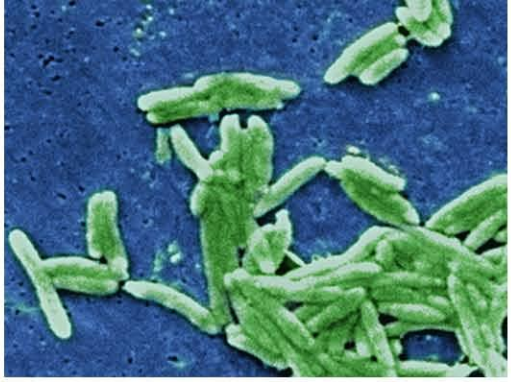
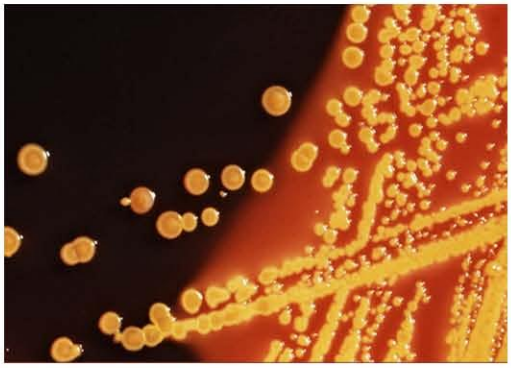


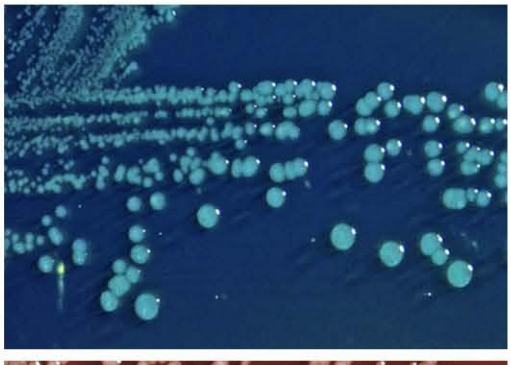
NARMS

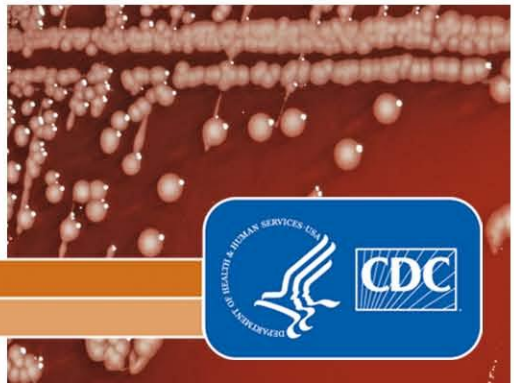
National Antimicrobial Resistance Monitoring System: Enteric Bacteria

2010

Human Isolates Final Report







National Center for Emerging and Zoonotic Infectious Diseases
Division of Foodborne, Waterborne, and Environmental Diseases

CS215511-A

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Information Available Online: Previous reports and additional information about NARMS are posted on the CDC NARMS website: http://www.cdc.gov/narms

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List of Abbreviations and Acronyms

ACSSuT	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline
ACSSuTAuCx	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone
ACT/S	Resistance to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole
ANT/S	Resistance to at least ampicillin, nalidixic acid and trimethoprim-sulfamethoxazole
AT/S	Resistance to at least ampicillin and trimethoprim-sulfamethoxazole
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CLSI	Clinical and Laboratory Standards Institute
EIP	Emerging Infections Program
ELC	Epidemiology and Laboratory Capacity
ESBL	Extended-spectrum beta-lactamase
FDA-CVM	Food and Drug Administration-Center for Veterinary Medicine
FoodNet	Foodborne Diseases Active Surveillance Network
MIC	Minimum inhibitory concentration
NARMS	National Antimicrobial Resistance Monitoring System for Enteric Bacteria
OR	Odds ratio
PHLIS	Public Health Laboratory Information System
USDA	United States Department of Agriculture
WHO	World Health Organization

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Introduction

The primary purpose of the National Antimicrobial Resistance Monitoring System (NARMS) at CDC is to monitor antimicrobial resistance among enteric bacteria isolated from humans. Other components of the interagency NARMS program include surveillance for resistance in enteric bacteria isolated from foods, conducted by the FDA-CVM (http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/default.htm), and resistance in enteric bacteria isolated from animals, conducted by the USDA Agricultural Research Service (http://www.ars.usda.gov/main/site_main.htm?modecode=66-12-05-08).

Many NARMS activities are conducted within the framework of CDC's Emerging Infections Program (EIP), Epidemiology and Laboratory Capacity (ELC) Program, and the Foodborne Diseases Active Surveillance Network (FoodNet). In addition to surveillance of resistance in enteric pathogens, the NARMS program at CDC also includes research into the mechanisms and public health impact of resistance, education efforts to promote prudent use of antimicrobial agents, and antimicrobial susceptibility testing of isolates that caused outbreaks.

Before NARMS was established, CDC monitored antimicrobial resistance in *Salmonella, Shigella*, and *Campylobacter* through periodic surveys of isolates from a panel of sentinel counties. NARMS at CDC began in 1996 with prospective monitoring of antimicrobial resistance among clinical non-Typhi *Salmonella* and *Escherichia coli* O157 isolates in 14 sites. In 1997, testing of clinical *Campylobacter* isolates was initiated in the five sites participating in FoodNet. Testing of clinical *Salmonella enterica* serotype Typhi and *Shigella* isolates was added in 1999. Since 2003, all 50 states have been forwarding a representative sample of non-Typhi *Salmonella, Salmonella* ser. Typhi, *Shigella*, and *E. coli* O157 isolates to NARMS for antimicrobial susceptibility testing, and 10 FoodNet states have been participating in *Campylobacter* surveillance. Since 2008, all 50 states have been forwarding every *Salmonella* Paratyphi A and C to NARMS for antimicrobial susceptibility testing.

This annual report includes CDC's surveillance data for 2010 for non-typhoidal *Salmonella*, typhoidal *Salmonella, Shigella*, *Campylobacter* and *E. coli* O157 isolates in addition to surveillance data for 2009 *Vibrio* species other than *V. cholerae.* Data for earlier years are presented in tables and graphs when appropriate. Antimicrobial classes defined by Clinical and Laboratory Standards Institute (CLSI) are used in data presentation and analysis. CLSI classes constitute major classifications of antimicrobial agents, e.g., aminoglycosides and cephems.

This report also includes the World Health Organization's categorization of antimicrobials of critical importance to human medicine (Table 1). The table includes only antimicrobials that are tested in NARMS.

Additional NARMS data and more information about NARMS activities are available at http://www.cdc.gov/narms

What is New in the NARMS Report for 2010

Vibrio Species other than *V. cholerae*

For the first time, in this NARMS report we present antimicrobial susceptibility data for *Vibrio* species other than *V. cholerae* isolated from humans. We asked NARMS participating public health laboratories to submit all *Vibrio* except *V. cholerae* species for susceptibility testing at the NARMS laboratory at CDC. CDC determined MICs for 9 antimicrobial agents using Etest® (BioMérieux, Marcy L'Etoile, France). Here we present MIC distributions for isolates collected in 2009 and report resistance frequencies for agents that have CLSI-published interpretive criteria for *Vibrio* species other than *V. cholerae*.

Fluoroquinolone Breakpoint Changes for *Enterobacteriaceae*

CLSI is revising fluoroquinolone interpretive criteria for invasive *Salmonella* and other *Enterobacteriaceae*. Specifically, for invasive *Salmonella*, updated ciprofloxacin MIC ranges for susceptible (S), intermediate (I), and resistant (R) categories appeared in the January 2012 CLSI M100 supplement. In this report, we show S, I, and R frequencies for *Salmonella* (typhoidal and non-typhoidal) using both the outgoing and new breakpoints in Box 2. The figures and tables in the results section are based on the pre-2012 breakpoints.

Susceptibility Data for Bacteria from Outbreaks

CDC has enhanced its approaches to attributing foodborne disease to specific foods and other sources of human infection. These changes include determining sources of antimicrobial-resistant infections. To support antimicrobial resistance attribution goals, CDC has requested that NARMS-participating state public health laboratories submit representative bacterial isolates from foodborne disease outbreaks for antimicrobial susceptibility testing. The scope and number of isolates requested over the years is described in the methods section of Appendix A. For the first time, in this NARMS report we show antimicrobial susceptibility results for outbreaks of *Salmonella* infections for which a vehicle was implicated.

Summary of NARMS 2010 Surveillance Data

Population

In 2010, all 50 states participated in NARMS, representing the entire U.S. population of approximately 309 million persons (Table 2). Surveillance was conducted in all states for non-typhoidal *Salmonella,* typhoidal *Salmonella, Shigella*, *Escherichia coli* O157, and *Vibrio* species other than *V. cholerae*. For *Campylobacter*, surveillance was conducted in 10 states that comprise the Foodborne Diseases Active Surveillance Network (FoodNet), representing approximately 47 million persons (15.2% of the U.S. population).

Clinically Important Antimicrobial Resistance Patterns

In the United States, fluoroquinolones (e.g., ciprofloxacin) and third-generation cephalosporins (e.g., ceftriaxone) are commonly used to treat severe *Salmonella* infections*,* including *Salmonella* ser. Typhi, the organism that causes typhoid fever. In *Enterobacteriaceae*, resistance to nalidixic acid, an elementary quinolone, correlates with decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL) and possible fluoroquinolone treatment failure. A substantial proportion of *Enterobacteriaceae* isolates tested in 2010 demonstrated resistance to clinically important antimicrobial agents.

- 2.0% (49/2474) of non-typhoidal *Salmonella* isolates were resistant to nalidixic acid, including
    - 5.2% (27/522) of *Salmonella* ser. Enteritidis isolates
    - Enteritidis was the most common serotype among nalidixic acid–resistant non-typhoidal *Salmonella* isolates: 55.1% (27/49) of nalidixic acid–resistant isolates were serotype Enteritidis.
- 2.8% (70/2474) of non-typhoidal *Salmonella* isolates were resistant to ceftriaxone, including
    - 24.2% (15/62) of *Salmonella* ser. Heidelberg isolates
    - 7.2% (22/305) of *Salmonella* ser. Newport isolates
    - 4.9% (18/366) of *Salmonella* ser. Typhimurium isolates
    - Newport was the most common serotype among ceftriaxone–resistant non-typhoidal *Salmonella* isolates: 31.4% (22/70) of ceftriaxone–resistant isolates were serotype Newport.
- 69.1% (307/444) of *Salmonella* ser. Typhi isolates were resistant to nalidixic acid and 2.7% (12/444) were resistant to ciprofloxacin.
- 90.4% (132/146) of *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C were resistant to nalidixic acid
- 4.4% (18/407) of *Shigella* isolates were resistant to nalidixic acid and 1.7% (7/407) were resistant to ciprofloxacin.

In *Campylobacter*, fluoroquinolones and macrolides (e.g., erythromycin) are important agents in the treatment of severe infections.

- 22.4% (294/1310) of *Campylobacter* isolates were resistant to ciprofloxacin, including
    - 21.8% (253/1158) of *Campylobacter jejuni* isolates
    - 31.3% (36/115) of *Campylobacter coli* isolates
- 1.5% (19/1310) of *Campylobacter* isolates were resistant to erythromycin, including
    - 1.2% (14/1158) *Campylobacter jejuni* isolates
    - 4.3% (5/115) of *Campylobacter coli* isolates

Multidrug Resistance

Multidrug resistance is described in NARMS as resistance to three or more antimicrobial classes and also by specific coresistant phenotypes. Antimicrobial classes of agents defined by the Clinical and Laboratory Standards Institute (CLSI) are used in this report (Table 3, Table 4, Table 5). For non-typhoidal *Salmonella*, an important multidrug-resistant phenotype includes resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide (sulfamethoxazole/sulfisoxazole), and tetracycline (ACSSuT). The ACSSuT phenotype includes resistance to at least five CLSI classes. Another important phenotype includes resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx). The ACSSuTAuCx phenotype includes resistance to at least seven CLSI classes.

- 11.3% (279/2474) of non-typhoidal *Salmonella* isolates were resistant to two or more CLSI classes of antimicrobial agents, and 9.1% (225/2474) were resistant to three or more CLSI classes.
    - 33.9% (21/62) of *Salmonella* ser. Heidelberg isolates were resistant to three or more CLSI classes.

    - 27.3% (100/366) of *Salmonella* ser. Typhimurium isolates were resistant to three or more CLSI classes.
    - 22.1% (17/77) of *Salmonella* ser. I,4,[5],12:i:- isolates were resistant to three or more CLSI classes.
    - 7.5% (23/305) of *Salmonella* ser. Newport isolates were resistant to three or more CLSI classes.
    - 2.1% (11/522) of *Salmonella* ser. Enteritidis isolates were resistant to three or more CLSI classes.
    - Of 225 non-typhoidal *Salmonella* resistant to three or more CLSI classes, 44.4% were *Salmonella* ser. Typhimurium.
- 4.3% (107/2474) of non-typhoidal *Salmonella* isolates were at least ACSSuT–resistant, including
    - 18.6% (68/366) of *Salmonella* ser. Typhimurium isolates, and
    - 7.2% (22/305) of *Salmonella* ser. Newport isolates.
- 1.3% (33/2474) of non-typhoidal *Salmonella* isolates were at least ACSSuTAuCx–resistant, including
    - 7.2% (22/305) of *Salmonella* ser. Newport isolates, and
    - 1.9% (7/366) of *Salmonella* ser. Typhimurium isolates.
- 13.7% (61/444) of *Salmonella* ser. Typhi isolates were resistant to three or more classes.
- 40.0% (163/407) of *Shigella* isolates were resistant to three or more classes.
- 3.6% (6/167) of *E. coli* O157 isolates were resistant to three or more classes.

Antimicrobial Resistance: 1996–2010

The following figures display resistance from 1996–2010 for non-typhoidal *Salmonella*, 1999–2010 for *Salmonella* ser. Typhi, and 1997–2010 for *Campylobacter*.

Figure 1. Percentage of non-typhoidal *Salmonella* isolates resistant to nalidixic acid, by year, 1996–2010

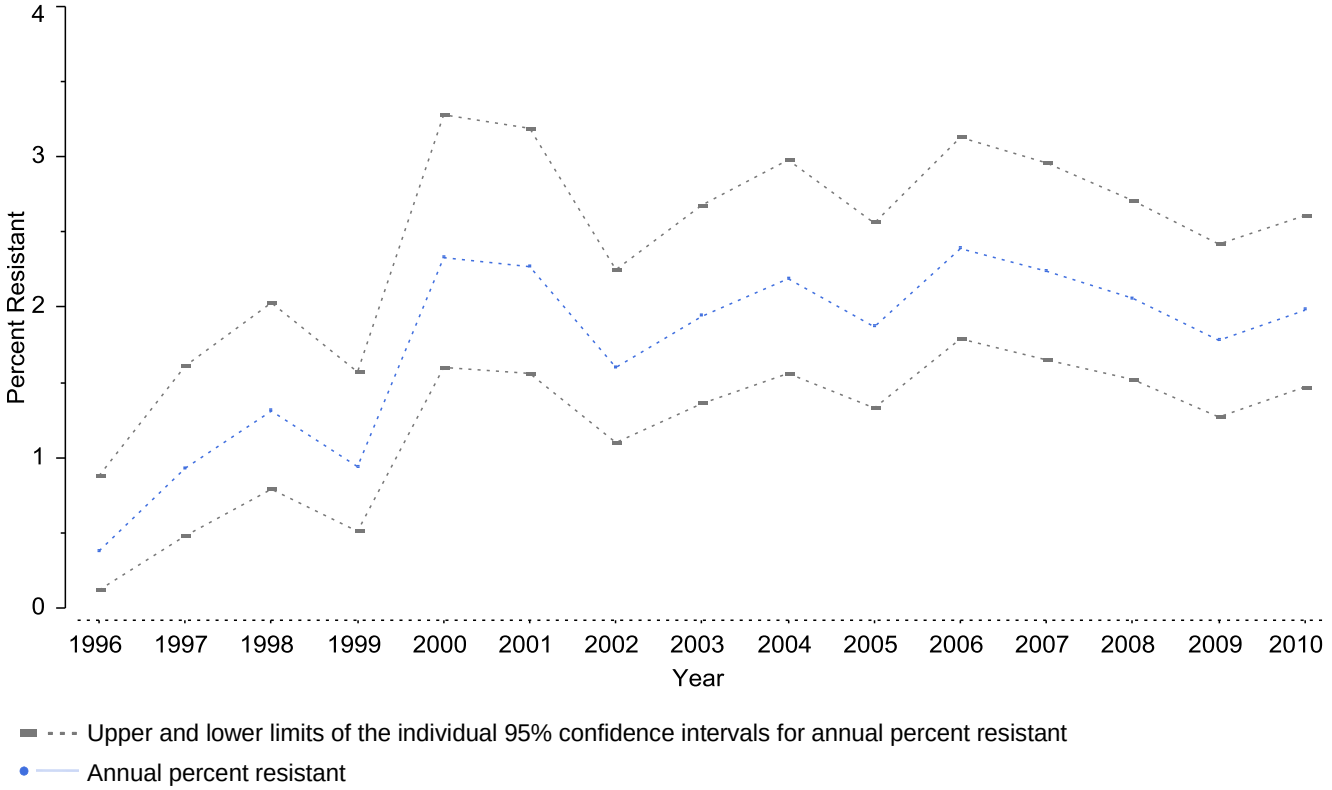


Figure 2. Percentage of non-typhoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2010

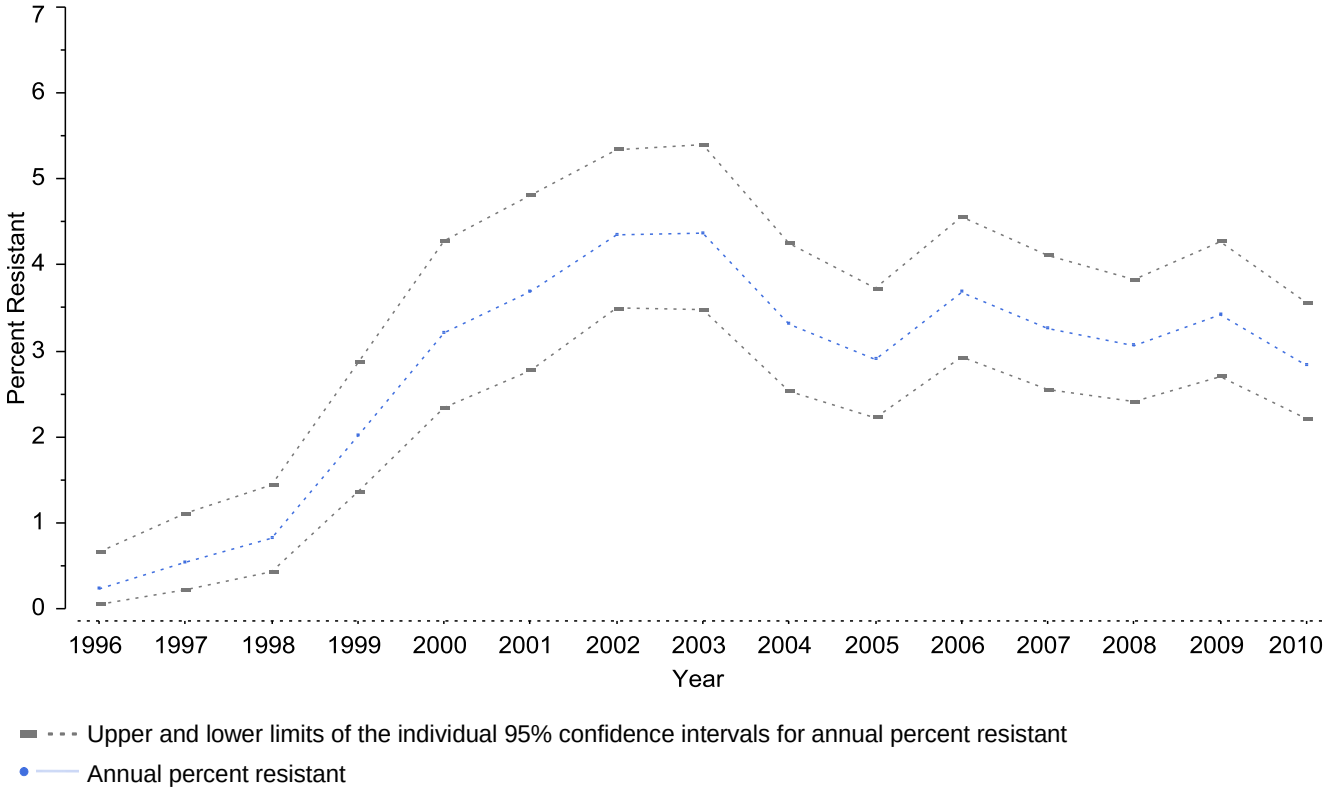


Figure 3. Percentage of *Salmonella* ser. Enteritidis isolates resistant to nalidixic acid, by year, 1996–2010

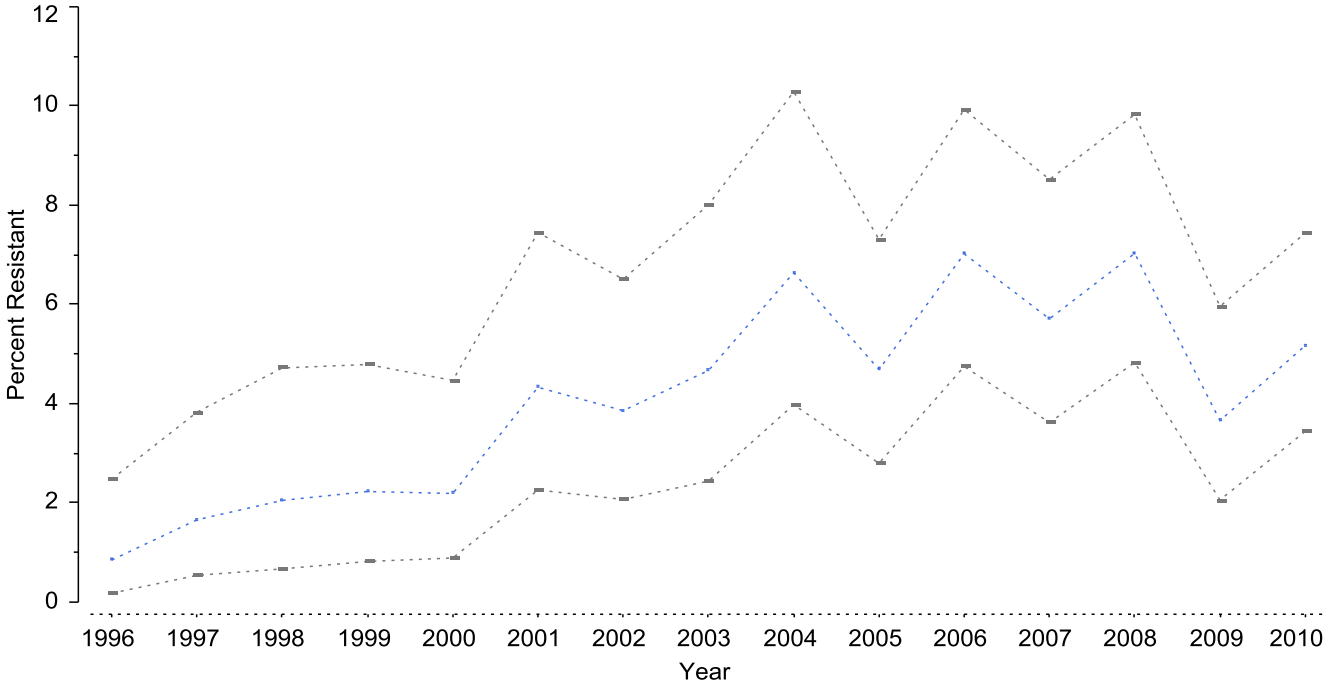


Figure 4. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2010

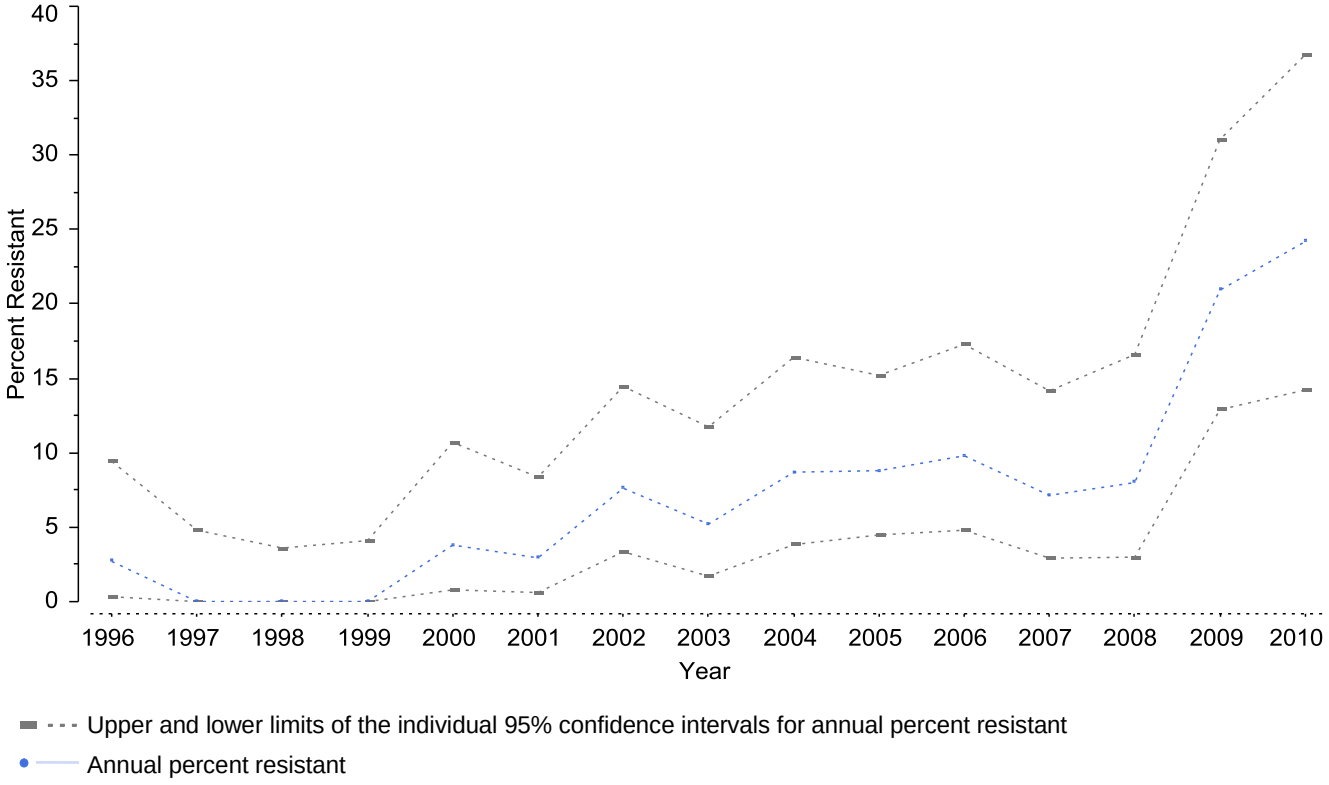


Figure 5. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2010

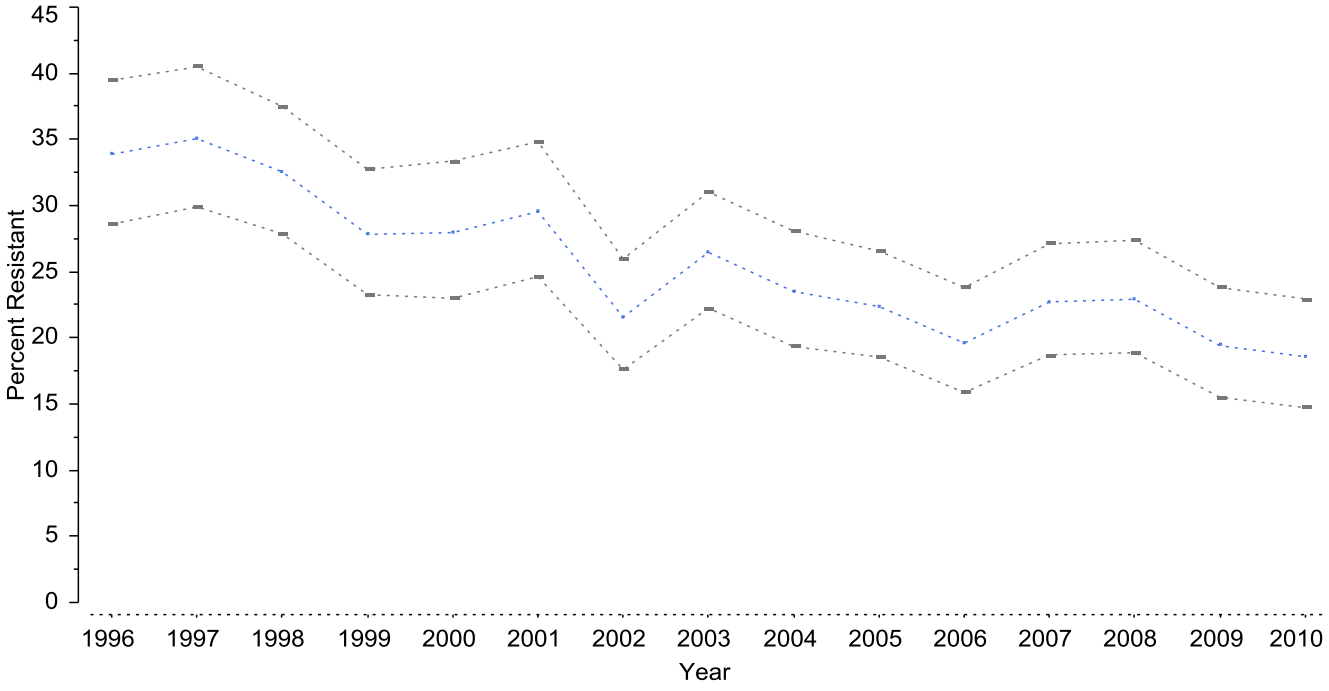


Figure 6. Percentage of *Salmonella* ser. Newport isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx), by year, 1996–2010

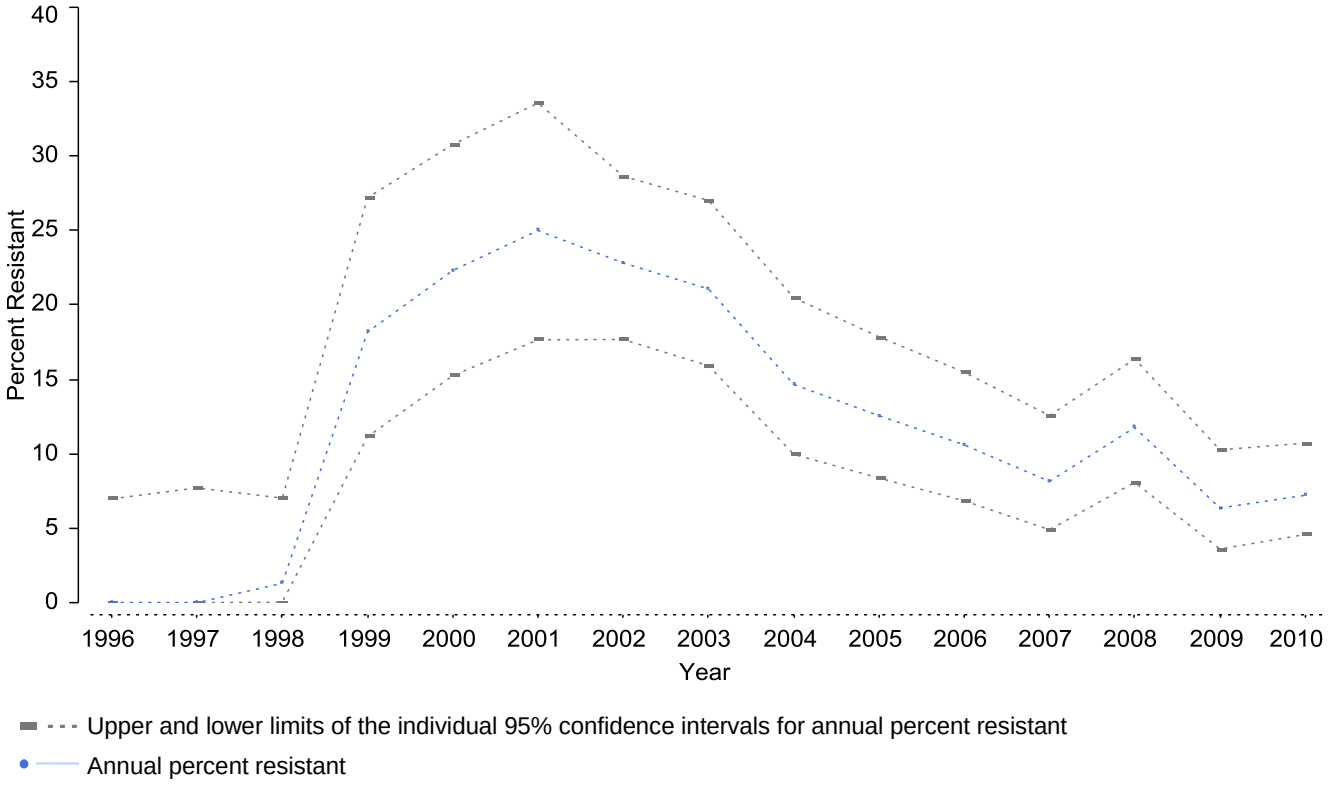


Figure 7. Percentage of non-typhoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2010

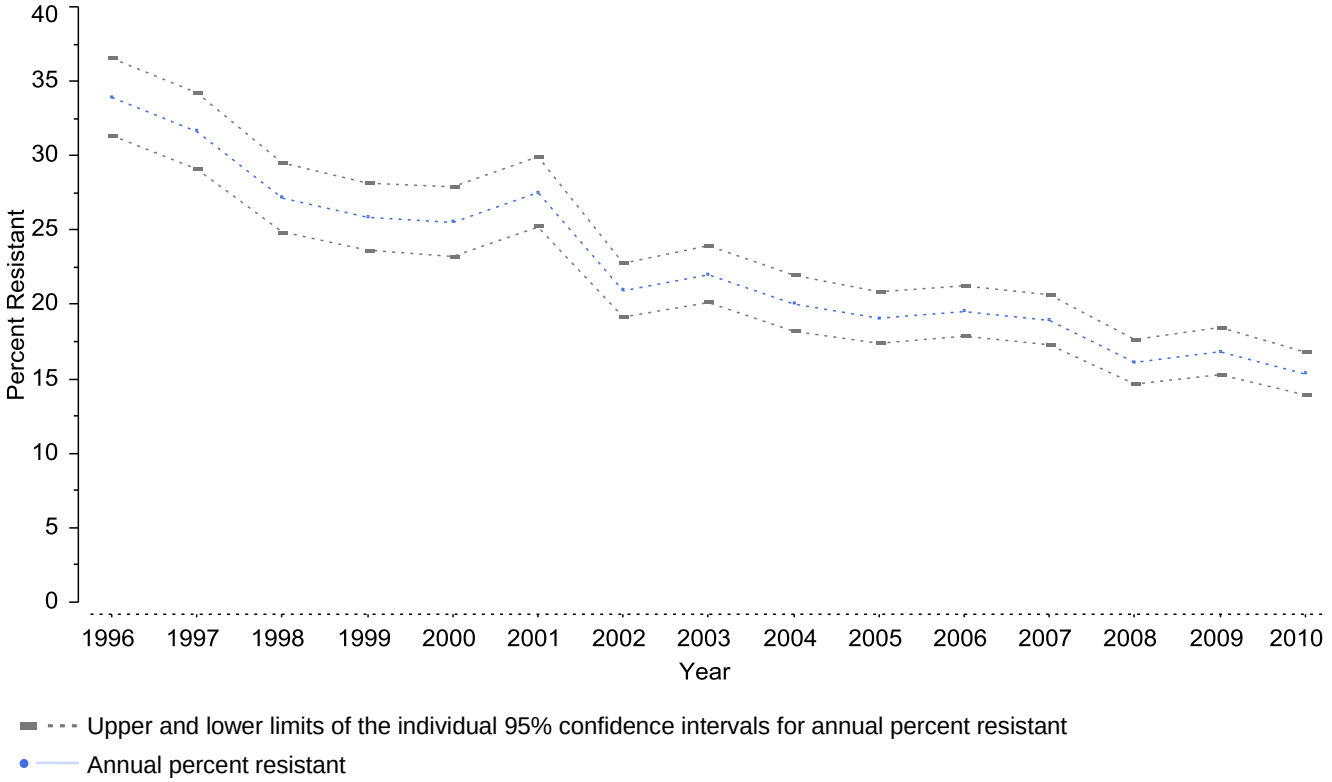


Figure 8. Percentage of non-typhoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2010

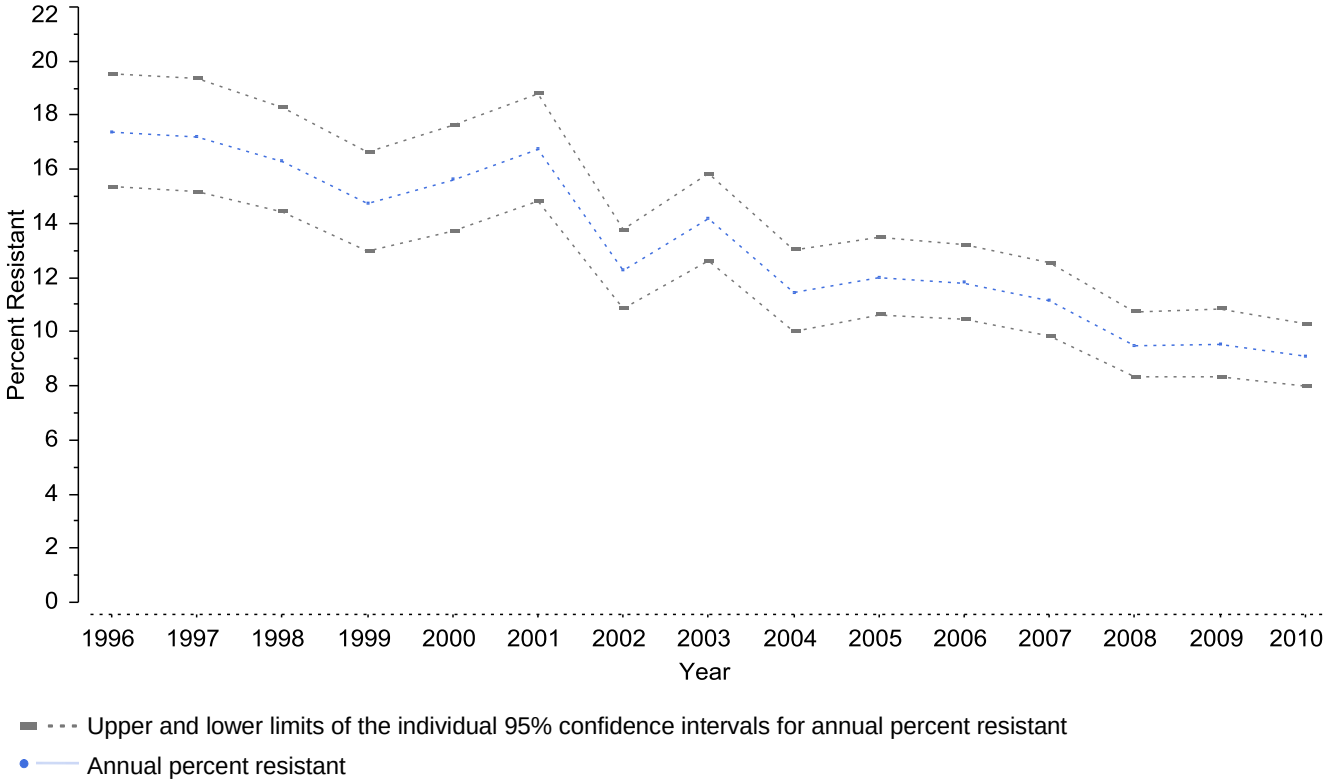


Figure 9. Percentage of *Salmonella* ser. Typhi isolates resistant to nalidixic acid, by year, 1999–2010

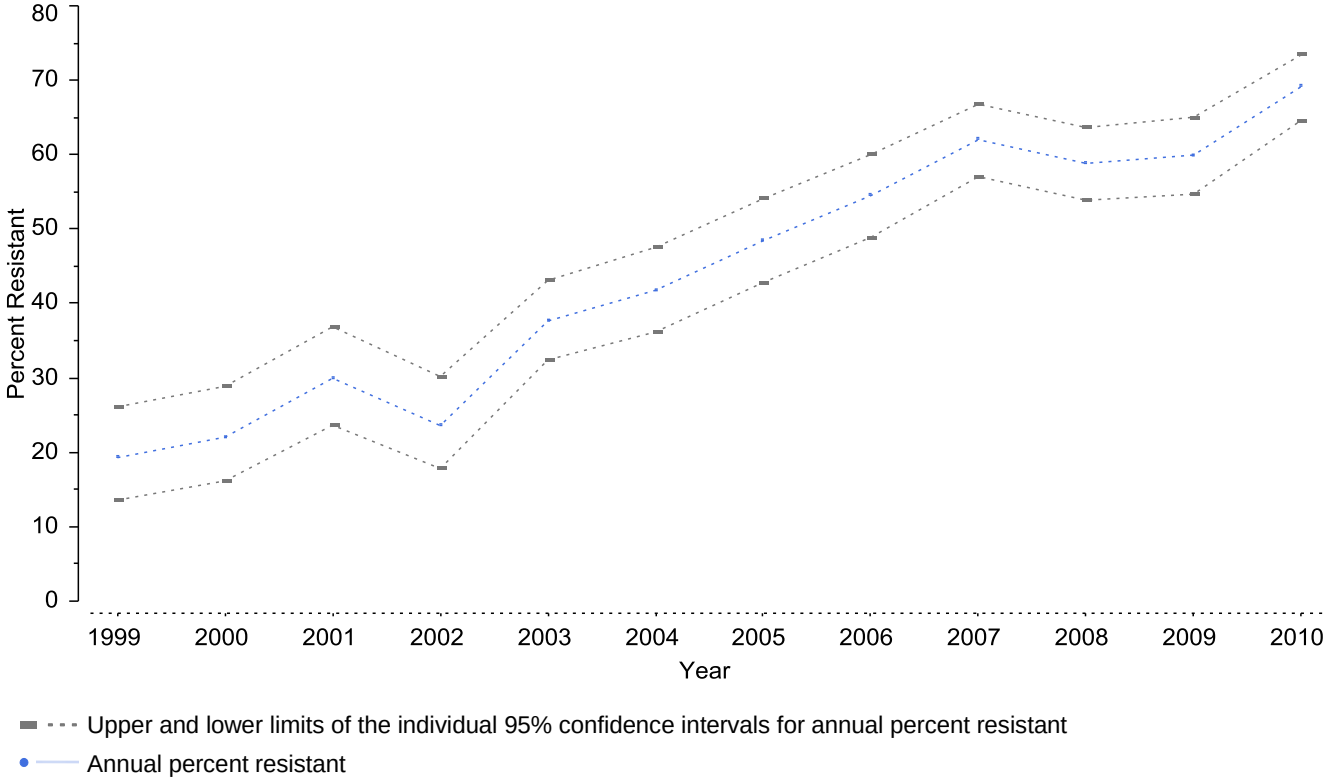
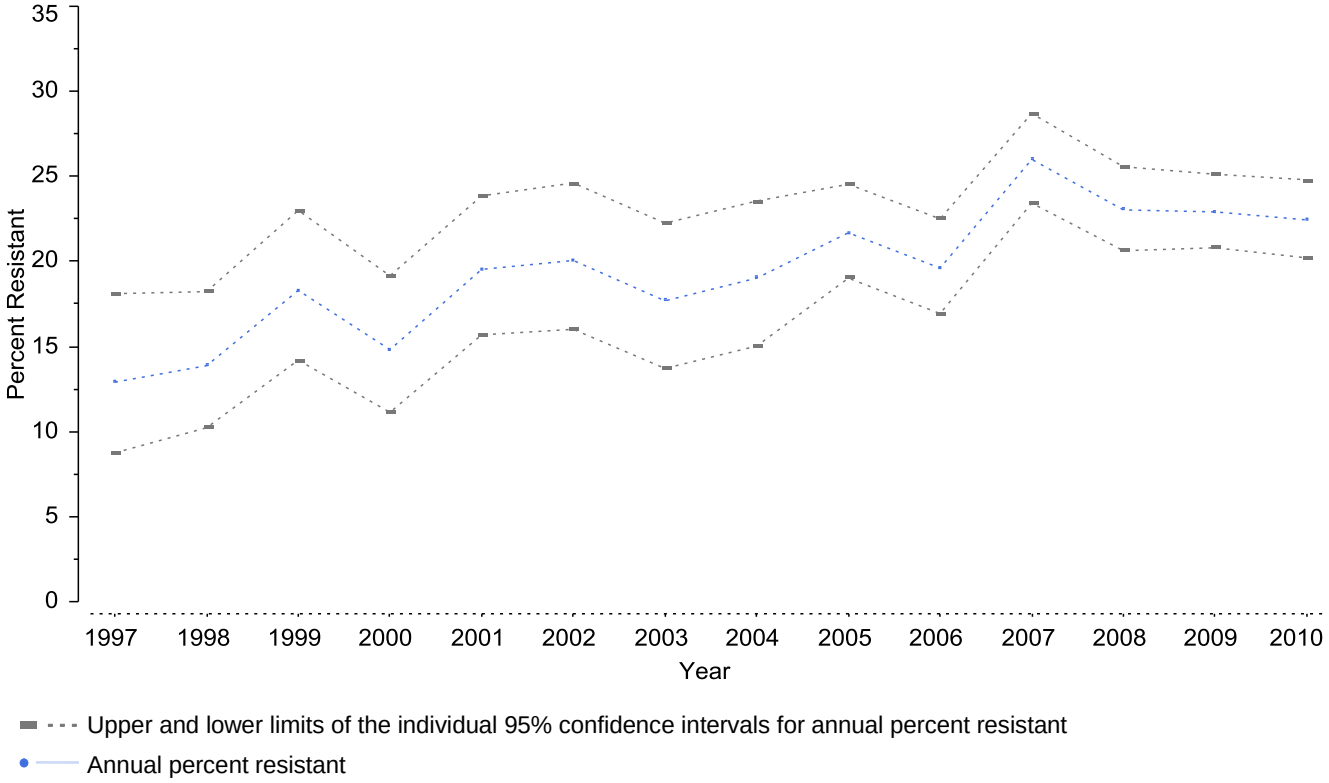


Figure 10. Percentage of *Campylobacter* isolates resistant to ciprofloxacin, by year, 1997–2010



WHO Categorization of Antimicrobial Agents

In 2009, the World Health Organization (WHO) convened a panel of experts to update a list of antimicrobial agents ranked according to their relative importance to human medicine (WHO, 2009). The participants categorized antimicrobial agents as either Critically Important, Highly Important, or Important based upon two criteria: (1) used as sole therapy or one of the few alternatives to treat serious human disease and (2) used to treat disease caused by either organisms that may be transmitted via non–human sources or diseases caused by organisms that may acquire resistance genes from non–human sources. In 2009, WHO recategorized tetracycline from highly important to critically important. Antimicrobial agents tested in NARMS have been included in the WHO categorization table.

- Antimicrobial agents are critically important if both criteria (1) and (2) are true.
- Antimicrobial agents are highly important if either criterion (1) or (2) is true.
- Antimicrobial agents are important if neither criterion is true.

Table 1. WHO categorization of antimicrobials of critical importance to human medicine

WHO Category Level	Importance	CLSI Class	Antimicrobial Agent tested in NARMS
I	Critically important	Aminoglycosides	Amikacin
			Gentamicin
			Streptomycin
		β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid
		Cephems	Ceftriaxone
		Ketolides	Telithromycin
		Macrolides	Azithromycin
			Erythromycin
		Penicillins	Ampicillin
		Quinolones	Ciprofloxacin
			Nalidixic acid
		Tetracyclines	Tetracycline
II	Highly important	Aminoglycosides	Kanamycin
		Cephems	Cefoxitin
			Cephalothin
		Folate pathway inhibitors	Sulfamethoxazole / Sulfisoxazole
			Trimethoprim-sulfamethoxazole
		Phenicols	Chloramphenicol
1. III	Important	Lincosamides	Clindamycin

Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2010 NARMS conducted nationwide surveillance among approximately 309 million persons (2010 U.S. Census Bureau estimates). Public health laboratories systematically selected every 20th non-typhoidal *Salmonella, Shigella*, and *Escherichia coli* O157 isolate as well as every *Salmonella* ser. Typhi, *Salmonella* ser. Paratyphi A and *Salmonella* ser. Paratyphi C isolate received at their laboratories and forwarded these isolates to CDC for antimicrobial susceptibility testing. *Salmonella* ser. Paratyphi B was included in the every 20th sampling for non-typhoidal *Salmonella* because available laboratory methods do not always allow for consistent distinction between serotype Paratyphi B (which typically causes typhoidal illness) and serotype Paratyphi B var. L(+) tartrate+ (which does not typically cause typhoidal illness). Beginning in 2009, NARMS also performed susceptibility testing on isolates of *Vibrio* species other than *V*. *cholerae* submitted by the NARMS participating public health laboratories. Participants were asked to forward every isolate of *Vibrio* species other than *V*. *cholerae* that they received to CDC for antimicrobial susceptibility testing and confirmation by CDC's National Enteric Reference Laboratory.

Since 2005, public health laboratories of the 10 state health departments that participated in CDC's Foodborne Diseases Active Surveillance Network (FoodNet) have forwarded a representative sample of *Campylobacter* isolates to CDC for susceptibility testing. The FoodNet sites, representing approximately 47 million persons (2010 U.S. Census Bureau estimates), include California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee. Depending on the burden of *Campylobacter* in each FoodNet site, one of the following four methods was used to obtain and test a representative sample of *Campylobacter* isolates in 2010: all isolates received by Oregon and Tennessee; every other isolate from California, Colorado, Connecticut, Georgia, Maryland, and New York; every third isolate from New Mexico; and every fifth isolate from Minnesota. Isolates received from 2005 to 2009 had the same methods except all isolates were sent from Georgia, Maryland, and New Mexico. From 1997 to 2004, one *Campylobacter* isolate was submitted each week from participating FoodNet sites.

Table 2. Population size and number of isolates received and tested, NARMS, 2010

State/Site	Population Size*	Non-typhoidal *Salmonella*		Typhoidal† *Salmonella*		*Shigella*		*E. coli* O157		*Campylobacter* ‡	
		n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Alabama	4,779,736	67	(2.7)	5	(0.8)	12	(2.9)	2	(1.2)		
Alaska	710,231	3	(0.1)	0	(0)	1	(0.2)	1	(0.6)		
Arizona	6,392,017	54	(2.2)	11	(1.9)	20	(4.9)	0	(0)		
Arkansas	2,915,918	30	(1.2)	0	(0)	3	(0.7)	1	(0.6)		
California§	27,435,351	236	(9.5)	100	(16.9)	4	(1.0)	9	(5.4)	151	(11.5)
Colorado	5,029,196	32	(1.3)	3	(0.5)	7	(1.7)	4	(2.4)	52	(4.0)
Connecticut	3,574,097	28	(1.1)	9	(1.5)	1	(0.2)	2	(1.2)	124	(9.5)
Delaware	897,934	10	(0.4)	2	(0.3)	2	(0.5)	0	(0)		
District of Columbia	601,723	10	(0.4)	2	(0.3)	0	(0)	0	(0)		
Florida	18,801,310	29	(1.2)	22	(3.7)	0	(0)	0	(0)		
Georgia	9,687,653	155	(6.3)	15	(2.5)	37	(9.1)	25	(15.0)	218	(16.6)
Hawaii	1,360,301	17	(0.7)	2	(0.3)	4	(1.0)	1	(0.6)		
Houston, Texas¶	2,099,451	41	(1.7)	6	(1.0)	10	(2.5)	1	(0.6)		
Idaho	1,567,582	9	(0.4)	1	(0.2)	0	(0)	1	(0.6)		
Illinois	12,830,632	96	(3.9)	30	(5.1)	30	(7.4)	10	(6.0)		
Indiana	6,483,802	40	(1.6)	3	(0.5)	1	(0.2)	4	(2.4)		
Iowa	3,046,355	23	(0.9)	7	(1.2)	4	(1.0)	4	(2.4)		
Kansas	2,853,118	16	(0.6)	1	(0.2)	6	(1.5)	1	(0.6)		
Kentucky	4,339,367	24	(1.0)	0	(0)	1	(0.2)	1	(0.6)		
Los Angeles**	9,818,605	60	(2.4)	24	(4.1)	4	(1.0)	0	(0)		
Louisiana	4,533,372	24	(1.0)	1	(0.2)	2	(0.5)	0	(0)		
Maine	1,328,361	4	(0.2)	3	(0.5)	3	(0.7)	2	(1.2)		
Maryland	5,773,552	55	(2.2)	13	(2.2)	5	(1.2)	5	(3.0)	111	(8.5)
Massachusetts	6,547,629	37	(1.5)	10	(1.7)	5	(1.2)	1	(0.6)		
Michigan	9,883,640	42	(1.7)	10	(1.7)	10	(2.5)	1	(0.6)		
Minnesota	5,303,925	35	(1.4)	8	(1.4)	4	(1.0)	8	(4.8)	183	(14.0)
Mississippi	2,967,297	55	(2.2)	2	(0.3)	2	(0.5)	2	(1.2)		
Missouri	5,988,927	53	(2.1)	2	(0.3)	67	(16.5)	8	(4.8)		
Montana	989,415	7	(0.3)	0	(0)	1	(0.2)	2	(1.2)		
Nebraska	1,826,341	12	(0.5)	2	(0.3)	6	(1.5)	4	(2.4)		
Nevada	2,700,551	19	(0.8)	5	(0.8)	2	(0.5)	1	(0.6)		
New Hampshire	1,316,470	9	(0.4)	5	(0.8)	1	(0.2)	1	(0.6)		
New Jersey	8,791,894	60	(2.4)	46	(7.8)	13	(3.2)	8	(4.8)		
New Mexico	2,059,179	18	(0.7)	0	(0)	7	(1.7)	0	(0)	97	(7.4)
New York††	11,202,969	80	(3.2)	28	(4.7)	7	(1.7)	3	(1.8)	196	(15.0)
New York City‡‡	8,175,133	76	(3.1)	58	(9.8)	14	(3.4)	4	(2.4)		
North Carolina	9,535,483	133	(5.4)	11	(1.9)	4	(1.0)	0	(0)		
North Dakota	672,591	4	(0.2)	2	(0.3)	0	(0)	1	(0.6)		
Ohio	11,536,504	72	(2.9)	14	(2.4)	9	(2.2)	6	(3.6)		
Oklahoma	3,751,351	3	(0.1)	0	(0)	1	(0.2)	0	(0)		
Oregon	3,831,074	26	(1.1)	5	(0.8)	3	(0.7)	6	(3.6)	138	(10.5)
Pennsylvania	12,702,379	85	(3.4)	21	(3.6)	30	(7.4)	3	(1.8)		
Rhode Island	1,052,567	9	(0.4)	6	(1.0)	1	(0.2)	1	(0.6)		
South Carolina	4,625,364	82	(3.3)	2	(0.3)	4	(1.0)	1	(0.6)		
South Dakota	814,180	9	(0.4)	1	(0.2)	1	(0.2)	1	(0.6)		
Tennessee	6,346,105	54	(2.2)	6	(1.0)	12	(2.9)	3	(1.8)	40	(3.1)
Texas§§	23,046,110	207	(8.4)	36	(6.1)	13	(3.2)	2	(1.2)		
Utah	2,763,885	19	(0.8)	1	(0.2)	4	(1.0)	3	(1.8)		
Vermont	625,741	5	(0.2)	0	(0)	1	(0.2)	1	(0.6)		
Virginia	8,001,024	69	(2.8)	21	(3.6)	5	(1.2)	3	(1.8)		
Washington	6,724,540	44	(1.8)	22	(3.7)	6	(1.5)	5	(3.0)		
West Virginia	1,852,994	35	(1.4)	0	(0)	15	(3.7)	8	(4.8)		
Wisconsin	5,686,986	45	(1.8)	6	(1.0)	2	(0.5)	5	(3.0)		
Wyoming	563,626	7	(0.3)	0	(0)	0	(0)	1	(0.6)		
Total	**308,745,538**	**2474**	**(100)**	**590**	**(100)**	**407**	**(100)**	**167**	**(100)**	**1310**	**(100)**

* US Census Bureau, 2010

† Typhoidal *Salmonella* includes Typhi, Paratyphi A, Paratyphi B, and Paratyphi C

‡ *Campylobacter* isolates are submitted only from FoodNet sites representing a total population 47,053,218. All *Campylobacter* isolates are received from Georgia, Maryland, New Mexico, Oregon, and Tennessee and every other isolate from California, Colorado, Connecticut, and New York; and every fifth isolate from Minnesota.

§ Excluding Los Angeles County

¶ Houston City

** Los Angeles County

†† Excluding New York City

‡‡ Five burroughs of New York City (Bronx, Brooklyn, Manhattan, Queens, Staten Island)

§§ Excluding Houston, Texas

Testing of *Salmonella*, *Shigella*, and *Escherichia coli* O157

Antimicrobial Susceptibility Testing

Salmonella, *Shigella*, and *E. coli* O157 isolates were tested using broth microdilution (Sensititre®, Trek Diagnostics, Cleveland, OH) according to manufacturer's instructions to determine the minimum inhibitory concentration (MIC) for each of 15 antimicrobial agents: amikacin, ampicillin, amoxicillin-clavulanic acid, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole (Table 3). Before 2004, sulfamethoxazole was used instead of sulfisoxazole to represent the sulfonamides. Interpretive criteria defined by CLSI were used when available. The resistance breakpoint for amikacin, according to CLSI guidelines, is ≥64 µg/mL. In 2002 and 2003, a truncated broth microdilution series was used for amikacin testing (0.5-4 µg/mL). For isolates that grew in all amikacin dilutions on the Sensititre panel (MIC>4 µg/mL), Etest® (AB BIODISK, Solna, Sweden) was performed to determine amikacin MIC. The amikacin Etest® strip range of dilutions was 0.016-256 µg/mL. Since 2004, amikacin had a full range of dilutions (0.5-64 µg/mL) on the Sensititre panel (CMV1AGNF). Repeat testing of isolates was done based on criteria in Appendix B.

In January 2010, CLSI published revised interpretive criteria for ceftriaxone and *Enterobacteriaceae;* the revised resistance breakpoint for ceftriaxone is MIC ≥4 µg/mL. Since the 2009 report, NARMS has applied the revised CLSI breakpoint for ceftriaxone resistance to data from all years. In January 2012, CLSI published revised ciprofloxacin breakpoints for invasive *Salmonella* infections. For those infections, ciprofloxacin susceptibility is defined as ≤0.06 µg/mL; the intermediate category is defined as 0.12 to 0.5 µg/mL; and resistance is defined as ≥1 µg/mL. This year's report includes a comparison of the frequency of resistance based on the revised breakpoints with the frequency of resistance based on the previous breakpoints. Since all *Salmonella* serotypes have the potential to cause invasive infection, the revised breakpoints are applied to all *Salmonella* in this comparison shown in Box 2.

Table 3. Antimicrobial agents used for susceptibility testing for *Salmonella*, *Shigella*, and *Escherichia coli* O157 isolates, NARMS, 2010

CLSI class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate*	Resistant
Aminoglycosides	Amikacin	0.5–64	≤16	32	≥64
	Gentamicin	0.25–16	≤4	8	≥16
	Kanamycin	8–64	≤16	32	≥64
	Streptomycin†	32–64	≤32	N/A	≥64
β–lactam / β–lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1/0.5–32/16	≤8/4	16/8	≥32/16
Cephems	Cefoxitin	0.5–32	≤8	16	≥32
	Ceftiofur	0.12–8	≤2	4	≥8
	Ceftriaxone‡	0.25–64	≤1	2	≥4
	Cephalothin§	2–32	≤8	16	≥32
Folate pathway inhibitors	Sulfamethoxazole¶	16–512	≤256	N/A	≥512
	Sulfisoxazole	16–256	≤256	N/A	≥512
	Trimethoprim-sulfamethoxazole	0.12/2.38–4/76	≤2/38	N/A	≥4/76
Penicillins	Ampicillin	1–32	≤8	16	≥32
Phenicols	Chloramphenicol	2–32	≤8	16	≥32
Quinolones	Ciprofloxacin**	0.015–4	≤1	2	≥4
	Nalidixic acid	0.5–32	≤16	N/A	≥32
Tetracyclines	Tetracycline	4–32	≤4	8	≥16

* N/A indicates that no MIC range of intermediate susceptibility exists
† No CLSI breakpoints; resistance breakpoint used in NARMS is ≥64 µg/mL.
‡ CLSI updated the ceftriaxone interpretive standards in January, 2010. Previous standards that were used for NARMS Human Isolate reports from 1996-2008 were susceptible ≤8 µg/mL, intermediate 16-32 µg/mL, and resistant ≥64 µg/mL.
§ Cephalothin was tested from 1996 to 2003 for *Salmonella*, *Shigella*, and *E. coli* O157.
¶ Sulfamethoxazole, which was tested during 1996–2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004.
** CLSI breakpoints for invasive *Salmonella* infections were updated, effective January 2012. For those infections, ciprofloxacin susceptibility is defined as ≤0.06 µg/mL; the intermediate category is defined as 0.12 to 0.5 µg/mL; and resistance is defined as ≥1 µg/mL.

Additional Testing of *Salmonella* Strains

Cephalosporin Retesting of Isolates from 1996-1998

Review of *Salmonella* isolates tested in NARMS during 1996 to 1998 gave conflicting cephalosporin susceptibility results. In particular, some isolates previously reported in NARMS as ceftiofur-resistant exhibited a low ceftriaxone MIC and, in some cases, did not exhibit an elevated MIC to other β-lactams. Because these findings suggested that some previously reported results were inaccurate, we retested, using the 2003 NARMS Sensititre® plate, isolates of *Salmonella* tested in NARMS during 1996 to 1998 that exhibited an MIC ≥2 µg/mL to ceftiofur or ceftriaxone. The retest results have been included in the NARMS annual reports since 2003.

Serotype Confirmation/Categorization

Salmonella serotype reported by the submitting laboratory was used for reporting with few exceptions. Serotype was confirmed by CDC for isolates that underwent subsequent molecular analysis for publication. Because of challenges associated with interpretation of tartrate fermentation assays, ability to ferment tartrate was confirmed for isolates reported as *Salmonella* ser. Paratyphi B by the submitting laboratory (serotype Paratyphi B is by definition unable to ferment L(+) tartrate). To distinguish *Salmonella* serotypes Paratyphi B and Paratyphi B var. L(+) tartrate+ (formerly serotype Java), CDC performed Jordan's tartrate test and/or Kauffmann's tartrate test on all *Salmonella* ser. Paratyphi B isolates from 1996 to 2010 for which the tartrate result was not reported or was reported to be negative. Isolates negative for tartrate fermentation by both assays were categorized as serotype Paratyphi B. Isolates that were positive for tartrate fermentation by either assay were categorized as serotype Paratyphi B var. L(+) tartrate+. Confirmation of other biochemical reactions or somatic and flagellar antigens was not performed at CDC.

Because of increased submissions of *Salmonella* ser. I 4,[5],12:i:- noted in previous years, and recognition of the possibility that this serotype may have been underreported in previous years, isolates reported as serogroup B and tested in NARMS during 1996 to 2010 were reviewed for additional information; isolates that could be clearly identified as serogroup B, first-phase flagellar antigen "i", second phase flagellar antigen absent were categorized in this report as *Salmonella* ser. I 4,[5],12:i:-.

Testing of *Campylobacter*

Changes in Sampling Scheme in 2010

The number of isolates received from Georgia, Maryland, and New Mexico increased over time. To avoid oversampling from these sites, instead of testing all isolates that had been received for 2010, the scheme for testing isolates was changed to every other isolate from Georgia and Maryland and every third from New Mexico. The sampling scheme was adjusted to reflect these changes.

Changes in Testing Methods in 2005

Starting in 2005, there were four changes in the methodology used for *Campylobacter*. First, a surveillance scheme for selecting a representative sample of *Campylobacter* isolates for submission by FoodNet sites was implemented. State public health laboratories within FoodNet sites receive *Campylobacter* isolates from reference and clinical laboratories within their state. In 2005, FoodNet sites changed from submitting the first isolate received each week to submitting every isolate (Georgia, Maryland, New Mexico, Oregon, and Tennessee), every other isolate (California, Colorado, Connecticut, and New York), or every fifth isolate received (Minnesota). The number of laboratories submitting isolates ranged from two to all. Second, the method of species identification was updated to parallel what is used by the CDC National *Campylobacter* Laboratory. Third, the susceptibility testing method changed from Etest® (AB bioMerieux, Solna, Sweden) to broth microdilution. Fourth, there were changes in the antimicrobial agents tested. Florfenicol replaced chloramphenicol as the phenicol class representative drug, and telithromycin was added to the NARMS panel of agents tested. These methods began in 2005 and continue through the current year's report except for noted changes to submissions from Georgia, Maryland, and New Mexico beginning in 2010.

Identification/Speciation and Antimicrobial Susceptibility Testing

From 2005 through 2010, isolates were confirmed as *Campylobacter* by determination of typical morphology and motility using dark-field microscopy and a positive oxidase test reaction. Identification of *C. jejuni* was performed using the hippurate hydrolysis test. Hippurate-positive isolates were identified as *C. jejuni.* Hippurate-negative isolates were further characterized with polymerase chain reaction (PCR) assays with specific targets for *C*. *jejuni (mapA* or *hipO* gene*)*, *C*. *coli*-specific *ceuE* gene (Linton *et al.* 1997, Gonzales et al. 1997, Pruckler *et al*. 2006), or other species specific primers. The only changes for 2010 include all *jejuni* and suspected *coli* isolates were confirmed through a multiplex PCR (Vandamme *et al.* 1997) and the ceuE PCR was not used. From 2003 to 2004, putative *Campylobacter* isolates were identified as *C. jejuni* or *C. coli* using BAX® System PCR Assay according to the manufacturer's instructions (DuPont Qualicon, Wilmington, DE). Isolates not identified as *C. jejuni* or *C. coli* were further characterized by other PCR assays (Linton *et al.* 1996) or were characterized by the

CDC National *Campylobacter* Reference Laboratory. From 1997 to 2002, methodology similar to that used from 2005 to 2009 was used.

The methods for susceptibility testing *Campylobacter* and criteria for interpreting the results have changed during the course of NARMS surveillance. Beginning in 2005, broth microdilution using the Sensititre® system (Trek Diagnostics, Cleveland, OH) was performed according to manufacturer's instructions to determine the MICs for nine antimicrobial agents: azithromycin, ciprofloxacin, clindamycin, erythromycin, florfenicol, gentamicin, nalidixic acid, telithromycin, and tetracycline (Table 4). CLSI recommendations for quality control were followed. From 1997 to 2004, Etest® (AB bioMerieux, Solna, Sweden) was used for susceptibility testing of *Campylobacter* isolates. *Campylobacter*-specific CLSI interpretive criteria were used for erythromycin, ciprofloxacin, and tetracycline beginning with the 2004 NARMS annual report. NARMS breakpoints were used when CLSI breakpoints were not available. Beginning in 2004, NARMS breakpoints were established based on the MIC distributions of NARMS isolates and the presence of known resistance genes or mutations. In pre-2004 annual reports, NARMS breakpoints used were based on those available for other organisms. Establishment of breakpoints based on MIC distributions resulted in higher MIC definitions for azithromycin and erythromycin resistance compared with those reported in pre-2004 annual reports. The breakpoints listed in Table 4 have been applied to MIC data collected for all years so that resistance prevalence is comparable over time. Repeat testing of isolates was done based on criteria in Appendix B.

Table 4. Antimicrobial agents used for susceptibility testing of *Campylobacter* isolates, NARMS, 1997–2010

CLSI class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate	Resistant
Aminoglycosides	Gentamicin	0.12–32 0.016–256*	≤2	4	≥8
Ketolides	Telithromycin†	0.015–8	≤4	8	≥16
Lincosamides	Clindamycin	0.03–16 0.016–256*	≤2	4	≥8
Macrolides	Azithromycin	0.015–64 0.016–256*	≤2	4	≥8
	Erythromycin	0.03–64 0.016–256*	≤8	16	≥32
Phenicols	Chloramphenicol‡	0.016–256*	≤8	16	≥32
	Florfenicol§	0.03–64	≤4	N/A	N/A
Quinolones	Ciprofloxacin	0.015–64 0.002–32*	≤1	2	≥4
	Nalidixic acid	4–64 0.016–256*	≤16	32	≥64
Tetracyclines	Tetracycline	0.06–64 0.016–256*	≤4	8	≥16

N/A indicates that no MIC range of either intermediate or resistant susceptibility exists

* Etest dilution range used from 1997–2004.

† Telithromycin added to NARMS panel in 2005.

‡ Chloramphenicol, tested from 1997–2004, was replaced by florfenicol in 2005.

§ Currently only a susceptible breakpoint (≤4 µg/mL) has been established. In this report isolates with a MIC ≥8 µg/mL are categorized as resistant.

Testing of *Vibrio* species other than *V. cholera*

NARMS participating public health laboratories were asked to forward every isolate of *Vibrio* species other than *V. cholerae* they received to CDC for antimicrobial susceptibility testing by the NARMS laboratory and, in some cases, confirmation of identity by CDC's National Enteric Reference Laboratory. Minimum inhibitory concentrations were determined by Etest® (AB bioMerieux, Solna, Sweden) according to manufacturer's instructions for 9 drugs: ampicillin, cephalothin, chloramphenicol, ciprofloxacin, kanamycin, nalidixic acid, streptomycin, tetracycline, and trimethoprim-sulfamethoxazole (Table 5). CLSI breakpoints specific for *Vibrio* species other than *V. cholera* were available for ampicillin, ciprofloxacin, tetracycline, and trimethoprim-sulfamethoxazole. Frequency of isolates susceptible, intermediate, and resistant for those drugs is shown in this report. MIC distributions are shown for drugs that do not have CLSI breakpoints. Identity confirmation is not yet complete for all isolates submitted in 2010, so results for isolates submitted in 2009 are presented in this report.

Table 5. Antimicrobial agents used for susceptibility testing of *Vibrio* species other than *V. cholerae* isolates, NARMS, 2009

CLSI class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate*	Resistant
Aminoglycosides	Kanamycin†	0.016-256			
	Streptomycin†	0.064-1024			
Cephems	Cephalothin†	0.016-256			
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	0.002-32	≤2/38	N/A	≥4/76
Penicillins	Ampicillin	0.016-256	≤8	16	≥32
Phenicols	Chloramphenicol†	0.016-256			
Quinolones	Ciprofloxacin	0.002-32	≤1	2	≥4
	Nalidixic acid†	0.016-256			
Tetracyclines	Tetracycline	0.016-256	≤4	8	≥16

* N/A indicates that no MIC range of intermediate susceptibility exists
† No CLSI or NARMS breakpoints established

Testing of Representative Bacteria from Outbreaks

CDC has often tested human clinical isolates of bacteria from selected foodborne disease outbreaks for various identification and subtyping purposes. Since 2004, efforts to characterize antimicrobial susceptibility of bacteria associated with foodborne disease outbreaks have increased, and CDC requests for state health departments to submit such isolates for this purpose have become more formal. Since 2006, all NARMS participating laboratories have been asked to forward 3 representative isolates from each outbreak of *Salmonella enterica* serotype Enteritidis, Newport, and Typhimurium. Also since 2006, FoodNet sites were asked to submit 3 representative isolates from all *Salmonella* outbreaks, regardless of serotype. The methods used for susceptibility testing were the same as those performed for *Salmonella* submitted for NARMS routine surveillance. A summary of antimicrobial susceptibility data of non-typhoidal *Salmonella* isolates tested in NARMS and available data from CDC's Foodborne Disease Outbreak Surveillance System for outbreaks from 2004 through 2008 are presented in this report in Appendix A.

Data Analysis

For all pathogens, MICs were categorized as resistant, intermediate (if applicable), or susceptible. Analysis was restricted to the first isolate received (per genus under surveillance) per patient in the calendar year. If two or more isolates were received for the same patient for *Salmonella* ser. Typhi, the first blood isolate collected would be included in analysis. If no blood isolates were submitted, the first isolate collected would be included in

analysis. The 95% confidence intervals (CIs) for the percentage of resistant isolates are included in the MIC distribution tables. The 95% CIs were calculated using the Paulson-Camp-Pratt approximation method.

When describing results for several years, multidrug resistance for *Salmonella, Shigella,* and *E. coli* O157 isolates was limited to the eight CLSI classes (Table 3) represented by the following 15 agents: amikacin, amoxicillin-clavulanic acid, ampicillin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole. Isolates that were not resistant to any of these 15 agents were considered to have no resistance detected. When describing multidrug resistance for several years for *Campylobacter* isolates, multidrug resistance was limited to the six CLSI classes represented by azithromycin, ciprofloxacin, chloramphenicol/florfenicol, clindamycin, erythromycin, gentamicin, nalidixic acid, and tetracycline (Table 4). *Campylobacter* isolates that were not resistant to any of these agents were considered to have no resistance detected.

Logistic regression was used to compare the prevalence of antimicrobial resistance among *Salmonella* and *Campylobacter* isolates tested in 2010 with the reference, which was the average prevalence of resistance in the first five years that NARMS surveillance was nationwide (2003–07). The analysis included the following:

1. Non-typhoidal *Salmonella*: resistance to nalidixic acid, resistance to ceftriaxone, resistance to one or more CLSI classes, resistance to three more CLSI classes
2. *Salmonella* ser. Enteritidis: resistance to nalidixic acid
3. *Salmonella* ser. Typhimurium: resistance to at least ACSSuT (ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline)
4. *Salmonella* ser. Newport: resistance to at least ACSSuTAuCx (ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone)
5. *Salmonella* ser. Typhi: resistance to nalidixic acid
6. *Campylobacter* species: resistance to ciprofloxacin
7. *Campylobacter jejuni*: resistance to ciprofloxacin

To account for site-to-site variation in the prevalence of antimicrobial resistance, we included main effects adjustments for site in the analysis. The final regression models for *Salmonella* adjusted for the submitting site using the nine geographic regions described by the U.S. Census Bureau: East North Central, East South Central, Mid-Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central. For *Campylobacter*, the final regression models adjusted for the submitting FoodNet site. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. The adequacy of model fit was assessed in several ways. The significance of the main effect of year was assessed using the likelihood ratio test. The likelihood ratio test was also used to test for significance of interaction between site and year, although the power of the test to detect a single site-specific interaction was low. The Hosmer and Lemeshow goodness-of-fit test was also used (Fleiss, et al.). Having assessed that the main effect of year was significant, we reported ORs with 95% CIs (for 2010 compared with reference) that did not include 1.00 as statistically significant.

MIC Distribution Tables and Proportional Figures

An explanation on "how to read a squashtogram" has been provided to assist the reader with the different parts of each table (Figure 11). A squashtogram shows the distribution of MICs for antimicrobial agents tested. Proportional figures visually display data from squashtograms for an immediate comparative summary of resistance in specific pathogens and serotypes. These figures are a categorical visual aid for the interpretation of MIC values. For most antimicrobial agents tested, three categories (susceptible, intermediate, and resistant) are used to interpret MICs. The proportion representing each category is shown in a horizontal proportional bar chart (Figure 12).

Figure 11. How to read a squashtogram

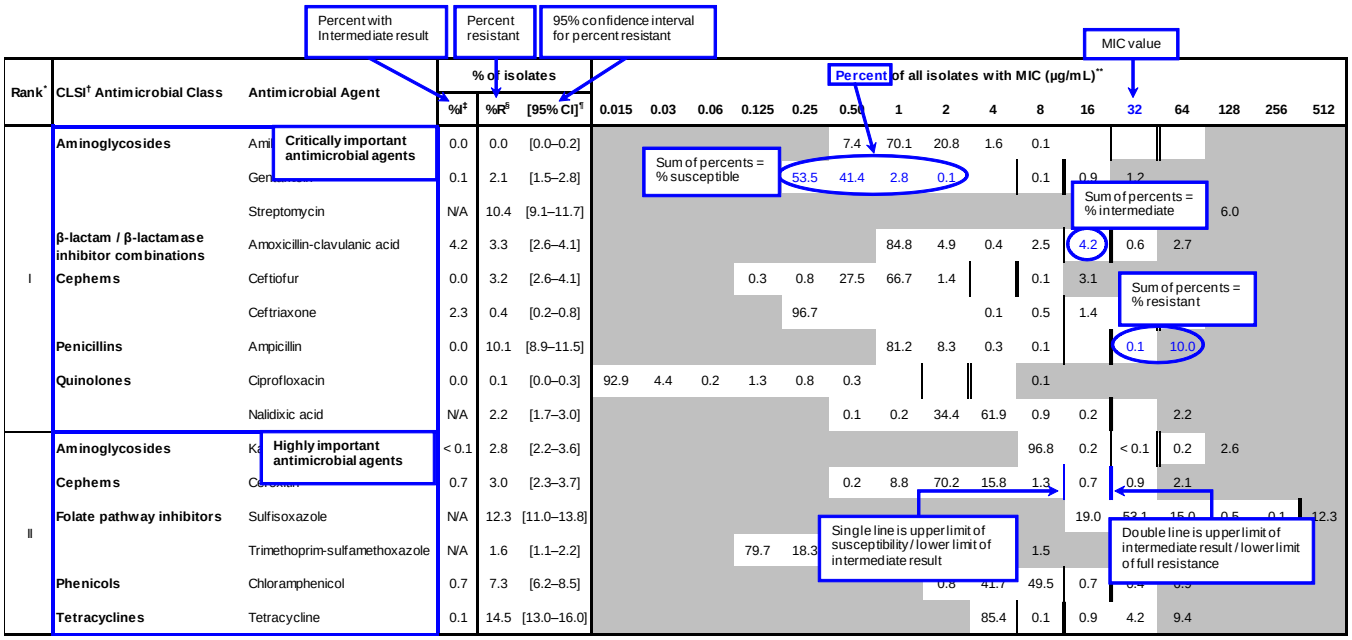


Figure 12. Proportional chart, a categorical graph of a squashtogram

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 0.2]						7.8	74.6	15.9	1.6	< 0.1						
		Gentamicin	0.2	1.3	[0.9 - 1.8]					64.2	32.8	1.3	0.1		0.2	0.7	0.6				
		Streptomycin	N/A	8.9	[7.8 - 10.2]												91.1	4.2	4.8		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	3.6	3.4	[2.7 - 4.3]							87.5	2.5	0.4	2.6	3.6	0.8	2.6			
	Cephems	Ceftiofur	< 0.1	3.4	[2.7 - 4.3]				0.1	0.8	21.1	73.2	1.3	< 0.1	0.2	3.2					
		Ceftriaxone	0.0	3.4	[2.7 - 4.3]					96.5	< 0.1		0.2	0.7	1.4	0.6	0.4	0.2			
	Penicillins	Ampicillin	< 0.1	9.9	[8.6 - 11.2]							83.7	5.9	0.3	0.2	< 0.1		9.9			
	Quinolones	Ciprofloxacin	0.1	< 0.1	[0.0 - 0.3]	92.9	4.6	0.2	0.7	1.0	0.4	0.1	0.1		< 0.1						
		Nalidixic acid	N/A	1.8	[1.3 - 2.4]							0.3	39.6	57.0	0.9	0.4	0.1	1.6			
II	**Aminoglycosides**	Kanamycin	< 0.1	2.5	[1.9 - 3.2]										97.3	0.2	< 0.1	< 0.1	2.4		
	Cephems	Cefoxitin	0.3	3.2	[2.5 - 4.1]						0.1	36.1	47.4	11.8	1.0	0.3	1.4	1.9			
	Folate pathway inhibitors	Sulfisoxazole	N/A	9.9	[8.7 - 11.2]											5.0	35.2	47.0	2.8	0.1	9.9
		Trimethoprim-sulfamethoxazole	N/A	1.7	[1.2 - 2.4]				95.8	2.2	0.2	< 0.1			1.7						
	Phenicols	Chloramphenicol	1.0	5.7	[4.8 - 6.8]								0.7	49.0	43.6	1.0	< 0.1	5.6			
	Tetracyclines	Tetracycline	0.2	11.9	[10.6 - 13.3]									87.9	0.2	0.2	2.9	8.8			

* Rank of antimicrobials based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

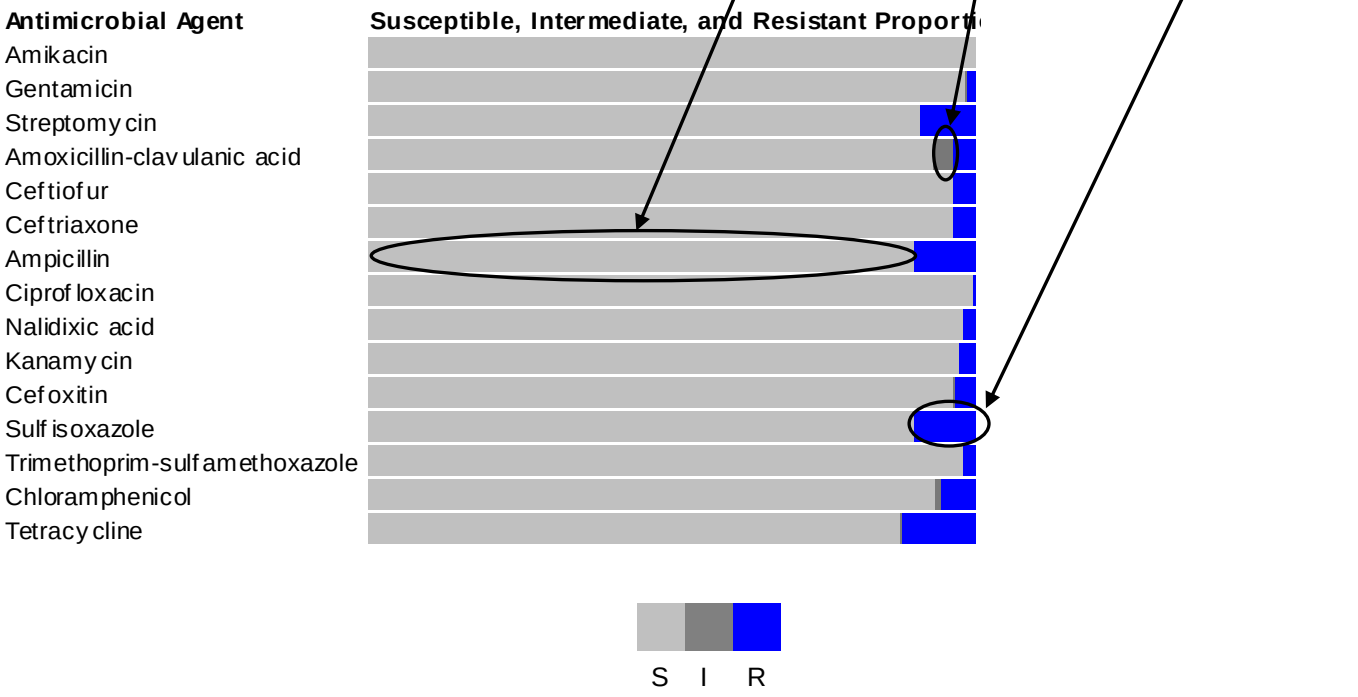
† CLSI: Clinical and Laboratory Standards Institute

‡ Percent of isolates with intermediate susceptibility, N/A if no MIC range of intermediate susceptibility exists

§ Percent of isolates that were resistant

¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method. The 95% CI is presented to summarize uncertainly in the observed resistance (R%).

** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.



Results

1. Non-typhoidal *Salmonella*

Table 6. Number and percentage of isolates with resistance to at least ACSSuT, ACSSuTAuCx, nalidixic acid, and ceftriaxone among the 20 most common non-typhoidal *Salmonella* serotypes isolated in NARMS, 2010

			ACSSuT*		ACSSuTAuCx†		Nalidixic Acid		Ceftriaxone	
Rank	Serotype	N	n	(%)	n	(%)	n	(%)	n	(%)
1	Enteritidis	522	0	(0)	0	(0)	**27**	**(55.1)**	0	(0)
2	Typhimurium	366	**68**	**(63.6)**	**7**	**(21.2)**	**5**	**(10.2)**	**18**	**(25.7)**
3	Newport	305	**22**	**(20.6)**	**22**	**(66.7)**	**1**	**(2.0)**	**22**	**(31.4)**
4	Javiana	178	0	(0)	0	(0)	0	**(0)**	**1**	**(1.4)**
5	I 4,[5],12:i:-	77	**1**	**(0.9)**	0	(0)	**2**	**(4.1)**	**2**	**(2.9)**
6	Heidelberg	62	**1**	**(0.9)**	0	(0)	0	(0)	**15**	**(21.4)**
7	Saintpaul	60	0	(0)	0	(0)	0	(0)	0	(0)
8	Montevideo	60	0	(0)	0	(0)	0	(0)	0	(0)
9	Braenderup	57	0	(0)	0	(0)	0	(0)	0	(0)
10	Infantis	55	**1**	**(0.9)**	**1**	**(3.0)**	0	(0)	**2**	**(2.9)**
11	Paratyphi B var. L(+) tartrate+	54	**7**	**(6.5)**	0	(0)	0	(0)	0	(0)
12	Muenchen	52	0	(0)	0	(0)	0	(0)	0	(0)
13	Agona	43	0	(0)	0	(0)	**1**	**(2.0)**	0	(0)
14	Oranienburg	40	0	(0)	0	(0)	0	(0)	0	(0)
15	Thompson	24	0	(0)	0	(0)	0	(0)	0	(0)
16	Mbandaka	24	0	(0)	0	(0)	0	(0)	0	(0)
17	Mississippi	23	0	(0)	0	(0)	0	(0)	0	(0)
18	Anatum	20	0	(0)	0	(0)	0	(0)	0	(0)
19	Schwarzengrund	19	0	(0)	0	(0)	0	(0)	0	(0)
20	Stanley	18	0	(0)	0	(0)	0	(0)	0	(0)
	Subtotal	**2059**	**100**	**(93.5)**	**30**	**(90.9)**	**36**	**(73.5)**	**60**	**(85.7)**
	All other serotypes	370	6	(5.6)	3	(9.1)	10	(20.4)	9	(12.9)
	Unknown serotype	18	1	(0.9)	0	(0)	0	(0)	0	(0)
	Partially serotyped	12	0	(0)	0	(0)	0	(0)	0	(0)
	Rough/Nonmotile isolates	15	0	(0)	0	(0)	3	(6.1)	1	(1.4)
	Total	**2474**	**107**	**(100)**	**33**	**(100)**	**49**	**(100)**	**70**	**(100)**

* ACSSuT: at least resistant to ampicillin, chloramphenicol, streptomycin, sulfisoxazole, tetracycline

† ACSSuTAuCx: at least resistant to ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone

Table 7. Minimum inhibitory concentrations (MICs) and resistance of non-typhoidal *Salmonella* isolates to antimicrobial agents, 2010 (N=2474)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 0.1]						4.4	73.3	20.2	2.0	0.2						
		Gentamicin	0.2	1.0	[0.6 - 1.4]					66.9	30.3	1.4	0.2		0.2	0.4	0.6				
		Streptomycin	N/A	8.6	[7.5 - 9.7]												91.4	3.6	4.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	3.3	2.8	[2.2 - 3.6]							89.1	1.5	0.8	2.5	3.3	0.8	2.1			
	Cephems	Ceftiofur	< 0.1	2.8	[2.2 - 3.5]				0.2	0.4	32.7	63.1	0.8	< 0.1	< 0.1	2.7					
		Ceftriaxone	0.0	2.8	[2.2 - 3.6]					97.1	< 0.1				0.2	1.2	1.1	0.2	0.2		
	Penicillins	Ampicillin	< 0.1	9.1	[8.0 - 10.3]							85.1	5.5	0.2	< 0.1	< 0.1	< 0.1	9.0			
	Quinolones	Ciprofloxacin	0.0	0.2	[0.0 - 0.4]	93.5	3.6	0.2	0.9	0.9	0.7	< 0.1		< 0.1	0.1						
		Nalidixic acid	N/A	2.0	[1.5 - 2.6]							0.2	33.3	63.3	0.6	0.5	< 0.1	1.9			
	Tetracyclines	Tetracycline	0.1	11.0	[9.8 - 12.3]									88.8	0.1	0.4	2.7	7.9			
II	**Aminoglycosides**	Kanamycin	0.0	2.3	[1.7 - 2.9]										97.7	< 0.1		< 0.1	2.2		
	Cephems	Cefoxitin	0.4	2.5	[2.0 - 3.2]							19.2	65.2	11.8	0.9	0.4	1.0	1.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	9.0	[7.9 - 10.2]											5.0	36.1	47.6	2.1	< 0.1	9.0
		Trimethoprim-sulfamethoxazole	N/A	1.6	[1.1 - 2.1]				97.0	1.3	0.1			< 0.1	1.5						
	Phenicols	Chloramphenicol	0.6	4.9	[4.1 - 5.9]								0.3	34.2	60.0	0.6	< 0.1	4.9			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 13. Antimicrobial resistance pattern for non-typhoidal *Salmonella*, 2010

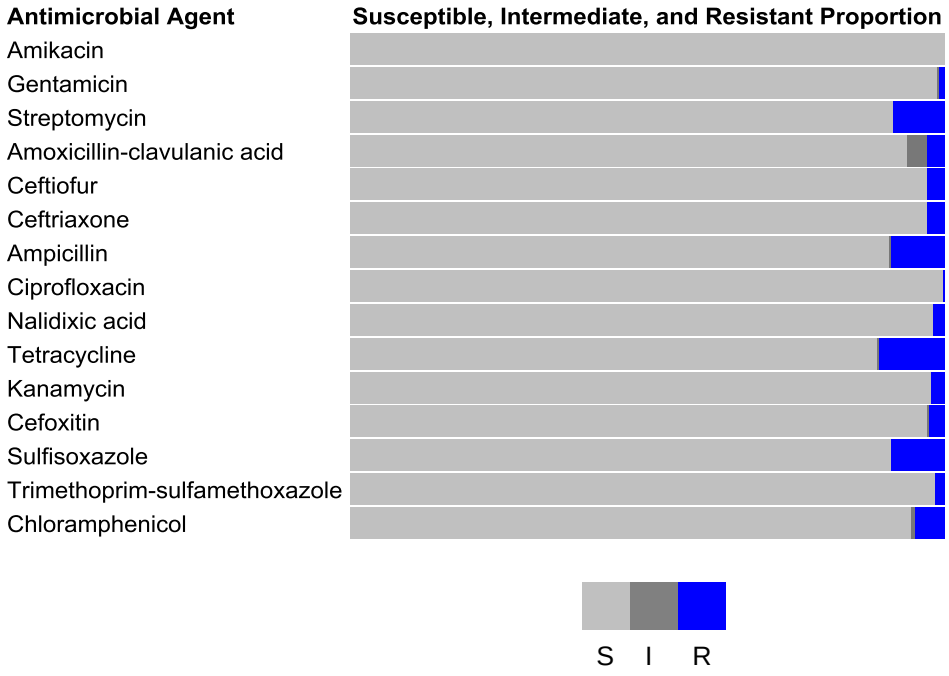


Table 8. Percentage and number of non-typhoidal *Salmonella* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 1410	2002 1998	2003 1855	2004 1782	2005 2034	2006 2172	2007 2145	2008 2384	2009 2193	2010 2474
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	< 0.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	1.9% 27	1.4% 27	1.4% 26	1.3% 24	2.2% 44	2.0% 44	2.1% 45	1.5% 35	1.3% 28	1.0% 24
		Streptomycin (MIC ≥ 64)	17.1% 241	13.2% 264	15.0% 279	12.0% 213	11.1% 225	10.7% 233	10.3% 222	10.0% 238	8.9% 196	8.6% 212
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.7% 66	5.3% 106	4.6% 86	3.7% 66	3.2% 65	3.7% 81	3.3% 70	3.1% 73	3.4% 75	2.8% 70
	Cephems	Ceftiofur (MIC ≥ 8)	4.1% 58	4.4% 87	4.5% 83	3.4% 60	2.9% 60	3.6% 79	3.3% 70	3.1% 73	3.4% 75	2.8% 69
		Ceftriaxone (MIC ≥ 4)	3.7% 52	4.4% 87	4.4% 81	3.3% 59	2.9% 59	3.7% 80	3.3% 70	3.1% 73	3.4% 75	2.8% 70
	Penicillins	Ampicillin (MIC ≥ 32)	17.5% 247	13.0% 259	13.6% 253	12.1% 216	11.4% 232	11.0% 238	10.1% 217	9.7% 232	9.8% 216	9.1% 224
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.2% 3	0.1% 1	0.2% 3	0.2% 4	< 0.1% 1	0.1% 2	0.1% 2	0.1% 2	< 0.1% 1	0.2% 4
		Nalidixic Acid (MIC ≥ 32)	2.3% 32	1.6% 32	1.9% 36	2.2% 39	1.9% 38	2.4% 52	2.2% 48	2.1% 49	1.8% 39	2.0% 49
	Tetracyclines	Tetracycline (MIC ≥ 16)	19.9% 280	14.9% 298	16.3% 303	13.6% 242	13.9% 282	13.5% 293	14.5% 310	11.5% 275	11.9% 261	11.0% 273
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	4.8% 68	3.8% 76	3.5% 64	2.8% 50	3.4% 70	2.9% 63	2.8% 61	2.1% 50	2.5% 54	2.3% 56
	Cephems	Cefoxitin (MIC ≥ 32)	3.4% 48	4.3% 86	4.3% 79	3.4% 61	3.0% 62	3.5% 77	2.9% 63	3.0% 72	3.2% 71	2.5% 63
		Cephalothin (MIC ≥ 32)	4.0% 57	5.1% 101	5.3% 99	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	17.8% 251	12.9% 258	15.1% 280	13.3% 237	12.6% 256	12.1% 263	12.3% 264	10.1% 240	9.9% 217	9.0% 223
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.0% 28	1.4% 28	1.9% 36	1.7% 31	1.7% 34	1.7% 36	1.5% 33	1.6% 37	1.7% 38	1.6% 39
	Phenicols	Chloramphenicol (MIC ≥ 32)	11.6% 164	8.6% 172	10.1% 187	7.6% 136	7.8% 159	6.4% 139	7.3% 156	6.1% 146	5.7% 125	4.9% 122

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 9. Resistance patterns of non-typhoidal *Salmonella* isolates, 2001–2010

Year Total Isolates	2001 1410	2002 1998	2003 1855	2004 1782	2005 2034	2006 2172	2007 2145	2008 2384	2009 2193	2010 2474
Resistance Pattern										
No resistance detected	72.5% 1022	79.1% 1580	78.0% 1447	80.0% 1425	80.9% 1646	80.5% 1748	81.1% 1739	83.9% 2000	83.2% 1824	84.7% 2095
Resistance ≥ 1 CLSI class*	27.5% 388	20.9% 418	22.0% 408	20.0% 357	19.1% 388	19.5% 424	18.9% 406	16.1% 384	16.8% 369	15.3% 379
Resistance ≥ 2 CLSI classes*	22.1% 311	15.8% 315	17.5% 325	15.0% 267	14.8% 302	14.7% 319	14.2% 305	12.5% 298	13.0% 284	11.3% 279
Resistance ≥ 3 CLSI classes*	16.7% 236	12.3% 245	14.2% 263	11.4% 204	12.0% 244	11.8% 256	11.1% 239	9.5% 226	9.5% 209	9.1% 225
Resistance ≥ 4 CLSI classes*	13.5% 191	9.8% 195	11.4% 211	9.3% 165	9.1% 185	8.1% 177	8.2% 176	7.4% 177	7.3% 159	6.8% 167
Resistance ≥ 5 CLSI classes*	10.3% 145	8.2% 164	9.8% 182	8.0% 142	7.2% 146	6.3% 137	6.9% 149	6.6% 157	6.2% 137	5.2% 128
At least ACSSuT†	10.1% 142	7.8% 156	9.3% 173	7.2% 129	6.9% 141	5.6% 121	6.3% 136	5.8% 138	5.1% 112	4.3% 107
At least ACT/S‡	0.5% 7	1.1% 21	1.2% 23	0.6% 10	0.9% 18	0.7% 15	0.7% 16	0.5% 11	0.7% 15	0.4% 11
At least ACSSuTAuCx§	2.6% 36	3.4% 67	3.2% 60	2.4% 42	2.0% 41	2.0% 43	2.1% 46	1.8% 44	1.4% 30	1.3% 33
At least ceftriaxone and nalidixic acid resistant	0.1% 2	0.2% 4	0.1% 1	0.1% 2	0.0% 1	0.2% 4	0.2% 5	0.0% 1	0.2% 4	0.1% 2

* CLSI: Clinical and Laboratory Standards Institute

† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

A. *Salmonella* ser. Enteritidis

Table 10. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Enteritidis isolates to antimicrobial agents, 2010 (N=522)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**													
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 0.7]						10.3	79.1	9.4	1.1							
		Gentamicin	0.2	0.2	[0.0 - 1.1]					83.5	15.7	0.2	0.2		0.2		0.2				
		Streptomycin	N/A	0.6	[0.1 - 1.7]												99.4	0.4	0.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.2	0.4	[0.0 - 1.4]							95.2	2.1	0.2	1.9	0.2	0.2	0.2			
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 0.7]				0.2	0.2	4.2	94.4	1.0								
		Ceftriaxone	0.0	0.0	[0.0 - 0.7]					100.0											
	Penicillins	Ampicillin	0.0	2.3	[1.2 - 4.0]							82.2	15.1	0.2	0.2			2.3			
	Quinolones	Ciprofloxacin	0.0	0.2	[0.0 - 1.1]	83.3	11.3	0.4	2.5	1.9	0.4				0.2						
		Nalidixic acid	N/A	5.2	[3.4 - 7.4]							0.4	10.9	82.8	0.6	0.2		5.2			
	Tetracyclines	Tetracycline	0.0	2.1	[1.1 - 3.7]									97.9				2.1			
II	**Aminoglycosides**	Kanamycin	0.0	0.2	[0.0 - 1.1]										99.8				0.2		
	Cephems	Cefoxitin	0.2	0.0	[0.0 - 0.7]							11.3	82.4	5.0	1.1	0.2					
	Folate pathway inhibitors	Sulfisoxazole	N/A	1.9	[0.9 - 3.5]											2.7	26.2	66.3	2.9		1.9
		Trimethoprim-sulfamethoxazole	N/A	1.0	[0.3 - 2.2]				98.5	0.6					1.0						
	Phenicols	Chloramphenicol	0.4	0.6	[0.1 - 1.7]									35.8	63.2	0.4	0.2	0.4			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 14. Antimicrobial resistance pattern for *Salmonella ser.* Enteritidis, 2010

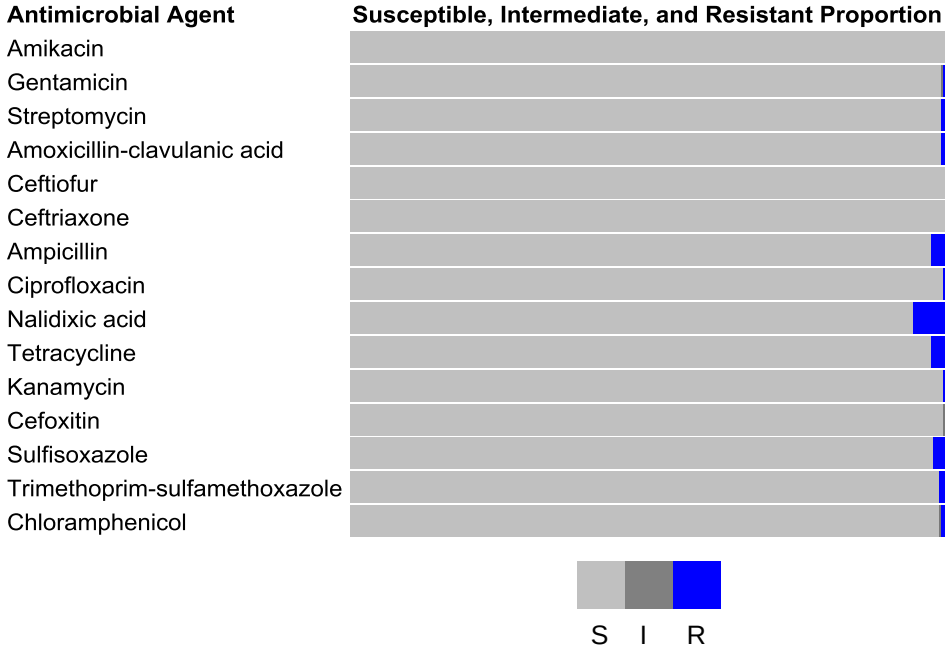


Table 11. Percentage and number of *Salmonella ser.* Enteritidis isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 277	2002 337	2003 257	2004 271	2005 384	2006 413	2007 385	2008 441	2009 410	2010 522
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	0.3% 1	0.4% 1	0.4% 1	0.8% 3	0.2% 1	0.0% 0	0.2% 1	0.0% 0	0.2% 1
		Streptomycin (MIC ≥ 64)	1.4% 4	1.5% 5	1.2% 3	2.2% 6	1.0% 4	1.2% 5	0.5% 2	0.5% 2	1.2% 5	0.6% 3
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.4% 4	0.6% 2	0.0% 0	0.0% 0	0.8% 3	0.5% 2	0.5% 2	0.0% 0	0.0% 0	0.4% 2
	Cephems	Ceftiofur (MIC ≥ 8)	2.2% 6	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	1.4% 4	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	8.7% 24	6.8% 23	2.3% 6	4.1% 11	2.9% 11	4.4% 18	2.1% 8	3.9% 17	3.9% 16	2.3% 12
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
		Nalidixic Acid (MIC ≥ 32)	4.3% 12	3.9% 13	4.7% 12	6.6% 18	4.7% 18	7.0% 29	5.7% 22	7.0% 31	3.7% 15	5.2% 27
	Tetracyclines	Tetracycline (MIC ≥ 16)	1.8% 5	4.2% 14	1.6% 4	3.3% 9	2.3% 9	1.7% 7	3.9% 15	1.8% 8	1.2% 5	2.1% 11
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.7% 2	0.3% 1	0.0% 0	0.7% 2	0.3% 1	0.2% 1	0.5% 2	0.0% 0	0.2% 1	0.2% 1
	Cephems	Cefoxitin (MIC ≥ 32)	0.4% 1	0.0% 0	0.0% 0	0.0% 0	1.0% 4	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0
		Cephalothin (MIC ≥ 32)	1.1% 3	0.6% 2	1.2% 3	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	2.2% 6	1.5% 5	1.2% 3	1.8% 5	1.6% 6	1.5% 6	1.6% 6	1.1% 5	1.7% 7	1.9% 10
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.7% 2	0.6% 2	0.8% 2	0.0% 0	0.5% 2	0.5% 2	1.0% 4	0.9% 4	0.7% 3	1.0% 5
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.3% 1	0.4% 1	0.4% 1	0.5% 2	0.0% 0	0.5% 2	0.5% 2	0.0% 0	0.6% 3

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 12. Resistance patterns of *Salmonella* ser. Enteritidis isolates, 2001–2010

Year Total Isolates	2001 277	2002 337	2003 257	2004 271	2005 384	2006 413	2007 385	2008 441	2009 410	2010 522
Resistance Pattern										
No resistance detected	86.6% 240	87.5% 295	91.8% 236	87.1% 236	91.4% 351	88.6% 366	90.4% 348	87.5% 386	92.0% 377	92.1% 481
Resistance ≥ 1 CLSI class*	13.4% 37	12.5% 42	8.2% 21	12.9% 35	8.6% 33	11.4% 47	9.6% 37	12.5% 55	8.0% 33	7.9% 41
Resistance ≥ 2 CLSI classes*	4.7% 13	3.9% 13	2.3% 6	3.0% 8	3.6% 14	2.9% 12	3.4% 13	2.0% 9	2.4% 10	2.9% 15
Resistance ≥ 3 CLSI classes*	2.9% 8	2.1% 7	0.4% 1	1.1% 3	1.6% 6	1.7% 7	1.0% 4	0.5% 2	1.0% 4	2.1% 11
Resistance ≥ 4 CLSI classes*	1.1% 3	0.6% 2	0.4% 1	0.7% 2	1.0% 4	0.7% 3	0.3% 1	0.0% 0	0.5% 2	0.4% 2
Resistance ≥ 5 CLSI classes*	0.4% 1	0.0% 0	0.4% 1	0.7% 2	0.5% 2	0.2% 1	0.3% 1	0.0% 0	0.2% 1	0.0% 0
At least ACSSuT†	0.0% 0	0.0% 0	0.4% 1	0.4% 1	0.5% 2	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0
At least ACT/S‡	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.2% 1	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

B. *Salmonella* ser. Typhimurium

Table 13. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhimurium isolates to antimicrobial agents, 2010 (N=366)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 1.0]						1.9	71.3	24.3	2.5							
		Gentamicin	0.3	0.8	[0.2 - 2.4]					54.6	41.8	2.5			0.3	0.3	0.5				
		Streptomycin	N/A	25.7	[21.3 - 30.5]												74.3	13.9	11.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	16.1	4.4	[2.5 - 7.0]							73.2	0.3	1.1	4.9	16.1	0.5	3.8			
	Cephems	Ceftiofur	0.0	4.9	[2.9 - 7.7]				0.3	0.3	26.0	68.0	0.5		0.3	4.6					
		Ceftriaxone	0.0	4.9	[2.9 - 7.7]					94.8	0.3				0.5	1.6	1.6	0.5	0.5		
	Penicillins	Ampicillin	0.0	26.2	[21.8 - 31.1]							69.7	4.1				0.5	25.7			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 1.0]	97.5	0.5		0.5	0.3	1.1										
		Nalidixic acid	N/A	1.4	[0.4 - 3.2]							0.3	42.3	54.9	0.5	0.5	0.3	1.1			
	Tetracyclines	Tetracycline	0.3	29.0	[24.4 - 33.9]									70.8	0.3	1.9	13.4	13.7			
II	**Aminoglycosides**	Kanamycin	0.0	7.4	[4.9 - 10.6]										92.6				7.4		
	Cephems	Cefoxitin	0.3	3.6	[1.9 - 6.0]							21.9	67.5	6.6	0.3	0.3	1.1	2.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	28.7	[24.1 - 33.6]											1.4	54.9	15.0			28.7
		Trimethoprim-sulfamethoxazole	N/A	1.9	[0.8 - 3.9]					94.0	3.6	0.5			1.9						
	Phenicols	Chloramphenicol	0.8	20.2	[16.2 - 24.7]									29.2	49.7	0.8		20.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 15. Antimicrobial resistance pattern for *Salmonella* ser. Typhimurium, 2010

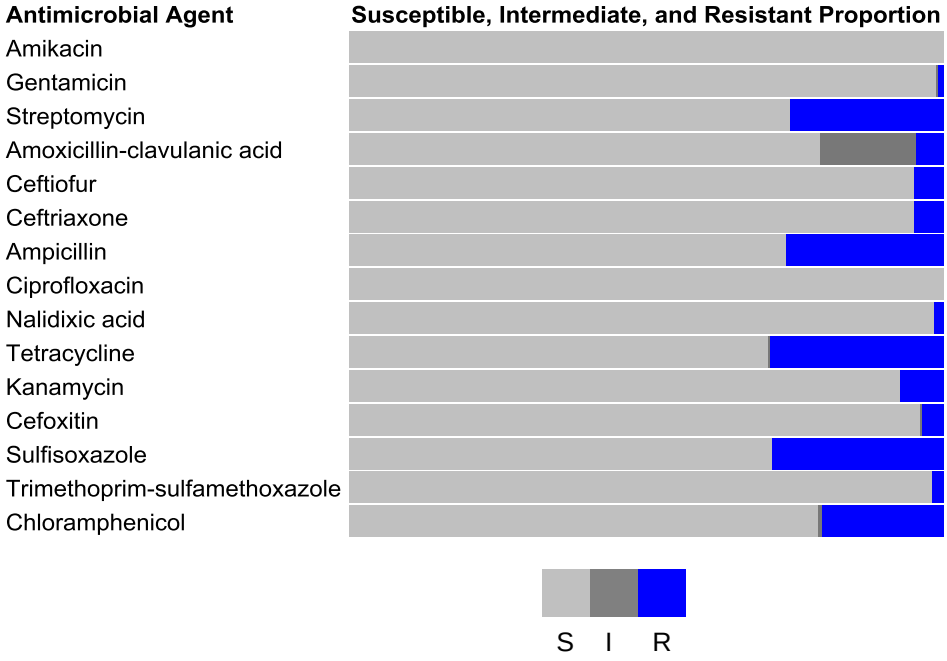


Table 14. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 325	2002 394	2003 408	2004 383	2005 438	2006 408	2007 405	2008 397	2009 371	2010 366
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	1.5% 5	2.3% 9	2.0% 8	2.1% 8	1.8% 8	2.7% 11	2.5% 10	1.5% 6	1.9% 7	0.8% 3
		Streptomycin (MIC ≥ 64)	40.0% 130	32.0% 126	35.5% 145	31.9% 122	28.1% 123	29.4% 120	32.3% 131	28.5% 113	25.9% 96	25.7% 94
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	6.2% 20	7.6% 30	5.6% 23	4.7% 18	3.2% 14	4.4% 18	6.7% 27	3.3% 13	6.2% 23	4.4% 16
	Cephems	Ceftiofur (MIC ≥ 8)	3.1% 10	4.3% 17	4.9% 20	4.4% 17	2.5% 11	4.2% 17	6.4% 26	3.3% 13	6.5% 24	4.9% 18
		Ceftriaxone (MIC ≥ 4)	3.1% 10	4.3% 17	4.9% 20	4.4% 17	2.5% 11	4.2% 17	6.4% 26	3.3% 13	6.5% 24	4.9% 18
	Penicillins	Ampicillin (MIC ≥ 32)	42.5% 138	33.8% 133	36.3% 148	32.1% 123	29.0% 127	28.2% 115	31.6% 128	26.2% 104	28.0% 104	26.2% 96
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.6% 2	1.3% 5	1.2% 5	0.5% 2	0.9% 4	0.7% 3	1.5% 6	1.3% 5	2.2% 8	1.4% 5
	Tetracyclines	Tetracycline (MIC ≥ 16)	43.4% 141	32.0% 126	38.2% 156	30.3% 116	30.4% 133	31.6% 129	36.8% 149	27.5% 109	28.8% 107	29.0% 106
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	8.3% 27	7.6% 30	7.1% 29	5.7% 22	5.7% 25	5.1% 21	5.9% 24	2.3% 9	4.9% 18	7.4% 27
	Cephems	Cefoxitin (MIC ≥ 32)	3.1% 10	4.3% 17	4.4% 18	4.7% 18	2.5% 11	3.9% 16	5.7% 23	3.3% 13	5.4% 20	3.6% 13
		Cephalothin (MIC ≥ 32)	3.1% 10	5.6% 22	6.1% 25	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	43.1% 140	32.2% 127	38.7% 158	36.0% 138	32.0% 140	33.3% 136	37.3% 151	30.2% 120	29.9% 111	28.7% 105
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.5% 8	2.3% 9	3.4% 14	2.6% 10	2.7% 12	2.2% 9	2.5% 10	1.8% 7	3.0% 11	1.9% 7
	Phenicols	Chloramphenicol (MIC ≥ 32)	31.7% 103	23.4% 92	28.2% 115	24.3% 93	24.4% 107	22.1% 90	25.4% 103	23.2% 92	20.5% 76	20.2% 74

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 15. Resistance patterns of *Salmonella* ser. Typhimurium isolates, 2001–2010

Year Total Isolates	2001 325	2002 394	2003 408	2004 383	2005 438	2006 408	2007 405	2008 397	2009 371	2010 366
Resistance Pattern										
No resistance detected	49.2% 160	59.9% 236	54.7% 223	60.6% 232	65.1% 285	62.5% 255	57.5% 233	68.0% 270	63.6% 236	66.9% 245
Resistance ≥ 1 CLSI class*	50.8% 165	40.1% 158	45.3% 185	39.4% 151	34.9% 153	37.5% 153	42.5% 172	32.0% 127	36.4% 135	33.1% 121
Resistance ≥ 2 CLSI classes*	47.4% 154	36.3% 143	41.4% 169	37.1% 142	33.3% 146	34.1% 139	39.3% 159	31.2% 124	33.2% 123	30.3% 111
Resistance ≥ 3 CLSI classes*	41.5% 135	32.5% 128	37.3% 152	31.6% 121	30.1% 132	30.4% 124	34.3% 139	27.7% 110	28.0% 104	27.3% 100
Resistance ≥ 4 CLSI classes*	37.8% 123	28.4% 112	32.4% 132	27.7% 106	27.4% 120	27.0% 110	29.9% 121	24.7% 98	24.0% 89	24.3% 89
Resistance ≥ 5 CLSI classes*	29.5% 96	23.1% 91	27.7% 113	24.3% 93	22.8% 100	20.8% 85	24.9% 101	23.7% 94	22.1% 82	20.8% 76
At least ACSSuT†	29.5% 96	21.6% 85	26.5% 108	23.5% 90	22.4% 98	19.6% 80	22.7% 92	22.9% 91	19.4% 72	18.6% 68
At least ACT/S‡	0.9% 3	2.0% 8	3.2% 13	1.6% 6	2.1% 9	0.7% 3	2.0% 8	0.5% 2	2.2% 8	1.1% 4
At least ACSSuTAuCx§	1.2% 4	1.8% 7	2.2% 9	2.6% 10	1.8% 8	2.9% 12	3.7% 15	2.0% 8	1.6% 6	1.9% 7
At least ceftriaxone and nalidixic acid resistant	0.3% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.5% 2	0.3% 1

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

C. *Salmonella* ser. Newport

Table 16. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Newport isolates to antimicrobial agents, 2010 (N=305)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 1.2]						1.3	78.0	19.3	1.3							
		Gentamicin	0.0	0.3	[0.0 - 1.8]					69.8	28.5	1.3					0.3				
		Streptomycin	N/A	8.2	[5.4 - 11.9]												91.8	0.7	7.5		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	7.5	[4.8 - 11.1]							90.5	1.3	0.3	0.3		2.6	4.9			
	Cephems	Ceftiofur	0.0	7.2	[4.6 - 10.7]				0.3		29.8	62.0	0.7			7.2					
		Ceftriaxone	0.0	7.2	[4.6 - 10.7]					92.8						2.3	3.6	1.0	0.3		
	Penicillins	Ampicillin	0.3	7.5	[4.8 - 11.1]							89.8	2.0	0.3		0.3		7.5			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 1.2]	98.0	1.0		0.7	0.3											
		Nalidixic acid	N/A	0.3	[0.0 - 1.8]							0.3	37.4	61.0	0.7	0.3		0.3			
	Tetracyclines	Tetracycline	0.3	8.2	[5.4 - 11.9]									91.5	0.3	0.3	0.3	7.5			
II	**Aminoglycosides**	Kanamycin	0.0	0.7	[0.1 - 2.3]										99.0	0.3			0.7		
	Cephems	Cefoxitin	0.0	7.2	[4.6 - 10.7]							20.7	67.9	3.9	0.3		2.3	4.9			
	Folate pathway inhibitors	Sulfisoxazole	N/A	7.5	[4.8 - 11.1]											0.7	14.4	73.4	3.3	0.7	7.5
		Trimethoprim-sulfamethoxazole	N/A	1.3	[0.4 - 3.3]				98.0	0.7					1.3						
	Phenicols	Chloramphenicol	0.3	7.2	[4.6 - 10.7]								0.3	62.3	29.8	0.3		7.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 16. Antimicrobial resistance pattern for *Salmonella* ser. Newport, 2010

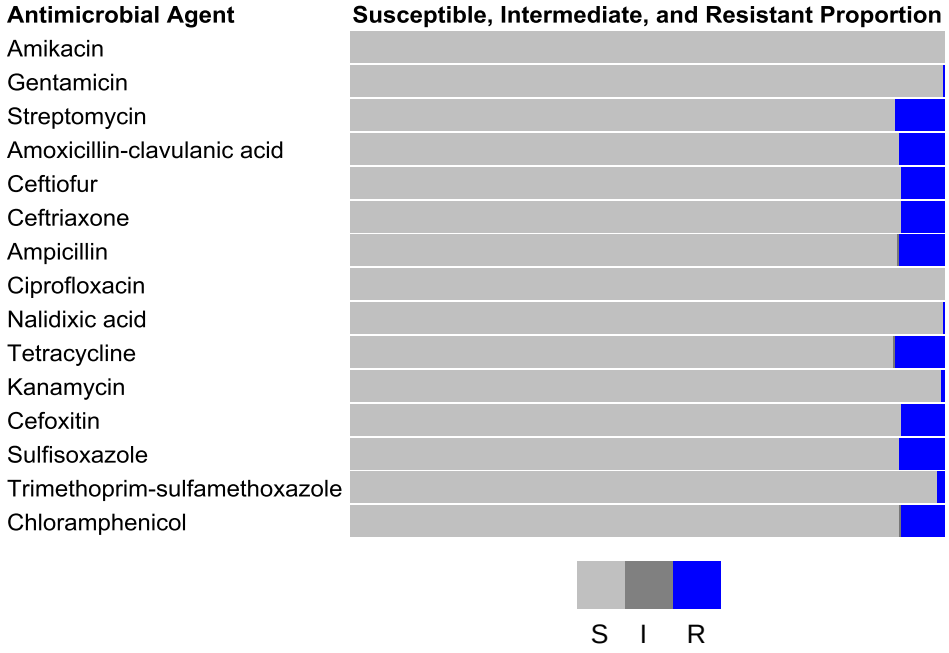


Table 17. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 124	2002 241	2003 223	2004 191	2005 207	2006 217	2007 221	2008 255	2009 236	2010 305
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	3.2% 4	3.3% 8	3.1% 7	0.5% 1	1.0% 2	0.9% 2	0.9% 2	0.4% 1	0.4% 1	0.3% 1
		Streptomycin (MIC ≥ 64)	31.5% 39	25.3% 61	24.2% 54	15.7% 30	14.0% 29	13.8% 30	10.4% 23	13.7% 35	7.6% 18	8.2% 25
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	26.6% 33	22.8% 55	21.5% 48	15.2% 29	12.6% 26	12.4% 27	8.1% 18	12.5% 32	6.8% 16	7.5% 23
	Cephems	Ceftiofur (MIC ≥ 8)	27.4% 34	22.8% 55	22.0% 49	15.2% 29	12.6% 26	12.4% 27	8.1% 18	12.5% 32	6.4% 15	7.2% 22
		Ceftriaxone (MIC ≥ 4)	25.8% 32	22.8% 55	21.5% 48	14.7% 28	12.6% 26	12.9% 28	8.1% 18	12.5% 32	6.4% 15	7.2% 22
	Penicillins	Ampicillin (MIC ≥ 32)	29.8% 37	24.9% 60	22.9% 51	15.7% 30	14.0% 29	15.2% 33	10.0% 22	14.5% 37	7.6% 18	7.5% 23
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	0.8% 2	0.4% 1	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.4% 1	0.0% 0	0.3% 1
	Tetracyclines	Tetracycline (MIC ≥ 16)	30.6% 38	25.7% 62	24.2% 54	16.8% 32	14.5% 30	14.3% 31	10.0% 22	14.1% 36	8.1% 19	8.2% 25
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	7.3% 9	10.0% 24	4.5% 10	2.6% 5	1.9% 4	2.3% 5	0.9% 2	3.5% 9	1.3% 3	0.7% 2
	Cephems	Cefoxitin (MIC ≥ 32)	25.8% 32	22.4% 54	21.5% 48	15.2% 29	12.6% 26	12.9% 28	8.1% 18	12.5% 32	5.9% 14	7.2% 22
		Cephalothin (MIC ≥ 32)	26.6% 33	22.8% 55	22.4% 50	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	32.3% 40	25.7% 62	24.7% 55	16.8% 32	15.5% 32	15.2% 33	10.4% 23	13.3% 34	8.1% 19	7.5% 23
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.6% 2	4.1% 10	0.9% 2	2.1% 4	1.9% 4	3.2% 7	1.8% 4	3.1% 8	0.4% 1	1.3% 4
	Phenicols	Chloramphenicol (MIC ≥ 32)	28.2% 35	25.3% 61	22.4% 50	15.2% 29	13.5% 28	12.4% 27	9.5% 21	12.2% 31	6.8% 16	7.2% 22

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 18. Resistance patterns of *Salmonella* ser. Newport isolates, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Isolates	124	241	223	191	207	217	221	255	236	305
Resistance Pattern										
No resistance detected	65.3% 81	72.2% 174	73.5% 164	82.2% 157	84.1% 174	82.9% 180	89.1% 197	85.1% 217	89.8% 212	90.8% 277
Resistance ≥ 1 CLSI class*	34.7% 43	27.8% 67	26.5% 59	17.8% 34	15.9% 33	17.1% 37	10.9% 24	14.9% 38	10.2% 24	9.2% 28
Resistance ≥ 2 CLSI classes*	32.3% 40	25.3% 61	25.1% 56	17.3% 33	15.0% 31	16.6% 36	10.9% 24	13.7% 35	8.5% 20	7.9% 24
Resistance ≥ 3 CLSI classes*	31.5% 39	25.3% 61	23.3% 52	16.2% 31	14.5% 30	15.2% 33	10.9% 24	13.7% 35	7.6% 18	7.5% 23
Resistance ≥ 4 CLSI classes*	31.5% 39	25.3% 61	22.9% 51	15.7% 30	14.0% 29	13.4% 29	9.5% 21	13.7% 35	6.8% 16	7.5% 23
Resistance ≥ 5 CLSI classes*	26.6% 33	23.7% 57	22.4% 50	14.7% 28	12.6% 26	12.9% 28	8.6% 19	12.9% 33	6.4% 15	7.2% 22
At least ACSSuT†	25.8% 32	23.7% 57	22.0% 49	14.7% 28	12.6% 26	12.0% 26	8.6% 19	11.8% 30	6.4% 15	7.2% 22
At least ACT/S‡	0.8% 1	3.7% 9	0.9% 2	1.0% 2	1.9% 4	2.3% 5	0.5% 1	2.7% 7	0.4% 1	1.3% 4
At least ACSSuTAuCx§	25.0% 31	22.8% 55	21.1% 47	14.7% 28	12.6% 26	10.6% 23	8.1% 18	11.8% 30	6.4% 15	7.2% 22
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.4% 1	0.0% 0	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

D. *Salmonella* ser. Heidelberg

Table 19. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Heidelberg isolates to antimicrobial agents, 2010 (N=62)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates %I‡	%R§	[95% CI]¶	Percent of all isolates with MIC (µg/mL)** 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 5.8]						6.5	64.5	24.2	4.8							
		Gentamicin	0.0	8.1	[2.7 - 17.8]					62.9	24.2	4.8				4.8	3.2				
		Streptomycin	N/A	27.4	[16.8 - 40.2]												72.6	12.9	14.5		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	24.2	[14.2 - 36.7]							61.3		1.6	12.9		4.8	19.4			
	Cephems	Ceftiofur	0.0	24.2	[14.2 - 36.7]					1.6	32.3	41.9				24.2					
		Ceftriaxone	0.0	24.2	[14.2 - 36.7]					75.8						16.1	6.5	1.6			
	Penicillins	Ampicillin	0.0	38.7	[26.6 - 51.9]							59.7	1.6					38.7			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 5.8]	100.0															
		Nalidixic acid	N/A	0.0	[0.0 - 5.8]								19.4	80.6							
	Tetracyclines	Tetracycline	0.0	24.2	[14.2 - 36.7]									75.8			1.6	22.6			
II	**Aminoglycosides**	Kanamycin	0.0	22.6	[12.9 - 35.0]										77.4			1.6	21.0		
	Cephems	Cefoxitin	0.0	24.2	[14.2 - 36.7]							40.3	29.0	6.5			16.1	8.1			
	Folate pathway inhibitors	Sulfisoxazole	N/A	11.3	[4.6 - 21.9]											19.4	53.2	16.1			11.3
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 5.8]				100.0												
	Phenicols	Chloramphenicol	0.0	1.6	[0.0 - 8.7]									19.4	79.0			1.6			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 17. Antimicrobial resistance pattern for *Salmonella* ser. Heidelberg, 2010

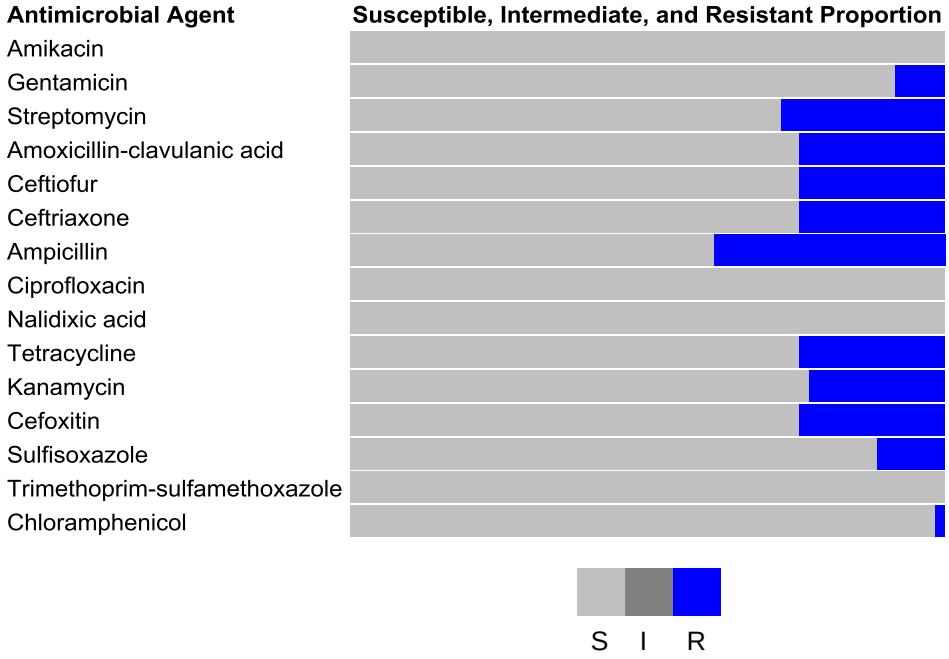


Table 20. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 102	2002 105	2003 96	2004 92	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	7.8% 8	3.8% 4	5.2% 5	4.3% 4	6.4% 8	4.9% 5	16.3% 16	14.7% 11	2.3% 2	8.1% 5
		Streptomycin (MIC ≥ 64)	25.5% 26	17.1% 18	12.5% 12	15.2% 14	13.6% 17	11.8% 12	12.2% 12	30.7% 23	23.3% 20	27.4% 17
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.9% 3	9.5% 10	5.2% 5	9.8% 9	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15
	Cephems	Ceftiofur (MIC ≥ 8)	2.9% 3	7.6% 8	5.2% 5	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15
		Ceftriaxone (MIC ≥ 4)	2.9% 3	7.6% 8	5.2% 5	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15
	Penicillins	Ampicillin (MIC ≥ 32)	9.8% 10	12.4% 13	10.4% 10	25.0% 23	20.0% 25	18.6% 19	18.4% 18	28.0% 21	27.9% 24	38.7% 24
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	0.0% 0	1.0% 1	0.0% 0	0.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	24.5% 25	19.0% 20	16.7% 16	19.6% 18	18.4% 23	13.7% 14	22.4% 22	36.0% 27	27.9% 24	24.2% 15
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	19.6% 20	10.5% 11	8.3% 8	8.7% 8	12.8% 16	8.8% 9	11.2% 11	26.7% 20	20.9% 18	22.6% 14
	Cephems	Cefoxitin (MIC ≥ 32)	2.9% 3	8.6% 9	5.2% 5	7.6% 7	8.8% 11	8.8% 9	7.1% 7	8.0% 6	19.8% 17	24.2% 15
		Cephalothin (MIC ≥ 32)	3.9% 4	10.5% 11	7.3% 7	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	8.8% 9	6.7% 7	7.3% 7	7.6% 7	8.0% 10	4.9% 5	18.4% 18	12.0% 9	7.0% 6	11.3% 7
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.0% 2	1.0% 1	2.1% 2	0.0% 0	0.8% 1	0.0% 0	0.0% 0	2.7% 2	3.5% 3	0.0% 0
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.0% 1	1.0% 1	0.0% 0	1.1% 1	0.8% 1	0.0% 0	3.1% 3	1.3% 1	4.7% 4	1.6% 1

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 21. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Isolates	102	105	96	92	125	102	98	75	86	62
Resistance Pattern										
No resistance detected	64.7% 66	67.6% 71	68.8% 66	56.5% 52	62.4% 78	67.6% 69	58.2% 57	57.3% 43	60.5% 52	51.6% 32
Resistance ≥ 1 CLSI class*	35.3% 36	32.4% 34	31.3% 30	43.5% 40	37.6% 47	32.4% 33	41.8% 41	42.7% 32	39.5% 34	48.4% 30
Resistance ≥ 2 CLSI classes*	28.4% 29	25.7% 27	17.7% 17	22.8% 21	24.8% 31	23.5% 24	28.6% 28	40.0% 30	34.9% 30	43.5% 27
Resistance ≥ 3 CLSI classes*	7.8% 8	12.4% 13	10.4% 10	13.0% 12	15.2% 19	12.7% 13	17.3% 17	28.0% 21	25.6% 22	33.9% 21
Resistance ≥ 4 CLSI classes*	2.0% 2	1.9% 2	0.0% 0	4.3% 4	4.8% 6	2.0% 2	5.1% 5	13.3% 10	17.4% 15	11.3% 7
Resistance ≥ 5 CLSI classes*	1.0% 1	1.9% 2	0.0% 0	3.3% 3	1.6% 2	2.0% 2	4.1% 4	6.7% 5	15.1% 13	9.7% 6
At least ACSSuT†	1.0% 1	1.0% 1	0.0% 0	1.1% 1	0.0% 0	0.0% 0	3.1% 3	1.3% 1	3.5% 3	1.6% 1
At least ACT/S‡	0.0% 0	1.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	3.5% 3	0.0% 0
At least ACSSuTAuCx§	1.0% 1	1.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.2% 1	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

E. *Salmonella* ser. I 4,[5],12:i:-

Table 22. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. I 4,[5],12:i:- isolates to antimicrobial agents, 2010 (N=77)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Amikacin	0.0	0.0	[0.0 - 4.7]							77.9	20.8		1.3						
		Gentamicin	0.0	1.3	[0.0 - 7.0]					76.6	20.8	1.3				1.3					
		Streptomycin	N/A	19.5	[11.3 - 30.1]												80.5	2.6	16.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	3.9	3.9	[0.8 - 11.0]							77.9		6.5	7.8	3.9	1.3	2.6			
	Cephems	Ceftiofur	0.0	2.6	[0.3 - 9.1]						29.9	67.5				2.6					
		Ceftriaxone	0.0	2.6	[0.3 - 9.1]					97.4						2.6					
	Penicillins	Ampicillin	0.0	22.1	[13.4 - 33.0]							74.0	3.9					22.1			
	Quinolones	Ciprofloxacin	0.0	1.3	[0.0 - 7.0]	96.1	1.3		1.3						1.3						
		Nalidixic acid	N/A	2.6	[0.3 - 9.1]								46.8	50.6				2.6			
	Tetracyclines	Tetracycline	0.0	28.6	[18.8 - 40.0]									71.4			1.3	27.3			
II	Aminoglycosides	Kanamycin	0.0	1.3	[0.0 - 7.0]										98.7				1.3		
	Cephems	Cefoxitin	1.3	2.6	[0.3 - 9.1]							22.1	63.6	9.1	1.3	1.3	2.6				
	Folate pathway inhibitors	Sulfisoxazole	N/A	19.5	[11.3 - 30.1]											1.3	50.6	27.3	1.3		19.5
		Trimethoprim-sulfamethoxazole	N/A	1.3	[0.0 - 7.0]				97.4	1.3					1.3						
	Phenicols	Chloramphenicol	1.3	1.3	[0.0- 7.0]									35.1	62.3	1.3		1.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 18. Antimicrobial resistance pattern for *Salmonella* ser. I 4,[5],12:i:-, 2010

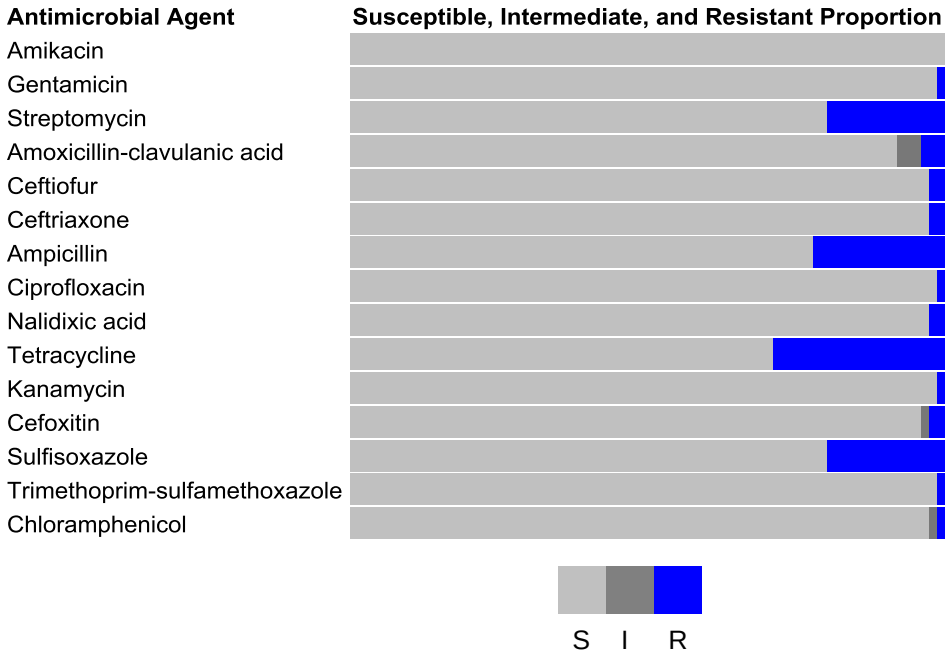


Table 23. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 14	2002 35	2003 37	2004 36	2005 33	2006 105	2007 73	2008 84	2009 72	2010 77
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	7.1% 1	0.0% 0	5.4% 2	5.6% 2	0.0% 0	4.8% 5	1.4% 1	3.6% 3	2.8% 2	1.3% 1
		Streptomycin (MIC ≥ 64)	14.3% 2	2.9% 1	8.1% 3	5.6% 2	3.0% 1	3.8% 4	8.2% 6	10.7% 9	12.5% 9	19.5% 15
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	2.9% 1	5.4% 2	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	4.2% 3	3.9% 3
	Cephems	Ceftiofur (MIC ≥ 8)	7.1% 1	2.9% 1	5.4% 2	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2
		Ceftriaxone (MIC ≥ 4)	0.0% 0	2.9% 1	5.4% 2	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2
	Penicillins	Ampicillin (MIC ≥ 32)	7.1% 1	8.6% 3	8.1% 3	5.6% 2	6.1% 2	6.7% 7	5.5% 4	9.5% 8	11.1% 8	22.1% 17
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	0.0% 0	2.7% 1	2.8% 1	0.0% 0	1.0% 1	1.4% 1	1.2% 1	0.0% 0	2.6% 2
	Tetracyclines	Tetracycline (MIC ≥ 16)	7.1% 1	5.7% 2	0.0% 0	11.1% 4	3.0% 1	8.6% 9	9.6% 7	16.7% 14	16.7% 12	28.6% 22
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	7.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.4% 1	1.2% 1	0.0% 0	1.3% 1
	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	2.9% 1	5.4% 2	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2
		Cephalothin (MIC ≥ 32)	7.1% 1	2.9% 1	5.4% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	14.3% 2	2.9% 1	5.4% 2	11.1% 4	0.0% 0	8.6% 9	4.1% 3	13.1% 11	13.9% 10	19.5% 15
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	7.1% 1	2.9% 1	0.0% 0	2.8% 1	0.0% 0	0.0% 0	1.4% 1	4.8% 4	1.4% 1	1.3% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	7.1% 1	2.9% 1	0.0% 0	2.8% 1	0.0% 0	1.9% 2	1.4% 1	6.0% 5	8.3% 6	1.3% 1

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 24. Resistance patterns of *Salmonella* ser. I 4,[5],12:i:- isolates, 2001–2010

Year Total Isolates	2001 14	2002 35	2003 37	2004 36	2005 33	2006 105	2007 73	2008 84	2009 72	2010 77
Resistance Pattern										
No resistance detected	78.6% 11	91.4% 32	78.4% 29	80.6% 29	87.9% 29	85.7% 90	82.2% 60	76.2% 64	76.4% 55	66.2% 51
Resistance ≥ 1 CLSI class*	21.4% 3	8.6% 3	21.6% 8	19.4% 7	12.1% 4	14.3% 15	17.8% 13	23.8% 20	23.6% 17	33.8% 26
Resistance ≥ 2 CLSI classes*	14.3% 2	8.6% 3	10.8% 4	13.9% 5	3.0% 1	11.4% 12	6.8% 5	17.9% 15	16.7% 12	22.1% 17
Resistance ≥ 3 CLSI classes*	7.1% 1	5.7% 2	5.4% 2	8.3% 3	3.0% 1	9.5% 10	5.5% 4	10.7% 9	12.5% 9	22.1% 17
Resistance ≥ 4 CLSI classes*	7.1% 1	2.9% 1	0.0% 0	2.8% 1	0.0% 0	3.8% 4	2.7% 2	7.1% 6	9.7% 7	19.5% 15
Resistance ≥ 5 CLSI classes*	7.1% 1	2.9% 1	0.0% 0	2.8% 1	0.0% 0	2.9% 3	1.4% 1	4.8% 4	6.9% 5	3.9% 3
At least ACSSuT†	7.1% 1	2.9% 1	0.0% 0	2.8% 1	0.0% 0	1.9% 2	1.4% 1	3.6% 3	6.9% 5	1.3% 1
At least ACT/S‡	7.1% 1	2.9% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.4% 2	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute

† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

2. Typhoidal *Salmonella*

A. *Salmonella* ser. Typhi

Table 25. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhi isolates to antimicrobial agents, 2010 (N=444)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**													
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 0.8]						26.4	66.2	7.2	0.2							
		Gentamicin	0.0	0.0	[0.0 - 0.8]					92.3	7.4	0.2									
		Streptomycin	N/A	10.1	[7.5 - 13.3]												89.9		10.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.2	0.0	[0.0 - 0.8]							87.6	0.2	2.5	9.5	0.2					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 0.8]				1.4	11.3	79.1	8.1	0.2								
		Ceftriaxone	0.0	0.0	[0.0 - 0.8]					100.0											
	Penicillins	Ampicillin	0.0	12.4	[9.5 - 15.8]							87.4	0.2				0.2	12.2			
	Quinolones	Ciprofloxacin	1.1	2.7	[1.4 - 4.7]	28.2	0.2	2.7	14.0	46.2	4.5	0.5	1.1		2.7						
		Nalidixic acid	N/A	69.1	[64.6 - 73.4]							2.9	24.3	2.5	1.1		1.4	67.8			
	Tetracyclines	Tetracycline	0.0	3.6	[2.1 - 5.8]									96.4				3.6			
II	**Aminoglycosides**	Kanamycin	0.0	0.2	[0.0 - 1.2]										99.8				0.2		
	Cephems	Cefoxitin	0.2	0.0	[0.0 - 0.8]						7.0	29.3	7.4	49.5	6.5	0.2					
	Folate pathway inhibitors	Sulfisoxazole	N/A	12.4	[9.5 - 15.8]											37.4	29.3	16.7	3.6	0.7	12.4
		Trimethoprim-sulfamethoxazole	N/A	11.9	[9.1 - 15.3]				88.1						11.9						
	Phenicols	Chloramphenicol	0.0	11.7	[8.9 - 15.1]								2.3	75.7	10.4		0.2	11.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 19. Antimicrobial resistance pattern for *Salmonella* ser. Typhi, 2010

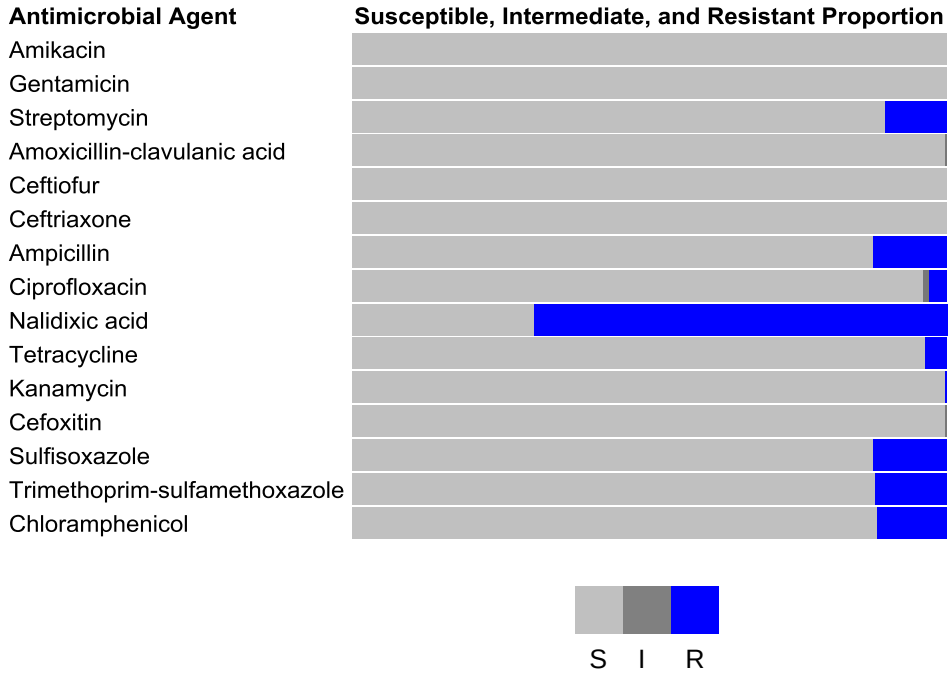


Table 26. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 197	2002 195	2003 332	2004 304	2005 318	2006 323	2007 400	2008 408	2009 362	2010 444
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	20.3% 40	7.2% 14	14.5% 48	11.8% 36	13.2% 42	18.9% 61	15.8% 63	11.5% 47	10.8% 39	10.1% 45
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.3% 1	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	20.3% 40	5.6% 11	16.0% 53	11.8% 36	13.2% 42	20.4% 66	17.0% 68	13.2% 54	12.4% 45	12.4% 55
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.3% 1	0.9% 3	1.0% 4	0.0% 0	3.3% 12	2.7% 12
		Nalidixic Acid (MIC ≥ 32)	29.9% 59	23.6% 46	37.7% 125	41.8% 127	48.4% 154	54.5% 176	62.0% 248	58.8% 240	59.9% 217	69.1% 307
	Tetracyclines	Tetracycline (MIC ≥ 16)	20.8% 41	6.7% 13	15.4% 51	8.9% 27	10.1% 32	8.4% 27	6.3% 25	4.7% 19	5.8% 21	3.6% 16
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
	Cephems	Cefoxitin (MIC ≥ 32)	0.5% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0
		Cephalothin (MIC ≥ 32)	0.5% 1	1.5% 3	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	20.8% 41	6.2% 12	16.9% 56	11.8% 36	14.2% 45	20.7% 67	17.5% 70	13.2% 54	13.5% 49	12.4% 55
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	20.8% 41	6.7% 13	16.9% 56	13.2% 40	14.5% 46	20.7% 67	16.3% 65	12.7% 52	12.4% 45	11.9% 53
	Phenicols	Chloramphenicol (MIC ≥ 32)	20.8% 41	6.2% 12	16.6% 55	13.2% 40	13.2% 42	19.5% 63	15.8% 63	13.0% 53	11.6% 42	11.7% 52

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 27. Resistance patterns of *Salmonella* ser. Typhi isolates, 2001–2010

Year Total Isolates	2001 197	2002 195	2003 332	2004 304	2005 318	2006 323	2007 400	2008 408	2009 362	2010 444
Resistance Pattern										
No resistance detected	58.9% 116	74.4% 145	56.6% 188	56.6% 172	48.1% 153	40.2% 130	35.5% 142	38.2% 156	37.6% 136	29.5% 131
Resistance ≥ 1 CLSI class*	41.1% 81	25.6% 50	43.4% 144	43.4% 132	51.9% 165	59.8% 193	64.5% 258	61.8% 252	62.4% 226	70.5% 313
Resistance ≥ 2 CLSI classes*	22.8% 45	7.2% 14	17.5% 58	13.2% 40	14.5% 46	21.7% 70	18.0% 72	14.5% 59	14.4% 52	13.7% 61
Resistance ≥ 3 CLSI classes*	21.8% 43	6.7% 13	16.6% 55	12.8% 39	13.8% 44	20.7% 67	17.5% 70	13.5% 55	13.0% 47	13.7% 61
Resistance ≥ 4 CLSI classes*	21.3% 42	6.2% 12	16.3% 54	12.5% 38	12.9% 41	19.2% 62	17.0% 68	13.0% 53	12.4% 45	11.7% 52
Resistance ≥ 5 CLSI classes*	16.8% 33	5.6% 11	14.2% 47	11.8% 36	11.9% 38	16.7% 54	14.8% 59	10.8% 44	10.2% 37	9.7% 43
At least ACSSuT†	16.8% 33	5.6% 11	12.7% 42	7.9% 24	9.1% 29	5.9% 19	3.8% 15	2.5% 10	2.8% 10	1.6% 7
At least ACT/S‡	17.8% 35	5.6% 11	15.7% 52	11.8% 36	12.9% 41	18.6% 60	15.3% 61	12.3% 50	10.8% 39	10.6% 47
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute

† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

B. *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C

Table 28. Frequency of *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C, 2010

Species	2010	
	n	(%)
Paratyphi A	143	(97.9)
Paratyphi B	3	(2.1)
Paratyphi C	0	(0)
Total	**146**	**(100)**

Table 29. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C isolates to antimicrobial agents, 2010 (N=146)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 2.5]						89.0	8.9	1.4	0.7							
		Gentamicin	0.0	0.7	[0.0 - 3.8]					96.6	2.1	0.7					0.7				
		Streptomycin	N/A	2.1	[0.4 - 5.9]												97.9		2.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.7	[0.0 - 3.8]							30.8	66.4	0.7	1.4			0.7			
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 2.5]				0.7	0.7	2.1	95.9	0.7								
		Ceftriaxone	0.0	0.0	[0.0 - 2.5]					100.0											
	Penicillins	Ampicillin	0.0	2.1	[0.4 - 5.9]							4.1	91.8	2.1				2.1			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 2.5]	8.9		0.7	0.7	3.4	83.6	2.7									
		Nalidixic acid	N/A	90.4	[84.4 - 94.7]							1.4	2.7	5.5				90.4			
	Tetracyclines	Tetracycline	0.0	2.1	[0.4 - 5.9]									97.9		0.7		1.4			
II	**Aminoglycosides**	Kanamycin	0.0	0.7	[0.0 - 3.8]										99.3				0.7		
	Cephems	Cefoxitin	3.4	0.0	[0.0 - 2.5]							2.1	4.8	76.7	13.0	3.4					
	Folate pathway inhibitors	Sulfisoxazole	N/A	1.4	[0.2 - 4.9]											36.3	52.7	8.2	1.4		1.4
		Trimethoprim-sulfamethoxazole	N/A	2.1	[0.4 - 5.9]					94.5	2.7	0.7			2.1						
	Phenicols	Chloramphenicol	15.8	1.4	[0.2 - 4.9]								0.7	2.1	80.1	15.8	0.7	0.7			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 20. Antimicrobial resistance pattern for *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C, 2010

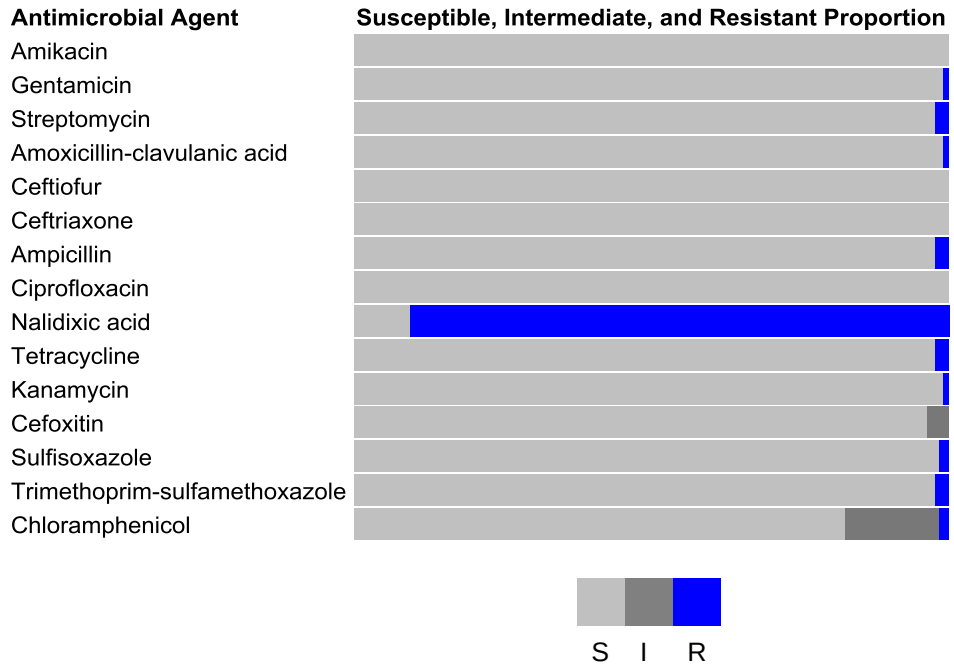


Table 30. Percentage and number of *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 9	2002 10	2003 8	2004 11	2005 18	2006 15	2007 17	2008 92	2009 101	2010 146
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1
		Streptomycin (MIC ≥ 64)	0.0% 0	10.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	12.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	55.6% 5	40.0% 4	75.0% 6	72.7% 8	66.7% 12	53.3% 8	94.1% 16	87.0% 80	86.1% 87	90.4% 132
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	10.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.1% 1	1.0% 1	2.1% 3
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1
	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Cephalothin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 31. Resistance patterns of *Salmonella* ser. Paratyphi A, Paratyphi B, and Paratyphi C isolates, 2001–2010

Year Total Isolates	2001 9	2002 10	2003 8	2004 11	2005 18	2006 15	2007 17	2008 92	2009 101	2010 146
Resistance Pattern										
No resistance detected	44.4% 4	50.0% 5	12.5% 1	27.3% 3	33.3% 6	46.7% 7	5.9% 1	12.0% 11	12.9% 13	6.8% 10
Resistance ≥ 1 CLSI class*	55.6% 5	50.0% 5	87.5% 7	72.7% 8	66.7% 12	53.3% 8	94.1% 16	88.0% 81	87.1% 88	93.2% 136
Resistance ≥ 2 CLSI classes*	0.0% 0	10.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	3.4% 5
Resistance ≥ 3 CLSI classes*	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3
Resistance ≥ 4 CLSI classes*	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2
Resistance ≥ 5 CLSI classes*	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1
At least ACSSuT†	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1
At least ACT/S‡	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute

† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

3. *Shigella*

Table 32. Frequency of *Shigella* species, 2010

Species	2010	
	n	(%)
Shigella sonnei	333	(81.8)
Shigella flexneri	60	(14.7)
Shigella boydii	5	(1.2)
Other	9	(2.2)
Total	**407**	**(100)**

Table 33. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2010 (N=407)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 0.9]						0.2	0.5	21.6	72.5	5.2						
		Gentamicin	0.0	0.5	[0.1 - 1.8]					0.7	12.8	81.6	4.4				0.5				
		Streptomycin	N/A	91.2	[88.0 - 93.7]												8.8	45.0	46.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	15.7	0.0	[0.0 - 0.9]							1.7	3.9	51.4	27.3	15.7					
	Cephems	Ceftiofur	0.0	0.2	[0.0 - 1.4]				9.8	83.8	5.4	0.7				0.2					
		Ceftriaxone	0.0	0.2	[0.0 - 1.4]					99.8									0.2		
	Penicillins	Ampicillin	0.5	40.8	[36.0 - 45.7]							5.2	47.4	5.7	0.5	0.5		40.8			
	Quinolones	Ciprofloxacin	0.0	1.7	[0.7 - 3.5]	95.1	0.2	0.5	1.5	0.5	0.5			1.5	0.2						
		Nalidixic acid	N/A	4.4	[2.6 - 6.9]						1.2	80.1	13.3	1.0			1.0	3.4			
	Tetracyclines	Tetracycline	0.0	31.7	[27.2 - 36.5]									68.3		0.2	10.8	20.6			
II	**Aminoglycosides**	Kanamycin	0.2	0.0	[0.0 - 0.9]										99.8		0.2				
	Cephems	Cefoxitin	0.0	0.0	[0.0 - 0.9]							6.1	77.6	15.7	0.5						
	Folate pathway inhibitors	Sulfisoxazole	N/A	30.2	[25.8 - 34.9]											57.5	9.6	2.5	0.2		30.2
		Trimethoprim-sulfamethoxazole	N/A	48.2	[43.2 - 53.1]				6.9	2.2	2.7	16.7	23.3	13.5	34.6						
	Phenicols	Chloramphenicol	0.0	10.1	[7.3 - 13.4]								12.0	74.9	2.9		0.7	9.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists

§ Percent of isolates that were resistant

¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method

** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 21. Antimicrobial resistance pattern for *Shigella*, 2010

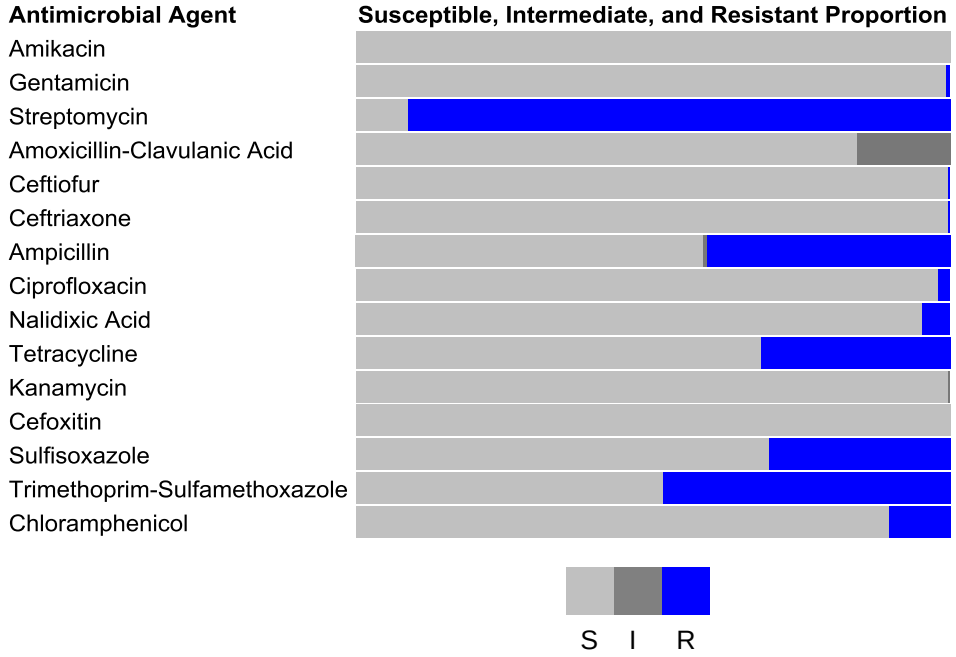


Table 34. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 344	2002 620	2003 495	2004 316	2005 396	2006 402	2007 480	2008 551	2009 475	2010 407
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	0.2% 1	0.0% 0	0.0% 0	1.0% 4	0.2% 1	0.8% 4	0.4% 2	0.6% 3	0.5% 2
		Streptomycin (MIC ≥ 64)	53.2% 183	54.4% 337	57.0% 282	59.8% 189	68.7% 272	60.7% 244	73.3% 352	80.6% 444	89.1% 423	91.2% 371
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.4% 15	2.6% 16	1.4% 7	1.6% 5	1.0% 4	1.5% 6	0.4% 2	3.3% 18	2.1% 10	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.2% 1	0.2% 1	0.3% 1	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.2% 1	0.2% 1	0.3% 1	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1
	Penicillins	Ampicillin (MIC ≥ 32)	79.7% 274	76.6% 475	79.4% 393	77.5% 245	70.7% 280	62.4% 251	63.8% 306	62.4% 344	46.3% 220	40.8% 166
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.2% 1	0.7% 4	0.6% 3	1.7% 7
		Nalidixic Acid (MIC ≥ 32)	1.7% 6	1.6% 10	1.0% 5	1.6% 5	1.5% 6	3.5% 14	1.7% 8	1.6% 9	2.1% 10	4.4% 18
	Tetracyclines	Tetracycline (MIC ≥ 16)	59.3% 204	30.6% 190	29.1% 144	49.4% 156	38.4% 152	34.6% 139	25.6% 123	24.3% 134	29.5% 140	31.7% 129
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.6% 2	0.8% 5	0.4% 2	0.0% 0	0.8% 3	0.0% 0	0.2% 1	0.5% 3	0.4% 2	0.0% 0
	Cephems	Cefoxitin (MIC ≥ 32)	1.2% 4	0.3% 2	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0
		Cephalothin (MIC ≥ 32)	9.0% 31	6.6% 41	9.3% 46	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	56.4% 194	31.8% 197	33.9% 168	52.5% 166	57.6% 228	40.3% 162	25.8% 124	28.5% 157	30.5% 145	30.2% 123
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	46.8% 161	37.3% 231	38.6% 191	46.8% 148	53.3% 211	46.0% 185	25.8% 124	31.2% 172	40.4% 192	48.2% 196
	Phenicols	Chloramphenicol (MIC ≥ 32)	21.5% 74	7.6% 47	8.5% 42	15.2% 48	10.9% 43	10.9% 44	8.3% 40	6.9% 38	9.3% 44	10.1% 41

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 35. Resistance patterns of *Shigella* isolates, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Isolates	**344**	**620**	**495**	**316**	**396**	**402**	**480**	**551**	**475**	**407**
Resistance Pattern										
No resistance detected	4.9% 17	8.2% 51	8.5% 42	4.7% 15	4.5% 18	6.5% 26	7.1% 34	4.5% 25	4.0% 19	3.7% 15
Resistance ≥ 1 CLSI class*	95.1% 327	91.8% 569	91.5% 453	95.3% 301	95.5% 378	93.5% 376	92.9% 446	95.5% 526	96.0% 456	96.3% 392
Resistance ≥ 2 CLSI classes*	68.6% 236	55.2% 342	57.8% 286	64.2% 203	72.0% 285	64.7% 260	65.4% 314	68.2% 376	68.0% 323	70.3% 286
Resistance ≥ 3 CLSI classes*	60.2% 207	41.6% 258	40.2% 199	59.5% 188	58.6% 232	43.8% 176	27.7% 133	35.2% 194	36.4% 173	40.0% 163
Resistance ≥ 4 CLSI classes*	45.3% 156	24.4% 151	24.8% 123	32.9% 104	19.4% 77	15.4% 62	11.7% 56	10.3% 57	13.3% 63	14.3% 58
Resistance ≥ 5 CLSI classes*	8.4% 29	2.9% 18	3.6% 18	7.0% 22	4.8% 19	5.2% 21	4.6% 22	2.7% 15	6.5% 31	4.7% 19
At least ACSSuT†	6.4% 22	1.8% 11	3.2% 16	6.0% 19	4.0% 16	5.0% 20	3.8% 18	2.2% 12	5.9% 28	4.4% 18
At least ACT/S‡	7.0% 24	2.7% 17	3.6% 18	6.6% 21	6.3% 25	6.0% 24	4.0% 19	2.9% 16	6.7% 32	4.9% 20
At least AT/S§	37.5% 129	29.8% 185	33.7% 167	34.5% 109	35.6% 141	26.6% 107	12.9% 62	16.0% 88	17.5% 83	17.9% 73
At least ANT/S¶	0.6% 2	0.3% 2	0.8% 4	0.6% 2	0.5% 2	0.5% 2	0.8% 4	0.0% 0	0.2% 1	1.2% 5
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.2% 1	0.3% 1	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.2% 1

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
¶ ANT/S: resistance to AT/S, naladixic acid
** ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

Table 36. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2010 (N=333)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 1.1]							0.3	22.5	71.8	5.4						
		Gentamicin	0.0	0.0	[0.0 - 1.1]					0.3	12.0	82.3	5.4								
		Streptomycin	N/A	96.4	[93.8 - 98.1]												3.6	52.0	44.4		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	10.5	0.0	[0.0 - 1.1]							0.6	0.3	59.2	29.4	10.5					
	Cephems	Ceftiofur	0.0	0.3	[0.0 - 1.7]				3.3	89.5	6.6	0.3				0.3					
		Ceftriaxone	0.0	0.3	[0.0 - 1.7]					99.7									0.3		
	Penicillins	Ampicillin	0.6	36.6	[31.5 - 42.1]							0.6	55.3	6.3	0.6	0.6		36.6			
	Quinolones	Ciprofloxacin	0.0	1.5	[0.5 - 3.5]	96.4		0.6	1.2		0.3			1.2	0.3						
		Nalidixic acid	N/A	3.3	[1.7 - 5.8]						0.9	82.9	12.0	0.9			1.2	2.1			
	Tetracyclines	Tetracycline	0.0	21.6	[17.3 - 26.4]									78.4			11.1	10.5			
II	**Aminoglycosides**	Kanamycin	0.0	0.0	[0.0 - 1.1]										100.0						
	Cephems	Cefoxitin	0.0	0.0	[0.0 - 1.1]							6.9	84.7	8.4							
	Folate pathway inhibitors	Sulfisoxazole	N/A	25.5	[20.9 - 30.6]											60.1	11.4	2.7	0.3		25.5
		Trimethoprim-sulfamethoxazole	N/A	47.4	[42.0 - 53.0]				1.8	0.6	2.1	19.8	28.2	16.5	30.9						
	Phenicols	Chloramphenicol	0.0	1.5	[0.5 - 3.5]								6.0	89.5	3.0			1.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 22. Antimicrobial resistance pattern for *Shigella sonnei*, 2010

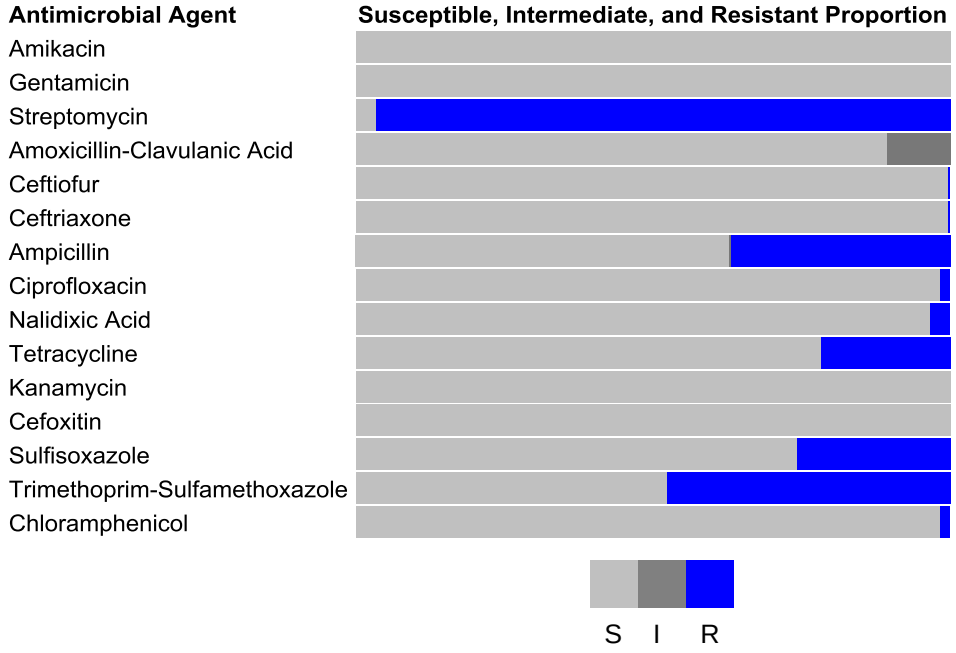


Table 37. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2001–2010

Year			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Isolates			239	536	434	241	340	321	414	497	410	333
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.2% 4	0.0% 0	1.0% 4	0.4% 2	0.7% 3	0.0% 0
		Streptomycin (MIC ≥ 64)	54.0% 129	55.4% 297	56.5% 245	56.8% 137	70.3% 239	61.7% 198	76.8% 318	82.3% 409	91.5% 375	96.4% 321
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.6% 11	2.2% 12	1.4% 6	1.7% 4	1.2% 4	1.9% 6	0.5% 2	3.2% 16	2.0% 8	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1
	Penicillins	Ampicillin (MIC ≥ 32)	82.8% 198	77.6% 416	79.7% 346	79.3% 191	70.6% 240	62.6% 201	64.0% 265	61.4% 305	43.2% 177	36.6% 122
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.5% 5
		Nalidixic Acid (MIC ≥ 32)	0.8% 2	1.5% 8	0.5% 2	1.7% 4	1.2% 4	2.8% 9	1.2% 5	1.6% 8	1.7% 7	3.3% 11
	Tetracyclines	Tetracycline (MIC ≥ 16)	44.8% 107	23.5% 126	22.1% 96	36.1% 87	29.4% 100	22.7% 73	16.2% 67	17.3% 86	20.7% 85	21.6% 72
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.4% 1	0.4% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.6% 3	0.2% 1	0.0% 0
	Cephems	Cefoxitin (MIC ≥ 32)	1.7% 4	0.4% 2	0.0% 0	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.7% 3	0.0% 0
		Cephalothin (MIC ≥ 32)	12.6% 30	7.3% 39	10.1% 44	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	54.4% 130	29.9% 160	31.3% 136	49.0% 118	57.9% 197	33.3% 107	20.0% 83	24.9% 124	23.9% 98	25.5% 85
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	50.6% 121	37.9% 203	38.5% 167	46.9% 113	55.0% 187	42.7% 137	22.0% 91	29.4% 146	36.1% 148	47.4% 158
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.3% 3	0.2% 1	1.2% 5	2.5% 6	2.4% 8	0.9% 3	1.2% 5	1.0% 5	1.2% 5	1.5% 5

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 38. Resistance patterns of *Shigella sonnei* isolates, 2001–2010

Year Total Isolates	2001 239	2002 536	2003 434	2004 241	2005 340	2006 321	2007 414	2008 497	2009 410	2010 333
Resistance Pattern										
No resistance detected	5.4% 13	7.1% 38	8.5% 37	5.4% 13	4.4% 15	6.2% 20	6.8% 28	4.6% 23	3.7% 15	1.5% 5
Resistance ≥ 1 CLSI class*	94.6% 226	92.9% 498	91.5% 397	94.6% 228	95.6% 325	93.8% 301	93.2% 386	95.4% 474	96.3% 395	98.5% 328
Resistance ≥ 2 CLSI classes*	59.8% 143	51.9% 278	54.1% 235	56.4% 136	70.6% 240	59.8% 192	63.0% 261	65.6% 326	65.4% 268	68.5% 228
Resistance ≥ 3 CLSI classes*	51.9% 124	36.6% 196	35.3% 153	51.0% 123	55.3% 188	35.8% 115	21.3% 88	29.8% 148	29.8% 122	33.0% 110
Resistance ≥ 4 CLSI classes*	37.7% 90	19.8% 106	20.5% 89	25.7% 62	12.4% 42	8.1% 26	5.1% 21	5.6% 28	5.9% 24	6.6% 22
Resistance ≥ 5 CLSI classes*	1.3% 3	0.7% 4	0.5% 2	0.8% 2	0.9% 3	0.0% 0	1.2% 5	0.4% 2	0.5% 2	0.6% 2
At least ACSSuT†	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.3% 1	0.0% 0	0.5% 2	0.2% 1	0.0% 0	0.6% 2
At least ACT/S‡	0.8% 2	0.2% 1	0.9% 4	1.7% 4	2.4% 8	0.9% 3	0.5% 2	0.8% 4	1.0% 4	0.9% 3
At least AT/S§	41.0% 98	30.2% 162	33.6% 146	35.3% 85	35.6% 121	22.7% 73	9.4% 39	14.3% 71	12.2% 50	14.4% 48
At least ANT/S¶	0.0% 0	0.2% 1	0.2% 1	0.8% 2	0.3% 1	0.0% 0	0.7% 3	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
¶ ANT/S: resistance to AT/S, naladixic acid
** ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

Table 39. Minimum inhibitory concentrations and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2010 (N=60)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 6.0]						1.7		11.7	81.7	5.0						
		Gentamicin	0.0	3.3	[0.4 - 11.5]					3.3	16.7	76.7					3.3				
		Streptomycin	N/A	70.0	[56.8 - 81.2]												30.0	10.0	60.0		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	46.7	0.0	[0.0 - 6.0]							3.3	25.0	8.3	16.7	46.7					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 6.0]				38.3	60.0		1.7									
		Ceftriaxone	0.0	0.0	[0.0 - 6.0]					100.0											
	Penicillins	Ampicillin	0.0	66.7	[53.3 - 78.3]							26.7	6.7					66.7			
	Quinolones	Ciprofloxacin	0.0	3.3	[0.4 - 11.5]	86.7	1.7		3.3	3.3	1.7			3.3							
		Nalidixic acid	N/A	11.7	[4.8 - 22.6]						1.7	66.7	20.0					11.7			
	Tetracyclines	Tetracycline	0.0	86.7	[75.4 - 94.1]									13.3		1.7	8.3	76.7			
II	**Aminoglycosides**	Kanamycin	1.7	0.0	[0.0 - 6.0]										98.3		1.7				
	Cephems	Cefoxitin	0.0	0.0	[0.0 - 6.0]								40.0	56.7	3.3						
	Folate pathway inhibitors	Sulfisoxazole	N/A	55.0	[41.6 - 67.9]											43.3	1.7				55.0
		Trimethoprim-sulfamethoxazole	N/A	55.0	[41.6 - 67.9]				28.3	10.0	6.7				55.0						
	Phenicols	Chloramphenicol	0.0	55.0	[41.6 - 67.9]								40.0	3.3	1.7		5.0	50.0			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 23. Antimicrobial resistance pattern for *Shigella flexneri*, 2010

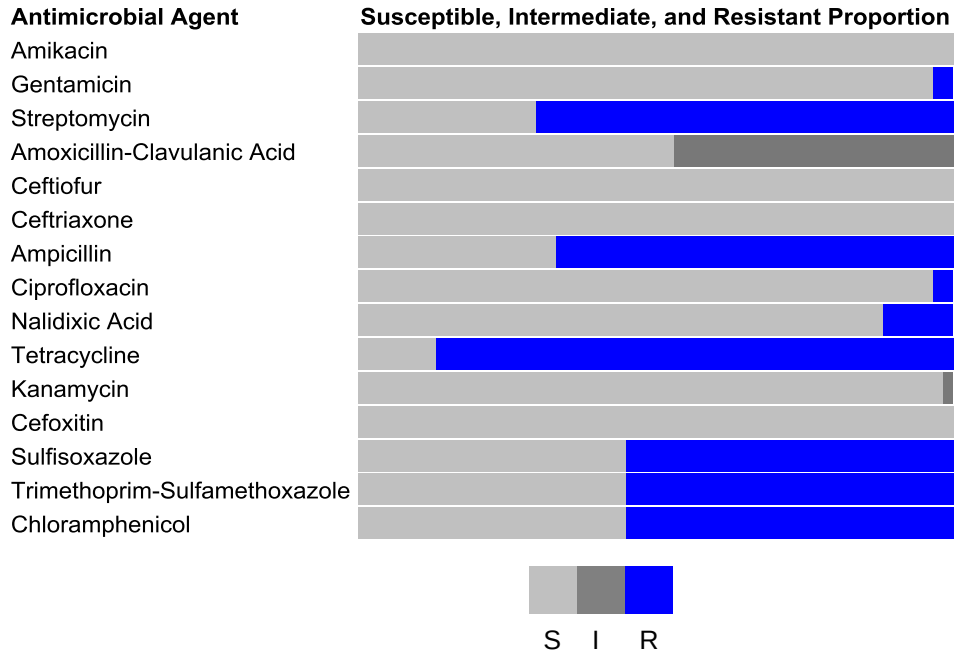


Table 40. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 91	2002 73	2003 51	2004 62	2005 52	2006 74	2007 61	2008 46	2009 57	2010 60
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	3.3% 2
		Streptomycin (MIC ≥ 64)	47.3% 43	43.8% 32	60.8% 31	71.0% 44	57.7% 30	58.1% 43	52.5% 32	63.0% 29	73.7% 42	70.0% 42
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.4% 4	5.5% 4	2.0% 1	1.6% 1	0.0% 0	0.0% 0	0.0% 0	4.3% 2	3.5% 2	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	1.4% 1	2.0% 1	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	1.4% 1	2.0% 1	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	72.5% 66	75.3% 55	84.3% 43	80.6% 50	75.0% 39	63.5% 47	63.9% 39	76.1% 35	70.2% 40	66.7% 40
	Quinolones	Ciprofloxacin (MIC ≥ 4)	1.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.4% 1	1.6% 1	2.2% 1	3.5% 2	3.3% 2
		Nalidixic Acid (MIC ≥ 32)	3.3% 3	2.7% 2	5.9% 3	1.6% 1	3.8% 2	5.4% 4	4.9% 3	2.2% 1	3.5% 2	11.7% 7
	Tetracyclines	Tetracycline (MIC ≥ 16)	94.5% 86	78.1% 57	82.4% 42	95.2% 59	94.2% 49	83.8% 62	83.6% 51	87.0% 40	87.7% 50	86.7% 52
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	1.1% 1	4.1% 3	3.9% 2	0.0% 0	3.8% 2	0.0% 0	0.0% 0	0.0% 0	1.8% 1	0.0% 0
	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Cephalothin (MIC ≥ 32)	1.1% 1	2.7% 2	3.9% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	57.1% 52	41.1% 30	52.9% 27	66.1% 41	55.8% 29	68.9% 51	62.3% 38	60.9% 28	73.7% 42	55.0% 33
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	34.1% 31	28.8% 21	39.2% 20	46.8% 29	44.2% 23	59.5% 44	49.2% 30	47.8% 22	68.4% 39	55.0% 33
	Phenicols	Chloramphenicol (MIC ≥ 32)	74.7% 68	63.0% 46	68.6% 35	61.3% 38	65.4% 34	54.1% 40	55.7% 34	67.4% 31	66.7% 38	55.0% 33

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 41. Resistance patterns of *Shigella flexneri* isolates, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Isolates	**91**	**73**	**51**	**62**	**52**	**74**	**61**	**46**	**57**	**60**
Resistance Pattern										
No resistance detected	3.3%	15.1%	7.8%	0.0%	5.8%	5.4%	9.8%	4.3%	5.3%	10.0%
	3	11	4	0	3	4	6	2	3	6
Resistance ≥ 1 CLSI class*	96.7%	84.9%	92.2%	100.0%	94.2%	94.6%	90.2%	95.7%	94.7%	90.0%
	88	62	47	62	49	70	55	44	54	54
Resistance ≥ 2 CLSI classes*	89.0%	76.7%	86.3%	93.5%	80.8%	85.1%	80.3%	93.5%	86.0%	83.3%
	81	56	44	58	42	63	49	43	49	50
Resistance ≥ 3 CLSI classes*	79.1%	75.3%	80.4%	90.3%	78.8%	75.7%	68.9%	84.8%	82.5%	80.0%
	72	55	41	56	41	56	42	39	47	48
Resistance ≥ 4 CLSI classes*	62.6%	57.5%	62.7%	64.5%	65.4%	47.3%	55.7%	56.5%	63.2%	56.7%
	57	42	32	40	34	35	34	26	36	34
Resistance ≥ 5 CLSI classes*	25.3%	19.2%	31.4%	29.0%	30.8%	28.4%	27.9%	28.3%	49.1%	28.3%
	23	14	16	18	16	21	17	13	28	17
At least ACSSuT†	22.0%	15.1%	29.4%	27.4%	28.8%	27.0%	26.2%	23.9%	47.4%	26.7%
	20	11	15	17	15	20	16	11	27	16
At least ACT/S‡	23.1%	21.9%	27.5%	24.2%	32.7%	28.4%	26.2%	26.1%	47.4%	26.7%
	21	16	14	15	17	21	16	12	27	16
At least AT/S§	25.3%	27.4%	37.3%	35.5%	38.5%	43.2%	36.1%	32.6%	52.6%	40.0%
	23	20	19	22	20	32	22	15	30	24
At least ANT/S¶	1.1%	1.4%	5.9%	0.0%	1.9%	2.7%	1.6%	0.0%	1.8%	8.3%
	1	1	3	0	1	2	1	0	1	5
At least ACSSuTAuCx**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0	0	0	0	0	0	0	0	0	0
At least ceftriaxone and nalidixic acid resistant	0.0%	0.0%	2.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%
	0	0	1	0	0	1	0	0	0	0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
§ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
¶ ANT/S: resistance to AT/S, naladixic acid
** ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

4. *Escherichia coli* O157

Table 42. Minimum inhibitory concentrations (MICs) and resistance of *Escherichia coli* O157 isolates to antimicrobial agents, 2010 (N=167)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Amikacin	0.0	0.0	[0.0 - 2.2]						1.8	52.1	40.7	4.2	1.2						
		Gentamicin	0.0	0.6	[0.0 - 3.3]					29.3	65.3	3.6	1.2				0.6				
		Streptomycin	N/A	1.8	[0.4 - 5.2]												98.2	0.6	1.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 2.2]							0.6	4.2	91.6	3.6						
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 2.2]					9.6	89.8	0.6									
		Ceftriaxone	0.0	0.0	[0.0 - 2.2]					100.0											
	Penicillins	Ampicillin	0.0	1.8	[0.4 - 5.2]							1.2	84.4	11.4	1.2			1.8			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 2.2]	97.6	1.2		0.6	0.6											
		Nalidixic acid	N/A	1.2	[0.1 - 4.3]							1.2	85.0	12.6				1.2			
	Tetracyclines	Tetracycline	0.0	4.2	[1.7 - 8.4]									95.8			0.6	3.6			
II	**Aminoglycosides**	Kanamycin	0.0	1.2	[0.1 - 4.3]										98.8				1.2		
	Cephems	Cefoxitin	1.8	0.0	[0.0 - 2.2]								3.0	82.6	12.6	1.8					
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.2	[1.7 - 8.4]											54.5	39.5	1.8			4.2
		Trimethoprim-sulfamethoxazole	N/A	1.2	[0.1 - 4.3]				97.0	1.8					1.2						
	Phenicols	Chloramphenicol	0.6	0.6	[0.0 - 3.3]									12.6	86.2	0.6	0.6				

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 24. Antimicrobial resistance pattern for *Escherichia coli* O157, 2010

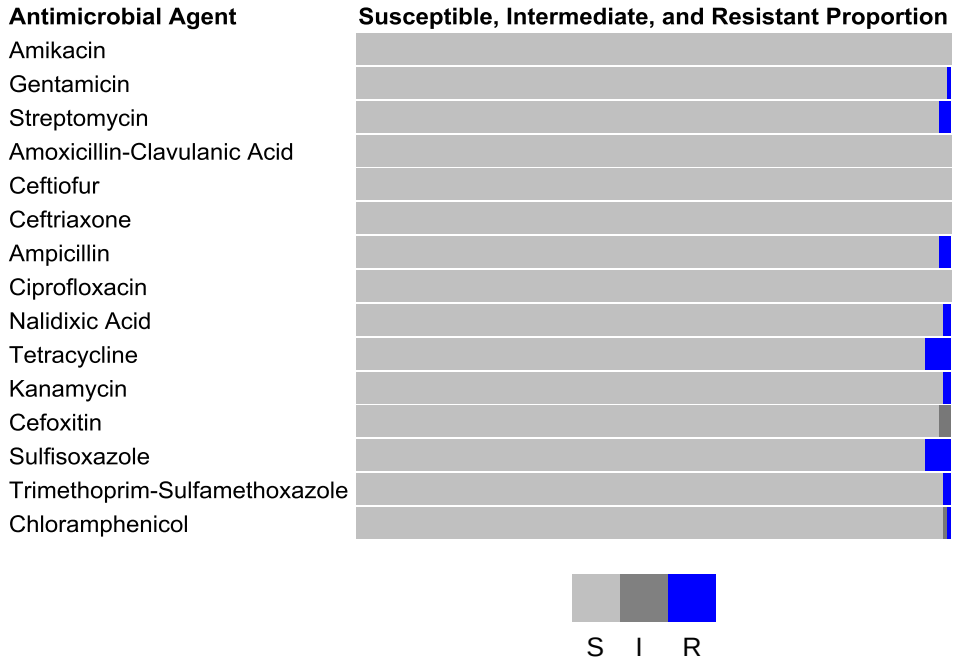


Table 43. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 277	2002 399	2003 158	2004 169	2005 194	2006 233	2007 190	2008 160	2009 187	2010 167
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Gentamicin (MIC ≥ 16)	0.4% 1	0.0% 0	0.0% 0	0.6% 1	0.5% 1	0.0% 0	0.0% 0	1.3% 2	0.5% 1	0.6% 1
		Streptomycin (MIC ≥ 64)	1.8% 5	2.3% 9	1.9% 3	1.8% 3	2.1% 4	2.6% 6	2.1% 4	1.9% 3	4.8% 9	1.8% 3
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.7% 2	0.0% 0	1.3% 2	0.0% 0	0.0% 0	1.3% 3	0.5% 1	0.6% 1	0.5% 1	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	1.1% 3	0.0% 0	1.3% 2	0.0% 0	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.7% 2	0.0% 0	1.3% 2	0.0% 0	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	2.2% 6	1.5% 6	3.2% 5	1.2% 2	4.1% 8	2.6% 6	2.1% 4	3.8% 6	4.3% 8	1.8% 3
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.5% 1	0.0% 0	0.5% 1	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	1.1% 3	1.0% 4	0.6% 1	1.8% 3	1.5% 3	2.1% 5	2.1% 4	1.3% 2	2.1% 4	1.2% 2
	Tetracyclines	Tetracycline (MIC ≥ 16)	5.4% 15	3.0% 12	5.7% 9	1.8% 3	8.8% 17	4.7% 11	4.7% 9	1.9% 3	7.5% 14	4.2% 7
II	Aminoglycosides	Kanamycin (MIC ≥ 64)	0.0% 0	0.5% 2	0.0% 0	0.0% 0	0.5% 1	0.4% 1	0.0% 0	0.0% 0	0.5% 1	1.2% 2
	Cephems	Cefoxitin (MIC ≥ 32)	0.7% 2	0.0% 0	1.3% 2	0.6% 1	0.0% 0	1.3% 3	0.0% 0	1.3% 2	0.5% 1	0.0% 0
		Cephalothin (MIC ≥ 32)	1.4% 4	1.5% 6	3.2% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	5.1% 14	3.5% 14	3.8% 6	1.8% 3	6.7% 13	3.0% 7	2.6% 5	3.1% 5	6.4% 12	4.2% 7
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.7% 2	0.5% 2	0.6% 1	0.0% 0	0.5% 1	0.4% 1	1.1% 2	1.3% 2	4.3% 8	1.2% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.4% 4	1.3% 5	1.3% 2	0.6% 1	1.0% 2	1.3% 3	0.5% 1	0.6% 1	1.1% 2	0.6% 1

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Sulfamethoxazole, which was tested during 1996-2003 to represent sulfonamides, was replaced by sulfisoxazole in 2004

Table 44. Resistance patterns of *Escherichia coli* O157 isolates, 2001–2010

Year Total Isolates	2001 277	2002 399	2003 158	2004 169	2005 194	2006 233	2007 190	2008 160	2009 187	2010 167
Resistance Pattern										
No resistance detected	91.3% 253	94.0% 375	90.5% 143	94.7% 160	87.6% 170	91.8% 214	92.1% 175	91.9% 147	89.8% 168	94.0% 157
Resistance ≥ 1 CLSI class*	8.7% 24	6.0% 24	9.5% 15	5.3% 9	12.4% 24	8.2% 19	7.9% 15	8.1% 13	10.2% 19	6.0% 10
Resistance ≥ 2 CLSI classes*	5.4% 15	3.8% 15	5.1% 8	2.4% 4	6.7% 13	4.7% 11	3.2% 6	3.1% 5	7.5% 14	4.2% 7
Resistance ≥ 3 CLSI classes*	2.2% 6	2.0% 8	3.2% 5	1.2% 2	5.2% 10	3.4% 8	2.1% 4	2.5% 4	5.9% 11	3.6% 6
Resistance ≥ 4 CLSI classes*	1.4% 4	0.8% 3	1.3% 2	0.6% 1	1.0% 2	2.1% 5	1.1% 2	1.3% 2	4.3% 8	1.8% 3
Resistance ≥ 5 CLSI classes*	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 2	0.5% 1	0.0% 0	0.5% 1	0.0% 0
At least ACSSuT†	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACT/S‡	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.0% 0	0.0% 0
At least ACSSuTAuCx§	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute

† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

‡ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

§ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

5. *Campylobacter*

Table 45. Frequency of *Campylobacter* species, 2010

Species	2010	
	N	(%)
Campylobacter jejuni	1158	(88.4)
Campylobacter coli	115	(8.8)
Other	37	(2.8)
Total	**1310**	**(100)**

Table 46. Minimum inhibition concentrations (MICs) and resistance of *Campylobacter* isolates to antimicrobial agents, 2010 (N=1310)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
	Aminoglycosides	Gentamicin	0.0	1.6	[1.0 - 2.4]				2.9	36.5	50.5	8.4	0.2				< 0.1	1.5			
	Ketolide	Telithromycin	1.8	1.6	[1.0 - 2.4]		< 0.1	< 0.1	0.2	2.4	17.3	35.4	32.7	8.5	1.8	1.6					
	Macrolides	Azithromycin	< 0.1	1.5	[0.9 - 2.3]	< 0.1	4.0	23.1	41.6	27.0	2.3	0.3		< 0.1					1.5		
I		Erythromycin	0.0	1.5	[0.9 - 2.3]			< 0.1	0.5	8.2	26.7	38.9	20.6	3.3	0.3				1.5		
	Quinolones	Ciprofloxacin	< 0.1	22.4	[20.2 - 24.8]	< 0.1	0.2	16.3	48.2	11.0	1.7	< 0.1	< 0.1	0.6	7.7	7.9	4.6	1.2	0.5		
		Nalidixic acid	< 0.1	22.7	[20.5 - 25.1]									52.4	21.5	3.3	< 0.1	0.3	22.4		
	Tetracyclines	Tetracycline	< 0.1	42.1	[39.4 - 44.8]			0.5	7.4	26.4	15.0	7.0	1.2	0.3	< 0.1	0.2	0.9	2.4	38.5		
II	**Phenicols**	Florfenicol††	N/A	1.3	[0.8 - 2.1]		< 0.1				2.9	35.6	51.5	8.6	1.1	0.2	< 0.1				
III	**Lincosamides**	Clindamycin	0.7	1.7	[1.1 - 2.5]		0.2	2.3	19.1	31.2	29.7	12.3	2.8	0.7	0.2	< 0.1	1.4				

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists

§ Percent of isolates that were resistant

¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method

** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

†† Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant.

Figure 25. Antimicrobial resistance pattern for *Campylobacter*, 2010

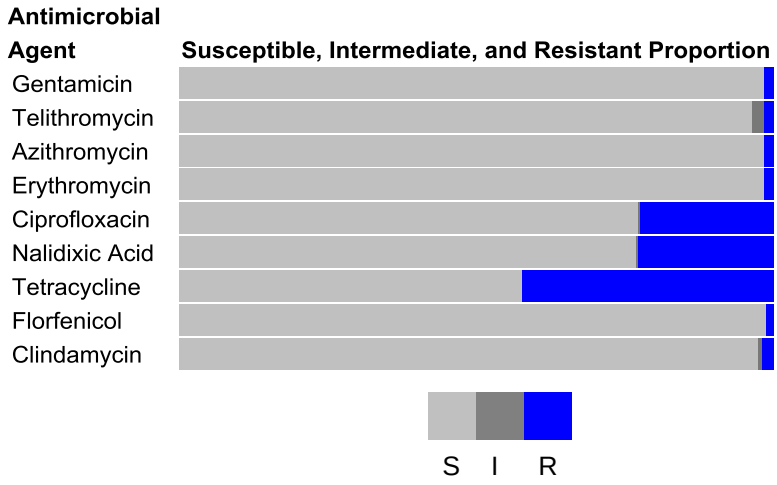


Table 47. Percentage and number of *Campylobacter* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 384	2002 354	2003 328	2004 347	2005 890	2006 816	2007 1100	2008 1155	2009 1497	2010 1310
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	0.0% 0	0.3% 1	0.3% 1	0.7% 6	0.1% 1	0.6% 7	1.1% 13	0.9% 13	1.6% 21
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	1.0% 9	1.6% 13	1.5% 16	2.5% 29	1.5% 22	1.6% 21
	Macrolides	Azithromycin (MIC ≥ 8)	2.1% 8	2.0% 7	0.9% 3	0.6% 2	1.9% 17	1.7% 14	2.0% 22	3.0% 35	1.7% 25	1.5% 19
		Erythromycin (MIC ≥ 32)	2.1% 8	1.4% 5	0.9% 3	0.3% 1	1.8% 16	1.7% 14	2.0% 22	3.0% 35	1.7% 25	1.5% 19
	Quinolones	Ciprofloxacin (MIC ≥ 4)	19.5% 75	20.1% 71	17.7% 58	19.0% 66	21.7% 193	19.6% 160	26.0% 286	23.0% 266	22.9% 343	22.4% 294
		Nalidixic Acid (MIC ≥ 64)	20.3% 78	20.6% 73	18.9% 62	19.6% 68	22.4% 199	20.1% 164	26.5% 291	23.5% 272	23.2% 347	22.7% 298
	Tetracyclines	Tetracycline (MIC ≥ 16)	40.9% 157	41.2% 146	38.4% 126	46.1% 160	40.6% 361	46.0% 375	44.4% 488	43.6% 504	43.6% 652	42.1% 551
II	Phenicols	Chloramphenicol (MIC ≥ 32)	0.3% 1	0.3% 1	0.0% 0	1.4% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	Not Tested	Not Tested	Not Tested	0.6% 5	0.0% 0	0.0% 0	0.5% 6	0.5% 8	1.3% 17
III	Lincosamides	Clindamycin (MIC ≥ 8)	2.1% 8	2.0% 7	0.6% 2	2.0% 7	1.5% 13	2.0% 16	1.7% 19	2.8% 32	1.4% 21	1.7% 22

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant

Table 48. Resistance patterns of *Campylobacter* isolates, 2001–2010

Year Total Isolates	2001 384	2002 354	2003 328	2004 347	2005 890	2006 816	2007 1100	2008 1155	2009 1497	2010 1310
Resistance Pattern										
No resistance detected	49.2% 189	48.0% 170	50.9% 167	46.1% 160	48.4% 431	43.9% 358	45.2% 497	45.9% 530	46.4% 694	47.3% 620
Resistance ≥ 1 CLSI class*	50.8% 195	52.0% 184	49.1% 161	53.9% 187	51.6% 459	56.1% 458	54.8% 603	54.1% 625	53.6% 803	52.7% 690
Resistance ≥ 2 CLSI classes*	13.3% 51	12.7% 45	8.5% 28	14.1% 49	13.8% 123	12.0% 98	17.5% 192	15.6% 180	14.2% 212	14.3% 187
Resistance ≥ 3 CLSI classes*	1.6% 6	1.4% 5	0.9% 3	1.7% 6	1.8% 16	1.5% 12	1.7% 19	2.7% 31	1.7% 25	2.1% 28
Resistance ≥ 4 CLSI classes*	0.3% 1	0.0% 0	0.3% 1	0.3% 1	0.4% 4	0.5% 4	0.9% 10	1.4% 16	1.1% 16	0.8% 10
Resistance ≥ 5 CLSI classes*	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.1% 1	0.1% 1	0.6% 7	0.7% 8	0.5% 8	0.6% 8

* CLSI: Clinical and Laboratory Standards Institute

Table 49. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2010 (N=1158)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
	Aminoglycosides	Gentamicin	0.0	0.7	[0.3 - 1.4]				2.5	37.3	52.6	6.8	< 0.1				< 0.1	0.6			
	Ketolide	Telithromycin	1.2	1.3	[0.7 - 2.1]		< 0.1		0.2	1.9	15.8	38.4	34.7	6.4	1.2	1.3					
	Macrolides	Azithromycin	< 0.1	1.2	[0.7 - 2.0]		4.5	25.5	41.7	25.5	1.5	< 0.1		< 0.1					1.2		
I		Erythromycin	0.0	1.2	[0.7 - 2.0]				0.5	8.9	27.5	40.3	19.7	1.8	< 0.1				1.2		
	Quinolones	Ciprofloxacin	0.0	21.8	[19.5 - 24.3]		0.3	18.0	49.7	8.8	1.4	< 0.1		0.6	7.9	7.5	4.1	1.3	0.4		
		Nalidixic acid	0.0	22.0	[19.7 - 24.5]									56.1	19.4	2.4		0.3	21.7		
	Tetracyclines	Tetracycline	< 0.1	42.7	[39.9 - 45.7]			0.5	8.0	27.2	14.5	5.5	1.2	0.2	< 0.1	0.2	0.9	2.7	38.9		
II	**Phenicols**	Florfenicol††	N/A	1.5	[0.9 - 2.3]		< 0.1				3.1	38.0	50.9	6.5	1.2	0.2	< 0.1				
III	**Lincosamides**	Clindamycin	0.2	1.3	[0.7 - 2.1]		0.2	2.6	21.2	31.9	30.0	10.7	2.0	0.2	< 0.1	< 0.1	1.1				

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.
†† Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant.

Figure 26. Antimicrobial resistance pattern for *Campylobacter jejuni*, 2010

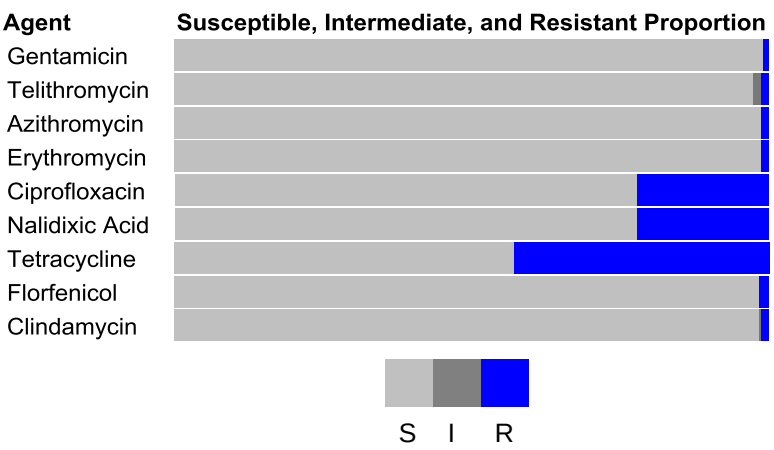


Table 50. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 365	2002 329	2003 303	2004 320	2005 791	2006 709	2007 992	2008 1043	2009 1351	2010 1158
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 4	0.0% 0	0.7% 7	1.2% 12	0.7% 9	0.7% 8
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	0.6% 5	0.8% 6	1.0% 10	2.2% 23	1.4% 19	1.3% 15
	Macrolides	Azithromycin (MIC ≥ 8)	1.9% 7	1.8% 6	0.3% 1	0.6% 2	1.8% 14	0.8% 6	1.6% 16	2.3% 24	1.6% 21	1.2% 14
		Erythromycin (MIC ≥ 32)	1.9% 7	1.2% 4	0.3% 1	0.3% 1	1.6% 13	0.8% 6	1.6% 16	2.3% 24	1.6% 21	1.2% 14
	Quinolones	Ciprofloxacin (MIC ≥ 4)	18.4% 67	20.7% 68	17.2% 52	18.1% 58	21.5% 170	19.5% 138	25.8% 256	22.3% 233	23.0% 311	21.8% 253
		Nalidixic Acid (MIC ≥ 64)	18.9% 69	21.3% 70	17.8% 54	18.4% 59	21.9% 173	19.0% 135	26.1% 259	22.8% 238	23.2% 313	22.0% 255
	Tetracyclines	Tetracycline (MIC ≥ 16)	40.3% 147	41.3% 136	38.3% 116	46.9% 150	41.8% 331	47.4% 336	44.8% 444	44.2% 461	43.4% 587	42.7% 495
II	Phenicols	Chloramphenicol (MIC ≥ 32)	0.3% 1	0.3% 1	0.0% 0	1.6% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	Not Tested	Not Tested	Not Tested	0.5% 4	0.0% 0	0.0% 0	0.6% 6	0.6% 8	1.5% 17
III	Lincosamides	Clindamycin (MIC ≥ 8)	1.9% 7	1.8% 6	0.0% 0	2.2% 7	1.1% 9	1.0% 7	1.3% 13	2.1% 22	1.3% 18	1.3% 15

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2010 (N=115)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
	Aminoglycosides	Gentamicin	0.0	11.3	[6.2 - 18.6]					27.0	39.1	21.7	0.9					11.3			
	Ketolide	Telithromycin	8.7	4.3	[1.4 - 9.9]					7.8	33.9	6.1	13.0	26.1	8.7	4.3					
	Macrolides	Azithromycin	0.0	4.3	[1.4 - 9.9]			3.5	35.7	47.0	7.8	1.7							4.3		
I		Erythromycin	0.0	4.3	[1.4 - 9.9]					2.6	21.7	25.2	27.0	16.5	2.6				4.3		
	Quinolones	Ciprofloxacin	0.0	31.3	[23.0 - 40.6]			3.5	32.2	29.6	3.5				7.0	13.0	11.3				
		Nalidixic acid	0.0	31.3	[23.0 - 40.6]									16.5	40.9	11.3			31.3		
	Tetracyclines	Tetracycline	0.0	48.7	[39.3 - 58.2]				0.9	19.1	14.8	15.7		0.9			0.9	0.9	47.0		
II	**Phenicols**	Florfenicol††	N/A	0.0	[0.0 - 3.2]						0.9	20.0	57.4	21.7							
III	**Lincosamides**	Clindamycin	4.3	6.1	[2.5 - 12.1]				1.7	27.0	31.3	23.5	6.1	4.3	1.7		4.3				

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists
§ Percent of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre plate. Numbers listed for the lowest tested concentrations represent the precentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.
†† Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant.

Figure 27. Antimicrobial resistance pattern for *Campylobacter coli*, 2010

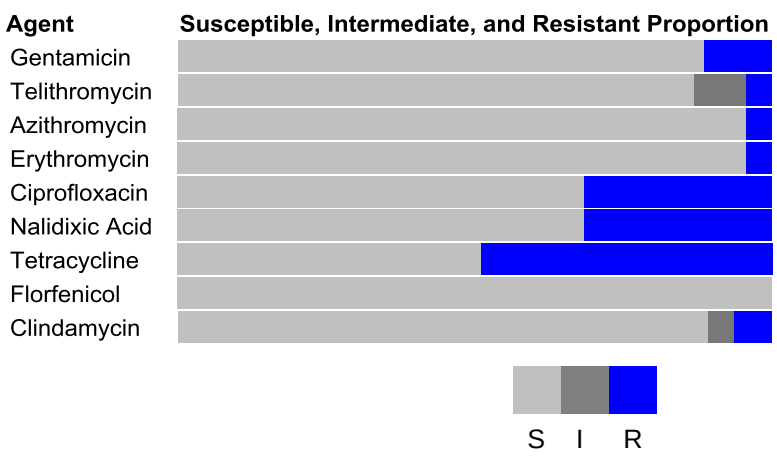


Table 52. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2001–2010

Year Total Isolates			2001 17	2002 25	2003 22	2004 26	2005 98	2006 97	2007 105	2008 109	2009 142	2010 115
Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	0.0% 0	4.5% 1	0.0% 0	2.0% 2	1.0% 1	0.0% 0	0.9% 1	2.8% 4	11.3% 13
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	4.1% 4	7.2% 7	5.7% 6	5.5% 6	2.1% 3	4.3% 5
	Macrolides	Azithromycin (MIC ≥ 8)	5.9% 1	4.0% 1	9.1% 2	0.0% 0	3.1% 3	8.2% 8	5.7% 6	10.1% 11	2.8% 4	4.3% 5
		Erythromycin (MIC ≥ 32)	5.9% 1	4.0% 1	9.1% 2	0.0% 0	3.1% 3	8.2% 8	5.7% 6	10.1% 11	2.8% 4	4.3% 5
	Quinolones	Ciprofloxacin (MIC ≥ 4)	47.1% 8	12.0% 3	22.7% 5	30.8% 8	23.5% 23	21.6% 21	28.6% 30	30.3% 33	21.8% 31	31.3% 36
		Nalidixic Acid (MIC ≥ 64)	47.1% 8	12.0% 3	22.7% 5	34.6% 9	26.5% 26	23.7% 23	30.5% 32	30.3% 33	23.2% 33	31.3% 36
	Tetracyclines	Tetracycline (MIC ≥ 16)	58.8% 10	40.0% 10	45.5% 10	38.5% 10	30.6% 30	39.2% 38	41.9% 44	39.4% 43	45.1% 64	48.7% 56
II	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	Not Tested	Not Tested	Not Tested	1.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
III	Lincosamides	Clindamycin (MIC ≥ 8)	5.9% 1	4.0% 1	9.1% 2	0.0% 0	4.1% 4	9.3% 9	5.7% 6	9.2% 10	2.1% 3	6.1% 7

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important; Rank 3, Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Only a susceptible breakpoint (≤ 4 µg/ml) has been established. In this report, isolates with an MIC ≥ 8 µg/ml are categorized as resistant

6. *Vibrio* species other than *V. cholerae*

Table 53. Frequency of *Vibrio* species other than *V. cholerae*, 2009

Species	2009	
	N	(%)
Vibrio parahaemolyticus	139	(50.5)
Vibrio vulnificus	50	(18.2)
Vibrio alginolyticus	46	(16.7)
Vibrio fluvialis	21	(7.6)
Vibrio mimicus	11	(4.0)
Other	8	(2.9)
Total	**275**	**(100)**

Table 54. Minimum inhibitory concentrations (MICs) and resistance of isolates of *Vibrio* species other than *V. cholerae* to antimicrobial agents, 2009 (N=275)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	% of isolates			Percent of all isolates with MIC (µg/mL)††																		
			%I§	%R¶	[95% CI]**	0.002	0.004	0.007	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512	1024
I	Aminoglycosides	Streptomycin‡	N/A	N/A	N/A											2.5	10.9	38.5	46.5	1.5					
	Penicillins	Ampicillin	21.1	22.5	[17.7 - 27.9]								1.5		14.5	11.3	10.2	18.9	21.1	9.5	4.7	1.5		6.9	
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 1.3]		7.6	2.9	2.5	8.0	18.5	56.4	3.6	0.4											
		Nalidixic acid‡	N/A	N/A	N/A								1.8	6.2	26.5	61.1	3.6	0.7							
	Tetracyclines	Tetracycline	0.0	0.0	[0.0- 1.3]							1.1	0.7	6.5	44.4	46.9	0.4								
II	Aminoglycosides	Kanamycin‡	N/A	N/A	N/A										0.4	6.2	55.6	33.5	4.4						
	Cephems	Cephalothin‡	N/A	N/A	N/A								0.7		2.9	5.5	20.4	58.5	6.9				0.7	4.4	
	Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 1.3]					0.4	8.4	60.0	30.9	0.4											
	Phenicols	Chloramphenicol‡	N/A	N/A	N/A									10.9	82.5	6.5									

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Table I): Rank 1, Critically Important; Rank 2, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ CLSI MIC interpretive criteria have not been established
§ Percent of isolates with intermediate susceptibility; N/A indicates that no MIC range of intermediate susceptibility exists or no CLSI breakpoints have been established
¶ Percent of isolates that were resistant; N/A indicates that no CLSI breakpoints have been established
** The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Clopper-Pearson exact method
†† The unshaded areas indicate the dilution range of the Etest® strips used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Etest® strip. CLSI breakpoints were used when available.

Figure 28. Antimicrobial resistance pattern for *Vibrio* species other than *V. cholerae*, 2009

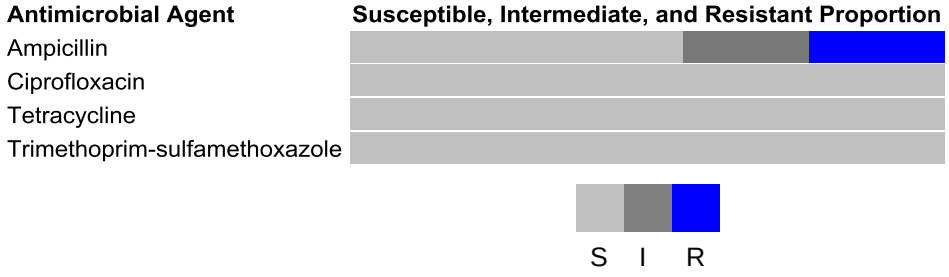


Table 55. Percentage and number of isolates of *Vibrio* species other than *V. cholerae*, by ampicillin MIC interpretation, 2009

Species	Susceptible	Intermediate	Resistant	Total Isolates
Vibrio parahaemolyticus	59.0% 82	30.9% 43	10.1% 14	**139**
Vibrio vulnificus	94.0% 47	4.0% 2	2.0% 1	**50**
Vibrio alginolyticus	8.7% 4	8.7% 4	82.6% 38	**46**
Vibrio fluvialis	38.1% 8	28.6% 6	33.3% 7	**21**
Vibrio mimicus	90.9% 10	0% 0	9.1% 1	**11**
Other	50.0% 4	37.5% 3	12.5% 1	**8**
Total	56.4% 155	21.1% 58	22.5% 62	**275**

Box 1. Changes in Antimicrobial Resistance: 2010 vs. 2003–07

To understand changes in prevalence of antimicrobial resistance over time, we used logistic regression to compare the prevalence of specific antimicrobial resistance patterns among *Salmonella* and *Campylobacter* isolates tested in 2010 with the average prevalence of resistance in 2003–2007. Since 2003, all 50 states have participated in *Salmonella* surveillance and all 10 FoodNet sites have participated in *Campylobacter* surveillance. A description of the methods is included in this report (refer to Surveillance and Laboratory Testing Methods).

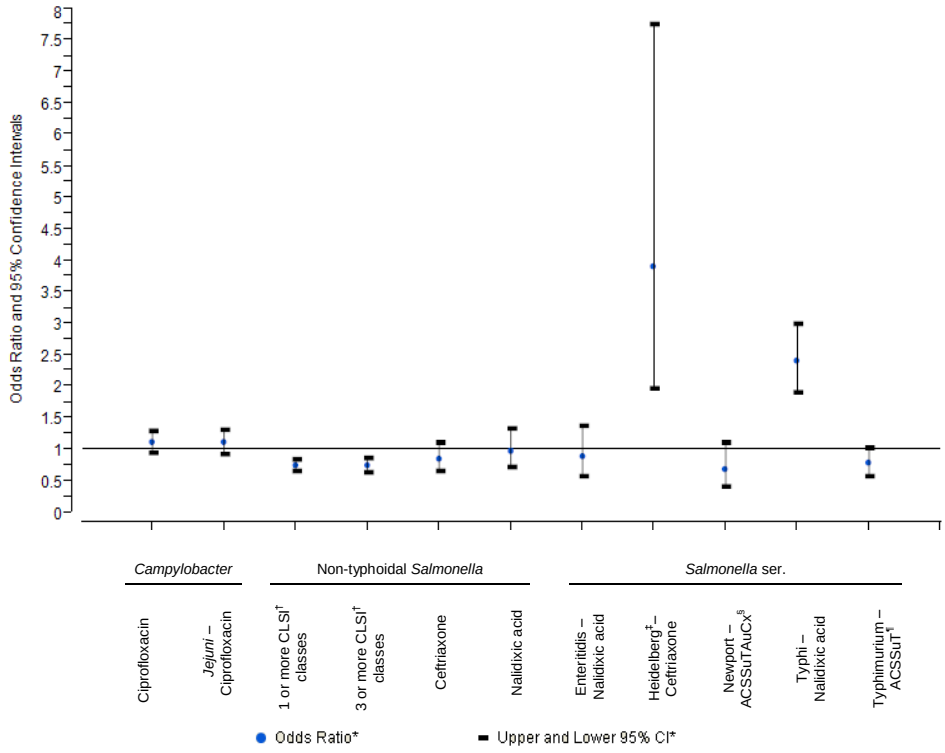
The differences between the prevalence of resistance in 2010 and the average prevalence of resistance in 2003–07 (Figure 1) were statistically significant for the following:

- Resistance to one or more CLSI classes in non-typhoidal *Salmonella* (NTS) was lower in 2010 than in 2003–2007 (Odds ratio [OR]=0.75, 95% Confidence interval [CI] 0.66–0.84)
- Resistance to three or more CLSI classes in NTS was lower in 2010 than in 2003–2007 (OR=0.74, 95% CI 0.64–0.86)
- Nalidixic acid resistance in *Salmonella* ser. Typhi was higher in 2010 than in 2003–2007 (OR=2.39, 95% CI 1.91–2.99)
- Ceftriaxone resistance among *Salmonella* ser. Heidelberg was higher in 2010 than in 2003–2007 (OR=3.90, 95% CI 1.96–7.75) Descriptive analysis suggests that resistance in 2010 was mainly driven by New York, California, and Wisconsin. When trend analysis excluded these 3 states, there was no significant change (OR=2.26, 95% CI 0.86–5.93). Thus, the reported OR represents a summary of possibly unequal trends across sites.

The differences between the prevalence of resistance in 2010 and the average prevalence of resistance in 2003–07 (Figure 1) were not statistically significant for the following:

- Among *Campylobacter*
  - Ciprofloxacin resistance (OR=1.11, 95% CI 0.94–1.30)
  - Ciprofloxacin resistance in *Campylobacter jejuni* (OR=1.11, 95% CI 0.93–1.32)
- Among non-typhoidal *Salmonella* in general
  - Ceftriaxone resistance (OR=0.85, 95% CI 0.65–1.11)
  - Nalidixic acid resistance (OR=0.97, 95% CI 0.71–1.34)
- Among *Salmonella* of particular serotypes
  - Nalidixic acid resistance in ser. Enteritidis (OR=0.88, 95% CI 0.57–1.37)
  - ACSSuTAuCx resistance in ser. Newport (OR=0.67, 95% CI 0.41–1.11)
  - ACSSuT resistance in ser. Typhimurium (OR=0.77, 95% CI 0.58–1.03)

Figure 1. Summary of trend analysis of the prevalence of specific resistance patterns among *Salmonella* and *Campylobacter* isolates, 2010 compared with 2003–2007*



* The reference is the average prevalence of resistance in 2003–2007. Logistic regression models adjusted for site. The odds ratios (ORs) and 95% confidence intervals (CIs) for 2010 compared with the reference were calculated by using unconditional maximum likelihood estimation. ORs that do not include 1.00 in the 95% CIs are reported as statistically significant.
† Clinical and Laboratory Standards Institute (CLSI) antimicrobial classes of agents are used
‡ Descriptive analysis suggests that increased resistance in 2010 was mainly driven by New York, California, and Wisconsin. Thus, the reported OR represents a summary of possibly unequal trends across sites.
§ ACSSuTAuCx: resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone
¶ ACSSuT: resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline

Box 2. Ciprofloxacin Breakpoint Changes for *Salmonella*

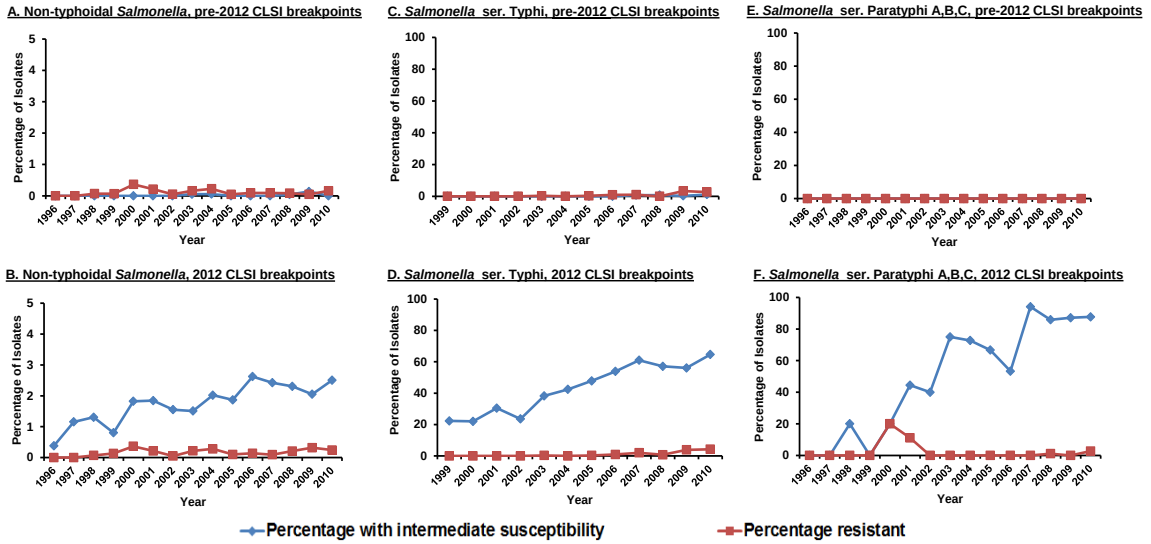
The Clinical and Laboratory Standards Institute (CLSI) is a consensus organization that publishes methods and interpretive criteria pertinent to clinical antimicrobial susceptibility testing. CLSI approved standards are used by NARMS and other entities throughout the world. CLSI reviewed fluoroquinolone interpretive criteria for *Enterobacteriaceae*. This process began with a review of the breakpoints for *Salmonella* infections. CLSI determined, after review of clinical and microbiologic data, that the MIC criteria for intermediate and resistant categories should be lowered for invasive *Salmonella* because patients whose isolates showed MICs in the susceptible range do not always respond to therapy with that class of agents; therefore, for invasive *Salmonella*, CLSI updated ciprofloxacin MIC ranges and disk diffusion correlates for susceptible (S), intermediate (I), and resistant (R) categories. These ranges appeared in the January 2012 CLSI M100 supplement. Pre-2012 breakpoints defined isolates with MICs ≤1 µg/mL as susceptible, isolates with an MIC of 2 µg/mL as intermediate, and isolates with an MIC of ≥4 µg/mL as resistant. The updated 2012 breakpoints defined the susceptible MIC range as ≤0.064 µg/mL, the intermediate range 0.12-0.5 µg/mL, and resistance as ≥1 µg/mL. To show how the data will change once the 2012 breakpoints are applied, in this report, we show S, I, and R frequencies for *Salmonella* (typhoidal and non-typhoidal) using both the outgoing and new breakpoints.

Table 1. Percentage of *Salmonella* isolates with intermediate susceptibility and resistance to ciprofloxacin, by pre-2012 and 2012 CLSI breakpoints, 1996–2010

Non-typhoidal *Salmonella*						*Salmonella* ser. Typhi						*Salmonella* ser. Paratyphi A, Paratyphi B, Paratyphi C					
Year	Total Isolates	Pre-2012 CLSI Breakpoints*		2012 CLSI Breakpoints†		Year	Total Isolates	Pre-2012 CLSI Breakpoints*		2012 CLSI Breakpoints†		Year	Total Isolates	Pre-2012 CLSI Breakpoints*		2012 CLSI Breakpoints†	
		%I‡	%R§	%I‡	%R§			%I‡	%R§	%I‡	%R§			%I‡	%R§	%I‡	%R§
1996	1318	0.0	0.0	0.4	0.0							1996	6	0.0	0.0	0.0	0.0
1997	1297	0.0	0.0	1.2	0.0							1997	4	0.0	0.0	0.0	0.0
1998	1455	0.0	0.1	1.3	0.1							1998	5	0.0	0.0	20.0	0.0
1999	1493	0.0	0.1	0.8	0.1	1999	166	0.0	0.0	22.3	0.0	1999	2	0.0	0.0	0.0	0.0
2000	1372	0.0	0.4	1.8	0.4	2000	177	0.0	0.0	22.0	0.0	2000	5	0.0	0.0	20.0	20.0
2001	1410	0.0	0.2	1.8	0.2	2001	197	0.0	0.0	30.5	0.0	2001	9	0.0	0.0	44.4	11.1
2002	1998	0.0	0.1	1.6	0.1	2002	195	0.0	0.0	23.6	0.0	2002	10	0.0	0.0	40.0	0.0
2003	1855	0.1	0.2	1.5	0.2	2003	332	0.0	0.3	38.3	0.3	2003	8	0.0	0.0	75.0	0.0
2004	1782	0.1	0.2	2.0	0.3	2004	304	0.0	0.0	42.4	0.0	2004	11	0.0	0.0	72.7	0.0
2005	2034	0.0	<0.1	1.9	0.1	2005	318	0.0	0.3	47.8	0.3	2005	18	0.0	0.0	66.7	0.0
2006	2172	0.0	0.1	2.6	0.1	2006	323	0.0	0.9	53.9	0.9	2006	15	0.0	0.0	53.3	0.0
2007	2145	0.0	0.1	2.4	0.1	2007	400	0.8	1.0	61.0	2.0	2007	17	0.0	0.0	94.1	0.0
2008	2384	<0.1	0.1	2.3	0.2	2008	408	0.7	0.0	57.1	0.7	2008	92	0.0	0.0	85.9	1.1
2009	2193	0.1	<0.1	2.1	0.3	2009	362	0.3	3.3	56.1	3.9	2009	101	0.0	0.0	87.1	0.0
2010	2474	0.0	0.2	2.5	0.2	2010	444	1.1	2.7	64.6	4.3	2010	146	0.0	0.0	87.7	2.7

* The current CLSI breakpoints used for ciprofloxacin in this report are: Resistant (R) MIC≥4 µg/mL, Intermediate (I) MIC=2 µg/mL
† The new CLSI breakpoints for ciprofloxacin that will be used in the 2011 NARMS Reports are: Resistant (R) MIC≥1 µg/mL, Intermediate (I) MIC=0.12-0.5 µg/mL
‡ Percentage of isolates with intermediate susceptibility to ciprofloxacin
§ Percentage of isolates that were resistant to ciprofloxacin

Figure 1. Percentage of *Salmonella* isolates with intermediate susceptibility and resistance to ciprofloxacin, by pre-2012 and 2012 CLSI breakpoints, 1996–2010



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Appendix A

Summary of Non-Typhoidal *Salmonella* Strains that Caused Outbreaks, United States, 2004–2008

BACKGROUND

Antimicrobial resistance among *Salmonella* has important public health implications. Treatment with antimicrobial agents is critical for persons with severe *Salmonella* infections, especially older adults, children, and immunocompromised patients. First-line agents for the treatment of severe *Salmonella* infections include fluoroquinolones (e.g., ciprofloxacin) and extended-spectrum cephalosporins (e.g., ceftriaxone).[1, 2] Monitoring resistance to these and other important antimicrobial agents is crucial because antimicrobial use in food-producing animals may result in resistance among enteric bacteria, which can be transmitted to humans through food. Surveillance of resistance among enteric bacteria transmitted commonly through food is performed by the National Antimicrobial Resistance Monitoring System (NARMS).

To aid in *Salmonella* outbreak investigations, NARMS collects isolates and performs antimicrobial susceptibility testing to determine resistance patterns. Antimicrobial susceptibility testing during outbreak investigations can help determine which food vehicles are associated with certain resistant patterns and provide information about food source attribution. We examined antimicrobial resistance among those isolates that were submitted to NARMS from non-typhoidal *Salmonella* outbreaks in the United States from 2004 through 2008.

METHODS

CDC asked public health laboratories to submit representative isolates to NARMS for antimicrobial susceptibility testing from all outbreaks caused by *Salmonella* serotypes Enteritidis, Newport, and Typhimurium that occurred from 2004 through 2008. CDC also asked sites in the Foodborne Diseases Active Surveillance Network (FoodNet) to submit representative isolates from all *Salmonella* outbreaks. CDC tested isolates using broth microdilution to determine the minimum inhibitory concentration (MIC) for 15 antimicrobial agents, which were categorized into eight classes: aminoglycosides (amikacin, gentamicin, kanamycin, streptomycin); β-lactam/β-lactamase inhibitor combinations (amoxicillin-clavulanic acid); cephems (cefoxitin, ceftiofur, ceftriaxone); penicillins (ampicillin); quinolones (ciprofloxacin, nalidixic acid); folate pathway inhibitors (sulfamethoxazole/sulfisoxazole, trimethoprim-sulfamethoxazole); phenicols (chloramphenicol); and tetracyclines (tetracycline). Antimicrobial classes and MIC resistance breakpoints were defined by using criteria established by the Clinical and Laboratory Standards Institute (CLSI).

A foodborne disease outbreak is defined as the occurrence of two or more similar illnesses that resulted from ingestion of a common food.[3] Local, state, and territorial health departments voluntarily report outbreaks to CDC's Foodborne Disease Outbreak Surveillance System by submitting a standard web-based form.[3] Data collected for each outbreak include the number of illnesses, hospitalizations, and deaths; etiologic agent; and the implicated food.[3] CDC classifies foods into 1 of 17 commodities, which are categorized into three groups: aquatic animals (finfish, crustaceans, mollusks); land animals (dairy, eggs, beef, game, pork, poultry); and plants (grains-beans, oils-sugars, fruits-nuts, fungi, leafy, root, sprout, vine-stalk).[3] Food items that contain ingredients from only one commodity were assigned to that commodity.[3] Food items that contain ingredients from more than one commodity were classified as "complex" if the contaminated commodity was not determined, and food items were classified as "unknown" when the outbreak report provided insufficient information.[3]

Non-typhoidal *Salmonella* outbreak data were linked to isolate resistance data using a combination of variables including outbreak identification number, state, year, month, and serotype. The PulseNet-assigned *Xba*I pattern and PulseNet cluster code were used to validate if an isolate was part of a reported outbreak. Outbreaks were considered to be caused by a resistant bacterium if at least one isolate was resistant to ≥1 antimicrobial agents; outbreaks were considered to have no resistance detected if results for all drugs were either susceptible or intermediate. Additionally, multidrug resistance patterns were defined: ACSSuT if resistant to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline; ACSSuTAuCx if resistant to at least ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone; and ACT/S if resistant to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole.

RESULTS

From 2004–2008, 592 non-typhoidal *Salmonella* outbreaks with known serotype information were reported to the Foodborne Disease Outbreak Surveillance System (FDOSS), and 484 outbreak isolates were submitted to NARMS. Isolates were submitted to NARMS for 103 (17%) of the outbreaks reported to FDOSS. The strain was resistant for 18 (17%) (Table 1) and no resistance detected for 85 (83%) (Table 2).

Of the 18 outbreaks with a resistant strain, 9 (50%) were caused by a strain resistant to at least ceftriaxone and 2 (11%) by a strain resistant to at least nalidixic acid (Table 3). Resistance was observed most often to tetracycline (15 outbreaks), followed by sulfamethoxazole/sulfisoxazole (13 outbreaks), amoxicillin-clavulanic acid (11 outbreaks), ampicillin (11 outbreaks), and streptomycin (11 outbreaks).

Seven (7%) of the 103 outbreaks were caused by a strain resistant to 1–4 agents and 11 (11%) by a strain resistant to ≥5 agents (Table 4). The multidrug resistance pattern ACSSuT was observed in 8 (8%) outbreaks; strains from 6 (75%) of these were also resistant to amoxicillin-clavulanic acid and ceftriaxone (ACSSuTAuCx).

Among the 47 outbreaks attributed to a single food commodity, 8 (17%) were caused by a resistant strain and 39 (83%) by strains with no resistance detected. Of the 8 outbreaks with a resistant strain, 4 (50%) were caused by strains that were resistant to ≥5 agents, including one caused by an ACSSuTAuCx resistant strain. Outbreaks attributed to a land animal commodity (e.g., beef, poultry, eggs, dairy) accounted for 6 (75%) of the 8 outbreaks caused by resistant strains and 22 (56%) of the 39 outbreaks caused by strains with no resistance detected.

CONCLUSIONS

Among *Salmonella* outbreaks attributed to a single food commodity and with information on resistance, land animal foods were identified as the predominant source of outbreaks caused by both resistant (6 of 8 outbreaks, 75%) and susceptible (22 of 39 outbreaks, 56%) strains. However, an isolate was received for a small proportion of outbreaks, so these findings may not be representative of all outbreaks. These data suggest that obtaining isolates from more outbreaks and determining their antimicrobial susceptibility could provide important information for food source attribution analyses.

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Table 1. Non-typhoidal *Salmonella* outbreaks caused by antimicrobial resistant strains (N=18), 2004–2008

Food Commodity	Year	No. of Cases	Serotype	Resistance Patterns[†, ‡]	Multistate Outbreak
Land animal					
Beef	2007	43	Newport	ACSSuTAuCxCfFox	Yes
Dairy	2004	100	Newport	ACSuTAuCxCfFox	No
Dairy	2006	20	Typhimurium	ASuTAuCxCfFoxKan	No
Poultry	2004	24	Agona	SuT	No
Poultry	2004	42	Istanbul	T	No
Poultry	2005	4	Heidelberg	SSuGen	No
Plants					
Root	2006	3	Typhimurium	ACSSuT, ACSSuTAu	No
Vine-stalk	2006	84	Braenderup	ASuTGen, Gen	Yes
Other					
Complex	2005	25	Typhimurium	ACSSuTSxt, ACSuTSxt, ACSSuTAuSxt	No
Complex	2006	24	Newport	ACSSuTAuCxCfFox	No
Unknown	2004	2	Newport	ACSSuTAuCxCfFox, ACSSuTAuCxCfFoxKan	No
Unknown	2005	19	Heidelberg	STGen, STNal, ST	No
Unknown	2005	100	Typhimurium	ACSSuTAuCxCfFox	No
Unknown	2005	6	Schwarzengrund	AAuCxCfFox	No
Unknown	2006	9	Hadar	T, ST	No
Unknown	2006	14	I 4,[5],12:i:-	Nal	No
Unknown	2006	9	Newport	ACSSuTAuCxCfFox	No
Unknown	2007	11	Newport	ACSSuTAuCxCfFox	No

* Outbreaks were considered to be caused by a resistant isolate if ≥1 isolate was resistant to ≥1 antimicrobial agent

† A: ampicillin; Au: amoxicillin-clavulanic acid; C: chloramphenicol; Cf: ceftiofur; Cx: ceftriaxone; Fox: cefoxitin; Gen: gentamicin; Kan: kanamycin; Nal: nalidixic acid; S: streptomycin; Su: sulfonamide; Sxt: trimethoprim-sulfamethoxazole; T: tetracycline

‡ Multiple isolates from each outbreak were tested; all different resistance patterns observed are listed and separated by a comma

Table 2. Non-typhoidal *Salmonella* outbreaks caused by strains with no resistance detected (N=85), 2004–2008*

Food Commodity	Year	No. of Cases	Serotype	Multistate Outbreak
Land animals				
Beef	2004	155	Berta	Yes
Beef	2004	34	Typhimurium	Yes
Beef	2004	108	Anatum	No
Beef	2006	72	Montevideo	No
Beef	2008	87	Newport	No
Dairy	2005	3	Typhimurium	No
Dairy	2006	4	Dublin	No
Dairy	2007	20	Montevideo	Yes
Eggs	2005	38	Enteritidis	No
Eggs	2005	23	Enteritidis	Yes
Eggs	2006	113	Enteritidis	No
Eggs	2006	9	Enteritidis	No
Eggs	2007	81	Enteritidis	Yes
Pork	2006	55	Anatum	No
Pork	2007	31	Montevideo	No
Pork	2007	13	Infantis	No
Pork	2007	67	Newport	No
Poultry	2004	49	Newport	No
Poultry	2004	21	Typhimurium	No
Poultry	2005	83	Enteritidis	No
Poultry	2006	22	Heidelberg	No
Poultry	2008	26	Saintpaul	Yes
Plants				
Fruits-nuts	2005	157	Typhimurium	Yes
Fruits-nuts	2006	715	Tennessee	Yes
Fruits-nuts	2006	41	Oranienburg	Yes
Fruits-nuts	2008	716	Typhimurium	Yes
Fruits-nuts	2008	53	Litchfield	Yes
Leafy	2004	97	Newport	Yes
Leafy	2006	16	Javiana	No
Leafy	2007	76	Typhimurium	Yes
Sprout	2006	4	Braenderup	No
Sprout	2007	24	Montevideo	No
Vine-stalk	2005	52	Newport	Yes
Vine-stalk	2006	16	Berta	No
Vine-stalk	2006	115	Newport	Yes
Vine-stalk	2006	192	Typhimurium	Yes
Vine-stalk	2008	1535	Saintpaul	Yes
Vine-stalk	2008	61	Enteritidis	Yes
Aquatic animals				
Finfish	2007	44	Paratyphi B Var. L(+) Tartrate+	Yes
Other				
Complex	2004	31	Amager	No
Complex	2004	19	Enteritidis	No
Complex	2004	4	Heidelberg	No
Complex	2004	4	I 4,[5],12:i:-	No
Complex	2004	12	I 4,[5],12:i:-	No
Complex	2005	24	Newport	No
Complex	2005	34	Enteritidis	No
Complex	2005	57	Typhimurium	No
Complex	2005	12	Enteritidis	No
Complex	2005	5	Manhattan	No
Complex	2005	34	Heidelberg	No
Complex	2005	27	Enteritidis	Yes
Complex	2005	26	Typhimurium	Yes
Complex	2006	161	Typhimurium	No
Complex	2006	7	Typhimurium	No
Complex	2006	7	Typhimurium	No
Complex	2007	16	Heidelberg	No
Complex	2007	46	Newport	No
Complex	2007	33	Typhimurium	No
Complex	2007	27	Enteritidis	No
Complex	2007	87	Typhimurium	Yes
Complex	2007	401	I 4,[5],12:i:-	Yes
Complex	2008	67	Muenchen	No
Complex	2008	17	I 4,[5],12:i:-	No
Complex	2008	101	Montevideo	No
Unclassifiable	2006	59	Oranienburg	No
Unknown	2004	48	Agbeni	Yes
Unknown	2004	66	Enteritidis	No
Unknown	2004	17	Typhimurium	No
Unknown	2004	4	Typhimurium	No
Unknown	2004	10	Typhimurium	No
Unknown	2005	95	Baildon	No
Unknown	2005	38	Newport	No
Unknown	2005	8	Typhimurium	No
Unknown	2006	42	Enteritidis	No
Unknown	2006	20	Typhimurium	No
Unknown	2006	47	Heidelberg	No
Unknown	2006	5	Tallahassee	No
Unknown	2006	9	Weltevreden	No
Unknown	2007	4	Newport	No
Unknown	2007	7	Typhimurium	No
Unknown	2007	6	Braenderup	No
Unknown	2008	8	Muenchen	No
Unknown	2008	77	Typhimurium	Yes
Unknown	2008	7	Poona	Yes
Unknown	2008	6	Agona	Yes

* Outbreaks were considered to have no resistance detected if isolates were intermediate or susceptible to the antimicrobial agents tested by NARMS

Table 3. Number and percent of outbreaks caused by antimicrobial resistant non-typhoidal *Salmonella*, by agent and food commodity group* (N=18), 2004–2008

CLSI† Antimicrobial Class / Antimicrobial Agent‡	Land animals (N=6)		Plants (N=2)		Complex or unclassifiable food (N=2)		Unknown Food (N=8)		Total (N=18)	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Aminoglycosides										
Amikacin	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Gentamicin	1	(17)	1	(50)	0	(0)	1	(13)	3	(17)
Streptomycin	2	(34)	1	(50)	2	(100)	6	(75)	11	(61)
Kanamycin	1	(17)	0	0	0	(0)	1	(13)	2	(11)
β-lactam/β-lactamase inhibitor combinations										
Amoxicillin-clavulanic acid	3	(50)	1	(50)	2	(100)	5	(63)	11	(61)
Cephems										
Ceftriaxone	3	(50)	0	(0)	1	(50)	5	(63)	9	(50)
Ceftiofur	3	(50)	0	(0)	1	(50)	5	(63)	9	(50)
Cefoxitin	3	(50)	0	(0)	1	(50)	5	(63)	9	(50)
Penicillins										
Ampicillin	3	(50)	2	(100)	2	(100)	4	(50)	11	(61)
Quinolones										
Ciprofloxacin	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Nalidixic acid	0	(0)	0	(0)	0	(0)	2	(25)	2	(11)
Folate pathway inhibitors										
Sulfamethoxazole/Sulfisoxazole§	5	(83)	2	(100)	2	(100)	4	(50)	13	(72)
Trimethoprim-sulfamethoxazole	0	(0)	0	(0)	1	(50)	0	(0)	1	(6)
Phenicols										
Chloramphenicol	2	(33)	1	(50)	2	(100)	4	(50)	9	(50)
Tetracyclines										
Tetracycline	5	(83)	2	(100)	2	(100)	6	(75)	15	(83)

* No outbreaks caused by resistant strains were attributed to aquatic animals

† CLSI: Clinical and Laboratory Standards Institute

‡ Antimicrobial agent categories are not mutually exclusive; outbreaks can be caused by strains resistant to multiple antimicrobial agents

§ Sulfamethoxazole was replaced by sulfisoxazole during 2004

Table 4. Antimicrobial resistance patterns of non-typhoidal *Salmonella* outbreak strains, by commodity group (N=103), 2004–2008

	Simple food commodity*									
	Land animals (N=28)		Plants (N=18)		Complex or unclassifiable food (N=28)		Unknown Food (N=28)		Overall (N=103)	
Resistance Pattern†	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
No resistance detected	22	(79)	16	(89)	26	(93)	20	(71)	85	(83)
Resistant to 1–4 agents	3	(11)	1	(6)	0	(0)	3	(11)	7	(7)
Resistant to ≥5 agents	3	(11)	1	(6)	2	(7)	5	(18)	11	(11)
At least ACSSuT‡	1	(4)	1	(6)	2	(7)	4	(14)	8	(8)
At least ACT/S§	0	(0)	0	(0)	1	(4)	0	(0)	1	(1)
At least ACSSuTAuCx¶	1	(4)	0	(0)	1	(4)	4	(14)	6	(6)

* No resistance was detected in one outbreak associated with an aquatic animal

† ACSSuT, ACT/S, and ACSSuTAuCx resistance patterns are not mutually exclusive; outbreaks can be categorized into multiple patterns

‡ ACSSuT: resistant to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

§ ACT/S: resistant to ampicillin, chloramphenicol, trimethoprim-sulfamethoxaxole

¶ ACSSuTAuCx: resistant to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

Appendix B – Criteria for Retesting of Isolates

Repeat testing of an isolate must be done when one or more of the following conditions occur:

- No growth on panel
- Growth in all wells
- Multiple skip patterns
- Apparent contamination in wells or isolate preparation
- Unlikely or discordant susceptibility results (Table 1)

If an isolate is retested, data for all antibiotics should be replaced with the new test results. *Categorical changes may require a third test (and may indicate a mixed culture).*

Uncommon test results (Table 2) may represent emerging resistance phenotypes. Retesting is encouraged.

Table 1. Retest criteria for unlikely or discordant resistance phenotypes

Organism(s)	Resistance phenotype	Comments
Salmonella* and *E. coli	nalidixic acid^{S} (≤16) AND ciprofloxacin^{R} (≥4)	The stepwise selection of mutations in the QRDR* does not support this phenotype
	ceftiofur^{R} (≥8) AND ampicillin^{S} (≤8)	The presence of an ESBL† or AmpC beta-lactamase should confer resistance to ampicillin.
	ceftiofur^{R} (≥8) AND ceftriaxone ≤1	
	ampicillin^{S} (≤8) AND amoxicillin-clavulanic acid^{R} (≥32/16)	
	sulfisoxazole^{S} (≤256) AND trimethoprim-sulfamethoxazole^{R} (≥4/76)	
Campylobacter	erythromycin^{S} (≤8) AND azithromycin^{R} (≥8)	Erythromycin is class representative for 14- and 15-membered macrolides (azithromycin, clarithromycin, roxithromycin, and dirithromycin)
	erythromycin^{R} (≥32) AND azithromycin^{S} (≤2)	
	nalidixic acid^{S} (≤16) AND ciprofloxacin^{R} (≥4)	In *Campylobacter*, one mutation is sufficient to confer resistance to both nalidixic acid and ciprofloxacin
	nalidixic acid^{R} (≥64) AND ciprofloxacin^{S} (≤1)	

* quinolone resistance-determining regions
† extended-spectrum beta-lactamase

Table 2. Uncommon resistance phenotypes for which retesting is encouraged

Organism(s)	Resistance phenotype
Salmonella* and *E. coli	Pan-resistance
	Resistance to amikacin (≥64), ceftriaxone and/or ceftiofur MIC ≥2 **AND** ciprofloxacin ≥0.125 and/or nalidixic acid ≥32
Campylobacter	Pan-resistance
	Resistance to gentamicin (≥8)
	Not susceptible to florfenicol (≥8)