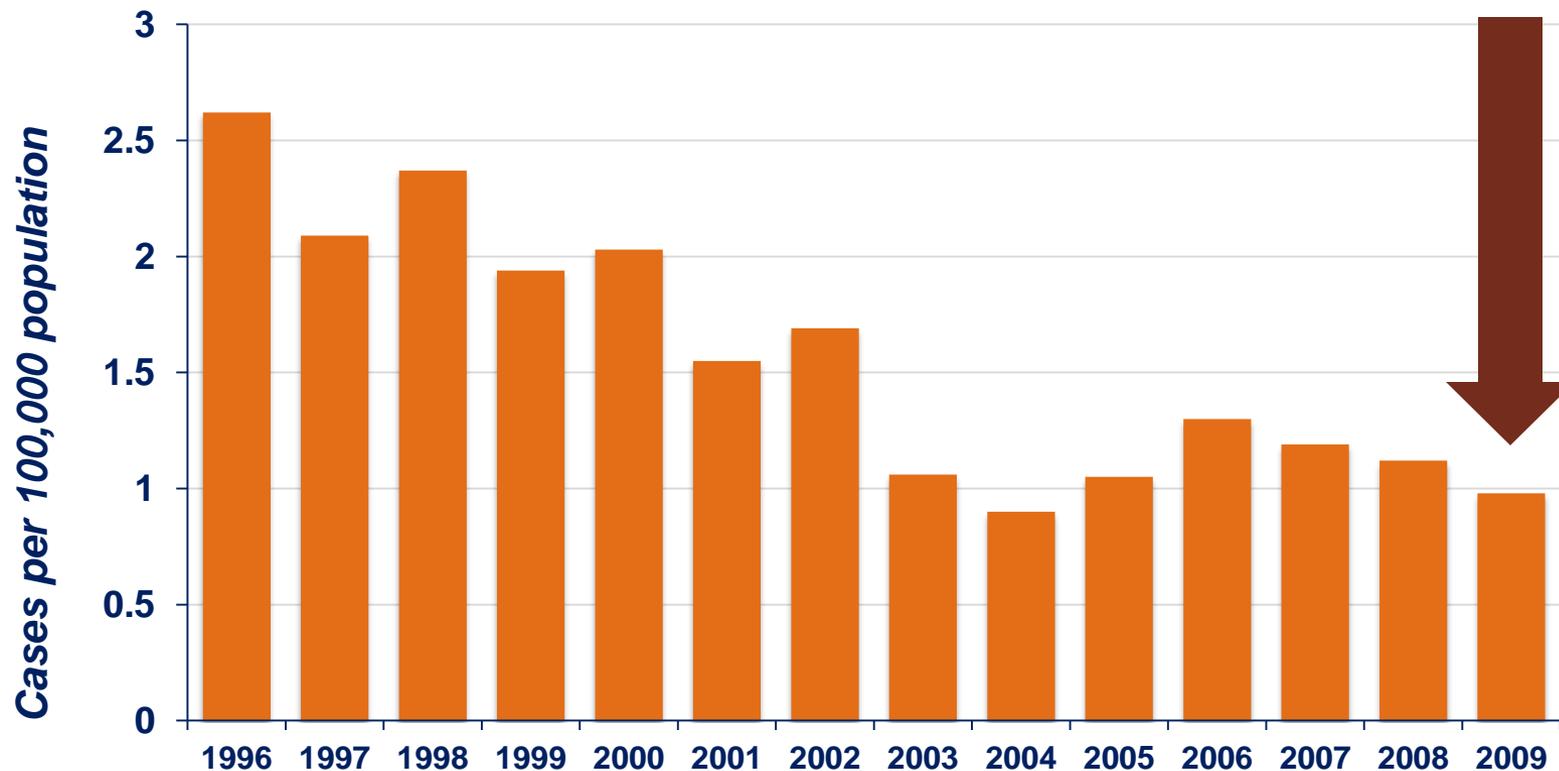
The 2003 model



Tracking progress

Met Healthy People 2010 goal 1 year early

Incidence rate of E. coli O157:H7 infections by year, 1996–2009, FoodNet

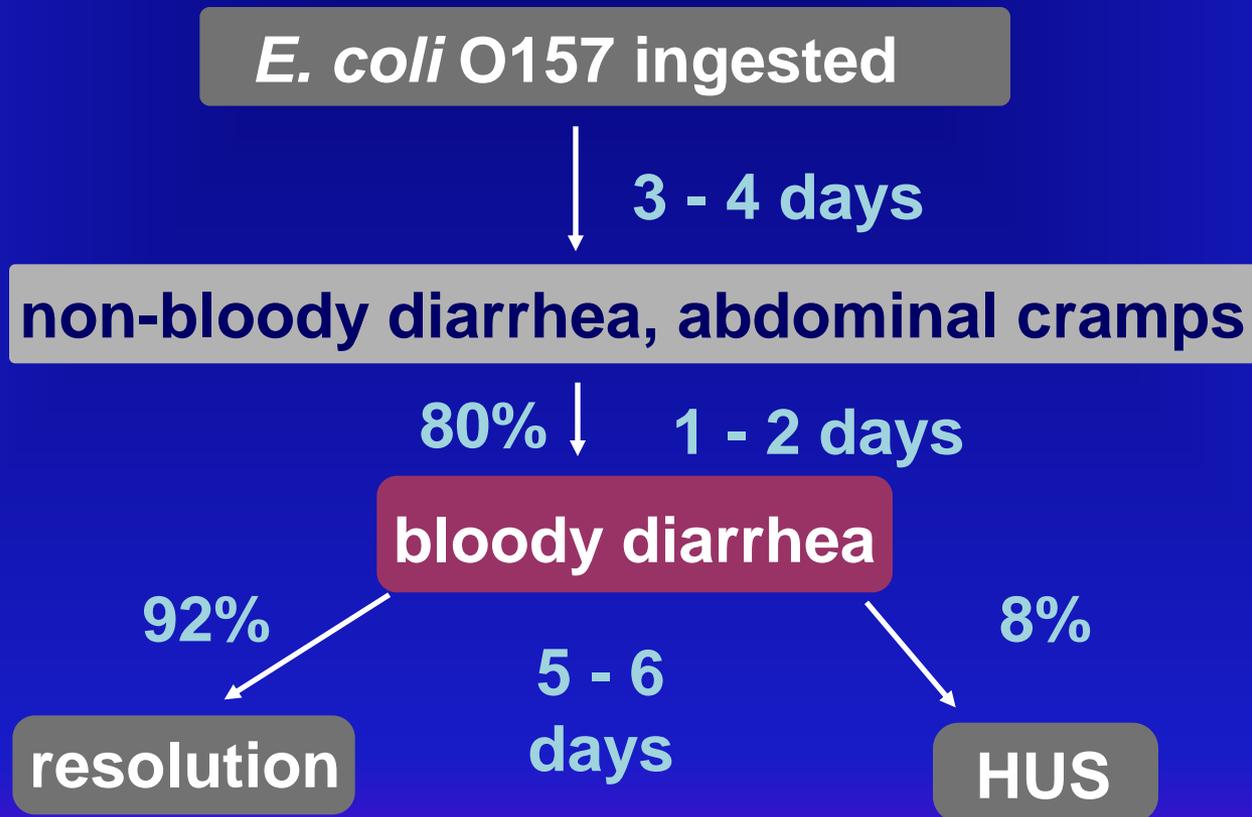


Activities Contributing to E.coli O157 Control in the US

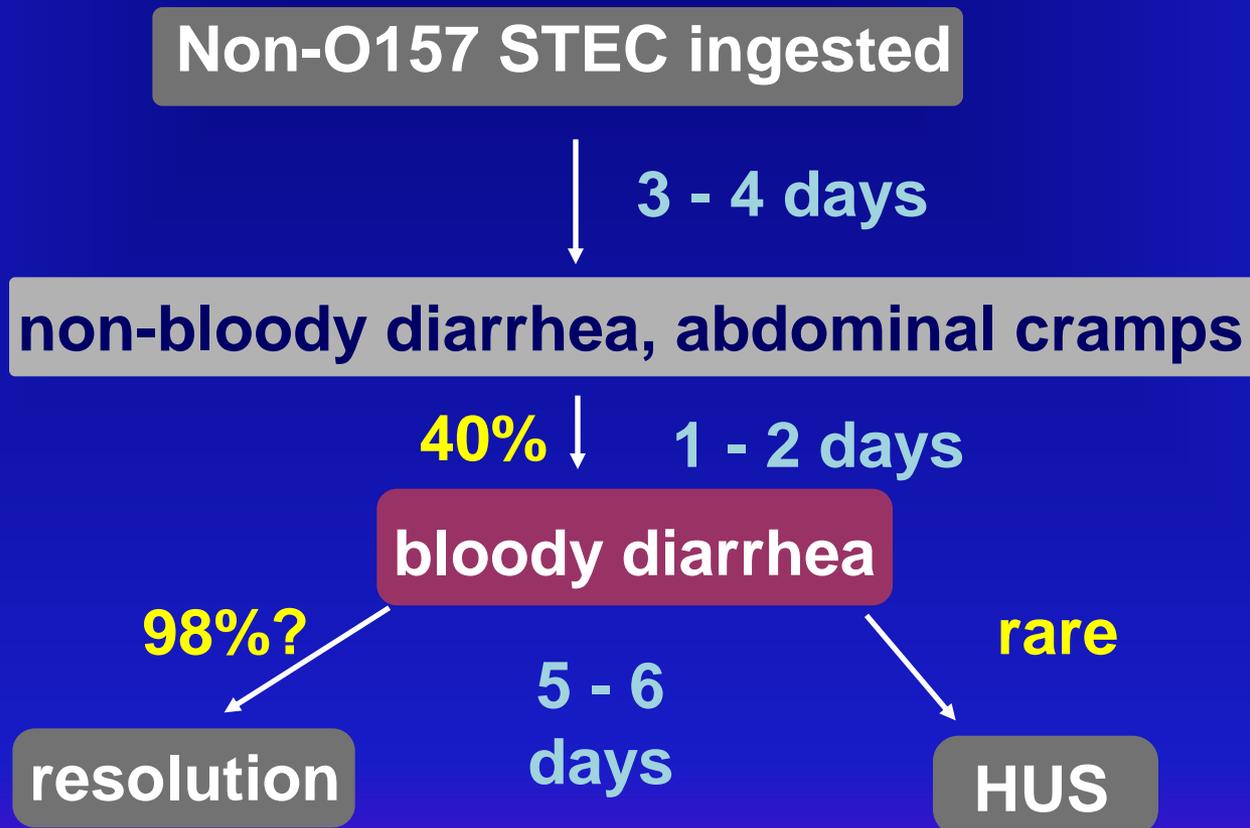
- **Monitor food production:** reduce contamination at farms, factories, and slaughterhouses (e.g., HACCP).
- **Prevent food contamination:** train restaurant managers and educate consumers in food safety (e.g., cook hamburgers well done).
- **Monitor and investigate illnesses and outbreaks:** prevent more cases; recall implicated foods; identify new risks.
- **Review and reset food safety policies:** made O157 an “adulterant” to facilitate recalls.

**What about
non-O157
STEC?**

Sequence of events in *E. coli* O157:H7 infection



Sequence of events in non-O157 STEC infection



Compared to persons with *E. coli* O157 infection,

- **persons with non-O157 STEC have less severe illness**
- **But non-O157 STEC include many serogroups, with varying virulence**
 - some typically cause only mild diarrhea
 - others can cause HUS and death

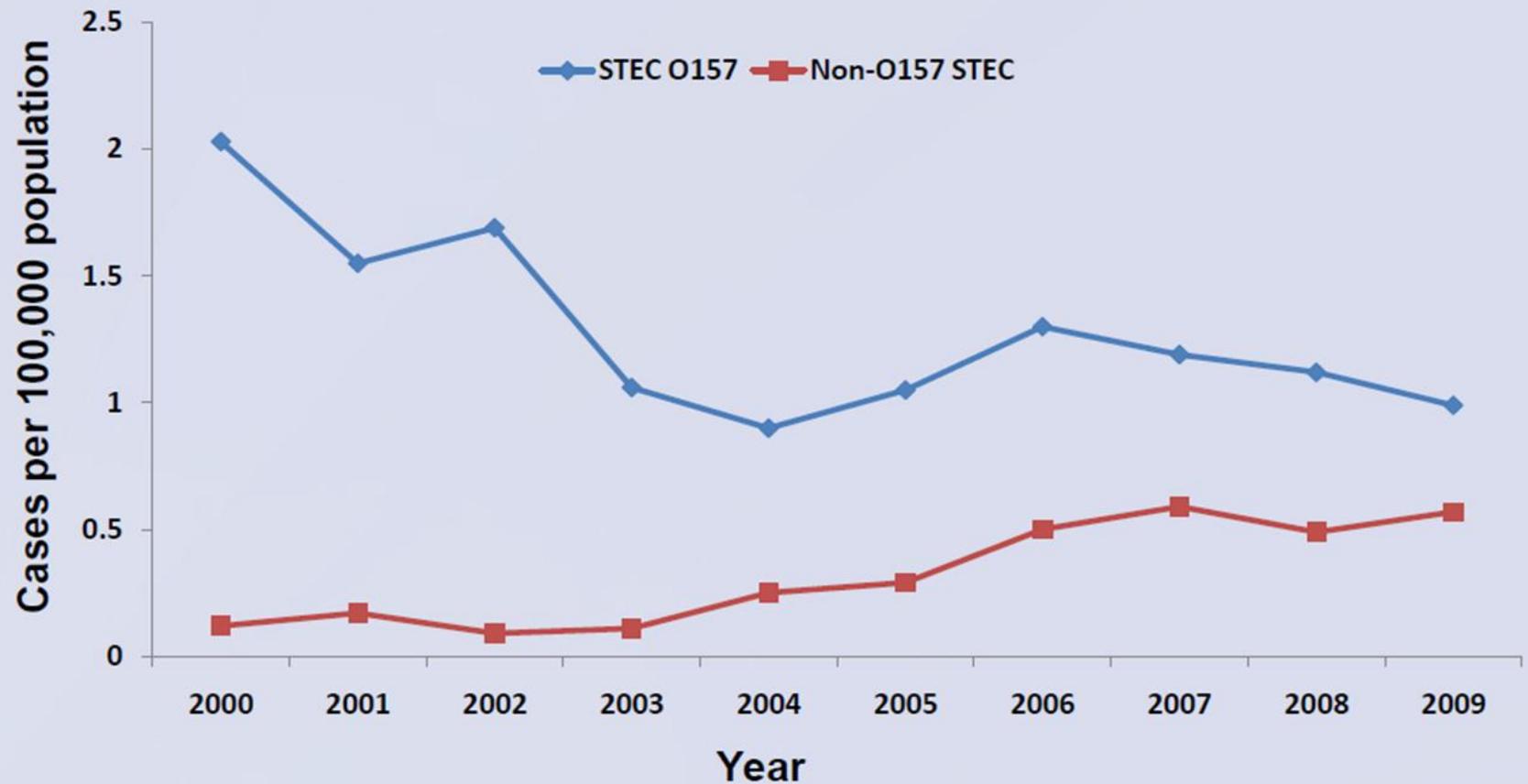
Timeline of public health reporting recommendations for STEC

- 1994** *E. coli* O157 infection nationally reportable (1996 in CA)
- 1995** Commercial Shiga toxin enzyme immunoassay (EIA) introduced
- 2000** Non-O157 STEC infections nationally reportable (2007 in CA)

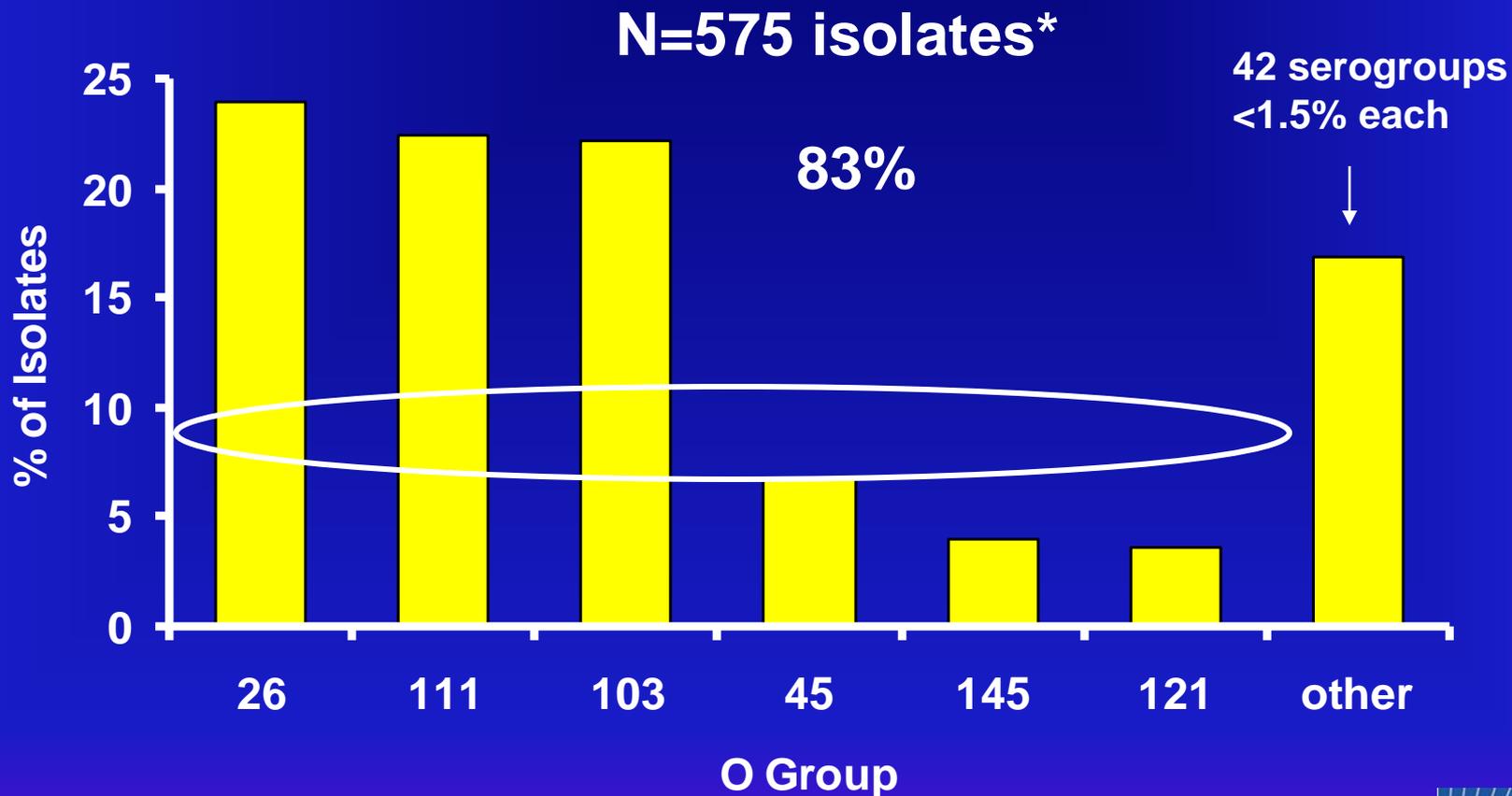
How do we learn about non-O157 STEC?

- FoodNet (Foodborne Disease Active Surveillance Network) surveillance data
- Some clinical labs isolate non-O157 STEC
 - strains are serotyped at CDC
- Some health departments are doing surveillance and studies (e.g., Connecticut and Minnesota)
- Outbreak investigations
- Studies of HUS

Incidence of All Reported STEC Infections, FoodNet Sites, 2000-09



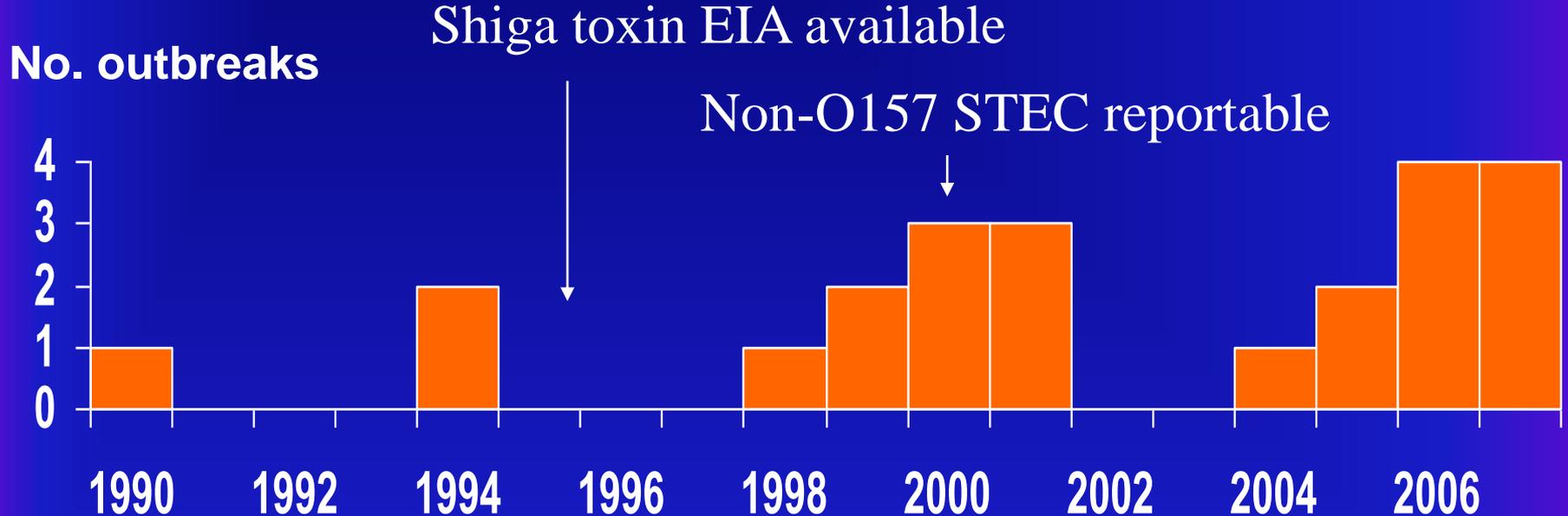
Human isolates of non-O157 STEC, by serogroup, FoodNet sites, 2000-2006



*preliminary data; an additional 54 isolates had missing O group information

Outbreaks of non-O157 STEC infections, U.S., 1990-2007

N = 23 outbreaks



Serogroups of 23 non-O157 STEC outbreaks, U.S., 1990-2007

Green shows most common serogroups of sporadic cases

Serogroup	No. outbreaks
O111 (one outbreak also had O157)	10
O121	3
O26	3
O45	2
O27, O103, O104, O153	1 each
O26 and O121	1

Modes of transmission in non-O157 STEC outbreaks, U.S., 1990-2007

(N = 23)

Mode	No. outbreaks
Food	11
Person-to-person	6
Lake water	3
Animal contact	2
Undetermined	1

Food vehicles in non-O157 STEC outbreaks, U.S., 1990-2007

N = 11

Food Vehicle	No. outbreaks
Salad bar	1
Salad and ice	1
Berries	1
Milk	1
Cider	1
Punch	1
Unknown	5

Outbreak of STEC 0111 infections, cheerleading camp, Texas, 1999



- 55 persons with diarrhea
 - ◆ most were teenage girls
 - ◆ 18 had bloody stools
 - ◆ 2 developed HUS
- Transmitted by salad bar and ice

■ *E. coli* O111 infections linked to OK restaurant

INTERNATIONAL FOOD SAFETY NETWORK INFOSHEET SEPT 12/08
www.foodsafety.ksu.edu foodsafetyinfosheets.ksu.edu



E. COLI O111 OUTBREAK LINKED TO BUFFET IN OKLAHOMA

ONE DEATH AND OVER 240 ILL PATRONS HAVE BEEN LINKED TO COUNTRY COTTAGE



An outbreak in Locust Grove, Oklahoma featuring an uncommon strain of *E. coli* has been linked to at least 248 people. Sixty-four people have been hospitalized and a 26 year-old gospel singer, Chad Ingle, has died. Sixteen of those hospitalized, including nine children, have received dialysis treatment.

The state has announced that it has not found *E. coli* O111 on surfaces or in leftovers at the restaurant. Many of the victims ate at Country Cottage between August 15 and 17. Ten attendees of a church tea catered by Country Cottage have also become ill with *E. coli* O111.

State Epidemiologist Kristy Bradley said that the lack of a specific food points to the possibility that there was an *E. coli* - infected food handler at the root of the outbreak. The restaurant is a large buffet-style operation with 58 food handlers. While most employees have a primary station, it is not unusual to handle a number of foods.

Several victims of this outbreak and their families have contacted attorneys looking to recoup at least the cost of their medical bills.

The *E. coli* O111 outbreak is believed to be the largest of its kind in U.S. history.

FOR MORE INFORMATION CONTACT BEN CHAPMAN, B.CHAPMAN@UOGLLELPH.CA OR DOUG POWELL, D.POWELL@KSU.EDU

- *E. coli* O111 is usually found in human and animal poop.
- Keep the poop out of the food you serve by practicing good hygiene and handwashing.
- *E. coli* can be passed on by food handlers who don't have symptoms.
- *E. coli* outbreaks have also been linked to fresh produce and other ready-to-eat foods.

■ *E. coli* O145 infections linked to romaine lettuce

MAY 6, 2010
FOOD SAFETY INFOSHEET

Romaine lettuce linked to *E. coli* O145 outbreak



CLUSTERS OF ILLNESSES IN THE NORTH EAST AND MIDWEST
60 ILL IN MICHIGAN, NEW YORK AND OHIO
LEAFY GREENS HAVE A HISTORY
LETTUCE, SPINACH, GREENS LINKED TO AT LEAST 30 OUTBREAKS OF PATHOGENIC *E. COLI* SINCE 1993



www.foodsafetyinfosheets.com

Freshway Foods of Sydney, Ohio is voluntarily recalling products containing romaine lettuce with a use by date of May 12 or earlier because they may be contaminated with *E. coli* O145. The products were sold under the Freshway brand and Imperial Sysco brand.

E. coli O145 causes a diarrheal illness often with bloody stools. Illnesses associated with this outbreak have been centered in the North East and Midwest U.S. To date 60 individuals have been confirmed ill.

This recall includes romaine lettuce products sold by Freshway Foods for food service outlets, wholesale, and in-store retail salad bars and delis. These products are sold under the **Freshway** and **Imperial Sysco** brands.

A full list of the 72 recalled products lines can be found at: www.freshwayfoods.com/recall/



Fresh produce is not cooked, so any poop that comes in contact with it from farm-to-fork can be passed to diners.

The recalled romaine products were also sold for distribution to in-store salad bars and delis for Kroger, Giant Eagle, Ingles Markets, and Marsh stores. States where the products were distributed include: AL, CT, DC, FL, GA, IL, IN, KS, KY, MD, MA, MI, MS, NJ, NY, NC, OH, PA, RI, SC, TN, VA, WV, WI.



For more information: Ben Chapman benjamin_chapman@ncsu.edu or Doug Powell, dpowell@ksu.edu



Summary: Non-O157 STEC in the United States

- Non-O157 STEC is a diverse group
 - but ~75% of human infections are due to 6 serogroups (O26, O45, O103, O111, O121, & O145)
- Clinical illness due to non-O157 STEC
 - includes diarrhea, bloody diarrhea, HUS
 - likely less severe than *E. coli* O157

Non-O157 STEC Summary (continued)

- Most non-O157 STEC infections are not diagnosed
 - few clinical labs test stools for Shiga toxin (11% of labs serving FoodNet sites in 2007)
 - but use of the EIA has increased → more non-O157 STEC illnesses and outbreaks detected
- Challenges in testing for STEC by EIA
 - “Shiga toxin positive” is not sufficient
 - Rapid identification of *E. coli* serogroup is important for outbreak detection

STEC O104:H4 Outbreak in Germany, May-July 2011*

- May-July 2011, total of 3816 cases including 845 (22%) with HUS and 54 deaths.
- Of those with HUS, 88% were adults, 68% female, median age 42 years.
- Estimated incubation period: 8 days.
- Locally grown sprouts implicated
- With another smaller cluster in France, implicated fenugreek seeds from Egypt

Frank C et al., N Engl J Med 2011; 365:1771-1780

Fenugreek Sprouts





Non-O157 STEC studies

K. E. Johnson et al. CID 2006;43

16 countries, 1988-2006 (1,402/2,892): 48%

Range 19%-100%

USA, Canada, UK, Germany, Spain, Italy, Czech Republic, Belgium, France, Denmark, Finland, Sweden, Australia, Chile, Argentina & Japan

Netherlands, 2006 80%

Australia, 2004 64%

Belgium, 2006 81%

Brazil, 2007 100%

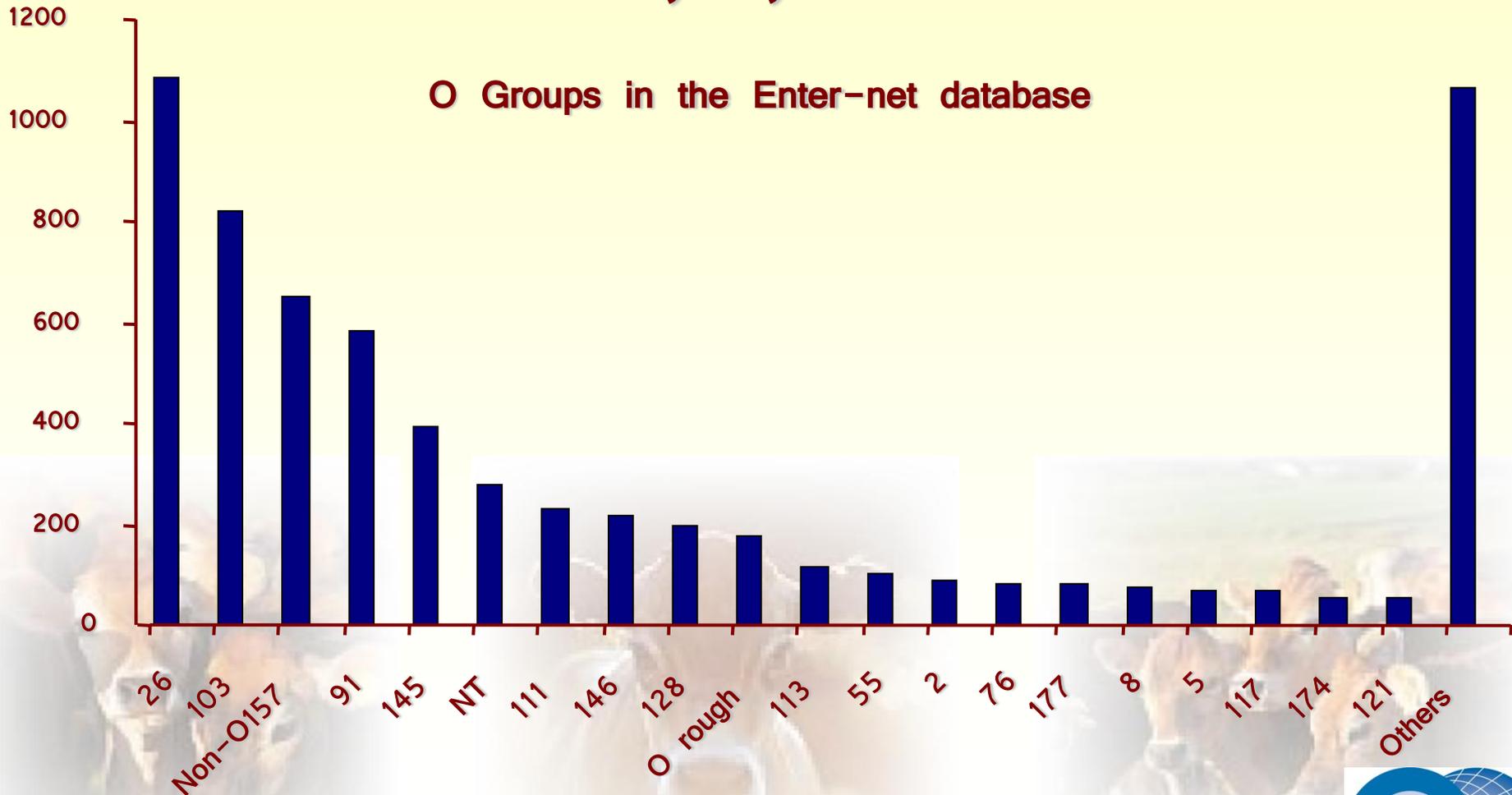
Poland, 2004 100%

Germany, 1998 88%





Non-O157 STEC surveillance 27 countries; 6,480 isolates





Non-O157 STEC outbreaks

O22:H8

O26:H11

O103:H2

O103:H25

O104:H21

O111:H- / H2 / H8

O113:H21

O117:H4

O118:H2

O119

O121:H19 / H21

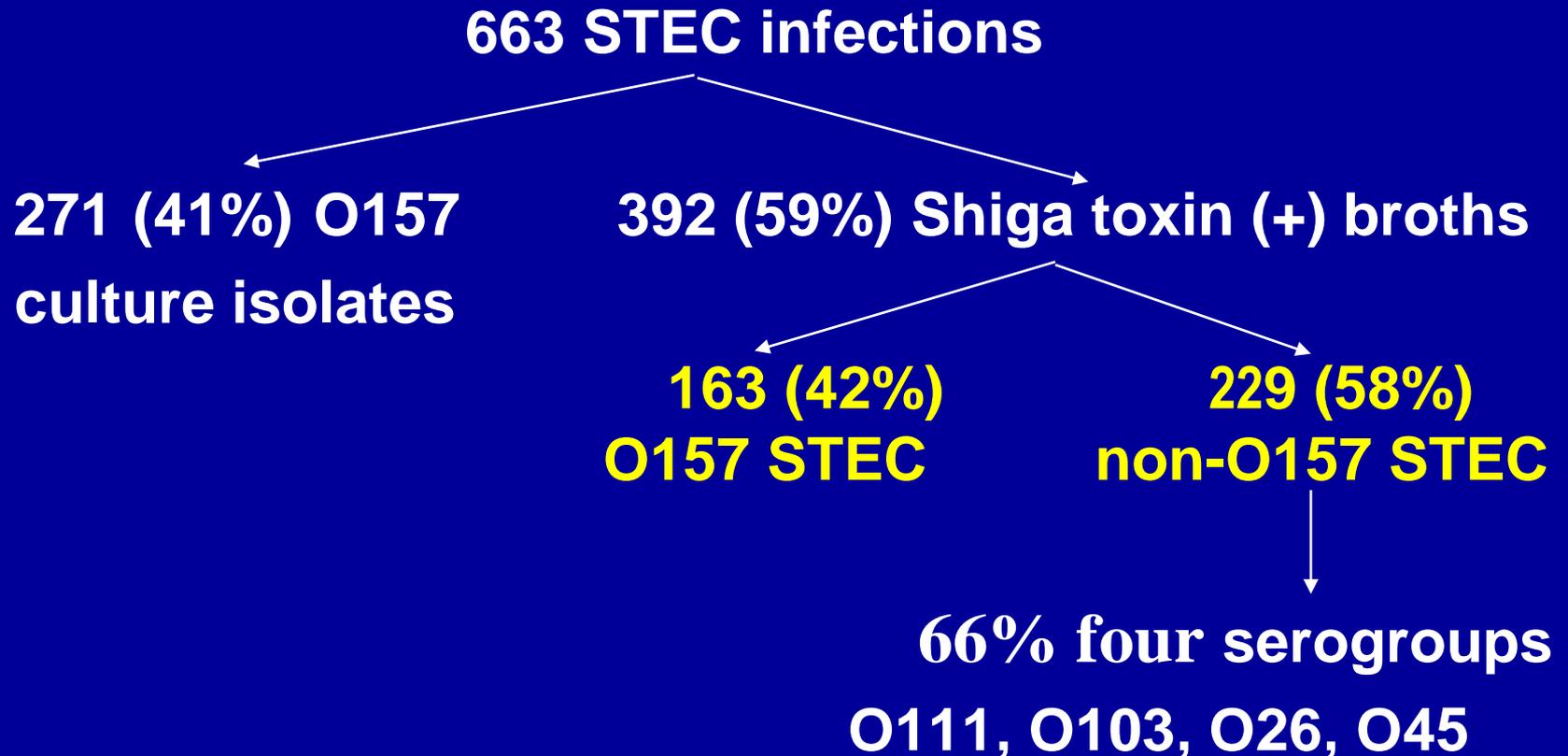
O128:H2

O145:H-

O?:H19

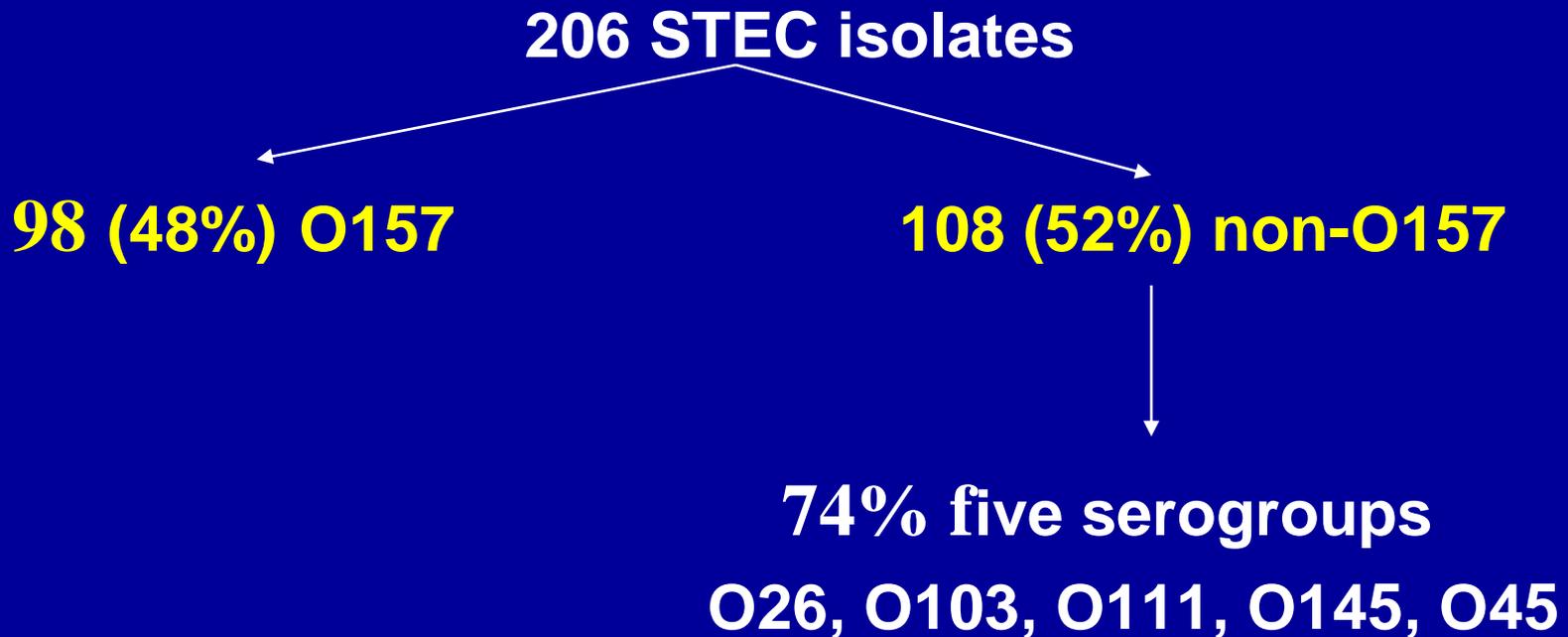


Statewide Surveillance for STEC Connecticut, 2000 – 2009*



*Hadler J et al. *Clin Infect Dis* 2011; 53:269-276.

Sentinel Surveillance for STEC Minnesota, 2000 – 2006*



*Hedican EB et al. *Clin Infect Dis* 2009; 49:358-364.

Relative Disease Severity, CT & MN

	Non-O157	O157	p-value
Bloody Diarrhea			
CT	60%	87%	< 0.01
MN	54%	78%	< 0.001
H.U.S.			
CT	<0.5%	10%	< 0.01
MN	0%	7%	0.005
Hospitalization			
CT	14%	38%	< 0.01
MN	8%	34%	< 0.001

Comparison of Non-O157 and O157 Patients by Selected Exposures, CT & MN

Selected Exposures	Non-O157	O157	p-value
	% exposed	% exposed	
Ate pink hamburger, CT	18%	26%	0.06
Ate ground beef, MN	58%	76%	0.03
Untreated water, CT	14%	8%	0.07
Drank raw water, MN	31%	22%	n.s.
Farm/petting zoo, CT	7%	6%	n.s.
Farm/petting zoo, MN	16%	20%	n.s.
Restaurant, MN/CT	71%	79%	n.s.
International travel, CT	15%	3%	<0.001
International travel, MN	12%	1%	0.01

Connecticut Conclusions*

- Both O157 and non-O157 STEC infections decreased in incidence between 2000 and 2009
- Non-O157 isolates more common than O157 when testing for both (i.e., via ST testing and culture)
- Increase in non-O157 identification likely due to an increase in ST testing
- Patients with O157 STEC had higher rates of bloody diarrhea, HUS, and hospitalization than those with non-O157 STEC
- Not all non-O157 STEC strains are epidemiologically similar

*Hadler J et al. *Clin Infect Dis* 2011; 53:269-276.

Minnesota Conclusions*

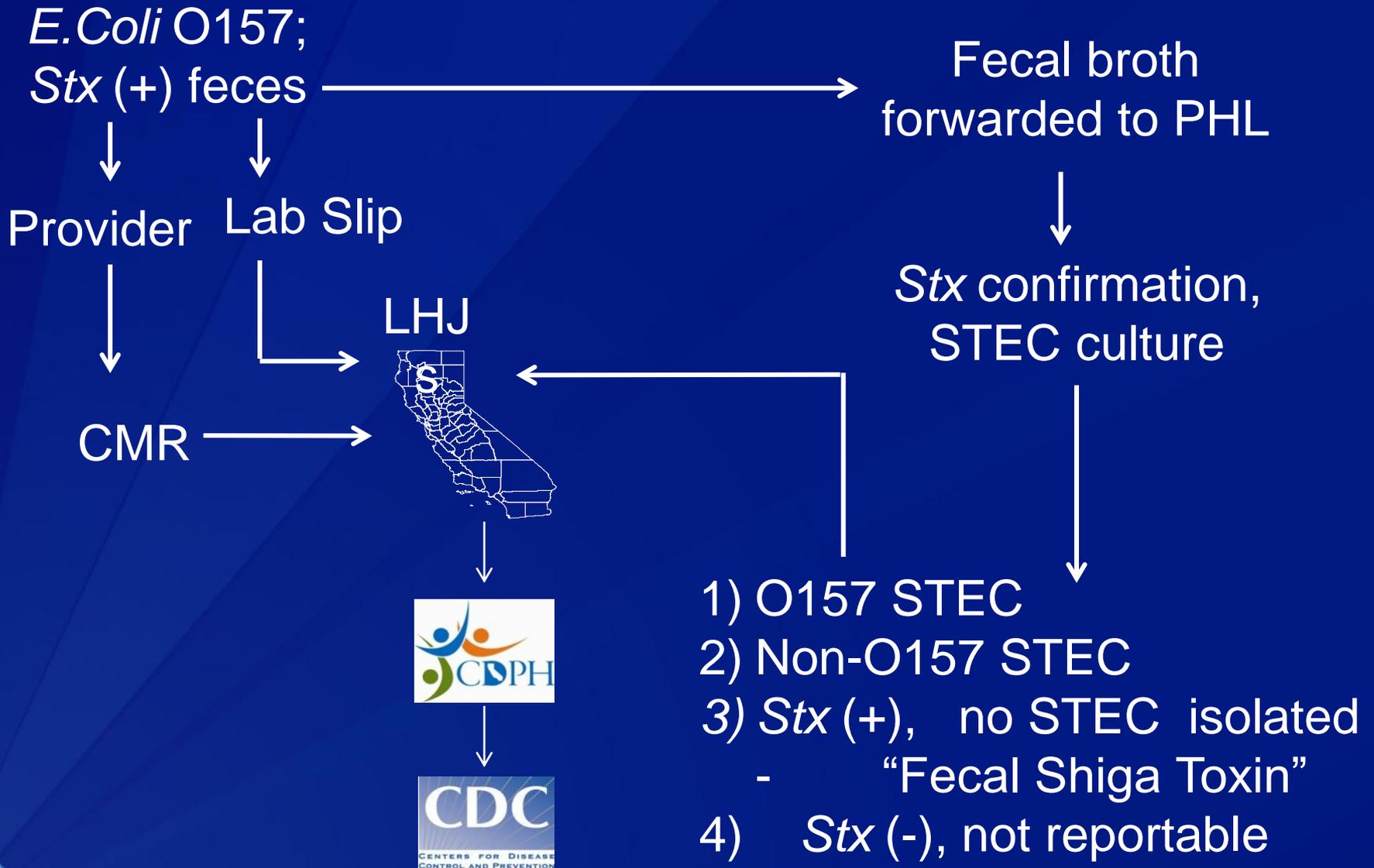
- Non-O157 STEC isolates recovered from stool from ill patients slightly more frequently than O157
- Most non-O157 cases identified during summer months, similar to O157
- Patients with O157 STEC more likely to have bloody diarrhea, HUS, and hospitalization
- Patients with non-O157 STEC also had substantial morbidity: 54% bloody diarrhea and 8% hospitalized
- Some risk factors for O157 and non-O157 STEC infections may be same, but epidemiology may differ

*Hedican EB et al. *Clin Infect Dis* 2009; 49:358-364.

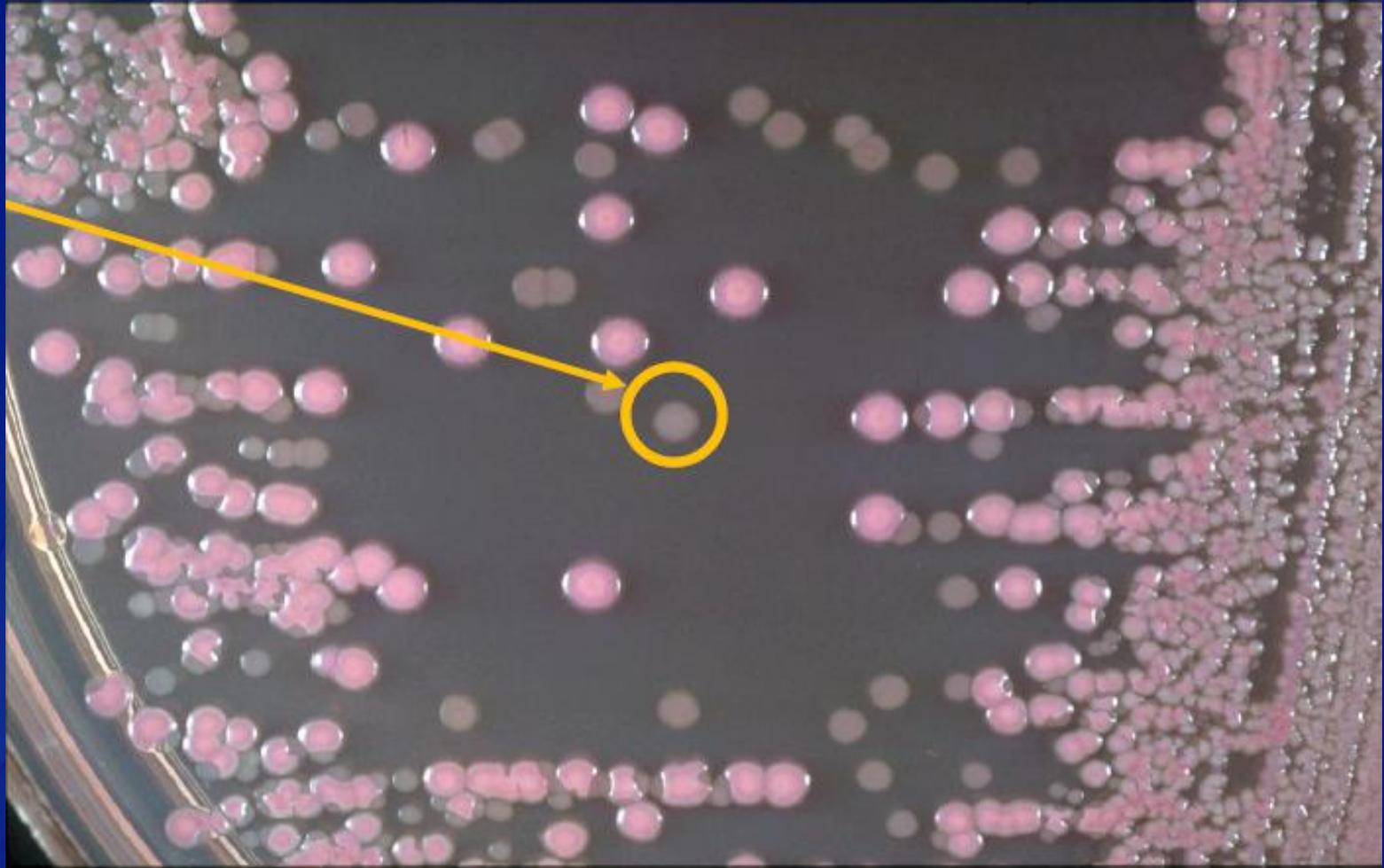
STEC in California

- ❑ Reportable by providers and laboratories
- ❑ Most clinical laboratories probably culture for O157 only; some use EIA for Shiga toxin only
- ❑ Voluntary submission of *Stx*+ fecal broths to public health laboratories (PHL)
- ❑ Only 4 PHLs culture *Stx*+ fecal broths
- ❑ CDPH MDL identifies 6 most common non-O157 serotypes (O26, O45, O103, O111, O121, O145); others forwarded to CDC for serotyping

STEC Surveillance Data Flow



E. Coli O157:H7 on SMAC Plate

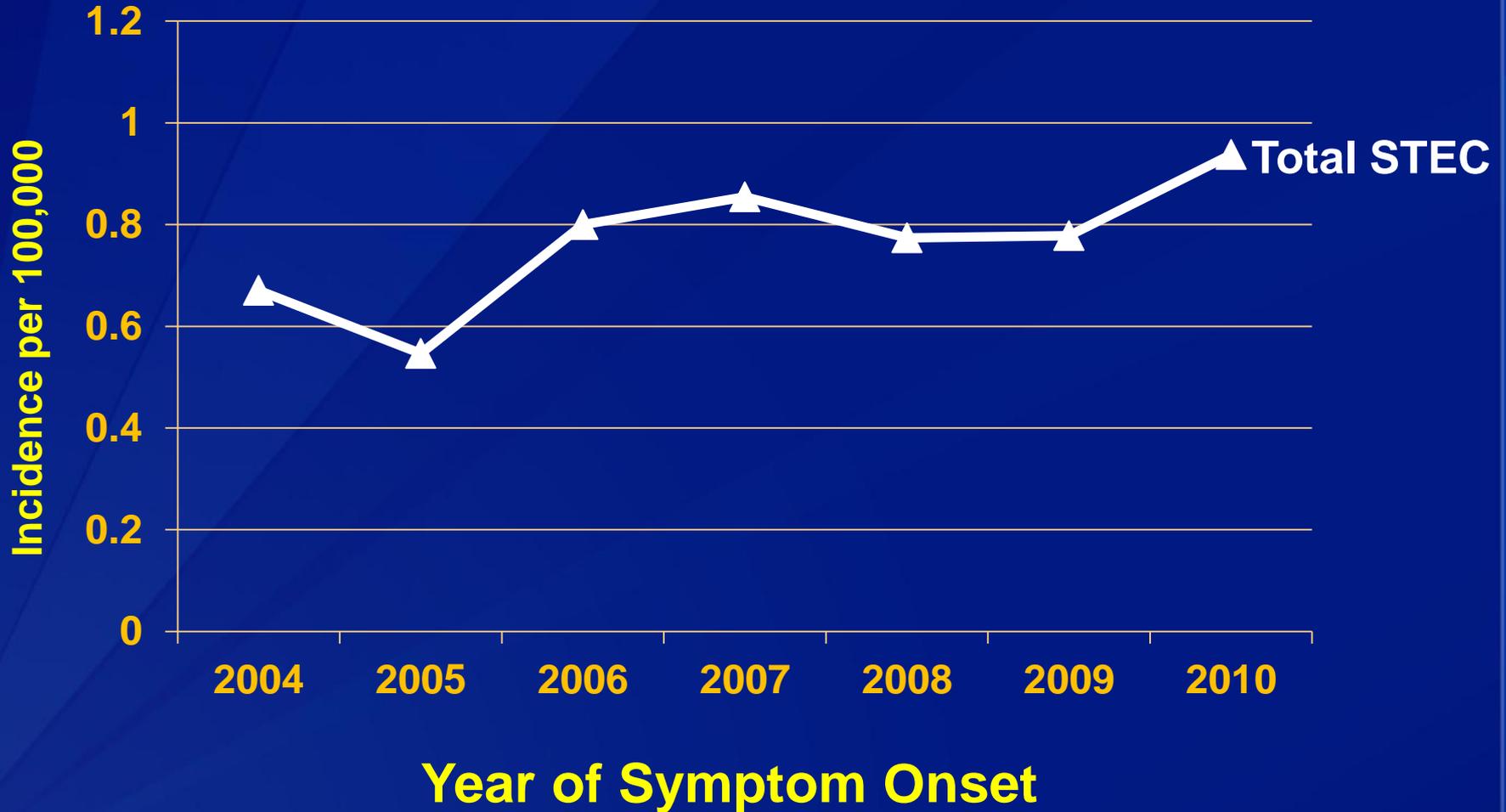


Non-O157 Diagnosis

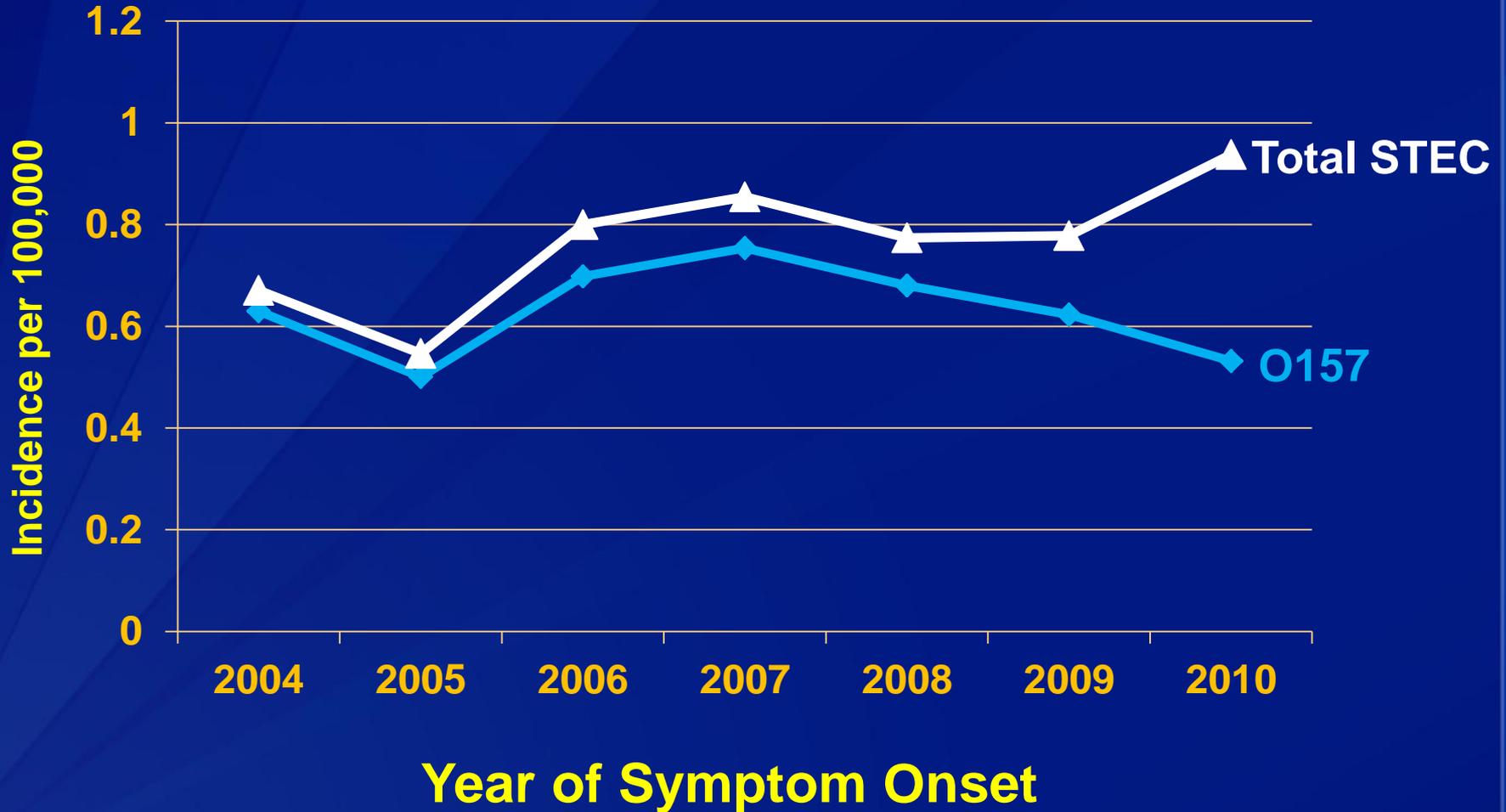
- ❑ No selective and differential media for non-O157
- ❑ *E.coli*-like colonies tested for specific O antigens
 - O26, O45, O103, O111, O121, O145



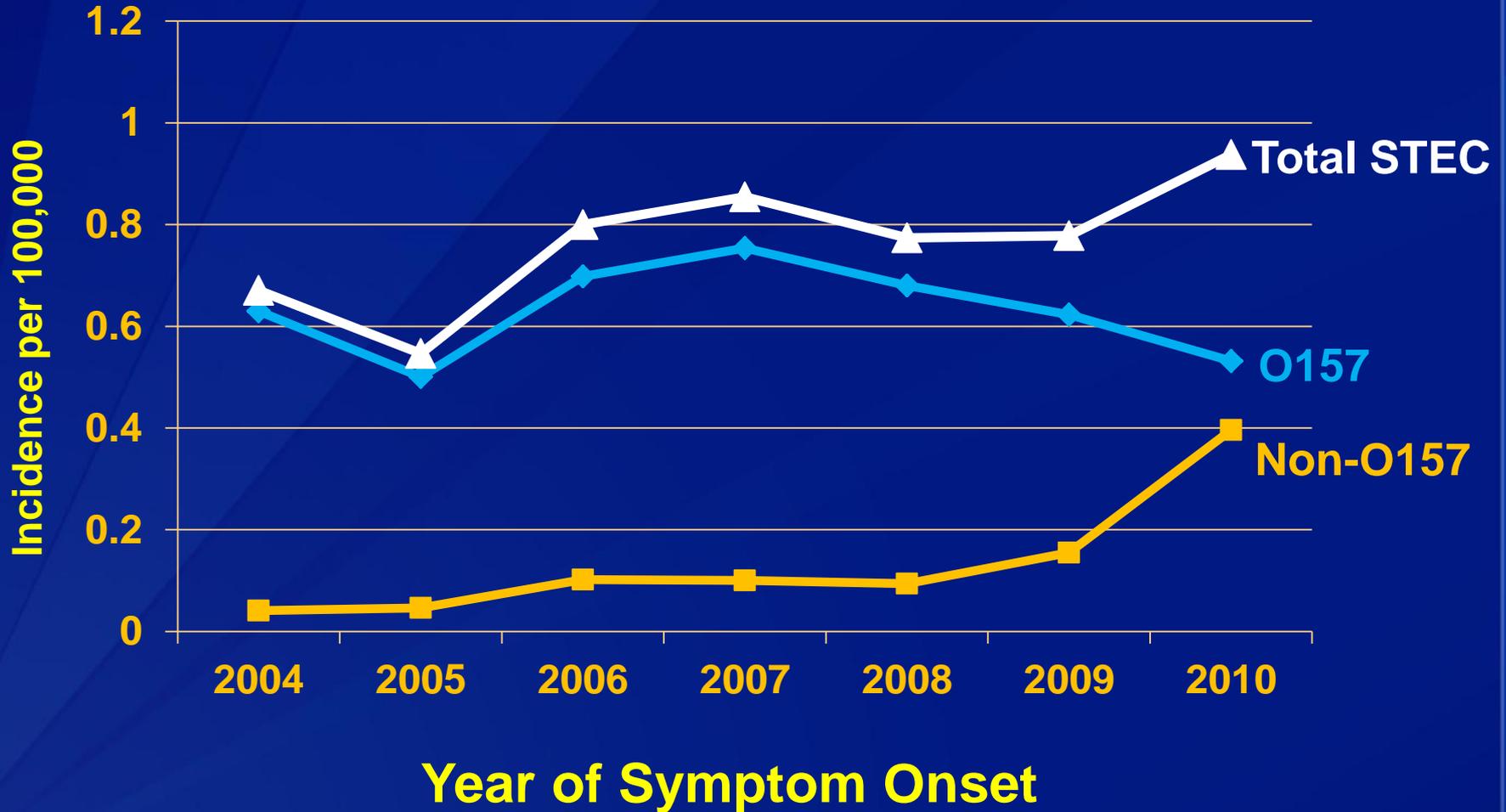
California Reported STEC



California Reported STEC



California Reported STEC



California Reported STEC, 2004–2010 (N=2029) Preliminary Analysis

Demographics	Non-O157 (n=359)	O157 (n=1670)	P-value
% Total	18	82	---
Median age, yrs (range)	9.5 (0–101)	11 (0–101)	<0.01
% Female	55	52	0.20
% White	40	49	<0.01
% Hispanic	39	18	<0.01
% HUS	3	9	<0.01

California Non-O157 Serogroups (n=270)

Serogroup	CDC % total [†]	California % total	California HUS (no.)
O26	22	27	2
O103	12	21	1
O111	18	18	1
O121	8	2	0
O45	7	2	1
O145	5	2	1
O118	---	7	1

[†] Brooks et al. JID 2005:192.

STEC in California FoodNet (CEIP), 2008-2011*

- Case report information collected on patients with STEC in CEIP catchment area (Alameda, Contra Costa, and San Francisco counties).
- Incidence of non-O157 STEC increased from 2008 through 2011.
- Patients with O157 had more bloody diarrhea, hospitalization, and HUS.
- Significantly more non-O157 patients traveled internationally in the 7 days before illness onset .

*Williamson A, Wymore K. Poster at IDSA, October 2012

From Recent USDA Studies on Non-O157 STECs in Beef*

- STEC are a natural part of the animal microflora.
- Non-O157 STEC is probably just as prevalent, maybe more, than O157 STEC in pre-harvest samples.
- A very small proportion of the non-O157 STECs (11.3, 7.3, 0.40, and 2.0%) have the combination of virulence factors (e.g., stx1, stx2, eae) that can cause disease.
- In 10,159 samples (carcass, trim and ground beef), we have detected the top 6 CDC serotypes only from 15 samples; a fraction of these with ability to cause disease.
- To the best of our knowledge, there has never been a meat-borne non-O157 STEC outbreak in the United States.

*Koohmaraie M, PhD. Agricultural Research Service, USDA

Non-O157 STEC: What do we know to date?

- Approximately 250 serogroups; >100 associated with human diarrheal illness; a few common serotypes among majority of cases
- As a group, non-O157 disease not as severe as O157; but some can cause HUS and death
- Outbreaks occur
- Detection increasing, probably from increasing ST testing and subsequent culture; may eventually surpass O157 in number

Non-O157 STEC:

What are the issues?

- Detection: clinical laboratories not uniform in testing; ST+ fecal broths not cultured; serogrouping not timely, particularly if not top 6
- Treatment: antibiotics or not?
- Prevention and food safety policies: besides usual cooking recommendations, unclear at this time since reservoirs/sources for human illness unclear
- More surveillance, studies, and outbreak investigations needed to increase knowledge

Non-O157 STEC:

Public Health Considerations in Time of Limited Resources?

- How can serogrouping timeliness be improved?
- How to detect outbreak when serogroup not yet known?
- Can ELR or CalREDIE be of help?
- All laboratories will soon be required to save STEC isolates and ST+ fecal broths and forward to public health
- Public health follow up still important to detect outbreak and prevent illness

Acknowledgments

- Reporting clinicians and laboratories
- Local Health Departments of California
- CDPH Microbial Disease Laboratory
- US Centers for Disease Control and Prevention
- FoodNet and Emerging Infections Programs

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the California Department of Public Health.





QUESTIONS?