

Susceptible Populations and Food Safety Workshop

Issues in Defining Susceptible Populations for Microbial Hazards

Barbara Mahon, MD, MPH

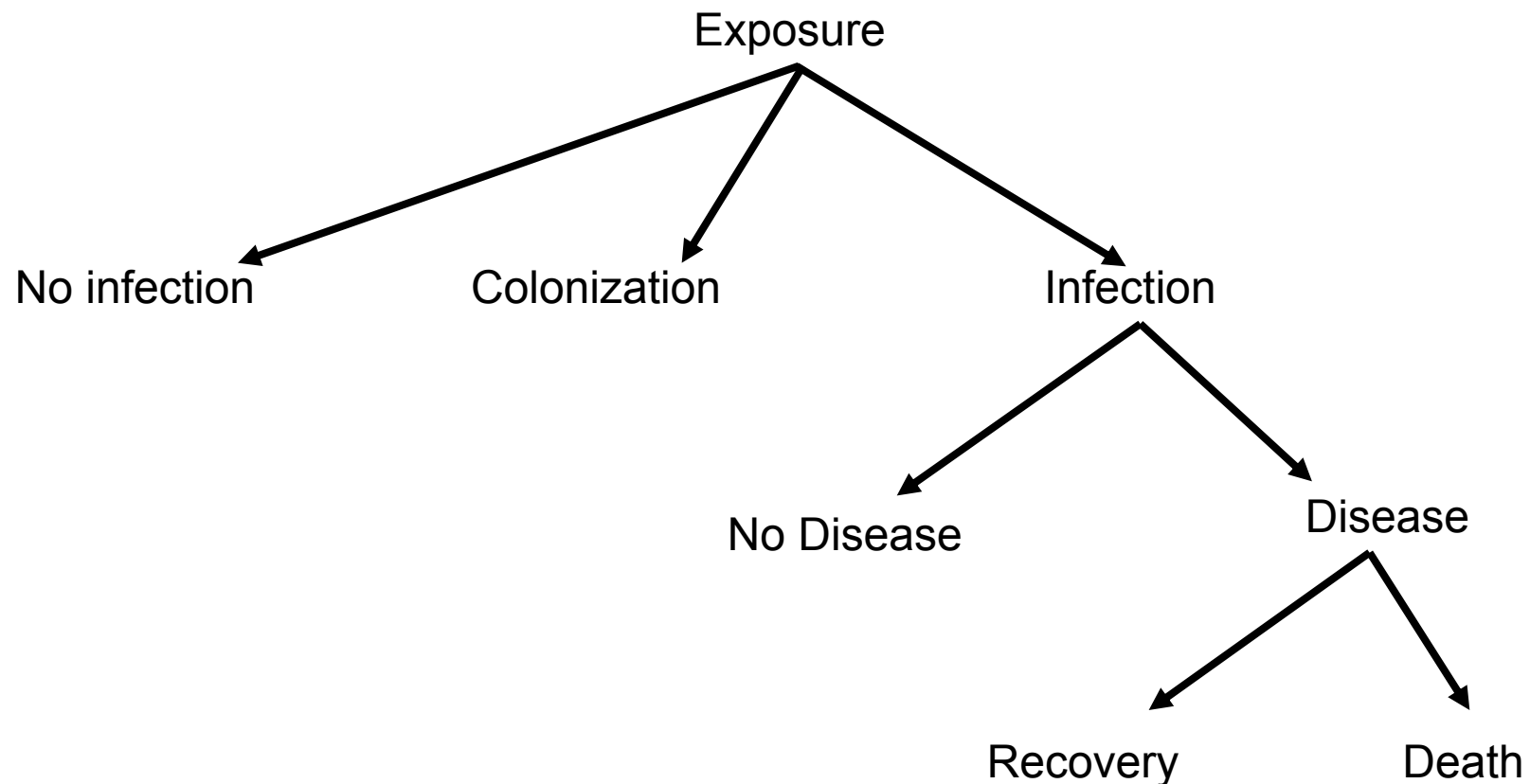
Lead, FoodNet and Outbreak Surveillance Team, CDC

January 20, 2010

Charge to Microbial Hazards Breakout Group

- Is the concept of susceptibility clear?
 - Usable across disciplines and public health settings?
 - Usable for data extraction from literature, databases?
 - Should probability and severity of outcomes be considered distinctly?
- What data resources are available?
 - Susceptible population size, demographics, exposures, outcomes
 - “Mash-ups” feasible?
 - Heterogeneity in data available across populations or types of susceptibility?
- What are we missing?
 - Untapped data resources/tools?
 - Important questions not included in this charge?
 - What are the most critical data gaps and what are the prospects for filling them?

Chain of Events for Infectious Diseases



One Definition of Susceptibility

(Balbus 2000)

Susceptibility is a capacity characterizable by:

- A set of *identifiable* traits,
- Including *intrinsic* and *extrinsic* factors,
- That increase the impacts of a *specific exposure*
- Upon the risk of a *specific adverse health outcome*
- In a *population*

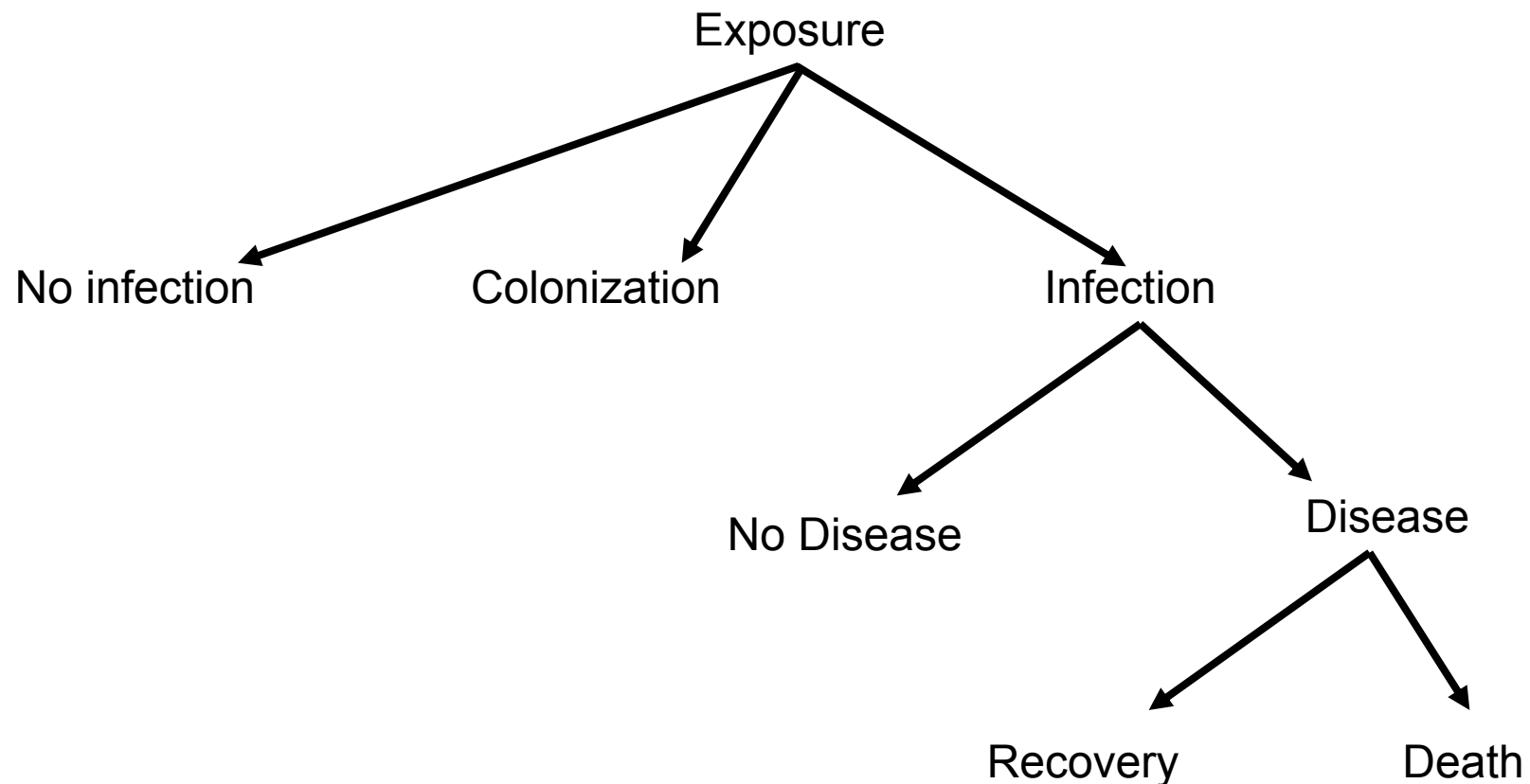
Difficulties in Distinguishing Exposure Risk from Susceptibility

- Susceptibility excludes exposure, but we often can't distinguish:
 - Disease given exposure from
 - Disease given infection
- Differences in disease rates may be due to differences in exposure frequency, not to differences in susceptibility
- Example: *Listeria* in Hispanic women

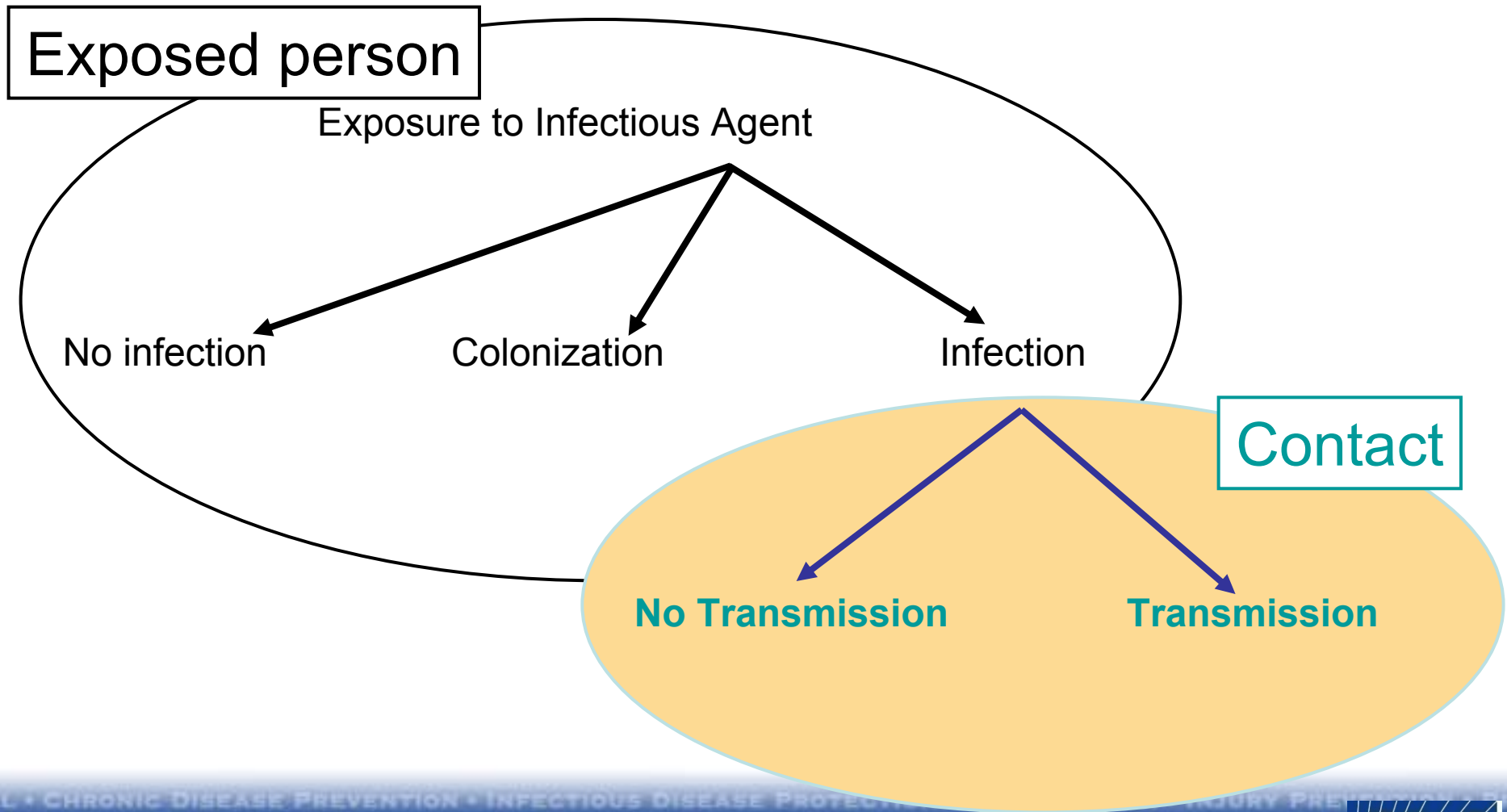
Importance of Defining Outcome

- Definition of outcome is critical:
 - Infection? disease? severe disease? death?
- Population could have:
 - ↑ risk of disease or severe disease without
 - ↑ risk of infection (etc. and vice versa)
- Examples:
 - *Vibrio vulnificus* with liver disease (↑ risk of disease given infection)
 - Hepatitis A in infants (↓ risk of disease given infection)

Chain of Events for Infectious Diseases



Consequences of transmission of infectious agents

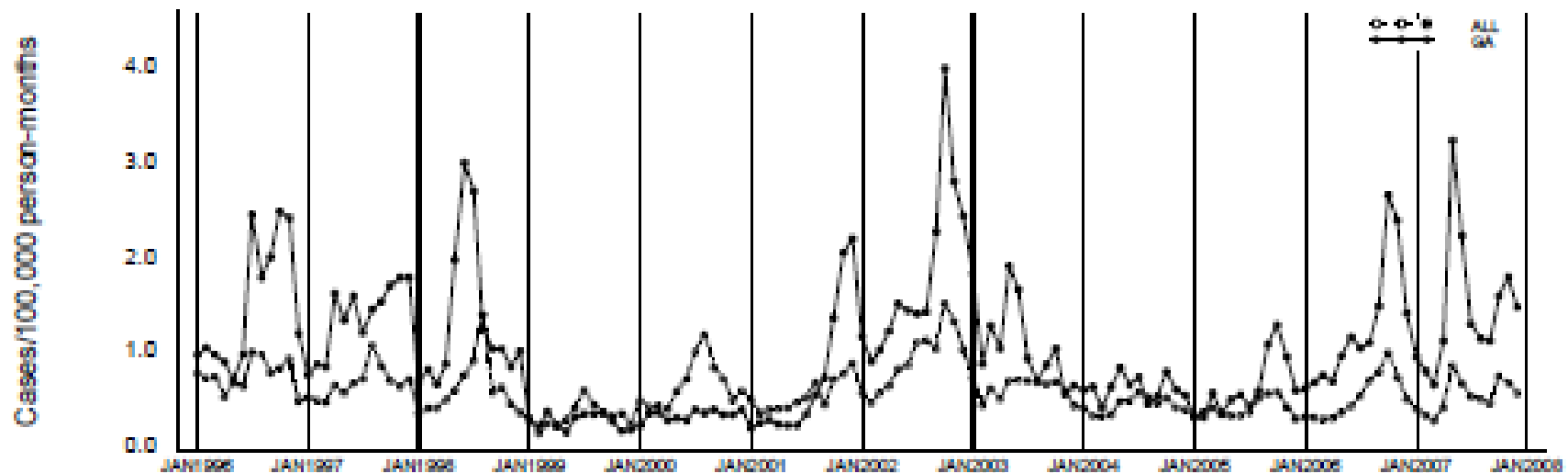


Implications of Transmission (1 of 2)

- Agents may be transmissible or not transmissible between humans
 - Measles (highly transmissible) vs tetanus (not transmissible)
 - *Shigella* (more easily transmitted) vs *Salmonella* (less easily transmitted)
- For transmissible agents:
 - Relative importance of food vs person-to-person contact varies as incidence varies
 - More person-to-person transmission during outbreaks

Shigellosis in Georgia FoodNet Site

Figure 10d - *Shigella*, all species Annual Summary (Georgia)
Incidence for 1996 through 2007, by month



Source: FoodNet 2007 Annual Report

Implications of Transmission (2 of 2)

- Vaccination programs for transmissible agents:
 - Can greatly reduce the risk of exposure (as well as of disease given exposure)
 - Therefore, can reduce the risk of disease even in unvaccinated populations
- Example—hepatitis A

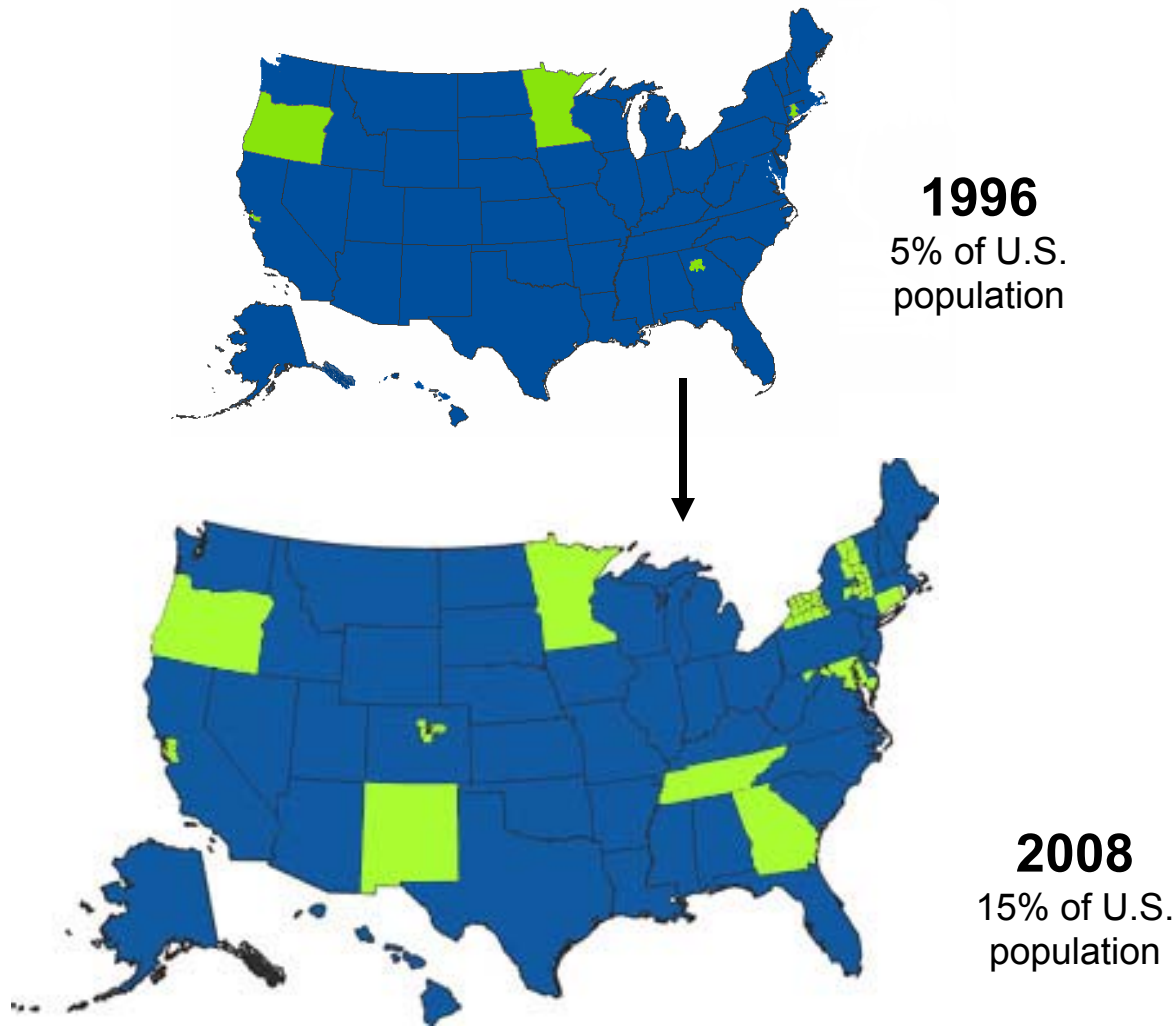
Differential testing/diagnosis

- Physician stool culture practices
 - With same symptoms, infants more likely to have stool culture performed than older patients
- Clinical laboratory practices
 - *Salmonella* culture routine
 - *Yersinia* by physician request only
- Biologic differences in pathogens
 - STEC O157 easily identified
 - STEC nonO157 less easily identified

FoodNet

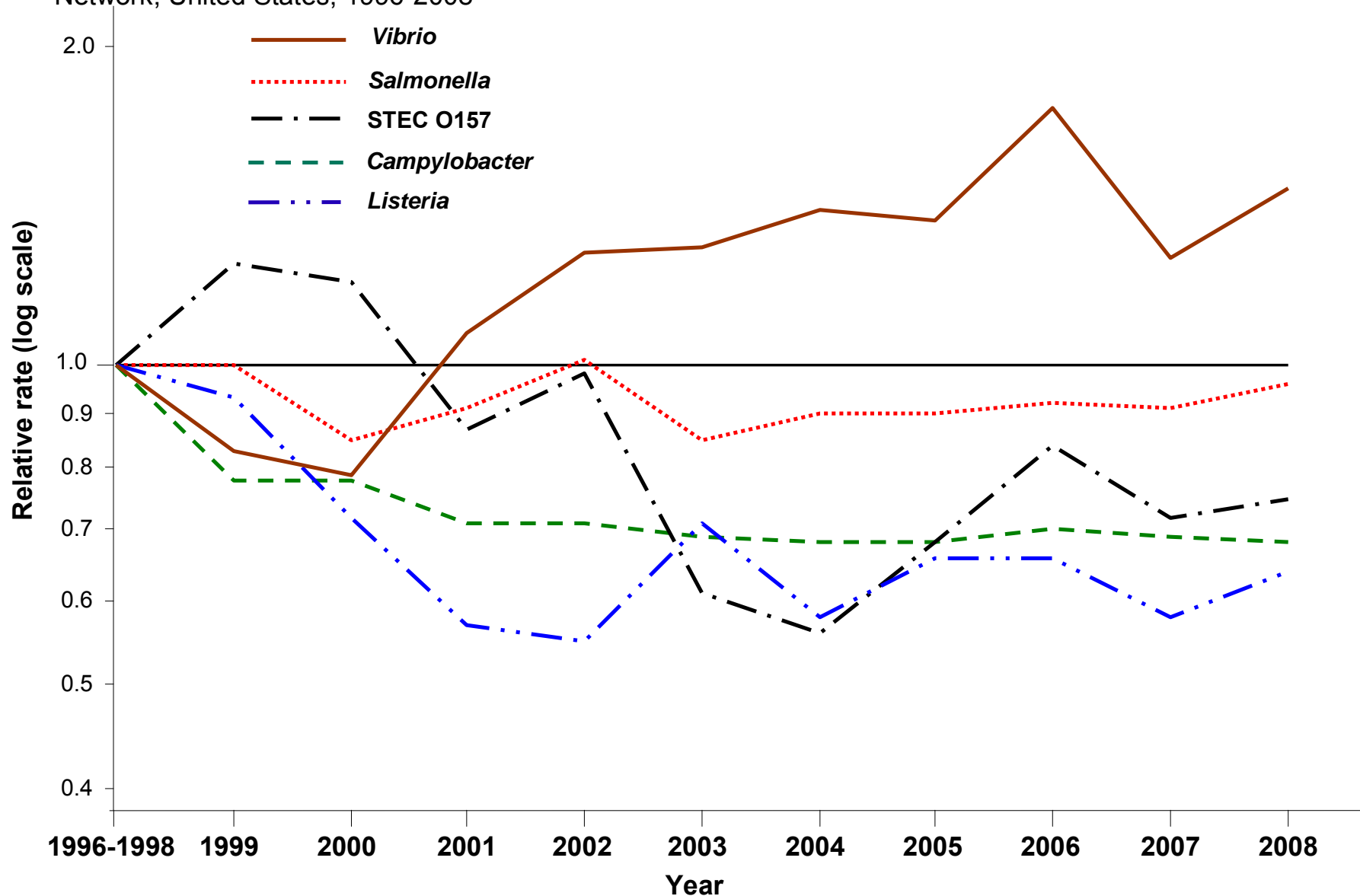
- Active population-based surveillance
- Laboratory-confirmed infections
 - Hospitalization
 - Death
- Demographic variables collected
 - Age
 - Sex
- Not collected routinely
 - Pregnancy
 - Immune status
 - Comorbidities

FoodNet Catchment Area



Year	Population (millions)
1996	14.3
1997	16.1
1998	20.7
1999	25.9
2000	30.6
2001	34.9
2002	38.0
2003	41.9
2004	44.5
2005	45.0
2006	45.5
2007	45.5
2008	46.0

FIGURE. Relative rates compared with 1996-1998 period of laboratory-diagnosed cases of infection with *Vibrio*, *Salmonella*, STEC* O157, *Campylobacter*, and *Listeria* by year – Foodborne Active Surveillance Network, United States, 1996-2008†



*Shiga toxin-producing *Escherichia coli*.

†The position of each line indicates only the relative change in the incidence of that pathogen compared with the years 1996-1998. The actual incidences of these infections can differ.

Incidence by Age Group

TABLE. Incidence* of cases of bacterial and parasitic infection in 2008, by age group - Foodborne Diseases Active Surveillance Network, United States

Pathogen	Age group (years) [†]				
	<4	4-11	12-19.	20-49	≥50
Bacteria					
<i>Campylobacter</i>	28.54	10.06	9.37	12.40	12.27
<i>Listeria</i>	0.76	0.00	0.00	0.15	0.63
<i>Salmonella</i>	74.65	19.28	11.29	11.41	13.09
<i>Shigella</i>	27.86	25.67	2.99	3.61	1.70
STEC [¶] O157	4.24	2.57	1.51	0.59	0.65
<i>Vibrio</i>	0.08	0.04	0.10	0.27	0.49
<i>Yersinia</i>	2.24	0.25	0.30	0.17	0.35
Parasites					
<i>Cryptosporidium</i>	6.08	3.05	1.73	2.32	1.38

*Per 100,000 population

†Age groups defined in CDC's Healthy People in Every Stage of Life Goals

¶Shiga toxin-producing *Escherichia coli*.

Hospitalization by Age Group

TABLE. Percentage of persons hospitalized of bacterial and parasitic infection in 2008, by age group - Foodborne Diseases Active Surveillance Network, United States

Pathogen	Age group (years) [†]				
	<4	4-11	12-19	20-49	≥50
Bacteria					
<i>Campylobacter</i>	9.68	10.37	9.87	10.61	20.48
<i>Listeria</i>	52.63	-	-	72.41	86.21
<i>Salmonella</i>	19.20	17.86	22.47	18.67	39.98
<i>Shigella</i>	10.78	12.76	12.50	16.32	27.85
STEC [¶] O157	31.13	38.21	35.06	40.17	53.33
<i>Vibrio</i>	0.00	0.00	40.00	25.93	45.59
<i>Yersinia</i>	25.00	8.33	6.67	33.33	37.50
Parasites					
<i>Cryptosporidium</i>	15.13	17.12	10.23	17.07	24.48

*Per 100,000 population

†Age groups defined in CDC's Healthy People in Every Stage of Life Goals

¶Shiga toxin-producing *Escherichia coli*.

Death by Age Group

TABLE. Case Fatality Rate (CFR) of bacterial and parasitic infection in 2008, by age group - Foodborne Diseases Active Surveillance Network, United States

Pathogen	Age group (years) [†]				
	<4	4-11	12-19	20-49	≥50
Bacteria					
<i>Campylobacter</i>	0.28	0.21	0.00	0.08	0.41
<i>Listeria</i>	10.53	-	-	3.45	19.54
<i>Salmonella</i>	0.21	0.00	0.00	0.22	1.32
<i>Shigella</i>	0.00	0.00	0.00	0.14	0.42
STEC [¶] O157	2.83	0.00	0.00	0.00	2.22
<i>Vibrio</i>	0.00	0.00	0.00	1.85	7.35
<i>Yersinia</i>	0.00	0.00	0.00	3.03	0.00
Parasites					
<i>Cryptosporidium</i>	0.00	0.00	0.00	1.31	1.04

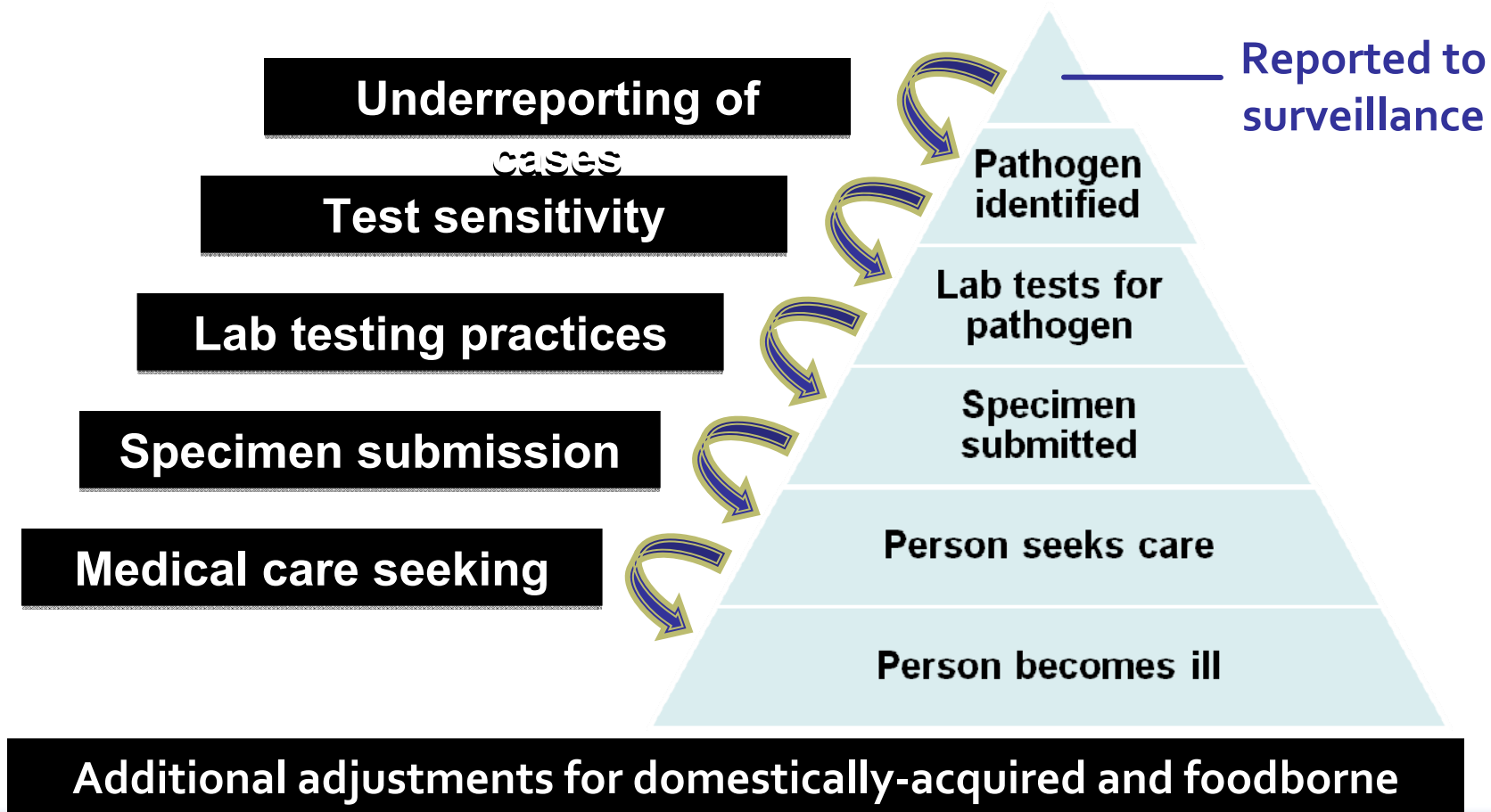
*Per 100,000 population

†Age groups defined in CDC's Healthy People in Every Stage of Life Goals

¶Shiga toxin-producing *Escherichia coli*.

Surveys to Adjust for Underestimation

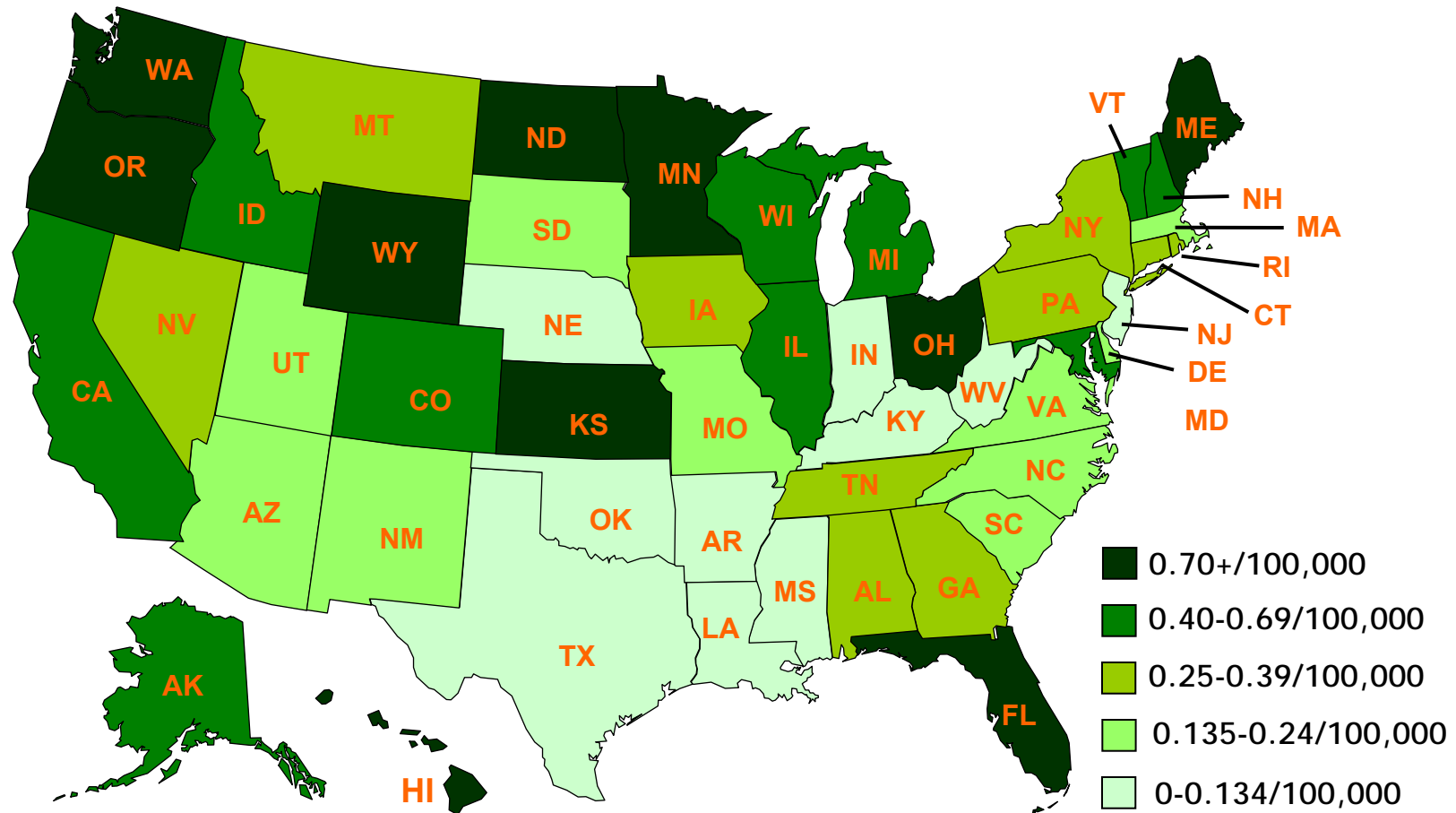
Laboratory, Physician, Population



Foodborne Outbreak Surveillance

- National Outbreak Reporting System (NORS)
- Passive reporting by health authorities
 - Great variability in outbreak detection, investigation, and reporting
- Data on outbreaks include:
 - # illnesses
 - # hospitalizations
 - # deaths
 - Proportions in age ranges
- Not collected routinely:
 - Age or sex of individual cases
 - Immune status or comorbidity

Foodborne Outbreaks Reported Annually Per 100,000 Population, by State, 2003-2007



CDC, National Foodborne Outbreak Reporting System



Charge to Microbial Hazards Breakout Group

- Is the concept of susceptibility clear?
 - Usable across disciplines and public health settings?
 - Usable for data extraction from literature, databases?
 - Should probability and severity of outcomes be considered distinctly?
- What data resources are available?
 - Susceptible population size, demographics, exposures, outcomes
 - “Mash-ups” feasible?
 - Heterogeneity in data available across populations or types of susceptibility?
- What are we missing?
 - Untapped data resources/tools?
 - Important questions not included in this charge?
 - What are the most critical data gaps and what are the prospects for filling them?