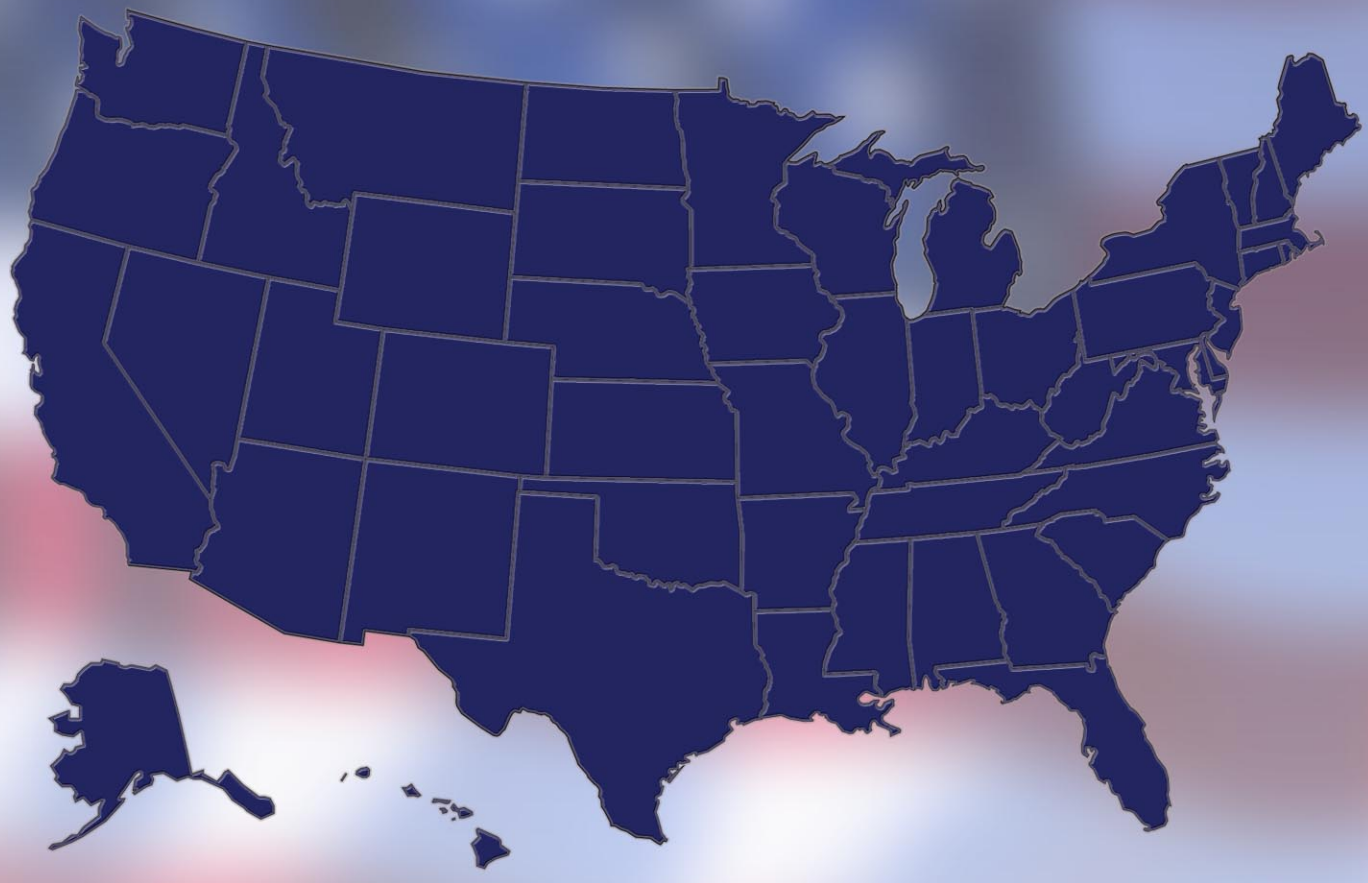
Human Isolates Final Report, 2003

NARMS

National Antimicrobial Resistance Monitoring System: Enteric Bacteria



CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

DEPARTMENT OF HEALTH & HUMAN SERVICES · USA

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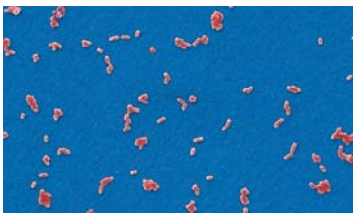

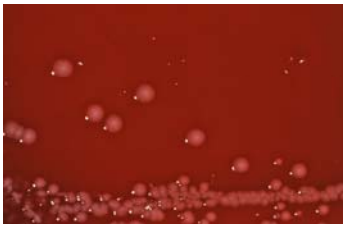

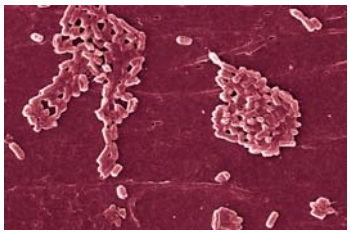

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Materials Available On-Line

All CDC NARMS Annual Reports and additional information about NARMS are posted on the CDC NARMS web-site. The address is: http://www.cdc.gov/narms

Additional general information about the NARMS surveillance program is posted on the FDA Center for Veterinary Medicine website at: http://www.fda.gov/cvm/narms_pg.html

Information on animal isolates in NARMS is available on the USDA-ARS website at: http://www.ars-grin.gov/ars/SoAtlantic/Athens/arru/narms.html

General information about antimicrobial resistance is posted on the CDC website at: http://www.cdc.gov/drugresistance

Information regarding CDC's Get Smart program can be found on the following website: http://www.cdc.gov/drugresistance/community

General information about CDC's Foodborne Diseases Active Surveillance Network (FoodNet) can be found on: http://www.cdc.gov/foodnet

General information about the National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet) can be found on: http://www.cdc.gov/pulsenet

General information about WHO Global Salm-Surv can be found on: http://www.who.int/salmsurv/en

CDC *Salmonella* Annual Summaries are posted on the PHLIS website. The address is: http://www.cdc.gov/ncidod/dbmd/phlisdata/salmonella.htm

CDC *Shigella* Annual Summaries are also posted on the PHLIS website. The address is: http://www.cdc.gov/ncidod/dbmd/phlisdata/shigella.htm

Introduction

The National Antimicrobial Resistance Monitoring System (NARMS) for Enteric Bacteria is a collaboration among the Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA), and U.S. Department of Agriculture (USDA). CDC monitors antimicrobial resistance among foodborne enteric bacteria isolated from humans. Other components of the interagency NARMS program include surveillance for resistance in foodborne bacterial pathogens isolated from foods, which is conducted by the FDA Center for Veterinary Medicine (http://www.fda.gov/cvm/narms_pg.html), and pathogens isolated from animals, conducted by the USDA Agricultural Research Services (http://www.ars-grin.gov/ars/SoAtlantic/Athens/arru/narms.html).

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). The primary purpose of NARMS is to monitor antimicrobial resistance among foodborne enteric bacteria isolated from humans.

Before NARMS was established, CDC monitored antimicrobial resistance in *Salmonella, Shigella*, and *Campylobacter* using periodic surveys of isolates from a panel of sentinel counties. NARMS at CDC began in 1996 with prospective monitoring of antimicrobial resistance among human non-Typhi *Salmonella* and *Escherichia coli* O157 isolates in 14 sites. In 1997, testing of human *Campylobacter* isolates was initiated in five sites that were participating in FoodNet. Testing of human *Salmonella* Typhi and *Shigella* isolates was added in 1999. Since 2003, 50 states have been forwarding a representative sample of non-Typhi *Salmonella, Salmonella* Typhi, *Shigella*, and *E. coli* O157 isolates to NARMS for antimicrobial susceptibility testing, while 10 FoodNet states have been participating in *Campylobacter* surveillance.

In addition to surveillance of resistance in enteric pathogens, the NARMS program at CDC also includes public health research into the mechanisms of resistance, education efforts to promote prudent use of antimicrobial agents, and studies of resistance in commensal organisms.

This annual report includes CDC's human surveillance data for 2003. Resistance trends and comparisons to previous years are included when appropriate. Unlike previous annual reports, antimicrobial subclasses defined by the Clinical and Laboratory Standards Institute (CLSI) are used in data presentation and analysis. CLSI subclasses constitute major classifications of antimicrobial agents, e.g., aminoglycosides and cephalosporins. Appendix A includes 2001-2003 data from the Enterococci Resistance Study, which is now part of NARMS surveillance on commensal bacteria. Additional NARMS data and more information about NARMS activities can be found at http://www.cdc.gov/narms.

Summary of 2003 Surveillance Data

Population

In 2003, all 50 states participated in the National Antimicrobial Resistance Monitoring System (NARMS) for Enteric Bacteria, representing approximately 291 million persons. Antimicrobial resistance surveillance included non-Typhi *Salmonella, Salmonella* Typhi, *Shigella*, and *E. coli* O157. Antimicrobial resistance among *Campylobacter* isolates was monitored in ten states that also participated in the Foodborne Diseases Active Surveillance Network (FoodNet), representing approximately 42 million persons (14% of the United States population). For more information about FoodNet, go to: http://www.cdc.gov/foodnet.

Multidrug Resistance

- Overall, 17.9% (334/1865) of non-Typhi *Salmonella* were resistant to 2 or more CLSI subclasses and 10.1% (189/1865) were resistant to 5 or more CLSI subclasses.
  - 24.8% (55/222) of *Salmonella* Newport were resistant to 2 or more CLSI subclasses and 22.1% (49/222) were resistant to 5 or more CLSI subclasses.
  - 40.9% (165/403) of *Salmonella* Typhimurium were resistant to 2 or more CLSI subclasses and 27.5% (111/403) were resistant to 5 or more CLSI subclasses.
  - 2.7% (7/257) of *Salmonella* Enteritidis were resistant to 2 or more CLSI subclasses and 0.4% (1/257) were resistant to 5 or more CLSI subclasses.

- A total of 9.3% (173/1865) of non-Typhi *Salmonella* were found to have the R-type ACSSuT (resistant to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline), compared with 8.8% (116/1324) in 1996.
  - 25.8% (104/403) of *Salmonella* Typhimurium were R-type ACSSuT, compared with 33.7% (103/306) in 1996.
  - 21.2% (47/222) of *Salmonella* Newport were R-type ACSSuT, compared with 5.9% (3/51) in 1996.

- A total of 3.2% (60/1865) of non-Typhi *Salmonella* were found to have the MDR-AmpC phenotype (resistant to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, tetracycline, amoxicillin/clavulanic acid, ceftiofur, and with decreased susceptibility to ceftriaxone [minimum inhibitory concentration (MIC) ≥ 2 μg/mL]. These isolates consisted of 7 different serotypes. In 1996, MDR-AmpC resistance was not detected in any serotype.
  - 20.7% (46/222) of *Salmonella* Newport were at least MDR-AmpC resistant (1996 vs. 2003: 95% CI [4.6, infinity]).
  - 2.2% (9/403) of *Salmonella* Typhimurium were at least MDR-AmpC resistant.

Clinically Important Resistance

In the U. S., certain quinolones (e.g., ciprofloxacin) and third generation cephalosporins (e.g., ceftriaxone) are commonly used antimicrobial agents for the treatment of severe *Campylobacter* and *Salmonella* infections, including *Salmonella* serotype Typhi. Nalidixic acid is an elementary quinolone; resistance to nalidixic acid correlates with decreased susceptibility to ciprofloxacin and possible treatment failure. Ceftiofur is a third-generation cephalosporin used in food animals in the United States; resistance to ceftiofur correlates with decreased susceptibility to ceftriaxone. An important proportion of isolates tested by NARMS in 2003 demonstrated resistance to these clinically important antimicrobials.

- A total of 17.7% (58/328) of *Campylobacter* isolates were resistant to the quinolone ciprofloxacin, compared with 12.9% (28/217) in 1997 (OR=1.8, 95% CI [1.1, 3.0]).
  - 22.7% (5/22) of *Campylobacter coli* were resistant to ciprofloxacin
  - 17.2% (52/303) of *Campylobacter jejuni* were resistant to ciprofloxacin.

- A total of 2.3% (43/1865) of non-Typhi *Salmonella* isolates were resistant to the quinolone nalidixic acid, compared with 0.4% (5/1324) in 1996 (OR=6.7, 95% CI [2.6, 17.7]).
  - *S.* Enteritidis was the most common serotype among nalidixic acid-resistant non-Typhi *Salmonella* iso-

lates: 12 (27.9%) of the 43 quinolone-resistant isolates were *S*. Enteritidis.

- A total of 4.5% (84/1865) of non-Typhi *Salmonella* isolates were resistant to the 3rd generation cephalosporin ceftiofur, compared with 0.2% (2/1324) in 1996 (OR=43.2, 95% CI [10.5, 177.4]).
  - *S*. Newport was the most common serotype among ceftiofur-resistant non-Typhi *Salmonella* isolates: 49 (58.3%) of the 84 ceftiofur-resistant isolates were *S*. Newport.
- A total of 37.7% (126/334) of *Salmonella* Typhi isolates were resistant to the quinolone nalidixic acid, compared with 18.7% (31/166) in 1999 (OR=2.6, 95% CI [1.6, 4.2]).

Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submission

In 2003, NARMS conducted nationwide surveillance among the population of approximately 291 million persons (based on 2003 U. S. Census Bureau estimates). Public health laboratories systematically selected every 20th non-Typhi *Salmonella, Shigella*, and *E. coli* O157, and every *Salmonella* Typhi isolate received at their laboratory, and forwarded these isolates to CDC for antimicrobial susceptibility testing. Non-Typhi *Salmonella* refers to all *Salmonella* serotypes except serotype Typhi.

Public health laboratories of the 10 state health departments that participated in the Foodborne Diseases Active Surveillance Network (FoodNet) in 2003 forwarded *Campylobacter* isolates to CDC for susceptibility testing. The FoodNet sites, which represented approximately 42 million persons (based on 2003 US Census Bureau estimates) included California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee. Selection of *Campylobacter* isolates submitted to NARMS was conducted by one of several ways. In Maryland, Minnesota, New York, and Tennessee, one isolate a week was selected (usually the first isolate received each week is selected, but otherwise isolates were randomly selected) from the collection of isolates sent to the state health department laboratory from almost all clinical laboratories in a geographical area (statewide in Maryland, Minnesota, and Tennessee, and metro Albany and Rochester areas in New York). In Georgia, all *Campylobacter* isolates received at the state laboratory from the Metropolitan Statistical Area (metro Atlanta area) were submitted to CDC. Once received, one isolate a week was selected (usually the first isolate received each week is selected, but otherwise isolates were randomly selected) from the collection of isolates from almost all clinical laboratories in metro Atlanta. In California, Colorado, Connecticut, and Oregon, one isolate a week was selected (usually the first isolate received each week is selected, but otherwise isolates were randomly selected) at one sentinel clinical laboratory. Sentinel clinical laboratories followed routine isolation practices for *Campylobacter*. No more than 53 *Campylobacter* isolates per state were included in the analyses; if more than one isolate was received in a week from a site, only the first isolate was included.

Testing of *Salmonella, Shigella*, and *E. coli* O157

Antimicrobial Susceptibility Testing

Salmonella, *Shigella*, and *E. coli* O157 isolates were tested using broth microdilution (Sensititre, Trek Diagnostics, Westlake, OH) to determine the minimum inhibitory concentration (MIC) for each of 16 antimicrobial agents: amikacin, ampicillin, amoxicillin/clavulanic acid, cefoxitin, ceftiofur, ceftriaxone, cephalothin, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline, and trimethoprim/sulfamethoxazole [Table 1]. The resistance breakpoint for amikacin, according to Clinical and Laboratory Standards Institute (CLSI) guidelines, is a minimum inhibitory concentration (MIC) of 64µg/mL. For isolates that grew in all amikacin dilutions on the Sensititre panel (MIC>4 µg/mL), E-Test (AB BIODISK, Solna, Sweden) was performed in order to determine amikacin MIC. The amikacin E-Test strip range of dilutions is 0.016-256 µg/mL.

Table 1: Antimicrobial agents used for susceptibility testing for *Salmonella*, *Shigella*, *E. coli* O157, and *Campylobacter* isolates, 2003

CLSI Subclass	Antimicrobial Agent	Antimicrobial Agent Concentration Range (μg/ml)	Breakpoints [R]	[I]	[S]
Aminoglycosides	Amikacin	0.5 – 4*	≥ 64	32	≤ 16
	Gentamicin	0.25 – 16 0.016 – 256**	≥ 16	8	≤ 4
	Kanamycin	8 – 64	≥ 64	32	≤ 16
	Streptomycin	32 – 64	≥ 64		≤ 32
Aminopenicillins	Ampicillin	1 – 32	≥ 32	16	≤ 8
Beta-lactamase inhibitor combinations	Amoxicillin–clavulanic acid	1/0.5 – 32/16	≥ 32/16	16/8	≤ 8/4
Cephalosporin (1st Gen.)	Cephalothin	2 – 32	≥ 32	16	≤ 8
Cephalosporins (3rd Gen.)	Ceftiofur***	0.12– 8	≥ 8	4	≤ 2
	Ceftriaxone	0.25 – 64	≥ 64	16 - 32	≤ 8
Cephamycins	Cefoxitin	0.5 – 16	≥ 32	16	≤ 8
Folate pathway inhibitors	Trimethoprim–sulfamethoxazole	0.12/2.4 – 4/76	≥ 4/76		≤ 2/38
Lincosamides	Clindamycin	0.016 – 256**	≥ 4	1-2	≤ 0.5
Macrolides	Azithromycin	0.016 – 256**	≥ 2	0.5-1	≤ 0.25
	Erythromycin	0.016 – 256**	≥ 8	1-4	≤ 0.5
Phenicols	Chloramphenicol	2 – 32 0.016 – 256**	≥ 32	16	≤ 8
Quinolones	Ciprofloxacin	0.015 – 4 0.002 – 32**	≥ 4	2	≤ 1
	Nalidixic acid	0.5 – 32 0.016 – 256**	≥ 32		≤ 16
Sulfonamides	Sulfamethoxazole	16 – 512	≥ 512		≤ 256
Tetracyclines	Tetracycline	4 – 16 0.016 – 256**	≥ 16	8	≤ 4

* The resistance breakpoint for amikacin, according to Clinical and Laboratory Standards Institute (CLSI) guidelines, is 64μg/mL. For isolates that grew in all amikacin dilutions on the Sensititre panel (minimum inhibitory concentration [MIC] >4 μg/mL), E-Test (AB BIODISK, Solna, Sweden) was performed in order to determine amikacin MIC. The amikacin E-Test strip range of dilutions is 0.016-256 μg/mL.
**E-test dilution range used for testing *Campylobacter.*
***No CLSI breakpoints; resistance breakpoint used in NARMS is 8 μg/mL.

Additional Testing of *Salmonella*

Cephalosporin Retesting

Upon review of previously reported results, conflicting cephalosporin susceptibility results were noted among *Salmonella* isolates tested in NARMS from 1996-1998. That is, some isolates NARMS previously reported to be ceftiofur-resistant exhibited a low ceftriaxone MIC, and in some cases, did not exhibit an elevated MIC to other β-lactams tested in NARMS. These findings indicated that some previously reported ceftiofur-resistant results were spurious. We therefore retested, using the 2003 NARMS Sensititre plate, isolates tested in NARMS from 1996-1998 that exhibited a MIC ≥2 ug/mL to ceftiofur or ceftriaxone. Totals reported here reflect the retest results.

Serotype Confirmation/Categorization

To distinguish *S*. Paratyphi B from *S*. Paratyphi B var L(+) tartrate-positive (formerly *S*. Paratyphi B var Java), tartrate testing was performed at CDC on all *S*. Paratyphi B isolates from 1996 to present for which the tartrate result was not reported. Jordan's tartrate test was used to determine tartrate fermentation, and Kauffman's tartrate test was subsequently performed on isolates that were negative for tartrate fermentation by Jordan's tartrate test. Isolates that were negative for tartrate fermentation by both assays were categorized as *S*. Paratyphi B. Isolates that were positive for tartrate fermentation by either assay were categorized as *S*. Paratyphi B var L(+) tartrate-positive, and are referred to as serotype Java in this report. Confirmation of other biochemical reactions or somatic and flagellar antigens was not performed at CDC.

Salmonella serotype was accepted as reported with few exceptions. As decribed above, tartrate testing was performed on all *S*. Paratyphi B isolates for which the tartrate result was not reported. Due to increased submissions of *S*. Typhimurium isolates lacking the second phase flagellar antigen (i.e., *S*. I 4,[5],12:i:-), reports of such isolates tested in NARMS from 1996 to 2003 were reviewed. Isolates identified by NARMS as Serogroup B that exhibited first phase flagellar antigen "i" but lacked a second phase are listed in this report as “monophasic Typhimurium.” Serogroup B isolates for which the first phase flagellar antigen was not reported were not included in this category since several common serogroup B serotypes could be the basis for these monophasic variants with other first phase flagellar antigens.

Testing of *Campylobacter*

Identification/Speciation and Antimicrobial Susceptibility Testing

Isolates were confirmed as *Campylobacter* by dark field microscopy and oxidase test. Identification to species level was performed using the hippurate hydrolysis test. Hippurate-positive isolates were identified as *C. jejuni*. Hippurate-negative isolates were identified by polymerase chain reaction (PCR) as *C. jejuni* by the hippuricase gene-based PCR assay[1], or as *C. coli* based on the *C. coli*-specific *ceuE* gene[2]. Isolates determined not to be *C. jejuni* or *C. coli* were referred to the National *Campylobacter* Reference Laboratory at CDC for identification using genotypic and phenotypic methods. The E-test methodology (AB Biodisk, Solna, Sweden) was used to determine the MICs for 8 antimicrobial agents: azithromycin, chloramphenicol, ciprofloxacin, clindamycin, erythromycin, gentamicin, nalidixic acid, and tetracycline [Table 1].

Retesting

Known mechanisms of quinolone resistance in *Campylobacter* are expected to confer equivalent susceptibilities to nalidixic acid and ciprofloxacin. Similarly, known mechanisms of macrolide resistance are expected to confer equivalent susceptibilities to erythromycin and azithromycin. Confirmatory testing of isolates with conflicting results was performed by E-test (AB Biodisk, Solna, Sweden). Totals reported here reflect the retest results.

Data Analysis

For all pathogens in this report, MIC results were categorized as resistant, intermediate susceptibility (if applicable), and susceptible. Analysis was restricted to one isolate (per pathogen) per patient. When established, CLSI interpretive criteria were used; ceftiofur resistance was defined as MIC ≥ 8μg/mL [Table 1]. The 95% confidence intervals (CI) for the percent isolates resistant are included in the MIC distribution tables. The 95% CI was calculated using the Clopper-Pearson exact method. Multidrug resistance by antimicrobial agent was defined as resistance to two or more agents. Similarly, multidrug resistance by CLSI antimicrobial subclass was defined as resistance two or more subclasses.

When describing results for several years, multidrug resistance for *Salmonella* and *E. coli* O157 isolates was limited to the 14 agents tested in all years from

1996 to 2003 (amoxicillin/clavulanic acid, ampicillin, ceftiofur, ceftriaxone, cephalothin, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline, trimethoprim-sulfamethoxazole). For *S*. Typhi and *Shigella,* results for several years included 15 agents tested in all years from 1999 to 2003 (14 antimicrobial agents and amikacin). Similarly, when describing multidrug resistance for several years for *Campylobacter* isolates, multidrug resistance was limited to the six agents tested in all years from 1997 to 2003 (chloramphenicol, ciprofloxacin, clindamycin, erythromycin, nalidixic acid, and tetracycline).

Logistic regression was performed to assess the change in antimicrobial resistance among *Salmonella* and *Campylobacter* isolates tested in NARMS in 2003 compared to previous years for the following:

1) Non-Typhi *Salmonella*: resistance to nalidixic acid, decreased susceptibility to ciprofloxacin (MIC≥0.12 µg/mL), decreased susceptibility to ceftriaxone (MIC≥2 µg/mL), resistance to ceftiofur, resistance to one or more CLSI subclass
2) *S*. Typhimurium: resistance to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline (ACSSuT)
3) *S*. Enteritidis: resistance to nalidixic acid
4) *S*. Newport: resistance to at least ACSSuT, amoxicillin/clavulanic acid, and ceftiofur, with decreased susceptibility to ceftriaxone (MDR-AmpC)
5) *S*. Typhi: resistance to nalidixic acid
6) *Campylobacter* species: resistance to ciprofloxacin, resistance to tetracycline
7) *Campylobacter jejuni*: resistance to ciprofloxacin

The final regression models for non-Typhi *Salmonella, S.* Typhimurium, and *S*. Typhi adjusted for site using the nine geographic regions described in PHLIS (Public Health Laboratory Information System, [http://www.cdc.gov/ncidod/dbmd/phlisdata/) based on the patient's state of residence. The PHLIS regions are: East North Central, East South Central, Mid-Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central. The final regression models for *S*. Enteritidis and *S*. Newport only included year. For *Campylobacter*, the final regression models adjusted for site using patient's state of residence. All analyses only included observations from state/local health departments that participated at least two years. 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. Finally, residual analysis was performed to examine the influence of individual observations. Odds ratios that did not include 1.0 in the 95% confidence interval were reported as significant.

Table 1.1: Population size and number of isolates received and tested, by site, 2003

State/Site	Population Size*	Non-Typhi *Salmonella*		*S*. Typhi		*Shigella*		*E. coli* O157		*Campylobacter***	
		N	%	N	%	N	%	N	%	N	%
Alaska	648,280	2	0.1	1	0.3	0	0	0	0	NA	
Alabama	4,503,726	36	2	4	1	10	2	2	1	NA	
Arkansas	2,727,774	12	1	0	0	0	0	0	0	NA	
Arizona	5,579,222	31	2	2	1	11	2	2	1	NA	
California[1]	25,602,330	148	8	56	17	1	0.2	11	7	23	7
Colorado	4,547,633	21	1	2	1	8	2	0	0	28	9
Connecticut	3,486,960	25	1	13	4	5	1	3	2	36	11
District of Columbia	557,620	0	0	0	0	0	0	0	0	NA	
Delaware	818,166	8	0.4	1	0.3	9	1.8	2	1.3	NA	
Florida	16,999,181	54	3	13	4	2	0.4	1	1	NA	
Georgia	8,676,460	113	6	6	2	43	9	16	10	40	12
Hawaii	1,248,755	12	1	2	1	2	0.4	0	0	NA	
Houston, Texas[2]	2,009,669	37	2	0	0	0	0	0	0	NA	
Iowa	2,941,976	14	1	2	1	0	0	0	0	NA	
Idaho	1,367,034	10	0.5	1	0.3	1	0.2	3	2	NA	
Illinois	12,649,087	99	5	16	5	43	9	5	3	NA	
Indiana	6,199,571	29	2	4	1	1	0.2	3	2	NA	
Kansas	2,724,786	12	1	0	0	5	1	1	1	NA	
Kentucky	4,118,189	19	1	0	0	3	1	1	1	NA	
Louisiana	4,493,665	43	2	0	0	9	2	1	1	NA	
Los Angeles[3]	9,860,382	54	3	25	7	6	1	1	1	NA	
Massachusetts	6,420,357	59	3	15	4	11	2	3	2	NA	
Maryland	5,512,310	57	3	12	4	27	5	4	3	25	8
Maine	1,309,205	7	0.4	0	0	1	0.2	1	0.6	NA	
Michigan	10,082,364	40	2	11	3	8	2	2	1	NA	
Minnesota	5,064,172	29	2	1	0.3	3	1	6	4	51	16
Missouri	5,719,204	55	3	1	0.3	13	3	6	4	NA	
Mississippi	2,882,594	34	2	0	0	1	0.2	0	0	NA	
Montana	918,157	2	0.1	0	0	0	0	0	0	NA	
North Carolina	8,421,190	70	4	8	2	15	3	1	1	NA	
North Dakota	633,400	2	0.1	0	0	1	0.2	2	1.3	NA	
Nebraska	1,737,475	15	1	1	0.3	8	2	5	3	NA	
New Hampshire	1,288,705	9	0.5	2	0.6	0	0	1	0.6	NA	
New Jersey	8,642,412	34	2	17	5	12	2	8	5	NA	
New Mexico	1,878,562	21	1	1	0.3	11	2	5	3	23	7
Nevada	2,242,207	9	0.5	2	0.6	2	0.4	1	0.6	NA	
New York[4]	11,102,799	72	4	13	4	19	4	10	6	53	16
New York City[5]	8,109,626	63	3	45	13	9	2	4	3	NA	
Ohio	11,437,680	68	4	4	1	11	2	5	3	NA	
Oklahoma	3,506,469	25	1	1	0.3	35	7	1	1	NA	
Oregon	3,564,330	19	1	4	1	4	1	3	2	17	5
Pennsylvania	12,370,761	69	4	7	2	39	8	5	3	NA	
Rhode Island	1,076,084	8	0.4	2	0.6	1	0.2	0	0	NA	
South Carolina	4,148,744	26	1	1	0.3	17	3	0	0	NA	
South Dakota	764,905	12	1	0	0	6	1	6	4	NA	
Tennessee	5,845,208	49	3	4	1	24	5	3	2	32	10
Texas[6]	20,093,705	62	3	18	5	26	5	1	1	NA	
Utah	2,352,119	15	1	0	0	3	1	3	2	NA	
Virginia	7,365,284	55	3	13	4	11	2	2	1	NA	
Vermont	619,343	2	0.1	0	0	0	0	1	0.6	NA	
Washington	6,131,298	40	2	3	1	10	2	6	4	NA	
Wisconsin	5,474,290	35	2	0	0	4	1	5	3	NA	
West Virginia	1,811,440	18	1	0	0	3	1	4	3	NA	
Wyoming	502,111	5	0.3	0	0	1	0.2	1	0.6	NA	
TOTAL	290,788,976	1865	100	334	100	495	100	157	100	328	100

*US Census Bureau, 2003

***Campylobacter* isolates are submitted only from FoodNet sites; total population size of FoodNet sites is 41,850,620

[1] Exlcuding Los Angeles County

[2] Houston County

[3] Los Angeles County

[4] Excluding New York City

[5] Five burroughs of New York City (Bronx, Brooklyn, Manhattan, Queens, Staten Island)

[6] Excluding Houston, Texas

Results for 2003

1. Non-Typhi *Salmonella*

A total of 1898 non-Typhi *Salmonella* isolates were received at CDC in 2003; of these isolates, 1873 (98.7%) were viable and tested for antimicrobial susceptibility. Of these 1873 isolates, eight isolates were not included in the analysis because they were duplicate submissions from the same patient, leaving 1865 isolates for analysis. Table 1.1 shows the number of isolates included in the final analysis by site and the population represented.

Table 1.2 shows the MIC distributions for the 16 antimicrobial agents tested and prevalence of antimicrobial resistance for the 1865 non-Typhi *Salmonella* isolates tested in 2003.

Fluoroquinolones (e.g., ciprofloxacin) and third generation cephalosporins (e.g., ceftriaxone) are commonly used antimicrobial agents for the treatment of severe *Salmonella* infections. Nalidixic acid is an elementary quinolone; resistance to nalidixic acid correlates with decreased susceptibility to ciprofloxacin and possible treatment failure. Ceftiofur is a third-generation cephalosporin used in food animals in the United States; resistance to ceftiofur correlates with decreased susceptibility to ceftriaxone. In 2003, the prevalence of resistance among *Salmonella* isolates was 2.3% for quinolones (represented by nalidixic acid) and 4.5% for third generation cephalosporins (represented by ceftiofur).

The antimicrobial agents with the highest prevalence of resistance were tetracycline (16.3%), sulfamethoxazole (15.1%), streptomycin (15.0%), and ampicillin (13.7%).

Table 1.2: Distribution of MICs and occurrence of resistance among non-Typhi *Salmonella* isolates, 2003 (N=1865)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:															
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 0.2]						3.6	62.3	31.2	2.7	0.1	0.2						
Gentamicin	0.5	**1.4**	[0.9 - 2.0]					35.9	38.7	23.3	0.1	0.1	0.5	**0.6**	**0.8**					
Kanamycin	0.2	**3.4**	[2.7 - 4.4]										96.1	0.3	0.2	**0.2**	**3.3**			
Streptomycin	N/A	**15.0**	[13.4 - 16.7]												84.8	**7.1**	**7.9**			
Aminopenicillins																				
Ampicillin	0.1	**13.7**	[12.1 - 15.3]							49.7	32.8	3.4	0.3	0.1	**0.1**	**13.6**				
Beta-lactamase inhibitor combinations																				
Amoxicillin/Clavulanic Acid	5.0	**4.6**	[3.7 - 5.7]							83.3	2.6	1.0	3.5	5.0	**0.8**	**3.8**				
Cephalosporins (1st Gen.)																				
Cephalothin	0.9	**5.4**	[4.4 - 6.5]								68.6	21.7	3.4	0.9	**0.8**	**4.7**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.1	**4.5**	[3.6 - 5.5]				0.3	1.0	61.8	31.3	1.1	0.1	**0.1**	**4.5**						
Ceftriaxone	3.4	**0.4**	[0.2 - 0.8]					95.3	0.2	0.1	0.1		0.5	2.3	1.1	**0.2**	**0.2**			
Cephamycins																				
Cefoxitin	0.6	**4.3**	[3.4 - 5.3]						0.2	16.1	63.1	13.5	2.1	0.6	**4.3**					
Folate pathway inhibitors																				
Trimethoprim/Sulfamethoxazole	N/A	**1.9**	[1.4 - 2.7]				84.9	12.5	0.6	0.1			**1.9**							
Phenicols																				
Chloramphenicol	1.0	**10.0**	[8.7 - 11.5]								2.0	55.3	31.6	1.0	**0.3**	**9.8**				
Quinolones																				
Ciprofloxacin	0.1	**0.2**	[0.0 - 0.5]	96.4	1.3	0.3	0.8	0.7	0.4	0.1	0.1		**0.2**							
Nalidixic Acid	N/A	**2.3**	[1.7 - 3.1]						0.1	0.2	4.7	84.9	7.5	0.4	**0.2**	**2.1**				
Sulfonamides																				
Sulfamethoxazole	N/A	**15.1**	[13.5 - 16.8]											76.6	7.9	0.4		0.1	**0.4**	**14.7**
Tetracyclines																				
Tetracycline	0.2	**16.3**	[14.7 - 18.1]									83.6	0.2	**3.6**	**4.1**	**8.6**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 1.3: Percent and number of isolates resistant to antimicrobial agents among non-Typhi *Salmonella* , 1996-2003

Year		1996	1997	1998	1999	2000	2001	2002	2003
Total Isolates		1324	1301	1460	1498	1377	1419	2008	1865
Subclass	Antibiotic (Resistance breakpoint)								
Aminoglycosides	Amikacin	Not	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
	(MIC ≥ 64)	Tested	0	0	1	0	0	0	0
	Gentamicin	4.8%	2.9%	2.8%	2.1%	2.7%	1.9%	1.3%	1.4%
	(MIC ≥ 16)	63	38	41	32	37	27	27	26
	Kanamycin	5.0%	5.1%	5.7%	4.3%	5.6%	4.8%	3.8%	3.4%
	(MIC ≥ 64)	66	67	83	65	77	68	76	64
	Streptomycin	20.6%	21.4%	18.6%	16.8%	16.3%	17.0%	13.2%	15.0%
	(MIC ≥ 64)	273	278	272	252	224	241	265	280
Aminopenicillins	Ampicillin	20.7%	18.3%	16.5%	15.6%	15.9%	17.4%	12.9%	13.7%
	(MIC ≥ 32)	274	238	241	233	219	247	259	255
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.1%	1.0%	1.7%	2.3%	3.9%	4.7%	5.3%	4.6%
	(MIC ≥ 32)	15	13	25	35	54	66	106	86
Cephalosporin (1st Gen.)	Cephalothin	2.9%	2.2%	2.3%	3.7%	4.0%	4.0%	5.0%	5.4%
	(MIC ≥ 32)	39	29	33	55	55	57	101	101
Cephalosporins (3rd Gen.)	Ceftiofur	0.2%	0.5%	0.8%	2.1%	3.2%	4.1%	4.3%	4.5%
	(MIC ≥ 8)	2	6	12	31	44	58	87	84
	Ceftriaxone	0.0%	0.1%	0.0%	0.4%	0.0%	0.0%	0.2%	0.4%
	(MIC ≥ 64)	0	1	0	6	0	0	4	8
Cephamycins	Cefoxitin	Not	Not	Not	Not	3.2%	3.4%	4.3%	4.3%
	(MIC ≥ 32)	Tested	Tested	Tested	Tested	44	48	86	80
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	3.9%	1.8%	2.3%	2.1%	2.1%	2.0%	1.4%	1.9%
	(MIC ≥ 4)	51	24	34	31	29	28	28	36
Phenicols	Chloramphenicol	10.6%	10.1%	9.9%	9.2%	10.1%	11.6%	8.6%	10.0%
	(MIC ≥ 32)	140	131	145	138	139	164	172	187
Quinolones	Ciprofloxacin	0.0%	0.0%	0.1%	0.1%	0.4%	0.2%	0.0%	0.2%
	(MIC ≥ 4)	0	0	1	1	5	3	1	3
	Nalidixic Acid	0.4%	0.9%	1.4%	1.1%	2.5%	2.6%	1.8%	2.3%
	(MIC ≥ 32)	5	12	20	16	34	37	36	43
Sulfonamides	Sulfamethoxazole	20.3%	22.8%	19.4%	18.1%	17.1%	17.7%	12.8%	15.1%
	(MIC ≥ 512)	269	297	283	271	235	251	258	281
Tetracyclines	Tetracycline	24.2%	21.7%	20.2%	19.4%	18.6%	19.7%	14.9%	16.3%
	(MIC ≥ 16)	320	282	295	291	256	280	299	304

The trends for individual antimicrobial resistance prevalences over time are shown in Table 1.3. The prevalence of nalidixic acid resistance increased from 0.4% (5/1324) in 1996 to 2.3% (43/1865) in 2003; a statistically significant increase (OR=6.7, 95% CI [2.6, 17.7]). The prevalence of ceftiofur resistance increased from 0.2% (2/1324) in 1996 to 4.5% (84/1865) in 2003; a statistically significant increase (OR=43.2, 95% CI [10.5, 177.4]).

The proportion of isolates resistant to ampicillin, tetracycline, streptomycin, and sulfamethoxazole was slightly higher in 2003 compared with 2002. However, for each of these antimicrobial agents, there has been an overall decrease from 1996.

Table 1.4 shows the percent of isolates with no detected resistance, and the percent of isolates resistant to one or more antibiotics, and resistant to one or more CLSI subclass from 1996 – 2003. In addition, five multidrug resistant phenotypes are also shown in Table 1.4.

Among the 1865 non-Typhi *Salmonella* isolates from 2003, 77.5% (1446) of the isolates had no detected resistance, a decrease compared with 78.9% isolates in 2002. In 2003, 419 (22.5%) were resistant to one or more CLSI subclass, 334 (17.9%) were resistant to two or more subclasses, 269 (14.4%) were resistant to three or more subclasses, 235 (12.6%) were resistant to four or more subclasses, and 189 (10.1%) were resistant to five or more subclasses. There was a statistically significant decline in resistance to one or more subclass from 33.8% in 1996 to 22.5% in 2003 (OR=0.7, 95% CI [0.6, 0.8]).

In 2003, the most common multidrug resistant phenotype among non-Typhi *Salmonella* was ACSSuT; 9.3% of isolates had this pattern. Since 1996, there has been no change in the prevalence of ACSSuT among non-Typhi *Salmonell*a. Another common multidrug resistant phenotype among non-Typhi *Salmonell*a was MDR-AmpC; 3.2% of isolates had this pattern. The prevalence of MDR-AmpC increased from 0% (0/1324) in 1996 to 3.2% (60/1865) in 2003.

Non-Typhi *Salmonella* isolates resistant to quinolones and third generation cephalosporins are also shown in Table 1.4. In 2003, five (0.3%) isolates were resistant to nalidixic acid and ceftiofur. This multidrug resistance pattern was first detected in 1997.

Table 1.4: Resistance patterns of non-Typhi *Salmonella* isolates, 1996-2003

Year Non-Typhi *Salmonella* isolates	1996 1324	1997 1301	1998 1460	1999 1498	2000 1377	2001 1419	2002 2008	2003 1865
No detected resistance	66.2% 876	68.3% 888	72.9% 1064	74.0% 1109	74.4% 1024	72.2% 1025	78.9% 1585	77.5% 1446
Resistant to ≥ 1 antimicrobial agent	33.8% 448	31.7% 413	27.1% 396	26.0% 389	25.6% 353	27.8% 394	21.1% 423	22.5% 419
Resistant to ≥ 2 antimicrobial agents	28.3% 375	24.4% 317	22.8% 333	21.1% 316	20.6% 284	22.2% 315	16.0% 321	18.0% 336
Resistant to ≥ 3 antimicrobial agents	20.6% 273	19.3% 251	18.5% 270	16.1% 241	16.9% 233	18.9% 268	13.2% 266	15.1% 281
Resistant to ≥ 4 antimicrobial agents	15.7% 208	15.3% 199	15.0% 219	14.1% 211	14.5% 200	15.6% 222	11.1% 223	13.3% 248
Resistant to ≥ 5 antimicrobial agents	11.9% 158	13.2% 172	12.8% 187	11.4% 171	11.5% 159	11.8% 168	9.4% 188	10.9% 203
Resistant to ≥ 1 CLSI subclass[1]	33.8% 448	31.7% 413	27.1% 396	26.0% 389	25.6% 353	27.8% 394	21.1% 423	22.5% 419
Resistant to ≥ 2 CLSI subclasses[1]	27.8% 368	24.4% 317	22.7% 332	21.1% 316	20.6% 283	22.2% 315	16.0% 321	17.9% 334
Resistant to ≥ 3 CLSI subclasses[1]	18.6% 246	17.8% 231	17.0% 248	15.2% 228	15.7% 216	17.0% 241	12.5% 250	14.4% 269
Resistant to ≥ 4 CLSI subclasses[1]	14.4% 191	14.1% 184	13.7% 200	13.0% 195	13.5% 186	14.9% 211	10.7% 215	12.6% 235
Resistant to ≥ 5 CLSI subclasses[1]	10.3% 137	10.5% 137	10.3% 150	9.1% 136	9.9% 137	10.9% 154	8.4% 169	10.1% 188
At least ACSSuT resistant[2]	8.8% 116	9.5% 124	8.9% 130	8.4% 126	8.9% 122	10.0% 142	7.8% 156	9.3% 173
At least ACSuTm resistant[3]	0.8% 10	0.4% 5	0.9% 13	1.0% 15	1.0% 14	0.5% 7	1.0% 21	1.2% 23
At least ACSSuTAuCf resistant[4]	0.0% 0	0.3% 4	0.3% 5	1.5% 23	2.6% 36	2.5% 36	3.3% 67	3.2% 60
At least MDR-AmpC resistant[5]	0.0% 0	0.3% 4	0.3% 5	1.5% 23	2.6% 36	2.5% 36	3.3% 67	3.2% 60
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.2% 2	0.1% 1	0.1% 2	0.3% 4	0.3% 4	0.2% 5	0.3% 5

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

Table 1.5: Twenty most common serotypes non-Typhi Salmonella serotypes in NARMS and PHLIS, 2003

NARMS				PHLIS			
Rank	**Serotype**	**ISOLATES**	**%TOT**	**Rank**	**Serotype**	**CASES**	**%TOT**
1	Typhimurium	403	21.6	**1**	Typhimurium	6,631	19.8
2	Enteritidis	257	13.8	**2**	Enteritidis	4,863	14.5
3	Newport	222	11.9	**3**	Newport	3,847	11.5
4	Heidelberg	96	5.1	**4**	Heidelberg	1,810	5.4
5	Javiana	85	4.6	**5**	Javiana	1,659	5.0
6	Saintpaul	58	3.1	**6**	Montevideo	849	2.5
7	Muenchen	48	2.6	**7**	Saintpaul	823	2.5
8	Oranienburg	43	2.3	**8**	Muenchen	781	2.3
9	Montevideo	43	2.3	**9**	Oranienburg	554	1.7
10	"Monophasic Typhimurium"	38	2.0	**10**	Infantis	539	1.6
11	Agona	32	1.7	**11**	Braenderup	530	1.6
12	Braenderup	31	1.7	**12**	Agona	510	1.5
13	Infantis	31	1.7	**13**	Thompson	494	1.5
14	Java	30	1.6	**14**	I 4,[5],12:i:- (Monophasic Typhimurium)	489	1.5
15	Mississippi	30	1.6	**15**	Mississippi	438	1.3
16	Thompson	24	1.3	**16**	Paratyphi B var.L(+) tartrate+ (Java)	331	1.0
17	Hadar	19	1.0	**17**	Hadar	280	0.8
18	Anatum	18	1.0	**18**	Bareilly	234	0.7
19	Bareilly	18	1.0	**19**	Stanley	224	0.7
20	Senftenberg	18	1.0	**20**	Paratyphi B	215	0.6
	Subtotal	**1,544**	**82.8**		**Subtotal**	**26,101**	**78.0**
	All Other serotyped	290	15.5		All Other serotyped	5,239	15.7
	Unknown serotype	4	0.2		Unknown serotype	735	2.2
	Partially serotyped	19	1.0		Partially serotyped	1,351	4.0
	Rough/nonmotile isolates	8	0.4		Rough/nonmotile isolates	19	0.1
	Subtotal	**321**	**17.2**		**Subtotal**	**7,344**	**22.0**
	Grand Total	**1,865**	**100.0**		**Grand Total**	**33,445**	**100.0**

Table 1.5 shows the 20 most common serotypes identified among the 1865 non-Typhi *Salmonella* isolates tested compared with the 20 most common serotypes reported nationally through the Public Health Laboratory Information System (PHLIS). When comparing the distribution of serotypes in NARMS and PHLIS, it should be noted that a higher proportion of isolates had serotype identified in NARMS (98.4%) than PHLIS (93.7%). The 20 most common serotypes accounted for 82.8% of isolates in NARMS and 78.0% in PHLIS. The five most common serotypes accounted for 57.0% of isolates in NARMS and 56.2% in PHLIS.

A. *Salmonella* Typhimurium

In 2003,Typhimurium was the most common *Salmonella* serotype found in NARMS and accounted for 21.6% (403/1865) of non-Typhi *Salmonella* isolates. Table 1.6 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 403 *Salmonella* Typhimurium isolates.

Among 403 *S.* Typhimurium isolates tested in 2003, resistance was highest to sulfamethoxazole (38.2%), tetracycline (37.7%), ampicillin (35.7%), streptomycin (35.0%), and chloramphenicol (27.5%). The prevalence of resistance among clinically important antibiotic classes was 1.2% for quinolones (nalidixic acid) and 4.7% for third generation cephalosporins (ceftiofur).

Table 1.6: Distribution of MICs and occurrence of resistance among *Salmonella* Typhimurium isolates, 2003 (N=403)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:															
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 0.9]						1.2	58.1	37.7	2.7		0.2						
Gentamicin	0.7	**2.0**	[0.9 - 3.9]					24.3	48.1	24.6		0.2	0.7	**0.5**	**1.5**					
Kanamycin	0.0	**7.2**	[4.9 - 10.2]										91.8	1.0			**7.2**			
Streptomycin	N/A	**35.0**	[30.3 - 39.9]												65.0	**20.3**	**14.6**			
Aminopenicillins																				
Ampicillin	0.2	**35.7**	[31.0 - 40.6]							32.5	28.8	2.7	0.5		**0.2**	**35.5**				
Beta-lactamase inhibitor combinations																				
Amoxicillin/Clavulanic Acid	19.4	**5.2**	[3.3 - 7.9]							61.8	2.7	0.7	10.4	19.4	**0.7**	**4.5**				
Cephalosporins (1st Gen.)																				
Cephalothin	1.7	**6.0**	[3.9 - 8.7]								57.1	27.3	7.9	1.7	**0.7**	**5.2**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.2	**4.7**	[2.9 - 7.3]				0.7	0.7	60.5	31.8	1.5	0.2		**4.7**						
Ceftriaxone	3.2	**0.2**	[0.0 - 1.4]					95.0			0.2		1.2	2.5	0.7		**0.2**			
Cephamycins																				
Cefoxitin	1.5	**4.2**	[2.5 - 6.7]						0.2	12.4	70.7	7.4	3.5	1.5	**4.2**					
Folate pathway inhibitors																				
Trimethoprim/Sulfamethoxazole	N/A	**3.5**	[1.9 - 5.8]				69.5	26.1	1.2				**3.5**							
Phenicols																				
Chloramphenicol	1.0	**27.5**	[23.2 - 32.2]								3.0	43.9	24.6	1.0	**0.2**	**27.3**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 0.9]	96.3	2.7	0.2		1.0												
Nalidixic Acid	N/A	**1.2**	[0.4 - 2.9]						0.2	0.2	4.7	83.4	9.9	0.5	**0.2**	**1.0**				
Sulfonamides																				
Sulfamethoxazole	N/A	**38.2**	[33.4 - 43.2]											60.0	1.2			0.5	**1.0**	**37.2**
Tetracyclines																				
Tetracycline	0.2	**37.7**	[33.0 - 42.6]									62.3	0.2	**14.4**	**9.7**	**13.6**				

Notes:

* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 1.7: Percent and number of isolates resistant to antimicrobial agents among *Salmonella* Typhimurium, 1996-2003

Year Total Isolates		1996 306	1997 328	1998 377	1999 362	2000 303	2001 325	2002 393	2003 403
Subclass	Antibiotic (Resistance breakpoint)								
Aminoglycosides	Amikacin (MIC ≥ 64)	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Gentamicin (MIC ≥ 16)	4.2% 13	4.6% 15	3.7% 14	2.2% 8	2.6% 8	1.5% 5	2.3% 9	2.0% 8
	Kanamycin (MIC ≥ 64)	14.4% 44	15.5% 51	15.9% 60	13.0% 47	13.2% 40	8.3% 27	7.6% 30	7.2% 29
	Streptomycin (MIC ≥ 64)	51.6% 158	55.2% 181	47.2% 178	43.1% 156	39.3% 119	40.0% 130	31.8% 125	35.0% 141
Aminopenicillins	Ampicillin (MIC ≥ 32)	50.0% 153	50.3% 165	45.1% 170	41.2% 149	41.9% 127	42.5% 138	33.6% 132	35.7% 144
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	2.6% 8	3.4% 11	4.5% 17	2.8% 10	6.3% 19	6.2% 20	7.6% 30	5.2% 21
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	2.0% 6	4.3% 14	4.0% 15	4.4% 16	4.3% 13	3.1% 10	5.6% 22	6.0% 24
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	1.5% 5	1.9% 7	1.9% 7	3.6% 11	3.1% 10	4.3% 17	4.7% 19
	Ceftriaxone (MIC ≥ 64)	0.0% 0	0.3% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.3% 1	0.2% 1
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	3.6% 11	3.1% 10	4.3% 17	4.2% 17
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	4.6% 14	3.0% 10	4.5% 17	2.8% 10	3.6% 11	2.5% 8	2.3% 9	3.5% 14
Phenicols	Chloramphenicol (MIC ≥ 32)	39.9% 122	36.0% 118	33.4% 126	28.7% 104	30.7% 93	31.7% 103	23.2% 91	27.5% 111
Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.0% 0
	Nalidixic Acid (MIC ≥ 32)	0.3% 1	0.9% 3	0.5% 2	0.0% 0	1.3% 4	0.6% 2	1.3% 5	1.2% 5
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	53.3% 163	56.7% 186	49.6% 187	45.6% 165	45.2% 137	43.1% 140	32.1% 126	38.2% 154
Tetracyclines	Tetracycline (MIC ≥ 16)	49.3% 151	52.4% 172	45.9% 173	41.7% 151	43.2% 131	43.4% 141	31.8% 125	37.7% 152

Changes in resistance to individual antimicrobial agents over time are shown in Table 1.7. The most dramatic increase occurred with ceftiofur resistance, increasing from 0% in 1996 to 4.7%. Nalidixic acid resistance increased from 0.3% in 1996 to 1.2% in 2003. Resistance to many of the other antimicrobial agents decreased since 1996 [Table 1.7]. Resistance to tetracycline decreased from 49.3% in 1996 to 37.7% in 2003. Similar decreases occurred in sulfamethoxazole (53.3% to 38.2%), ampicillin (50.0% to 35.7%), streptomycin (51.6% to 35.0%), chloramphenicol (39.9% to 27.5%), and gentamicin (4.2% to 2.0%).

Table 1.8 shows the percent of *Salmonella* Typhimurium isolates with no detected resistance, and the percent of isolates resistant to one or more antibiotics, and resistant to one or more CLSI subclass from 1996 – 2003. Among the 403 *Salmonella* Typhimurium isolates from 2003, 55.1% (222) of the isolates had no detected resistance, a decrease compared with 60.1% of isolates in 2002. In 2003, 40.9% (165/403) were resistant to two or more CLSI subclasses compared to 36.4% in 2002. Similarly, in 2003, 27.5% (111/403) were resistant to at least five subclasses compared to 23.4% in 2002.

In 2003, the most common multidrug resistant phenotype among *Salmonella* Typhimurium was ACSSuT; 25.8% of isolates had this pattern. In *Salmonella* Typhimurium, ACSSuT is a phenotype commonly associated with Definitive Phage Type 104 (DT104). Since 1996, the prevalence of ACSSuT among *S.* Typhimurium decreased from 33.7% to 25.8%. In the logistic regression, this decrease is not statistically significant (95% CI [0.5, 1.1]).

No *S.* Typhimurium isolates were resistant to both quinolones and third generation cephalosporins in 2003. Since 1996, five *S.* Typhimurium isolates have had this multidrug resistance pattern.

Table 1.8: Resistance patterns of *Salmonella* Typhimurium isolates, 1996-2003

Year *S.* Typhimurium isolates	1996 306	1997 328	1998 377	1999 362	2000 303	2001 325	2002 393	2003 403
No detected resistance	37.9% 116	39.0% 128	46.9% 177	50.6% 183	49.5% 150	49.2% 160	60.1% 236	55.1% 222
Resistant to ≥ 1 antimicrobial agent	62.1% 190	61.0% 200	53.1% 200	49.4% 179	50.5% 153	50.8% 165	39.9% 157	44.9% 181
Resistant to ≥ 2 antimicrobial agents	57.2% 175	56.7% 186	51.2% 193	46.1% 167	47.2% 143	48.0% 156	36.4% 143	41.2% 166
Resistant to ≥ 3 antimicrobial agents	52.9% 162	54.6% 179	48.0% 181	43.6% 158	43.6% 132	42.8% 139	33.8% 133	37.2% 150
Resistant to ≥ 4 antimicrobial agents	48.7% 149	51.2% 168	45.6% 172	41.7% 151	41.9% 127	40.3% 131	30.8% 121	35.0% 141
Resistant to ≥ 5 antimicrobial agents	40.8% 125	46.6% 153	41.9% 158	35.6% 129	35.6% 108	33.8% 110	27.2% 107	30.0% 121
Resistant to ≥ 1 CLSI subclasses[1]	62.1% 190	61.0% 200	53.1% 200	49.4% 179	50.5% 153	50.8% 165	39.9% 157	44.9% 181
Resistant to ≥ 2 CLSI subclass[1]	56.9% 174	56.7% 186	51.2% 193	46.1% 167	47.2% 143	48.0% 156	36.4% 143	40.9% 165
Resistant to ≥ 3 CLSI subclasses[1]	51.3% 157	52.4% 172	47.5% 179	43.1% 156	43.2% 131	41.8% 136	32.8% 129	36.5% 147
Resistant to ≥ 4 CLSI subclasses[1]	45.4% 139	49.1% 161	43.2% 163	40.1% 145	40.9% 124	39.4% 128	30.3% 119	33.7% 136
Resistant to ≥ 5 CLSI subclasses[1]	35.9% 110	37.5% 123	34.5% 130	28.7% 104	30.4% 92	30.5% 99	23.4% 92	27.5% 111
At least ACSSuT resistant[2]	33.7% 103	35.1% 115	31.8% 120	27.6% 100	27.7% 84	29.5% 96	21.4% 84	25.8% 104
At least ACSuTm resistant[3]	2.0% 6	0.6% 2	2.7% 10	2.2% 8	1.7% 5	0.9% 3	2.0% 8	3.2% 13
At least ACSSuTAuCf resistant[4]	0.0% 0	1.2% 4	1.1% 4	0.6% 2	2.0% 6	1.2% 4	1.8% 7	2.2% 9
At least MDR-AmpC resistant[5]	0.0% 0	1.2% 4	1.1% 4	0.6% 2	2.0% 6	1.2% 4	1.8% 7	2.2% 9
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.3% 1	0.3% 1	0.5% 2	0.0% 0

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

B. *Salmonella* Enteritidis

In 2003, *Salmonella* Enteritidis was the second most common serotype in NARMS and accounted for 13.8% (257/1865) of non-Typhi *Salmonella* isolates.

Table 1.9 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 257 *S.* Enteritidis isolates.

Among 257 *S.* Enteritidis isolates tested in 2003, resistance was uncommon. The most dramatic increase occurred with nalidixic acid resistance. In 2003, 4.7% of *S*. Enteritidis isolates were resistant to nalidixic acid. *S.* Enteritidis was the most prevalent non-Typhi *Salmonella* serotype with nalidixic acid resistance. The percent of *S.* Enteritidis isolates resistant to nalidixic acid was 0.9% in 1996 and 4.7% in 2003 [Table 1.10]. This is not a statistically significant increase (95% CI [0.8, 27.5]), however, in the logistic regression model, there was a statistically significant increase in nalidixic acid resistance from 1996 to 2002 (95% CI [1.3, 25.6]).

Table 1.9: Distribution of MICs and occurrence of resistance among *Salmonella* Enteritidis isolates, 2003 (N=257)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:															
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 1.4]						10.9	71.2	16.7	1.2								
Gentamicin	0.0	**0.4**	[0.0 - 2.1]					63.4	22.2	14.0					**0.4**					
Kanamycin	0.0	**0.0**	[0.0 - 1.4]										100.0							
Streptomycin	N/A	**1.2**	[0.2 - 3.4]												98.8	**0.4**	**0.8**			
Aminopenicillins																				
Ampicillin	0.0	**2.3**	[0.9 - 5.0]							33.5	55.3	8.6	0.4			**2.3**				
Beta-lactamase inhibitor combinations																				
Amoxicillin/Clavulanic Acid	0.8	**0.0**	[0.0 - 1.4]							94.2	3.5		1.6	0.8						
Cephalosporins (1st Gen.)																				
Cephalothin	0.8	**1.2**	[0.2 - 3.4]								75.1	22.2	0.8	0.8	**0.8**	**0.4**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**0.0**	[0.0 - 1.4]					1.9	47.9	48.2	1.9									
Ceftriaxone	0.0	**0.0**	[0.0 - 1.4]					100.0												
Cephamycins																				
Cefoxitin	0.0	**0.0**	[0.0 - 1.4]						0.4	14.4	79.8	4.7	0.8							
Folate pathway inhibitors																				
Trimethoprim/Sulfamethoxazole	N/A	**0.8**	[0.1 - 2.8]				93.8	5.1	0.4				**0.8**							
Phenicols																				
Chloramphenicol	0.4	**0.4**	[0.0 - 2.1]								1.6	65.4	32.3	0.4		**0.4**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 1.4]	94.2	1.2	0.8	3.1	0.4	0.4											
Nalidixic Acid	N/A	**4.7**	[2.4 - 8.0]							0.4	1.9	81.7	11.3			**4.7**				
Sulfonamides																				
Sulfamethoxazole	N/A	**1.2**	[0.2 - 3.4]											86.8	11.7	0.4				**1.2**
Tetracyclines																				
Tetracycline	0.0	**1.6**	[0.4 - 3.9]									98.4		**0.4**	**0.4**	**0.8**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 1.10: Percent and number of isolates resistant to antimicrobial agents among *Salmonella* Enteritidis, 1996-2003

Year		1996	1997	1998	1999	2000	2001	2002	2003
Total Isolates		351	301	244	269	319	276	337	257
Subclass	Antibiotic (Resistance breakpoint)								
Aminoglycosides	Amikacin (MIC ≥ 64)	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Gentamicin (MIC ≥ 16)	4.8% 17	0.3% 1	0.4% 1	0.0% 0	0.3% 1	0.0% 0	0.3% 1	0.4% 1
	Kanamycin (MIC ≥ 64)	0.0% 0	0.7% 2	0.4% 1	0.4% 1	0.3% 1	0.7% 2	0.3% 1	0.0% 0
	Streptomycin (MIC ≥ 64)	2.0% 7	4.3% 13	1.6% 4	2.2% 6	0.0% 0	1.4% 4	1.8% 6	1.2% 3
Aminopenicillins	Ampicillin (MIC ≥ 32)	20.5% 72	11.3% 34	6.1% 15	10.8% 29	7.5% 24	8.7% 24	7.1% 24	2.3% 6
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	0.6% 2	0.0% 0	0.0% 0	0.4% 1	0.0% 0	1.4% 4	0.6% 2	0.0% 0
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	4.0% 14	1.3% 4	0.0% 0	1.9% 5	0.9% 3	1.1% 3	0.6% 2	1.2% 3
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.3% 1	0.0% 0	0.4% 1	0.0% 0	2.2% 6	0.0% 0	0.0% 0
	Ceftriaxone (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
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.4% 1	0.0% 0	0.0% 0
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	6.6% 23	1.3% 4	0.8% 2	0.7% 2	0.0% 0	0.7% 2	0.6% 2	0.8% 2
Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.7% 2	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.6% 2	0.4% 1
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
	Nalidixic Acid (MIC ≥ 32)	0.9% 3	1.7% 5	2.0% 5	2.2% 6	2.2% 7	4.3% 12	3.9% 13	4.7% 12
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	8.5% 30	9.0% 27	2.0% 5	3.0% 8	0.9% 3	2.2% 6	1.8% 6	1.2% 3
Tetracyclines	Tetracycline (MIC ≥ 16)	16.8% 59	9.6% 29	6.6% 16	8.2% 22	1.9% 6	1.8% 5	4.5% 15	1.6% 4

Table 1.11: Resistance patterns of *Salmonella* Enteritidis isolates, 1996-2003

Year *S.* Enteritidis isolates	1996 351	1997 301	1998 244	1999 269	2000 319	2001 276	2002 337	2003 257
No detected resistance	73.5% 258	77.4% 233	87.7% 214	83.6% 225	89.0% 284	86.6% 239	87.2% 294	91.4% 235
Resistant to ≥ 1 antimicrobial agents	26.5% 93	22.6% 68	12.3% 30	16.4% 44	11.0% 35	13.4% 37	12.8% 43	8.6% 22
Resistant to ≥ 2 antimicrobial agents	20.2% 71	10.3% 31	6.6% 16	10.0% 27	2.8% 9	5.1% 14	4.2% 14	2.7% 7
Resistant to ≥ 3 antimicrobial agents	9.4% 33	3.0% 9	1.2% 3	1.1% 3	0.3% 1	2.9% 8	2.7% 9	0.8% 2
Resistant to ≥ 4 antimicrobial agents	5.1% 18	1.3% 4	0.0% 0	1.1% 3	0.0% 0	2.2% 6	1.8% 6	0.4% 1
Resistant to ≥ 5 antimicrobial agents	2.3% 8	1.0% 3	0.0% 0	0.4% 1	0.0% 0	0.7% 2	0.6% 2	0.4% 1
Resistant to ≥ 1 CLSI subclasses[1]	26.5% 93	22.6% 68	12.3% 30	16.4% 44	11.0% 35	13.4% 37	12.8% 43	8.6% 22
Resistant to ≥ 2 CLSI subclasses[1]	20.2% 71	10.3% 31	6.6% 16	10.0% 27	2.8% 9	5.1% 14	4.2% 14	2.7% 7
Resistant to ≥ 3 CLSI subclasses[1]	9.4% 33	3.0% 9	0.8% 2	1.1% 3	0.3% 1	2.9% 8	2.7% 9	0.8% 2
Resistant to ≥ 4 CLSI subclasses[1]	4.8% 17	1.3% 4	0.0% 0	0.7% 2	0.0% 0	1.8% 5	1.5% 5	0.4% 1
Resistant to ≥ 5 CLSI subclasses[1]	2.0% 7	1.0% 3	0.0% 0	0.4% 1	0.0% 0	0.7% 2	0.6% 2	0.4% 1
At least ACSSuT resistant[2]	0.0% 0	0.3% 1	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.3% 1	0.4% 1
At least ACSuTm resistant[3]	0.0% 0	0.3% 1	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.4% 1
At least ACSSuTAuCf resistant[4]	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least MDR-AmpC resistant[5]	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.4% 1

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

Table 1.11 shows the percent of *S*. Enteritidis isolates with no detected resistance. Among the 257 *S*. Enteritidis isolates from 2003, 91.4% had no detected resistance, an increase compared to 87.2% in 2002.

C. *Salmonella* Newport

In 2003, Newport was the third most common *Salmonella* serotype in NARMS and accounted for 11.9% (222/1865) of non-Typhi *Salmonella* isolates. Table 1.12 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 222 *S.* Newport isolates.

Among 222 *S.* Newport isolates tested in 2003, resistance was highest to sulfamethoxazole (24.3%), tetracycline (23.9%), streptomycin (23.9%), ampicillin (22.1%), chloramphenicol (21.6%), amoxicillin/clavulanic acid (21.2%) and ceftiofur (22.1%). The prevalence of resistance among clinically important antibiotic classes was 0.5% for quinolones (nalidixic acid) and 22.1% for third generation cephalosporins (ceftiofur). Ceftiofur resistance was more prevalent among *S.* Newport than any other serotype.

Table 1.12: Distribution of MICs and occurrence of resistance among S*almonella* Newport isolates, 2003 (N=222)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:																
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 1.6]						1.4	78.4	18.0	1.4	0.9							
Gentamicin	0.5	**3.2**	[1.3 - 6.4]					44.6	35.6	16.2			0.5	**1.4**	**1.8**					
Kanamycin	0.5	**4.5**	[2.2 - 8.1]										95.0		0.5		**4.5**			
Streptomycin	N/A	**23.9**	[18.4 - 30.0]												76.1	**1.8**	**22.1**			
Aminopenicillins																				
Ampicillin	0.0	**22.1**	[16.8 - 28.1]							49.5	25.7	1.8	0.5	0.5		**22.1**				
Beta-lactamase inhibitor combinations																				
Amoxicillin/Clavulanic Acid	0.5	**21.2**	[16.0 - 27.1]							75.7	1.4	0.9	0.5	0.5	**3.6**	**17.6**				
Cephalosporins (1st Gen.)																				
Cephalothin	0.5	**22.1**	[16.8 - 28.1]								63.1	13.1	1.4	0.5	**0.9**	**21.2**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**22.1**	[16.8 - 28.1]					0.9	50.5	25.7	0.9			**22.1**						
Ceftriaxone	18.9	**1.8**	[0.5 - 4.5]					78.4					0.9	11.7	7.2	**0.9**	**0.9**			
Cephamycins																				
Cefoxitin	0.5	**21.6**	[16.4 - 27.6]							12.2	59.5	5.4	0.9	0.5	**21.6**					
Folate pathway inhibitors																				
Trimethoprim/Sulfamethoxazole	N/A	**0.9**	[0.1 - 3.2]				82.4	15.8	0.5	0.5			**0.9**							
Phenicols																				
Chloramphenicol	0.5	**21.6**	[16.4 - 27.6]								0.9	65.8	11.3	0.5		**21.6**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 1.6]	99.1	0.5					0.5										
Nalidixic Acid	N/A	**0.5**	[0.0 - 2.5]								3.2	86.9	8.6	0.9		**0.5**				
Sulfonamides																				
Sulfamethoxazole	N/A	**24.3**	[18.8 - 30.5]											62.2	12.6	0.9			**0.9**	**23.4**
Tetracyclines																				
Tetracycline	0.0	**23.9**	[18.4 - 30.0]									76.1			**5.4**	**18.5**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 1.13: Percent and number of isolates resistant to antimicrobial agents among *Salmonella* Newport, 1996-2003

Year		1996	1997	1998	1999	2000	2001	2002	2003
Total Isolates		51	46	77	99	121	124	239	222
Subclass	Antibiotic (Resistance breakpoint)								
Aminoglycosides	Amikacin (MIC ≥ 64)	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Gentamicin (MIC ≥ 16)	5.9% 3	4.3% 2	0.0% 0	0.0% 0	2.5% 3	3.2% 4	3.3% 8	3.2% 7
	Kanamycin (MIC ≥ 64)	2.0% 1	0.0% 0	1.3% 1	1.0% 1	5.0% 6	7.3% 9	9.6% 23	4.5% 10
	Streptomycin (MIC ≥ 64)	7.8% 4	4.3% 2	2.6% 2	19.2% 19	24.0% 29	31.5% 39	24.7% 59	23.9% 53
Aminopenicillins	Ampicillin (MIC ≥ 32)	5.9% 3	6.5% 3	2.6% 2	18.2% 18	23.1% 28	29.8% 37	24.3% 58	22.1% 49
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	2.0% 1	0.0% 0	2.6% 2	18.2% 18	22.3% 27	26.6% 33	22.2% 53	21.2% 47
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	3.9% 2	4.3% 2	2.6% 2	18.2% 18	22.3% 27	26.6% 33	22.2% 53	22.1% 49
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	1.3% 1	18.2% 18	22.3% 27	27.4% 34	22.2% 53	22.1% 49
	Ceftriaxone (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	3.0% 3	0.0% 0	0.0% 0	0.8% 2	1.8% 4
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	22.3% 27	25.8% 32	22.2% 53	21.6% 48
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	3.9% 2	4.3% 2	1.3% 1	2.0% 2	4.1% 5	1.6% 2	4.2% 10	0.9% 2
Phenicols	Chloramphenicol (MIC ≥ 32)	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	28.2% 35	24.7% 59	21.6% 48
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
	Nalidixic Acid (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.8% 1	0.0% 0	0.8% 2	0.5% 1
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	11.8% 6	4.3% 2	3.9% 3	22.2% 22	23.1% 28	32.3% 40	25.1% 60	24.3% 54
Tetracyclines	Tetracycline (MIC ≥ 16)	7.8% 4	4.3% 2	2.6% 2	19.2% 19	23.1% 28	30.6% 38	25.1% 60	23.9% 53

Changes in resistance to individual antimicrobial agents over time are shown in Table 1.13. The most dramatic increase occurred with ceftiofur resistance, increasing from 0% in 1996 to 22.1% in 2003.

In Table 1.14 shows the percent of *S*. Newport isolates with no detected resistance. In contrast to other common serotypes, there has been a decrease in the percent of *S*. Newport isolates with no detected resistance from 86.3% in 1996 to 73.9% in 2003. In addition, resistance to at least five subclasses of antimicrobial agents in *S.* Newport increased from 5.9% in 1996 to 22.1% in 2003.

In 2003, the most common multidrug resistant phenotype among *S.* Newport was MDR-AmpC; 20.7% of isolates had this pattern. Since 1996, the prevalence of MDR-AmpC among *S*. Newport increased. In 1996 and 1997, none of the *S.* Newport isolates were MDR-AmpC. This proportion increased to 1.3% in 1998, 18.2% in 1999, 22.3% in 2000, 25.0% in 2001, 22.2% in 2002, and 20.7% in 2003. In the logistic regression model, this represents a statistically significant increase (95% CI [4.6, infinity]).

Table 1.14: Resistance patterns of *Salmonella* Newport isolates, 1996-2003

Year *S.* Newport isolates	1996 51	1997 46	1998 77	1999 99	2000 121	2001 124	2002 239	2003 222
No detected resistance	86.3% 44	93.5% 43	94.8% 73	75.8% 75	75.2% 91	64.5% 80	72.8% 174	73.9% 164
Resistant to ≥ 1 antimicrobial agent	13.7% 7	6.5% 3	5.2% 4	24.2% 24	24.8% 30	35.5% 44	27.2% 65	26.1% 58
Resistant to ≥ 2 antimicrobial agents	7.8% 4	4.3% 2	2.6% 2	18.2% 18	23.1% 28	32.3% 40	25.1% 60	24.8% 55
Resistant to ≥ 3 antimicrobial agents	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	31.5% 39	24.7% 59	23.4% 52
Resistant to ≥ 4 antimicrobial agents	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	31.5% 39	24.7% 59	22.5% 50
Resistant to ≥ 5 antimicrobial agents	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	27.4% 34	23.4% 56	22.1% 49
Resistant to ≥ 1 CLSI subclass[1]	13.7% 7	6.5% 3	5.2% 4	24.2% 24	24.8% 30	35.5% 44	27.2% 65	26.1% 58
Resistant to ≥ 2 CLSI subclasses[1]	7.8% 4	4.3% 2	2.6% 2	18.2% 18	23.1% 28	32.3% 40	25.1% 60	24.8% 55
Resistant to ≥ 3 CLSI subclasses[1]	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	31.5% 39	24.7% 59	23.0% 51
Resistant to ≥ 4 CLSI subclasses[1]	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	31.5% 39	24.7% 59	22.5% 50
Resistant to ≥ 5 CLSI subclasses[1]	5.9% 3	4.3% 2	2.6% 2	18.2% 18	23.1% 28	27.4% 34	23.0% 55	22.1% 49
At least ACSSuT resistant[2]	5.9% 3	4.3% 2	1.3% 1	18.2% 18	23.1% 28	25.8% 32	23.0% 55	21.2% 47
At least ACSuTm resistant[3]	3.9% 2	4.3% 2	1.3% 1	2.0% 2	4.1% 5	0.8% 1	3.8% 9	0.9% 2
At least ACSSuTAuCf resistant[4]	0.0% 0	0.0% 0	1.3% 1	18.2% 18	22.3% 27	25.0% 31	22.2% 53	20.7% 46
At least MDR-AmpC resistant[5]	0.0% 0	0.0% 0	1.3% 1	18.2% 18	22.3% 27	25.0% 31	22.2% 53	20.7% 46
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.0% 0	1.3% 1	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.5% 1

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

D. Specific Phenotypes

The multidrug resistant phenotypes ACSSuT and MDR-AmpC, and resistance to nalidixic acid and ceftiofur were found in several other serotypes in 2003 [Table 1.15].

In 2003, 173 (9.3%) non-Typhi *Salmonella* isolates were at least resistant to ACSSuT. Among the isolates resistant to at least ACSSuT, 60.1% were serotype Typhimurium, 27.2% Newport, 2.9% Java, 1.2% Hadar, 0.6% Enteritidis, 0.6% Oranienburg, 0.6% "monophasic Typhimurium," and 0.6% Agona.

In 2003, 60 (3.2%) non-Typhi *Salmonella* isolates were at least MDR-AmpC resistant. Among the isolates with at least MDR-AmpC resistance, 76.7% were serotype Newport, 15.0% Typhimurium, 1.7% Agona, and 1.7% Hadar.

In 2003, 43 (2.3%) non-Typhi *Salmonella* isolates were nalidixic acid resistant. Among the nalidixic acid-resistant isolates, 27.9% were serotype Enteritidis, 11.6% Typhimurium, 4.7% Agona, 4.7% Hadar, 4.7% Infantis, and 2.3% Newport.

In 2003, 84 (4.5%) non-Typhi *Salmonella* isolates were ceftiofur resistant. Among the ceftiofur-resistant isolates, 58.3% were serotype Newport, 22.6% Typhimurium, 6.0% Heidelberg, 2.4% Agona, 2.4% "monophasic Typhimurium," 1.2% Hadar, 1.2% Muenchen, and 1.2% Senftenberg.

Table 1.15: Number and percent of ACSSuT, MDRAmpC, nalidixic acid- and ceftiofur-resistant isolates among the twenty most common non-Typhi *Salmonella* serotypes, 2003

Rank	Serotype	No. Isolates Tested	ACSSuT[1]		MDRAmpC[2]		Nalidixic Acid		Ceftiofur	
			N	% Total	N	% Total	N	% Total	N	% Total
1	Typhimurium	403	**104**	**60.1%**	**9**	**15.0%**	**5**	**11.6%**	**19**	**22.6%**
2	Enteritidis	257	**1**	**0.6%**	0	0.0%	**12**	**27.9%**	0	0.0%
3	Newport	222	**47**	**27.2%**	**46**	**76.7%**	**1**	**2.3%**	**49**	**58.3%**
4	Heidelberg	96	0	0.0%	0	0.0%	0	0.0%	**5**	**6.0%**
5	Javiana	85	0	0.0%	0	0.0%	0	0.0%	0	0.0%
6	Saintpaul	59	0	0.0%	0	0.0%	0	0.0%	0	0.0%
7	Muenchen	48	0	0.0%	0	0.0%	0	0.0%	**1**	**1.2%**
8	Oranienburg	43	**1**	**0.6%**	0	0.0%	0	0.0%	0	0.0%
9	Montevideo	43	0	0.0%	0	0.0%	0	0.0%	0	0.0%
10	"Monophasic Typhimurium"	38	**1**	**0.6%**	0	0.0%	0	0.0%	**2**	**2.4%**
11	Agona	32	**1**	**0.6%**	**1**	**1.7%**	**2**	**4.7%**	**2**	**2.4%**
12	Braenderup	31	0	0.0%	0	0.0%	0	0.0%	0	0.0%
13	Infantis	31	0	0.0%	0	0.0%	**2**	**4.7%**	0	0.0%
14	Java	30	**5**	**2.9%**	0	0.0%	0	0.0%	0	0.0%
15	Mississippi	30	0	0.0%	0	0.0%	0	0.0%	0	0.0%
16	Thompson	24	0	0.0%	0	0.0%	0	0.0%	0	0.0%
17	Hadar	19	**2**	**1.2%**	**1**	**1.7%**	**2**	**4.7%**	**1**	**1.2%**
18	Anatum	18	0	0.0%	0	0.0%	0	0.0%	0	0.0%
19	Bareilly	18	0	0.0%	0	0.0%	0	0.0%	0	0.0%
20	Senftenberg	18	0	0.0%	0	0.0%	**4**	**9.3%**	**1**	**1.2%**
	Subtotal	**1545**	**162**	**93.6%**	**57**	**95.0%**	**28**	**65.1%**	**80**	**95.2%**
	All Other Serotyped	**321**	**11**	**6.4%**	**3**	**5.0%**	**15**	**34.9%**	**4**	**4.8%**
	Total	**1865**	**173**	**100.0%**	**60**	**100.0%**	**43**	**100.0%**	**84**	**100.0%**

1: ACSSuT: ampicillin, chloramphenicol, Streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

2: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 0.12µg/ml)

2. *Salmonella* Typhi

A total of 393 *S.* Typhi isolates were received at CDC in 2003; of these isolates 352 (89.6%) were viable and tested for antimicrobial susceptibility. Of these 352 isolates, 18 isolates were not included in the analysis because they were duplicate submissions from the same patient, leaving 334 isolates for analysis. Table 1.1 shows the number of isolates included in the final analysis by site and the population represented. Table 2.1 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 334 *S.* Typhi isolates tested in 2003.

Antimicrobial agents with the highest prevalence of resistance were nalidixic acid (37.7%), trimethoprim-sulfamethoxazole (16.8%), chloramphenicol (16.5%), ampicillin (16.2%), and tetracycline (15.6%). Two isolates were resistant to ceftiofur. There was one ciprofloxacin-resistant isolate in 2003, the first reported since NARMS began testing *S*. Typhi in 1999.

Table 2.1: Distribution of MICs and occurrence of resistance among *Salmonella* Typhi isolates, 2003 (N=334)

Antibiotic	% of Isolates %I	%R	CI	Percent of all isolates with MIC (µg/mL) of: 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512	1024
Aminoglycosides																				
Amikacin	0.3	**0.0**	[0.0 - 1.1]						14.7	78.4	6.6				0.3					
Gentamicin	0.0	**0.0**	[0.0 - 1.1]					85.6	13.5	0.6	0.3									
Kanamycin	0.0	**0.0**	[0.0 - 1.1]										99.7	0.3						
Streptomycin	N/A	**14.4**	[10.8 - 18.6]												85.6		**14.4**			
Aminopenicillins																				
Ampicillin	0.0	**16.2**	[12.4 - 20.6]							52.7	29.9	0.6	0.6			**16.2**				
Beta-lactamase inhibitor combinations																				
Amoxicillin-clavulanic acid	0.6	**0.3**	[0.0 - 1.7]							82.6	0.6	7.5	8.4	0.6		**0.3**				
Cephalosporins (1st Gen.)																				
Cephalothin	1.8	**0.6**	[0.1 - 2.1]								65.6	24.3	7.8	1.8	**0.3**	**0.3**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**0.6**	[0.1 - 2.1]				2.4	12.3	73.7	11.1				**0.6**						
Ceftriaxone	0.3	**0.3**	[0.0 - 1.7]					99.1	0.3					0.3			**0.3**			
Cephamycins																				
Cefoxitin	0.9	**0.9**	[0.2 - 2.6]						2.7	37.7	14.7	24.9	18.3	0.9	**0.6**	**0.3**				
Folate pathway inhibitors																				
Trimethoprim-sulfamethoxazole	N/A	**16.8**	[12.9 - 21.2]				76.3	6.9					**16.8**							
Phenicols																				
Chloramphenicol	0.0	**16.5**	[12.7 - 20.9]								5.1	68.3	10.2		**0.3**	**16.2**				
Quinolones																				
Ciprofloxacin	0.0	**0.3**	[0.0 - 1.7]	59.9	0.6	0.9	9.6	27.5	1.2				**0.3**							
Nalidixic acid	N/A	**37.7**	[32.5 - 43.2]							0.9	26.0	30.8	3.9	0.6		**37.7**				
Sulfonamides																				
Sulfamethoxazole	N/A	**17.1**	[13.2 - 21.5]											81.4	1.5				**0.3**	**16.8**
Tetracyclines																				
Tetracycline	0.0	**15.6**	[11.9 - 19.9]									84.4			**0.6**	**15.0**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 2.2: Percent and number of isolates resistant to antimicrobial agents among *Salmonella* Typhi, 1999-2003

Year Total Isolates		1999 166	2000 177	2001 197	2002 195	2003 334
Subclass	Antibiotic (Resistance breakpoint)					
Aminoglycosides	Amikacin (MIC ≥ 64)	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
	Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.5% 1	0.0% 0	0.0% 0
	Streptomycin (MIC ≥ 64)	13.3% 22	9.0% 16	20.3% 40	7.2% 14	14.4% 48
Aminopenicillins	Ampicillin (MIC ≥ 32)	12.7% 21	9.0% 16	20.3% 40	5.6% 11	16.2% 54
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	2.4% 4	1.1% 2	0.5% 1	1.5% 3	0.6% 2
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 2
	Ceftriaxone (MIC ≥ 64)	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	0.6% 1	0.5% 1	0.0% 0	0.9% 3
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	12.7% 21	9.0% 16	20.8% 41	6.7% 13	16.8% 56
Phenicols	Chloramphenicol (MIC ≥ 32)	12.0% 20	10.7% 19	20.8% 41	6.2% 12	16.5% 55
Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1
	Nalidixic acid (MIC ≥ 32)	18.7% 31	22.0% 39	29.9% 59	23.6% 46	37.7% 126
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	16.3% 27	11.3% 20	20.8% 41	6.2% 12	17.1% 57
Tetracyclines	Tetracycline (MIC ≥ 16)	9.0% 15	9.6% 17	20.8% 41	6.7% 13	15.6% 52

Resistance to individual antimicrobial agents in 2003 increased among most of the drugs tested as compared to 2002 [Table 2.2]. Nalidixic acid resistance increased from 23.6% to 37.7%, trimethoprim/sulfamethoxazole resistance increased from 6.7% to 16.8%, chloramphenicol resistance increased from 6.2% to 16.5%, ampicillin resistance increased from 5.6% to 16.2%, and tetracycline resistance increased from 6.7% to 15.6%.

Nalidixic acid resistance increased from 18.7% in 1999 to 37.7% in 2003; a statistically significant increase (OR=2.6, 95% CI [1.6, 4.2]).

Table 2.3 shows the percent of *S.* Typhi isolates resistant to one or more CLSI subclass from 1999-2003. In 1999, 12.0% of *S.* Typhi isolates were resistant to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole (ACSuTm) compared with 15.6% in 2003. One isolate was resistant to nalidixic acid and ceftiofur in 2003; it is the first isolate with this phenotype since NARMS began testing in 1999.

Table 2.3: Resistance patterns of *Salmonella* Typhi isolates, 1999-2003

Year *S.* Typhi isolates	1999 166	2000 177	2001 197	2002 195	2003 334
No detected resistance	71.7% 119	72.9% 129	58.9% 116	74.4% 145	56.6% 189
Resistant to ≥ 1 antimicrobial agent	28.3% 47	27.1% 48	41.1% 81	25.6% 50	43.4% 145
Resistant to ≥ 2 antimicrobial agents	14.5% 24	10.7% 19	22.8% 45	7.2% 14	18.0% 60
Resistant to ≥ 3 antimicrobial agents	12.7% 21	9.6% 17	22.8% 45	6.7% 13	17.7% 59
Resistant to ≥ 4 antimicrobial agents	12.7% 21	9.0% 16	21.8% 43	6.7% 13	17.1% 57
Resistant to ≥ 5 antimicrobial agents	12.7% 21	9.0% 16	19.3% 38	5.6% 11	16.5% 55
Resistant to ≥ 1 CLSI subclass[1]	28.3% 47	27.1% 48	41.1% 81	25.6% 50	43.4% 145
Resistant to ≥ 2 CLSI subclasses[1]	14.5% 24	10.7% 19	22.8% 45	7.2% 14	18.0% 60
Resistant to ≥ 3 CLSI subclasses[1]	12.7% 21	9.6% 17	22.8% 45	6.7% 13	17.7% 59
Resistant to ≥ 4 CLSI subclasses[1]	12.7% 21	9.0% 16	21.8% 43	6.7% 13	17.1% 57
Resistant to ≥ 5 CLSI subclasses[1]	12.7% 21	9.0% 16	18.8% 37	5.6% 11	16.5% 55
At least ACSSuT resistant[2]	9.0% 15	7.9% 14	16.8% 33	5.6% 11	12.6% 42
At least ACSuTm resistant[3]	12.0% 20	9.0% 16	17.8% 35	5.6% 11	15.6% 52
At least ACSSuTAuCf resistant[4]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least MDR-AmpC resistant[5]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

3. *Shigella*

A total of 552 *Shigella* isolates were received at CDC in 2003; of these isolates, 495 (89.7%) were viable and tested for antimicrobial susceptibility. Of these 495 isolates, 434 (87.7%) were *S. sonnei*, 51 (10.3%) *S. flexneri*, 5 (1.0%) *S. boydii*, and 2 (0.4%) *S. dysenteriae* [Table 3.1].

Table 3.1: Frequency of *Shigella* species, 2003

Species	N	%
sonnei	434	87.7
flexneri	51	10.3
boydii	5	1.0
dysenteriae	2	0.4
Other	3	0.6
Total	495	100

Table 1.1 shows the number of isolates included in the final analysis by site and the population represented. Table 3.2 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 495 *Shigella* isolates tested in 2003. Among the 495 *Shigella* isolates tested in 2003, resistance was highest to ampicillin (78.8%), trimethoprim-sulfamethoxazole (38.2%), and chloramphenicol (8.9%).

Table 3.2: Distribution of MICs and occurrence of resistance among *Shigella i* solates, 2003 (N=495)

Antibiotic	% of Isolates %I	%R	CI	Percent of all isolates with MIC (µg/mL) of: 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512	1024
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 0.7]						0.2	7.1	65.3	26.1	0.6							
Gentamicin	0.0	**0.0**	[0.0 - 0.7]					1.6	41.8	54.3	1.4									
Kanamycin	0.0	**0.4**	[0.0 - 1.5]										98.8			**0.2**	**0.2**			
Streptomycin	N/A	**56.8**	[52.3 - 61.2]												42.4	**28.1**	**28.7**			
Aminopenicillins																				
Ampicillin	0.4	**78.8**	[74.9 - 82.3]							1.8	10.3	7.1	0.6	0.6	**0.4**	**78.4**				
Beta-lactamase inhibitor combinations																				
Amoxicillin-clavulanic acid	19.6	**1.6**	[0.7 - 3.2]							3.4	3.4	17.6	53.5	19.6	**1.4**	**0.2**				
Cephalosporins (1st Gen.)																				
Cephalothin	18.6	**9.3**	[6.9 - 12.2]								3.4	11.5	56.4	18.6	**6.7**	**2.6**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**0.4**	[0.0 - 1.5]				16.0	72.7	8.5	1.4	0.2			**0.4**						
Ceftriaxone	0.4	**0.0**	[0.0 - 0.7]					98.8						0.2	0.2					
Cephamycins																				
Cefoxitin	0.0	**0.2**	[0.0 - 1.1]							8.5	70.5	18.8	1.2		**0.2**					
Folate pathway inhibitors																				
Trimethoprim-sulfamethoxazole	N/A	**38.2**	[33.9 - 42.6]				36.6	3.2	5.5	9.3	6.5	**1.8**	**36.4**							
Phenicols																				
Chloramphenicol	2.2	**8.9**	[6.5 - 11.7]								9.1	71.7	7.3	2.2	**2.4**	**6.5**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 0.7]	97.6	0.6		0.2		0.8											
Nalidixic acid	N/A	**1.0**	[0.3 - 2.3]							26.9	63.8	6.7	0.8			**1.0**				
Sulfonamides																				
Sulfamethoxazole	N/A	**0.0**	[25.3 - 33.5]									69.1	0.8	1.2	4.2	23.8				
Tetracyclines																				
Tetracycline	0.0	**99.2**	[30.0 - 38.5]											**63.6**	**1.0**	**0.2**		**0.2**	**1.0**	**33.1**

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Tables 3.3 and 3.4 show the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the two most common species of *Shigella*, *Shigella sonnei* and *Shigella flexneri.* Isolates of *S. flexneri* had a higher prevalence of resistance to most antimicrobial agents. Important differences between the species include the prevalence of nalidixic acid resistance which was 5.9% in *S. flexneri* compared with 0.5% in *S. sonnei,* and chloramphenicol resistance which was 68.6% in *S. flexneri* compared with 1.6% in *S. sonnei*.

Table 3.3: Distribution of MICs and occurrence of resistance among *Shigella sonnei* isolates, 2003 (N=464)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:															
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 0.8]						0.2	6.7	70.5	21.7								
Gentamicin	0.0	**0.0**	[0.0 - 0.8]					1.2	41.7	55.1	1.2									
Kanamycin	0.0	**0.0**	[0.0 - 0.8]										99.1							
Streptomycin	N/A	**56.2**	[51.4 - 60.9]												42.9	**30.0**	**26.3**			
Aminopenicillins																				
Ampicillin	0.5	**79.0**	[74.9 - 82.8]							0.7	10.1	7.8	0.7	0.7	**0.5**	**78.6**				
Beta-lactamase inhibitor combinations																				
Amoxicillin-clavulanic acid	15.7	**1.6**	[0.7 - 3.3]							2.1	3.0	18.9	57.8	15.7	**1.4**	**0.2**				
Cephalosporins (1st Gen.)																				
Cephalothin	19.8	**10.1**	[7.5 - 13.4]								2.3	7.6	59.2	19.8	**7.4**	**2.8**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**0.2**	[0.0 - 1.3]				11.3	78.3	7.8	1.2	0.2			**0.2**						
Ceftriaxone	0.2	**0.0**	[0.0 - 0.8]					98.8							0.2					
Cephamycins																				
Cefoxitin	0.0	**0.2**	[0.0 - 1.3]							9.0	74.7	14.1	1.2		**0.2**					
Folate pathway inhibitors																				
Trimethoprim-sulfamethoxazole	N/A	**38.0**	[33.4 - 42.8]				35.7	2.1	5.5	10.4	7.4	**2.1**	**35.9**							
Phenicols																				
Chloramphenicol	2.5	**1.6**	[0.7 - 3.3]								6.7	80.6	7.6	2.5	**0.7**	**0.9**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 0.8]	98.2	0.5		0.2		0.2											
Nalidixic acid	N/A	**0.5**	[0.1 - 1.7]							28.3	64.3	5.5	0.5			**0.5**				
Sulfonamides																				
Sulfamethoxazole	N/A	**31.6**	[27.2 - 36.2]											66.4	0.9	0.2			**0.7**	**30.9**
Tetracyclines																				
Tetracycline	0.7	**22.4**	[18.5 - 26.6]									76.0	0.7	**0.7**	**2.8**	**18.9**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 3.4: Distribution of MICs and occurrence of resistance among *Shigella flexneri* isolates, 2003 (N=51)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:															
Antibiotic	**%I**	**%R**	**CI**	**0.015**	**0.03**	**0.06**	**0.125**	**0.25**	**0.50**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 7.0]							9.8	27.5	58.8	3.9							
Gentamicin	0.0	**0.0**	[0.0 - 7.0]					3.9	45.1	51.0										
Kanamycin	0.0	**3.9**	[0.5 - 13.5]										96.1			**2.0**	**2.0**			
Streptomycin	N/A	**60.8**	[46.1 - 74.2]												39.2	**13.7**	**47.1**			
Aminopenicillins																				
Ampicillin	0.0	**84.3**	[71.4 - 93.0]							7.8	5.9	2.0				**84.3**				
Beta-lactamase inhibitor combinations																				
Amoxicillin-clavulanic acid	52.9	**2.0**	[0.0 - 10.4]							11.8	3.9	2.0	27.5	52.9	**2.0**					
Cephalosporins (1st Gen.)																				
Cephalothin	9.8	**3.9**	[0.5 - 13.5]								7.8	41.2	37.3	9.8	**2.0**	**2.0**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**2.0**	[0.0 - 10.4]				49.0	35.3	11.8	2.0				**2.0**						
Ceftriaxone	2.0	**0.0**	[0.0 - 7.0]					98.0						2.0						
Cephamycins																				
Cefoxitin	0.0	**0.0**	[0.0 - 7.0]							2.0	37.3	60.8								
Folate pathway inhibitors																				
Trimethoprim-sulfamethoxazole	N/A	**39.2**	[25.8 - 53.9]				41.2	11.8	5.9	2.0			**39.2**							
Phenicols																				
Chloramphenicol	0.0	**68.6**	[54.1 - 80.9]								21.6	3.9	5.9		**17.6**	**51.0**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 7.0]	92.2	2.0				5.9											
Nalidixic acid	N/A	**5.9**	[1.2 - 16.2]							15.7	58.8	15.7	3.9			**5.9**				
Sulfonamides																				
Sulfamethoxazole	N/A	**52.9**	[38.5 - 67.1]											43.1	2.0			2.0	**2.0**	**51.0**
Tetracyclines																				
Tetracycline	2.0	**82.4**	[69.1 - 91.6]									15.7	2.0	**5.9**	**13.7**	**62.7**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 3.5: Percent and number of isolates resistant to antimicrobial agents among *Shigella*, 1999-2003

Year Total Isolates		1999 375	2000 450	2001 344	2002 620	2003 495
Subclass	Antibiotic (Resistance breakpoint)					
Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Gentamicin (MIC ≥ 16)	0.3% 1	0.2% 1	0.0% 0	0.2% 1	0.0% 0
	Kanamycin (MIC ≥ 64)	0.5% 2	1.3% 6	0.6% 2	0.8% 5	0.4% 2
	Streptomycin (MIC ≥ 64)	55.7% 209	57.1% 257	53.2% 183	54.5% 338	56.8% 281
Aminopenicillins	Ampicillin (MIC ≥ 32)	77.6% 291	79.1% 356	79.7% 274	76.6% 475	78.8% 390
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	1.1% 4	2.2% 10	4.4% 15	2.6% 16	1.6% 8
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	3.2% 12	8.0% 36	9.0% 31	6.6% 41	9.3% 46
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.4% 2
	Ceftriaxone (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	0.2% 1	1.2% 4	0.3% 2	0.2% 1
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	51.5% 193	52.9% 238	46.8% 161	37.3% 231	38.2% 189
Phenicols	Chloramphenicol (MIC ≥ 32)	17.3% 65	14.0% 63	21.5% 74	7.6% 47	8.9% 44
Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.0% 0
	Nalidixic acid (MIC ≥ 32)	1.6% 6	0.9% 4	1.7% 6	1.6% 10	1.0% 5
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	56.0% 210	55.8% 251	56.4% 194	31.8% 197	34.1% 169
Tetracyclines	Tetracycline (MIC ≥ 16)	57.3% 215	44.9% 202	59.3% 204	30.6% 190	29.3% 145

Tables 3.5 (all *Shigella* spp.), 3.6 (*S. sonnei*), and 3.7 (*S. flexneri*) show the percent of resistance to individual antimicrobial agents from 1999-2003.

Among *Shigella sonnei*, the percent of isolates resistant to trimethoprim/sulfamethoxazole was 53.1% in 1999 compared with 38.0% in 2003; nalidixic acid resistance was 1.5% or less from 1999-2003.

Among *Shigella flexneri*, the percent of isolates resistant to trimethoprim/sulfamethoxazole was 48.3% in 1999 compared to 39.2% in 2003, and 1.1% were resistant to nalidixic acid in 1999 compared to 5.9% in 2003.

Table 3.6: Percent and number of isolates resistant to antimicrobial agents among *Shigella sonnei* , 1999-2003

Year Total Isolates		1999 275	2000 366	2001 239	2002 536	2003 434
Subclass	Antibiotic (Resistance breakpoint)					
Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Gentamicin (MIC ≥ 16)	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0
	Kanamycin (MIC ≥ 64)	0.7% 2	1.6% 6	0.4% 1	0.4% 2	0.0% 0
	Streptomycin (MIC ≥ 64)	52.0% 143	56.0% 205	54.0% 129	55.4% 297	56.2% 244
Aminopenicillins	Ampicillin (MIC ≥ 32)	79.6% 219	80.6% 295	82.8% 198	77.6% 416	79.0% 343
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	0.4% 1	1.9% 7	4.6% 11	2.2% 12	1.6% 7
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	2.9% 8	8.7% 32	12.6% 30	7.3% 39	10.1% 44
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
	Ceftriaxone (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	0.3% 1	1.7% 4	0.4% 2	0.2% 1
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	53.1% 146	54.9% 201	50.6% 121	37.9% 203	38.0% 165
Phenicols	Chloramphenicol (MIC ≥ 32)	1.8% 5	2.7% 10	1.3% 3	0.2% 1	1.6% 7
Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Nalidixic acid (MIC ≥ 32)	1.5% 4	1.1% 4	0.8% 2	1.5% 8	0.5% 2
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	54.5% 150	56.0% 205	54.4% 130	29.9% 160	31.6% 137
Tetracyclines	Tetracycline (MIC ≥ 16)	46.2% 127	34.4% 126	44.8% 107	23.5% 126	22.4% 97

Table 3.7: Percent and number of isolates resistant to antimicrobial agents among *Shigella flexneri* , 1999-2003

Year Total Isolates		1999 87	2000 75	2001 91	2002 73	2003 51
Subclass	Antibiotic (Resistance breakpoint)					
Aminoglycosides	Amikacin (MIC ≥ 64)	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	1.4% 1	0.0% 0
	Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	1.1% 1	4.1% 3	3.9% 2
	Streptomycin (MIC ≥ 64)	63.2% 55	61.3% 46	47.3% 43	45.2% 33	60.8% 31
Aminopenicillins	Ampicillin (MIC ≥ 32)	77.0% 67	77.3% 58	72.5% 66	75.3% 55	84.3% 43
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	3.4% 3	4.0% 3	4.4% 4	5.5% 4	2.0% 1
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	4.6% 4	2.7% 2	1.1% 1	2.7% 2	3.9% 2
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	1.4% 1	2.0% 1
	Ceftriaxone (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	48.3% 42	42.7% 32	34.1% 31	28.8% 21	39.2% 20
Phenicols	Chloramphenicol (MIC ≥ 32)	64.4% 56	69.3% 52	74.7% 68	63.0% 46	68.6% 35
Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	1.1% 1	0.0% 0	0.0% 0
	Nalidixic acid (MIC ≥ 32)	1.1% 1	0.0% 0	3.3% 3	2.7% 2	5.9% 3
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	58.6% 51	53.3% 40	57.1% 52	41.1% 30	52.9% 27
Tetracyclines	Tetracycline (MIC ≥ 16)	92.0% 80	92.0% 69	94.5% 86	78.1% 57	82.4% 42

Table 3.8: Resistance patterns of *Shigella* isolates, 1999-2003

Year *Shigella* isolates	1999 375	2000 450	2001 344	2002 620	2003 495
No detected resistance	9.1% 34	7.3% 33	4.9% 17	8.2% 51	9.1% 45
Resistant to ≥ 1 antimicrobial agent	90.9% 341	92.7% 417	95.1% 327	91.8% 569	90.9% 450
Resistant to ≥ 2 antimicrobial agents	65.3% 245	66.9% 301	70.9% 244	57.9% 359	60.8% 301
Resistant to ≥ 3 antimicrobial agents	61.1% 229	62.9% 283	62.2% 214	42.7% 265	43.2% 214
Resistant to ≥ 4 antimicrobial agents	54.4% 204	56.7% 255	54.1% 186	31.0% 192	33.5% 166
Resistant to ≥ 5 antimicrobial agents	40.5% 152	26.9% 121	36.3% 125	21.0% 130	23.2% 115
Resistant to ≥ 1 CLSI subclass[1]	90.9% 341	92.7% 417	95.1% 327	91.8% 569	90.9% 450
Resistant to ≥ 2 CLSI subclasses[1]	65.3% 245	66.9% 301	70.9% 244	57.9% 359	60.8% 301
Resistant to ≥ 3 CLSI subclasses[1]	61.1% 229	62.9% 283	62.2% 214	42.7% 265	43.2% 214
Resistant to ≥ 4 CLSI subclasses[1]	54.1% 203	56.7% 255	54.1% 186	31.0% 192	33.5% 166
Resistant to ≥ 5 CLSI subclasses[1]	40.5% 152	26.9% 121	36.0% 124	20.8% 129	23.2% 115
At least ACSSuT resistant[2]	8.5% 32	5.6% 25	6.4% 22	1.9% 12	3.6% 18
At least ACSuTm resistant[3]	9.9% 37	6.9% 31	7.0% 24	2.7% 17	3.6% 18
At least ASuTm resistant[4]	44.3% 166	44.4% 200	37.5% 129	29.8% 185	33.3% 165
At least ANSuTm resistant[5]	0.3% 1	0.0% 0	0.6% 2	0.3% 2	0.8% 4
At least ACSSuTAuCf resistant[6]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
At least MDR-AmpC resistant[7]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ASuTm: ampicillin, trimethoprim-sulfamethoxazole

5: ANSuTm: ASuTm + naladixic acid

6: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

7: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

Changes in resistance from 1999-2003 to multiple antimicrobial classes among *Shigella* isolates are shown in Table 3.8. In all years, over 90% of isolates tested were resistant to at least one CLSI subclass. A total of 40.5% were resistant to at least five subclasses in 1999 compared with 23.2% in 2003.

Table 3.9: Resistance patterns of *Shigella sonnei* isolates, 1999-2003

Year *S. sonnei* isolates	1999 275	2000 366	2001 239	2002 536	2003 434
No detected resistance	10.5% 29	7.7% 28	5.4% 13	7.1% 38	9.2% 40
Resistant to ≥ 1 antimicrobial agent	89.5% 246	92.3% 338	94.6% 226	92.9% 498	90.8% 394
Resistant to ≥ 2 antimicrobial agents	58.2% 160	63.4% 232	62.3% 149	55.0% 295	57.6% 250
Resistant to ≥ 3 antimicrobial agents	54.5% 150	58.7% 215	54.4% 130	37.7% 202	38.2% 166
Resistant to ≥ 4 antimicrobial agents	50.9% 140	54.1% 198	49.0% 117	26.7% 143	29.5% 128
Resistant to ≥ 5 antimicrobial agents	38.5% 106	24.3% 89	36.0% 86	19.8% 106	21.0% 91
Resistant to ≥ 1 CLSI subclass[1]	89.5% 246	92.3% 338	94.6% 226	92.9% 498	90.8% 394
Resistant to ≥ 2 CLSI subclasses[1]	58.2% 160	63.4% 232	62.3% 149	55.0% 295	57.6% 250
Resistant to ≥ 3 CLSI subclasses[1]	54.5% 150	58.7% 215	54.4% 130	37.7% 202	38.2% 166
Resistant to ≥ 4 CLSI subclasses[1]	50.5% 139	54.1% 198	49.0% 117	26.7% 143	29.5% 128
Resistant to ≥ 5 CLSI subclasses[1]	38.5% 106	24.3% 89	36.0% 86	19.8% 106	21.0% 91
At least ACSSuT resistant[2]	0.4% 1	0.8% 3	0.0% 0	0.0% 0	0.7% 3
At least ACSuTm resistant[3]	1.8% 5	1.9% 7	0.8% 2	0.2% 1	0.9% 4
At least ASuTm resistant[4]	45.1% 124	46.2% 169	41.0% 98	30.2% 162	33.2% 144
At least ANSuTm resistant[5]	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.2% 1
At least ACSSuTAuCf resistant[6]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
At least MDR-AmpC resistant[7]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ASuTm: ampicillin, trimethoprim-sulfamethoxazole

5: ANSuTm: ASuTm + naladixic acid

6: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

7: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

Changes in resistance to multiple antimicrobial classes and specific combinations from 1999-2003 among *Shigella sonnei* and *Shigella flexneri* isolates are shown in Tables 3.9 and 3.10.

One *Shigella* (*S. flexneri*) isolate was resistant to both nalidixic acid and ceftiofur in 2003; this is the first isolate with this phenotype since NARMS began monitoring *Shigella* in 1999.

Table 3.10: Resistance patterns of *Shigella flexneri* isolates, 1999-2003

Year *S. flexneri* isolates	1999 87	2000 75	2001 91	2002 73	2003 51
No detected resistance	4.6% 4	4.0% 3	3.3% 3	15.1% 11	7.8% 4
Resistant to ≥ 1 antimicrobial agent	95.4% 83	96.0% 72	96.7% 88	84.9% 62	92.2% 47
Resistant to ≥ 2 antimicrobial agents	83.9% 73	82.7% 62	90.1% 82	76.7% 56	86.3% 44
Resistant to ≥ 3 antimicrobial agents	80.5% 70	81.3% 61	80.2% 73	75.3% 55	82.4% 42
Resistant to ≥ 4 antimicrobial agents	67.8% 59	69.3% 52	65.9% 60	58.9% 43	66.7% 34
Resistant to ≥ 5 antimicrobial agents	49.4% 43	40.0% 30	33.0% 30	30.1% 22	45.1% 23
Resistant to ≥ 1 CLSI subclass[1]	95.4% 83	96.0% 72	96.7% 88	84.9% 62	92.2% 47
Resistant to ≥ 2 CLSI subclasses[1]	83.9% 73	82.7% 62	90.1% 82	76.7% 56	86.3% 44
Resistant to ≥ 3 CLSI subclasses[1]	80.5% 70	81.3% 61	80.2% 73	75.3% 55	82.4% 42
Resistant to ≥ 4 CLSI subclasses[1]	67.8% 59	69.3% 52	65.9% 60	58.9% 43	66.7% 34
Resistant to ≥ 5 CLSI subclasses[1]	49.4% 43	40.0% 30	31.9% 29	28.8% 21	45.1% 23
At least ACSSuT resistant[2]	33.3% 29	29.3% 22	22.0% 20	16.4% 12	29.4% 15
At least ACSuTm resistant[3]	34.5% 30	32.0% 24	23.1% 21	21.9% 16	27.5% 14
At least ASuTm resistant[4]	44.8% 39	38.7% 29	25.3% 23	27.4% 20	37.3% 19
At least ANSuTm resistant[5]	1.1% 1	0.0% 0	1.1% 1	1.4% 1	5.9% 3
At least ACSSuTAuCf resistant[6]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least MDR-AmpC resistant[7]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Quinolone and cephalosporin (3rd gen.) resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.0% 1

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ASuTm: ampicillin, trimethoprim-sulfamethoxazole

5: ANSuTm: ASuTm + naladixic acid

6: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

7: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

4. *E.* Coli O157

A total of 170 *E. coli* O157 isolates were received at CDC in 2003, of these isolates, 158 (92.9%) were viable and tested for antimicrobial susceptibility. Of these 158 isolates, one isolate was not included in the analysis because it was a duplicate submission from the same patient, leaving 157 isolates for analysis.

Table 1.1 shows the number of isolates included in the final analysis by site and the population represented.

Table 4.1 shows the MIC distributions for the 16 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 157 *E. coli* O157 isolates tested in 2003.

Antimicrobial agents with the highest prevalence of resistance were sulfamethoxazole (3.8%) and streptomycin (1.9%). Two isolates in 2003 were resistant to ceftiofur [Table 4.2].

Table 4.1: Distribution of MICs and occurrence of resistance among E. *coli* O157 isolates, 2003 (N=157)

Antibiotic	% of Isolates %I	%R	CI	Percent of all isolates with MIC (gµ/mL) of: 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512	1024
Aminoglycosides																				
Amikacin	0.0	**0.0**	[0.0 - 2.3]						1.9	61.8	31.8	4.5								
Gentamicin	0.0	**0.0**	[0.0 - 2.3]					24.8	40.1	34.4	0.6									
Kanamycin	0.0	**0.0**	[0.0 - 2.3]										100.0							
Streptomycin	N/A	**1.9**	[0.4 - 5.5]												98.1	**0.6**	**1.3**			
Aminopenicillins																				
Ampicillin	0.0	**3.2**	[1.0 - 7.3]							3.8	29.3	56.1	7.0	0.6		**3.2**				
Beta-lactamase inhibitor combinations																				
Amoxicillin-clavulanic acid	0.0	**1.3**	[0.2 - 4.5]							3.2	9.6	84.1	1.9			**1.3**				
Cephalosporins (1st Gen.)																				
Cephalothin	6.4	**2.5**	[0.7 - 6.4]								2.5	13.4	75.2	6.4	**1.3**	**1.3**				
Cephalosporins (3rd Gen.)																				
Ceftiofur	0.0	**1.3**	[0.2 - 4.5]				2.5	39.5	56.1	0.6				**1.3**						
Ceftriaxone	1.3	**0.0**	[0.0 - 2.3]					98.7						1.3						
Cephamycins																				
Cefoxitin	1.3	**1.3**	[0.2 - 4.5]							1.3	8.3	63.1	24.8	1.3	**1.3**					
Folate pathway inhibitors																				
Trimethoprim-sulfamethoxazole	N/A	**0.6**	[0.0 - 3.5]				97.5	1.9					**0.6**							
Phenicols																				
Chloramphenicol	0.6	**1.3**	[0.2 - 4.5]								1.3	41.4	55.4	0.6	**0.6**	**0.6**				
Quinolones																				
Ciprofloxacin	0.0	**0.0**	[0.0 - 2.3]	98.7	0.6			0.6												
Nalidixic acid	N/A	**0.6**	[0.0 - 3.5]								27.4	70.7	1.3			**0.6**				
Sulfonamides																				
Sulfamethoxazole	N/A	**3.8**	[1.4 - 8.1]											95.5	0.6					**3.8**
Tetracyclines																				
Tetracycline	0.6	**5.7**	[2.7 - 10.6]									93.6	0.6		**0.6**	**5.1**				

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas indicate the dilution range of the Sensititre plate used to test the 2003 isolates
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 4.2: Percent and number of isolates resistant to antimicrobial agents among E. *coli* O157, 1996-2003

Year Total Isolates		1996 201	1997 161	1998 318	1999 292	2000 407	2001 277	2002 399	2003 157
Subclass	Antibiotic (Resistance breakpoint)								
Aminoglycosides	Amikacin (MIC ≥ 64)	Not Tested	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	0.3% 1	0.5% 2	0.4% 1	0.0% 0	0.0% 0
	Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.3% 1	0.7% 2	1.0% 4	0.0% 0	0.5% 2	0.0% 0
	Streptomycin (MIC ≥ 64)	2.0% 4	2.5% 4	1.9% 6	2.7% 8	5.2% 21	1.8% 5	2.3% 9	1.9% 3
Aminopenicillins	Ampicillin (MIC ≥ 32)	1.5% 3	0.0% 0	2.5% 8	1.4% 4	2.7% 11	2.2% 6	1.5% 6	3.2% 5
Beta-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.3% 1	1.0% 4	0.7% 2	0.0% 0	1.3% 2
Cephalosporin (1st Gen.)	Cephalothin (MIC ≥ 32)	1.5% 3	2.5% 4	0.0% 0	0.7% 2	1.2% 5	1.4% 4	1.5% 6	2.5% 4
Cephalosporins (3rd Gen.)	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 4	1.1% 3	0.0% 0	1.3% 2
	Ceftriaxone (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
Cephamycins	Cefoxitin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	1.0% 4	0.7% 2	0.0% 0	1.3% 2
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole (MIC ≥ 4)	0.0% 0	0.0% 0	0.6% 2	1.4% 4	0.7% 3	0.7% 2	0.5% 2	0.6% 1
Phenicols	Chloramphenicol (MIC ≥ 32)	0.5% 1	0.0% 0	0.3% 1	0.0% 0	3.7% 15	1.4% 4	1.3% 5	1.3% 2
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
	Nalidixic acid (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.7% 2	0.5% 2	1.1% 3	1.0% 4	0.6% 1
Sulfonamides	Sulfamethoxazole (MIC ≥ 512)	11.9% 24	9.9% 16	5.7% 18	8.2% 24	5.9% 24	5.1% 14	3.5% 14	3.8% 6
Tetracyclines	Tetracycline (MIC ≥ 16)	5.0% 10	3.1% 5	4.4% 14	3.4% 10	7.1% 29	5.4% 15	3.0% 12	5.7% 9

Table 4.3: Resistance patterns of E. *coli* O157 isolates, 1996-2003

Year E. coli O157 isolates	1996 201	1997 161	1998 318	1999 292	2000 407	2001 277	2002 399	2003 157
No detected resistance	85.1% 171	88.8% 143	92.8% 295	89.7% 262	90.2% 367	91.3% 253	93.0% 371	89.2% 140
Resistant to ≥ 1 antimicrobial agent	14.9% 30	11.2% 18	7.2% 23	10.3% 30	9.8% 40	8.7% 24	7.0% 28	10.8% 17
Resistant to ≥ 2 antimicrobial agents	5.0% 10	6.2% 10	5.3% 17	4.1% 12	6.6% 27	5.4% 15	3.8% 15	5.1% 8
Resistant to ≥ 3 antimicrobial agents	1.5% 3	0.6% 1	1.9% 6	3.1% 9	4.7% 19	2.5% 7	2.3% 9	3.2% 5
Resistant to ≥ 4 antimicrobial agents	0.5% 1	0.0% 0	0.9% 3	1.7% 5	4.2% 17	2.2% 6	1.0% 4	2.5% 4
Resistant to ≥ 5 antimicrobial agents	0.5% 1	0.0% 0	0.3% 1	0.7% 2	1.7% 7	1.1% 3	0.5% 2	0.6% 1
Resistant to ≥ 1 CLSI subclass[1]	14.9% 30	11.2% 18	7.2% 23	10.3% 30	9.8% 40	8.7% 24	7.0% 28	10.8% 17
Resistant to ≥ 2 CLSI subclasses[1]	5.0% 10	6.2% 10	5.3% 17	4.1% 12	6.6% 27	5.4% 15	3.8% 15	5.1% 8
Resistant to ≥ 3 CLSI subclasses[1]	1.5% 3	0.6% 1	1.9% 6	3.1% 9	4.7% 19	2.2% 6	2.3% 9	3.2% 5
Resistant to ≥ 4 CLSI subclasses[1]	0.5% 1	0.0% 0	0.9% 3	1.0% 3	3.7% 15	2.2% 6	1.0% 4	2.5% 4
Resistant to ≥ 5 CLSI subclasses[1]	0.5% 1	0.0% 0	0.0% 0	0.7% 2	1.5% 6	1.1% 3	0.3% 1	0.6% 1
At least ACSSuT resistant[2]	0.5% 1	0.0% 0	0.0% 0	0.0% 0	1.2% 5	0.4% 1	0.0% 0	0.0% 0
At least ACSuTm resistant[3]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCf resistant[4]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 4	0.4% 1	0.0% 0	0.0% 0
At least MDR-AmpC resistant[5]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 4	0.4% 1	0.0% 0	0.0% 0
Quinolone and cephalosporin (3rd gen.) 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

1: CLSI: Clinical and Laboratory Standards Institute

2: ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline

3: ACSuTm: ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole

4: ACSSuTAuCf: ACSSuT + amoxicillin-clavulanic acid, ceftiofur

5: MDR-AmpC: ACSSuTAuCf + decreased susceptibility to ceftriaxone (MIC ≥ 2µg/mL)

Isolates resistant to at least one CLSI subclass increased from 7.0% in 2002 to 10.8% in 2003 [Table 4.3]. Resistance to at least two CLSI subclasses increased from 3.8% in 2002 to 5.1% in 2003. Isolates resistant to at least five subclasses was 0.3% (1/399) in 2002 and 0.6% (1/157) in 2003.

Antimicrobial treatment of *E. coli* O157 infections is not recommended, but resistance changes, particularly appearance of third generation cephalosporin resistance, might prove useful in understanding exchange of mobile resistance elements in bovine production settings.

5. *Campylobacter*

A total of 428 *Campylobacter* isolates were received at CDC in 2003; of these isolates, 405 (95%) were viable upon receipt and tested for antimicrobial susceptibility. Of these 405 isolates, 77 were not included in the analysis because they were duplicate submissions (four isolates) from the same patient, were not part of the sampling scheme (68 isolates), or were not *Campylobacter* (five isolates), leaving 328 isolates for analysis. Of the 328 isolates tested, 303 (92.4%) were *C. jejuni* and 22 (6.7%) were *C. coli* [Table 5.1].

Table 1.1 shows the number of isolates included in the final analysis by site and the population represented. Table 5.2 shows the MIC distributions for the 8 antimicrobial agents tested and the prevalence of antimicrobial resistance for the 328 *Campylobacter* isolates tested in 2003. Among 328 *Campylobacter* isolates tested in 2003, resistance was highest to tetracycline (38.4%), nalidixic acid (18.9%), and ciprofloxacin (17.7%). Of note, 33.8% of MIC results for erythromycin fell within the intermediate range and were non-susceptible. None of the *Campylobacter* isolates tested were resistant to chloramphenicol.

Table 5.1: Frequency of *Campylobacter* species, 2003

Species	N	%
jejuni	303	92.4%
coli	22	6.7%
other species	3	0.9%
Total	**328**	**100.0%**

Table 5.2: Distribution of MICs and occurrence of resistance among *Campylobacter* isolates, 2003 (N=328)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:														
Antibiotic	**%I**	**%R**	**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	0.3	[0.0 - 1.7]		0.3	0.3	1.2	15.9	64.0	15.9	2.1								**0.3**
Lincosamides Clindamycin	5.2	1.2	[0.3 - 3.1]		0.3	4.6	22.0	46.6	20.1	4.6	0.6	**0.6**	**0.3**						**0.3**
Macrolides Azithromycin	1.2	0.9	[0.2 - 2.6]		5.5	31.7	45.4	14.9	0.9	0.3									**0.9**
Erythromycin	33.8	0.9	[0.2 - 2.6]			0.3	2.1	15.9	47.3	24.1	7.3	2.4							**0.9**
Phenicols Chloramphenicol	0.9	0.0	[0.0 - 1.1]					0.3	10.4	47.9	31.7	7.6	1.2	0.9					
Quinolones Ciprofloxacin	0.3	17.7	[13.7 - 22.3]	1.8	50.0	23.8	5.5	0.3	0.6		0.3			**0.3**		**17.4**			
Nalidixic acid	N/A	18.9	[14.8 - 23.6]				0.3		1.8	24.4	40.2	10.7	3.7	0.6					**18.9**
Tetracyclines Tetracycline	1.8	38.4	[33.1 - 43.9]		15.2	25.3	11.9	4.6	1.8	0.3	0.9		1.8	**2.4**	**4.0**	**4.6**	**1.2**		**26.2**

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas represent E-test MIC ranges
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 5.3: Percent and number of isolates resistant to antimicrobial agents among *Campylobacter*, 1997-2003

Year		1997	1998	1999	2000	2001	2002	2003
Total Isolates		217	310	317	324	384	354	328
Subclass	Antibiotic (Resistance breakpoint)							
Aminoglycosides	Gentamicin (MIC ≥ 16)	Not Tested	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.3% 1
Lincosamides	Clindamycin (MIC ≥ 4)	2.3% 5	1.3% 4	1.6% 5	1.2% 4	2.9% 11	2.0% 7	1.2% 4
Macrolides	Azithromycin (MIC ≥ 2)	Not Tested	1.3% 4	3.2% 10	1.9% 6	2.1% 8	2.0% 7	0.9% 3
	Erythromycin (MIC ≥ 8)	3.2% 7	1.9% 6	2.8% 9	1.9% 6	2.1% 8	2.0% 7	0.9% 3
Phenicols	Chloramphenicol (MIC ≥ 32)	5.1% 11	2.9% 9	0.6% 2	0.0% 0	0.3% 1	0.3% 1	0.0% 0
Quinolones	Ciprofloxacin (MIC ≥ 4)	12.9% 28	13.9% 43	18.3% 58	14.8% 48	19.5% 75	20.1% 71	17.7% 58
	Nalidixic acid (MIC ≥ 32)	20.3% 44	18.4% 57	21.1% 67	16.7% 54	20.8% 80	20.6% 73	18.9% 62
Tetracyclines	Tetracycline (MIC ≥ 16)	47.9% 104	45.5% 141	43.8% 139	38.3% 124	40.9% 157	41.2% 146	38.4% 126

Table 5.3 shows the percent of *Campylobacter* isolates resistant to each antimicrobial agent from 1997-2003. The antimicrobial agent with a statistically significant increase in resistance was ciprofloxacin; the percent of *Campylobacter* isolates resistant to ciprofloxacin was 12.9% in 1997 and 17.7% in 2003 (OR=1.8, 95% CI [1.1, 3.0]).

Table 5.4 shows the percent of *Campylobacter* isolates resistant to one or more CLSI subclasses from 1997-2003. In 2003, 48.8% of *Campylobacter* isolates were resistant to one or more CLSI subclasses compared to 52.0% in 2002. In 2003, 9.1% of *Campylobacter* isolates were resistant to two or more subclasses compared to 12.7% in 2002.

Table 5.4: Resistance patterns of *Campylobacter*, 1997-2003

Year	1997	1998	1999	2000	2001	2002	2003
Campylobacter isolates	217	310	317	324	384	354	328
No detected resistance	43.8% 95	44.8% 139	47.0% 149	51.9% 168	48.7% 187	48.0% 170	51.2% 168
Resistant to ≥ 1 antimicrobial agent	56.2% 122	55.2% 171	53.0% 168	48.1% 156	51.3% 197	52.0% 184	48.8% 160
Resistant to ≥ 2 antimicrobial agents	22.1% 48	18.1% 56	20.5% 65	15.7% 51	21.4% 82	21.2% 75	18.3% 60
Resistant to ≥ 3 antimicrobial agents	12.4% 27	8.7% 27	12.3% 39	7.7% 25	12.5% 48	12.1% 43	8.5% 28
Resistant to ≥ 4 antimicrobial agents	0.5% 1	1.9% 6	1.6% 5	0.9% 3	1.3% 5	0.8% 3	0.9% 3
Resistant to ≥ 5 antimicrobial agents	0.5% 1	0.0% 0	0.9% 3	0.3% 1	0.0% 0	0.0% 0	0.3% 1
Resistant to ≥ 1 CLSI subclass[1]	56.2% 122	55.2% 171	53.0% 168	48.1% 156	51.3% 197	52.0% 184	48.8% 160
Resistant to ≥ 2 CLSI subclasses[1]	19.4% 42	11.3% 35	14.2% 45	8.6% 28	13.5% 52	12.7% 45	9.1% 30
Resistant to ≥ 3 CLSI subclasses[1]	2.8% 6	2.6% 8	1.6% 5	0.9% 3	1.8% 7	1.4% 5	0.9% 3
Resistant to ≥ 4 CLSI subclasses[1]	0.5% 1	1.0% 3	1.3% 4	0.3% 1	0.3% 1	0.0% 0	0.3% 1
Resistant to ≥ 5 CLSI subclasses[1]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

1: CLSI: Clinical and Laboratory Standards Institute

Table 5.5: Distribution of MICs and occurrence of resistance among *Campylobacter jejuni* isolates, 2003 (N=303)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:														
Antibiotic	**%I**	**%R**	**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	0.0	[0.0 - 1.2]			0.3	1.3	16.8	65.7	13.5	2.3								
Lincosamides Clindamycin	4.0	0.3	[0.0 - 1.8]			5.0	23.4	49.2	18.2	3.6	0.3	**0.3**							
Macrolides Azithromycin	1.0	0.3	[0.0 - 1.8]		5.9	34.0	45.9	12.5	1.0										**0.3**
Erythromycin	32.3	0.3	[0.0 - 1.8]				2.3	16.2	49.2	25.1	5.9	1.3							**0.3**
Phenicols Chloramphenicol	0.7	0.0	[0.0 - 1.2]					0.3	11.2	50.8	30.0	5.9	1.0	0.7					
Quinolones Ciprofloxacin	0.3	17.2	[13.1 - 21.9]	2.0	51.5	23.8	5.0		0.3		0.3			**0.3**		**16.8**			
Nalidixic acid	N/A	17.8	[13.7 - 22.6]				0.3		2.0	26.1	40.9	10.2	2.6	0.7					**17.8**
Tetracyclines Tetracycline	2.0	38.3	[32.8 - 44.0]		16.2	26.7	10.6	4.3	1.7		0.7		2.0	**2.3**	**4.3**	**5.0**	**1.3**		**25.4**

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas represent E-test MIC ranges
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 5.5 shows the MIC distributions for the eight antimicrobial agents tested and the prevalence of antimicrobial resistance for the 303 *Campylobacter jejuni* isolates tested in 2003. Antimicrobial agents with the highest prevalence of resistance among the 303 *Campylobacter jejuni* isolates were tetracycline (38.3%) followed by nalidixic acid (17.8%) and ciprofloxacin (17.2%). Of note, 32.3% of MIC results for *C. jejuni* for erythromycin fell within the intermediate range and were non-susceptible. No *C. jejuni* isolates were resistant to gentamicin or chloramphenicol.

Table 5.6: Percent and number of isolates resistant to antimicrobial agents among *Campylobacter jejuni* , 1997-2003

Year		1997	1998	1999	2000	2001	2002	2003
Total Isolates		209	297	293	306	365	329	303
Subclass	Antibiotic (Resistance breakpoint)							
Aminoglycosides	Gentamicin (MIC ≥ 16)	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Lincosamides	Clindamycin (MIC ≥ 4)	1.4% 3	1.0% 3	1.0% 3	1.0% 3	2.5% 9	1.8% 6	0.3% 1
Macrolides	Azithromycin (MIC ≥ 2)	Not Tested	0.3% 1	2.7% 8	1.6% 5	1.9% 7	1.8% 6	0.3% 1
	Erythromycin (MIC ≥ 8)	2.9% 6	1.0% 3	2.4% 7	1.6% 5	1.9% 7	1.8% 6	0.3% 1
Phenicols	Chloramphenicol (MIC ≥ 32)	3.8% 8	1.0% 3	0.7% 2	0.0% 0	0.3% 1	0.3% 1	0.0% 0
Quinolones	Ciprofloxacin (MIC ≥ 4)	12.4% 26	13.8% 41	17.7% 52	14.7% 45	18.4% 67	20.7% 68	17.2% 52
	Nalidixic acid (MIC ≥ 32)	19.1% 40	16.5% 49	20.1% 59	16.0% 49	19.5% 71	21.3% 70	17.8% 54
Tetracyclines	Tetracycline (MIC ≥ 16)	47.8% 100	46.1% 137	45.4% 133	39.2% 120	40.3% 147	41.3% 136	38.3% 116

Table 5.7: Distribution of MICs and occurrence of resistance among *Campylobacter coli* isolates, 2003 (N=22)

	% of Isolates			Percent of all isolates with MIC (µg/mL) of:														
Antibiotic	**%I**	**%R**	**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	4.5	[0.1 - 22.8]						45.5	50.0									**4.5**
Lincosamides Clindamycin	18.2	13.6	[2.9 - 34.9]				4.5	18.2	45.5	13.6	4.5	**4.5**	**4.5**						**4.5**
Macrolides Azithromycin	4.5	9.1	[1.1 - 29.2]			4.5	40.9	40.9		4.5									**9.1**
Erythromycin	54.5	9.1	[1.1 - 29.2]					13.6	22.7	13.6	22.7	18.2							**9.1**
Phenicols Chloramphenicol	4.5	0.0	[0.0 - 15.4]							13.6	54.5	22.7	4.5	4.5					
Quinolones Ciprofloxacin	0.0	22.7	[7.8 - 45.4]		36.4	27.3	9.1	4.5								**22.7**			
Nalidixic acid	N/A	22.7	[7.8 - 45.4]							4.5	36.4	18.2	18.2						**22.7**
Tetracyclines Tetracycline	0.0	45.5	[24.4 - 67.8]		4.5	9.1	31.8	4.5	4.5					**4.5**					**40.9**

Notes:
* A single vertical bar indicates the CLSI Susceptible breakpoints for each drug
* Double vertical bars indicate the CLSI Resistant breakpoints for each drug
* Unshaded areas represent E-test MIC ranges
* Figures outside the Sensititre plate range were reported as ">" the plate's highest dilution for that drug
* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

Table 5.6 shows the percent of *C. jejuni* isolates resistant for each antimicrobial agent from 1997-2003. The percent of *C. jejuni* resistant to ciprofloxacin was 12.4% in 1997 and 17.2% in 2003; a statistically significant increase (OR=1.8, 95% CI [1.1, 3.1]).

Table 5.7 shows the MIC distributions for the eight antimicrobial agents tested and the prevalence of antimicrobial resistance for the 22 *Campylobacter coli* isolates tested in 2003. Antimicrobial agents with the highest prevalence of resistance among the 22 *C. coli* isolates were tetracycline (45.5%), ciprofloxacin (22.7%), nalidixic acid (22.7%), clindamycin (13.6%) and azithromycin (9.1%).

Table 5.8 shows the percent of *C. coli* isolates resistant for each antimicrobial agent from 1997-2003. The percent of *C. coli* isolates resistant to ciprofloxacin was 33.3% in 1997 and 22.7% in 2003. The percent of *C. coli* isolates resistant to azithromycin was 37.5% in 1998 and 9.1% in 2003.

Table 5.8: Percent and number of isolates resistant to antimicrobial agents among *Campylobacter coli* , 1997-2003

Year		1997	1998	1999	2000	2001	2002	2003
Total Isolates		6	8	20	12	17	25	22
Subclass	Antibiotic (Resistance breakpoint)							
Aminoglycosides	Gentamicin (MIC ≥ 16)	Not Tested	0.0% 0	0.0% 0	8.3% 1	0.0% 0	0.0% 0	4.5% 1
Lincosamides	Clindamycin (MIC ≥ 4)	16.7% 1	12.5% 1	10.0% 2	8.3% 1	11.8% 2	4.0% 1	13.6% 3
Macrolides	Azithromycin (MIC ≥ 2)	Not Tested	37.5% 3	10.0% 2	8.3% 1	5.9% 1	4.0% 1	9.1% 2
	Erythromycin (MIC ≥ 8)	0.0% 0	37.5% 3	10.0% 2	8.3% 1	5.9% 1	4.0% 1	9.1% 2
Phenicols	Chloramphenicol (MIC ≥ 32)	50.0% 3	37.5% 3	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Quinolones	Ciprofloxacin (MIC ≥ 4)	33.3% 2	0.0% 0	30.0% 6	25.0% 3	47.1% 8	12.0% 3	22.7% 5
	Nalidixic acid (MIC ≥ 32)	66.7% 4	50.0% 4	30.0% 6	25.0% 3	47.1% 8	12.0% 3	22.7% 5
Tetracyclines	Tetracycline (MIC ≥ 16)	66.7% 4	50.0% 4	30.0% 6	25.0% 3	58.8% 10	40.0% 10	45.5% 10

Limitations

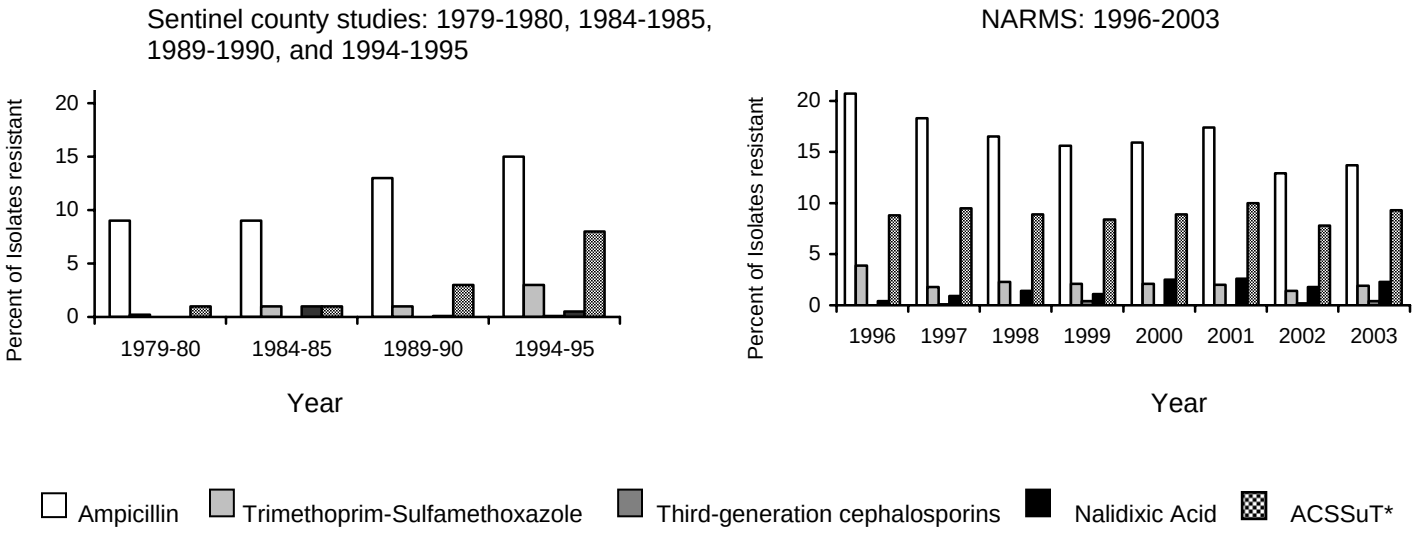
Three limitations are evident in NARMS *Campylobacter* surveillance; the use of sentinel clinical laboratories in some states, the sampling scheme, and the limited geographic area under surveillance.

In four states that participated in NARMS *Campylobacter* surveillance in 2003 (California, Colorado, Connecticut, and Oregon), *Campylobacter* isolates were submitted to NARMS from one sentinel clinical laboratory. In Georgia, Maryland, Minnesota, New York, and Tennessee, the *Campylobacter* isolates submitted to NARMS were selected from all *Campylobacter* isolates from most clinical laboratories within a specific geographical area (metro Atlanta area in Georgia, statewide in Maryland and Minnesota, the metro Albany and Rochester areas in New York, and the metro Gallatin, Knoxville, and Nashville areas in Tennessee). In California, Colorado, Connecticut, and Oregon, the sentinel clinical laboratory selected the first *Campylobacter* isolate isolated each week for submission to NARMS; if no isolate was isolated in a week, then no isolate was submitted from that laboratory. Since none of the sentinel clinical laboratories used an isolation procedure that was more or less likely to yield antimicrobial-resistant *Campylobacter* isolates than other clinical laboratories in their respective states, it is unlikely that the use of a sentinel clinical laboratory would be associated with an increased or decreased likelihood of antimicrobial resistance among *Campylobacter* isolates submitted to NARMS.

In 2003, the NARMS participating public health laboratory in Georgia, Maryland, Minnesota, New York, and Tennessee, and sentinel clinical laboratories in all other FoodNet sites, selected one *Campylobacter* isolate each week and forwarded the isolate to CDC. When the isolates were selected, the antimicrobial resistance pattern of the isolates was not known. Therefore, it is unlikely that the antimicrobial resistance pattern of an isolate would influence submission of the isolate to NARMS. However, the one-a-week sampling scheme could result in over- or under-sampling of antimicrobial-resistant isolates if the prevalence of such resistance is not uniform throughout the year. The impact of the over- or under-sampling may be variable among states. *Campylobacter* isolates were forwarded to CDC by ten FoodNet participating states in 2003, representing approximately 42 million persons or 14% of the United States population. Because NARMS 2003 *Campylobacter* surveillance was not nationwide, generalization to the United States population should be done with caution due to potential regional differences in the prevalence of antimicrobial resistance among *Campylobacter*.

Summary of Long Term Changes

Non-Typhi *Salmonella*, 1979-2003

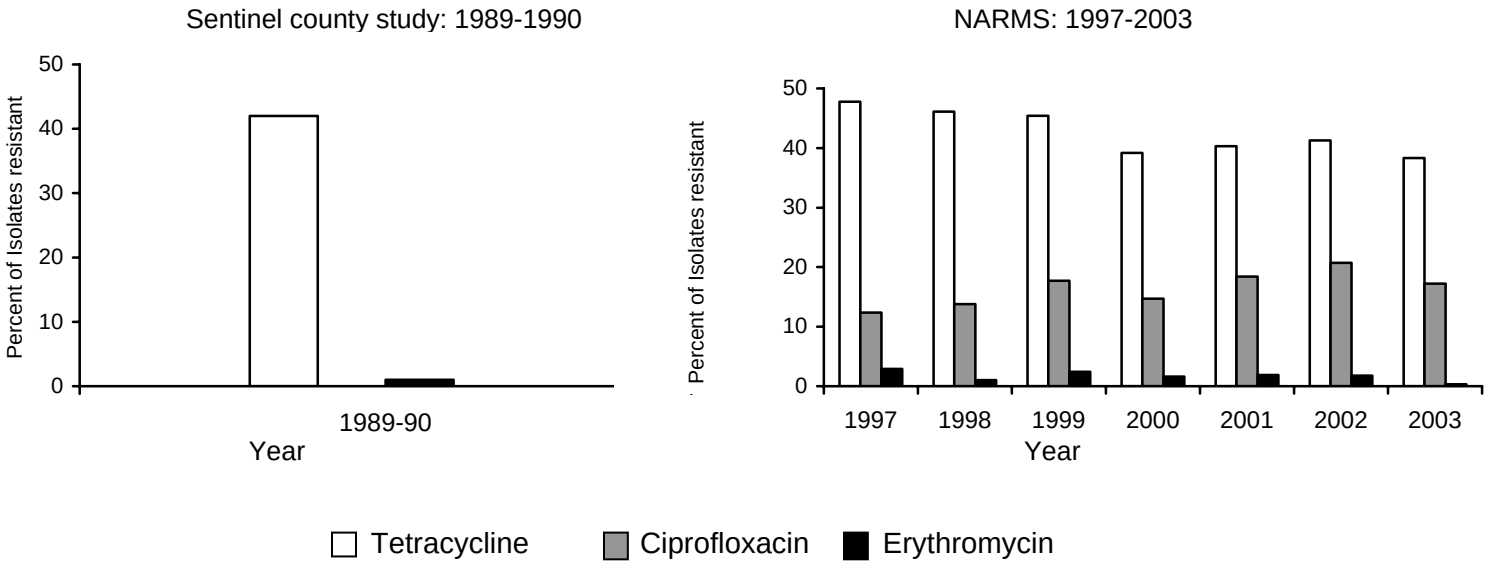


*ACSSuT = resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline

For non-Typhi *Salmonella*, sentinel county surveys were conducted in 1979-1980, 1984-1985, 1989-1990, and 1994-1995.[3,4,5,6] Isolates were tested at CDC by disk diffusion. NARMS began testing *Salmonella* in 1996. There were 14 participating sites in 1996. In 2003, NARMS expanded to become nationwide. From 1996 to 2002, participating sites forwarded every 10th non-Typhi *Salmonella* received at their public health laboratories to CDC. In 2003, sites forwarded every 20th isolate. In NARMS, isolates were tested by broth microdilution to determine minimum inhibitory concentrations (MICs) to 16 antimicrobial agents.

Over the last quarter century, resistance among non-Typhi *Salmonella* has increased to a number of clinically important antimicrobial agents. Resistance to ampicillin and trimethoprim/sulfamethoxazole increased first, reaching 21% and 4%, respectively, in 1996. Resistance to third-generation cephalosporins (e.g., ceftriaxone), quinolones (e.g., nalidixic acid), and the ACSSuT resistance pattern increased more recently. A public health concern raised by this resistance is the loss of efficacious agents to treat serious *Salmonella* infections, especially in children. The clinical implications of current resistance levels are potential treatment failure, increased duration of illness, and increased length of hospitalization.[5,7,8] For more information on treatment of *Salmonella* see Diagnosis and Management of Foodborne Illness: A Primer for Physicians.[9]

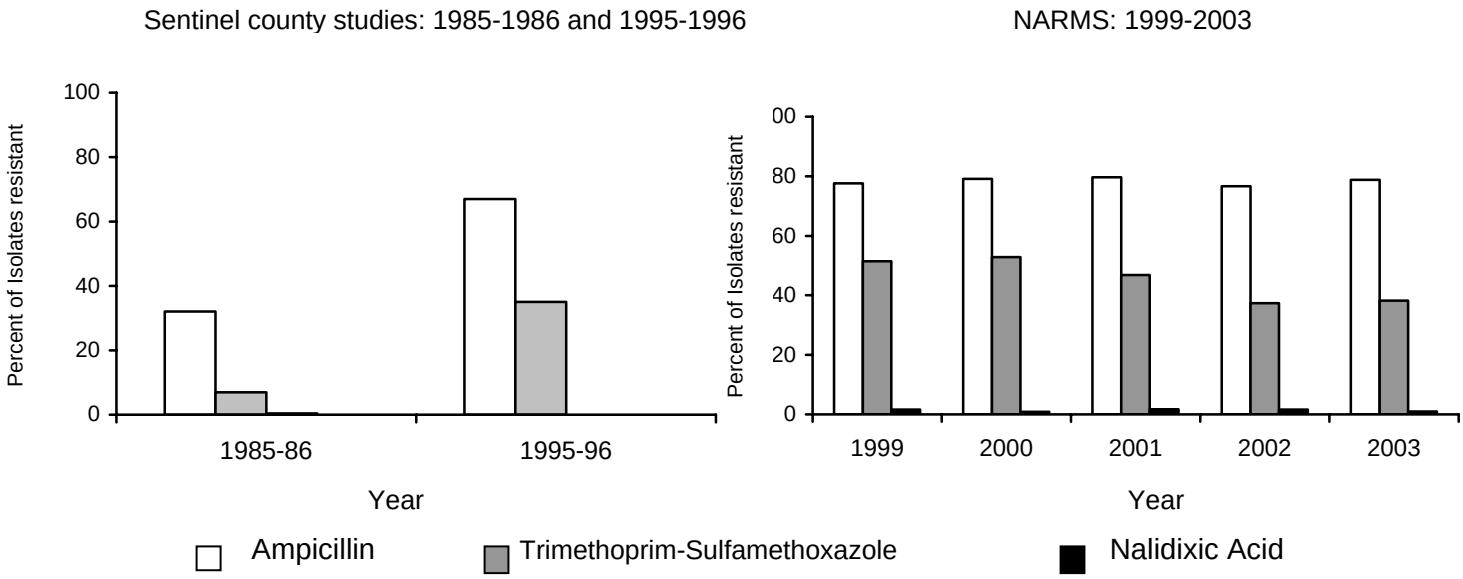
***Campylobacter jejuni*, 1989-2003**



For *Campylobacter jejuni*, a sentinel county survey was conducted in 1989-1990.[10] Isolates were received and tested at CDC. NARMS began testing *Campylobacter* in 1997. In NARMS, there were five participating sites in 1997, seven in 1998, eight in 1999, nine in 2000-2002, and 10 in 2003. In 2003, one *Campylobacter* isolate per week was forwarded to CDC from 10 states and tested by E-test for susceptibility to eight antimicrobial agents.

Over the last 15 years, resistance among *Campylobacter jejuni* to a number of clinically important antimicrobial agents has changed. Resistance to tetracycline was already 42% in 1989-1990 and has declined in more recent years. Resistance to ciprofloxacin increased more recently. No isolates resistant to ciprofloxacin were identified in 1989-1990, 12% were resistant in 1997, 21% in 2002, and 17% in 2003. Resistance to erythromycin has remained low at 3% or less. Because the primary reservoir for *Campylobacter jejuni* is among poultry, it is likely that this increasing ciprofloxacin resistance is related to the use of fluoroquinolones, which were approved for use in poultry farming in 1995. Public health concern was raised by this resistance because of the threat it posed to the efficacy of fluoroquinolones for treating campylobacteriosis. The clinical implications of resistance to fluoroquinolones include an increased duration of illness and potential treatment failure.[11] For more information on treatment of *Campylobacter* see Diagnosis and Management of Foodborne Illness: A Primer for Physicians.[9]

***Shigella*, 1985-2003**



For *Shigella*, sentinel county surveys were conducted in 1985-1986 and 1995-1996.[12] Isolates were received and tested at CDC. NARMS began testing *Shigella* in 1999. In NARMS, every 10th *Shigella* isolate received at participating state public health laboratories was forwarded to CDC in 1999-2002, and every 20th isolate in 2003. Isolates were tested by broth microdilution to determine MICs to 16 antimicrobial agents.

Over the last 18 years, resistance among *Shigella* has increased to a number of clinically important antimicrobial agents. Resistance to ampicillin was already 32% in 1985-1986 and increased to 67% by 1995. Resistance to nalidixic acid emerged more recently. One *Shigella* isolate resistant to nalidixic acid was identified in 1985-1986. The percentage of *Shigella* isolates resistant to nalidixic acid increased to nearly 2% in 1999 but has remained at 2% or less. A single isolate was resistant to ciprofloxacin in 2001. No resistance to ceftriaxone has been identified.

As *Shigella* have no environmental or animal reservoir except humans, it is likely that this resistance is related to the use of antimicrobials in human medicine. A public health concern raised by these resistances is the loss of efficacious agents to treat *Shigella* infections. The clinical implication of current resistance levels is potential treatment failure. This may be particularly important for infections related to international travel.[13] For more information on treatment of *Shigella* see Diagnosis and Management of Foodborne Illness: A Primer for Physicians.[9]

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Appendix A:

Summary of Enterococci Resistance Surveillance (ERS) 2001 - 2003

Enterococci Working Group

Centers for Disease Control and Prevention

Foodborne and Diarrheal Diseases Branch
Division of Bacterial and Mycotic Diseases
National Center for Infectious Diseases
Frederick Angulo
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Introduction

Enterococci are Gram positive cocci whose major habitat is the gastrointestinal tract of humans and other animals. Intestinal carriage of resistant enterococci in humans is known to be associated with hospitalization and antimicrobial use. However, carriage of enterococci resistant to certain antimicrobial agents has been documented among persons who have not been hospitalized or recently taken antimicrobial agents, suggesting a community source of some resistant enterococci. Antimicrobial agents are commonly used for growth promotion, disease prevention and therapy in food animals such as chickens and pigs. Such use results in the selection of resistant enterococci in the intestinal tracts of animals. Taken together, this suggests that use of antimicrobial agents in food animals creates selective pressure on enterococci among food animals and ultimately may contribute to the pool of resistant enterococci among human populations. It is therefore important to monitor resistance in commensals to determine the role of these bacteria as reservoirs of resistance determinants for human pathogens. The Enterococci Resistance Surveillance (ERS) project was designed to determine the prevalence of clinically important antimicrobial-resistant enterococci in stool samples among persons in the community.

Summary of 2001-2003 Surveillance Data

Background

Enterococci resistance study began in 2001 to prospectively monitor the prevalence of antimicrobial resistance of human enterococci isolates from stool samples. The study includes five sites: Georgia, Maryland, Michigan, Minnesota, and Oregon.

Multi-drug resistance

- 96.4% of enterococci isolates tested were resistant to ≥ 2 antimicrobial agents [Table A.6].
- 27.2% of enterococci isolates tested were resistant to ≥ 5 antimicrobial agents [Table A.6].

Clinically Important Resistance

There are a limited number of antimicrobial agents available for the treatment of serious enterococcal infections in humans. This is due, in part, to the intrinsic resistance of enterococci to many antimicrobials, and also to the ease at which the bacteria acquire resistance. There is a concern that currently available antimicrobial agents are also progressively losing effectiveness because of resistance, complicating treatment or presenting with serious enterococci infection. In particular, resistance to gentamicin, penicillin, quinupristin-dalfopristin (Synercid®), and vancomycin has developed.

- In 2001, 1.7% of *Enterococcus faecium* and 5.7% of *Enterococcus faecalis* were resistant to gentamicin. In 2002, 0.6% of *E. faecium* and 6.4% of *E. faecalis* were resistant to gentamicin. In 2003, there were no resistant *E. faecium* and 2.0% of *E. faecalis* were resistant to gentamicin [Table A.4]
- In 2001, 4.3% of *E. faecium* were resistant to penicillin and there was no resistance among *E. faecalis*. In 2002, 7.6% of *E. faecium* and 2.3% of *E. faecalis* were resistant to penicillin. In 2003, 10.3% of *E. faecium* and 0.4% of *E. faecalis* were resistant to penicillin [Table A.4].
- In 2001, 20.9% of *E. faecium* were resistant to quinupristin-dalfopristin. In 2002, 1.2% of *E. faecium* were resistant to quinupristin-dalfopristin. In 2003, 3.6% of *E. faecium* were resistant to quinupristin-dalfopristin [Table A.4].
- In 2001, 1.7% of *E. faecium* were resistant to vancomycin. In 2002, 2.3% of *E. faecium* were resistant to vancomycin. In 2003, there was no vancomycin resistance among *E. faecium* [Table A.4].

Surveillance and Laboratory Testing Methods

Stool samples from outpatients with diarrhea and healthy volunteers were collected by laboratories in Georgia, Maryland, Michigan, Minnesota, and Oregon between 2001 and 2003. All presumptive enterococci were submitted to the NARMS lab for species identification and antimicrobial susceptibility testing. In 2001, 20 stool samples (i.e., patients) per month were requested from each site. In all other years, 10 stool samples per month were requested.

Predominant enterococci

Predominant enterococci were selected by mixing 0.5 grams of each stool in 5 mL of bile-esculin azide broth and incubating at 35-37°C for 48 hours. After incubation, 10 μl from a black culture was streaked onto Columbia CNA[1] with 5% sheep blood and incubated at 35-37°C for 24 hours. A predominant colony with typical enterococci morphology were Gram stained and PYR spot tested.

Enrichment for vancomycin-resistant enterococci (VRE)

Vancomycin-resistant enterococci were selected as above with the addition of 10 μg/ml vancomycin and 10 μg/ml aztreonam to the bile-esculin azide broth. After incubation, 10 μl from a black culture was streaked onto Modified Ford agar[2] supplemented with 10 μg/ml raffinose and incubated at 35-37 C for 24 hours. A red colony characteristic of *E. faecium* and *E. faecalis* (raffinose non-fermenters) were Gram stained and PYR spot tested.

Enterococcus species identification and antimicrobial susceptibility testing

Upon arrival at CDC isolates were subcultured on trypticase soy agar at least two times to obtain isolated single colonies. All incubations were performed at 35° ± 1°C. A pure culture was selected for definitive identification, antimicrobial susceptibility testing and freezing at -70°C for archival purposes. Enterococci were identified to the species level according by standard biochemical methods[3]. Antimicrobial susceptibility was tested by microbroth dilution using a custom Sensititre® panel, according to the manufacturer's instructions (Trek Diagnostics, Cleveland, OH). Minimal inhibitory concentrations (MICs) of antimicrobials were read manually using the Sensititre Sensitouch™ system in 2001. In 2002 and 2003, susceptibility results were read and interpreted using an automated system, ARIS™ by Trek Diagnostics. *Staphylococcus aureus* ATCC 29213, *Escherichia coli* ATCC 25922, *Enterococcus faecalis* ATCC 29212, and *Enterococcus faecalis* ATCC 51299 were used as quality controls for *Enterococcus* susceptibility testing according to Clinical and Laboratory Standards Institute (CLSI) guidelines[4]. The minimum inhibitory concentration (MIC) was determined for 18 antimicrobial agents: bacitracin, chloramphenicol, ciprofloxacin, erythromycin, flavomycin, gentamicin, kanamycin, lincomycin, linezolid, nitrofurantoin, penicillin, salinomycin, streptomycin, quinupristin/dalfopristin, tetracycline, tylosin, vancomycin, and virginiamycin [Table A.1].

Table A.1 Antimicrobial Agents used for Susceptibility Testing of *Enterococci* spp. CDC NARMS, 2001-2003						
CLSI Subclass	**Antimicrobial Agent**	**Antimicrobial Agent Concentration Range (µg/ml)**	**Breakpoints***			**Source of MIC**
			[R]	**[I]**	**[S]**	
Aminoglycoside	Gentamicin	128 - 1024	≥ 500		<256	CLSI
	Kanamycin	128 - 1024	≥ 2048		<1024	DanMap
	Streptomycin	512 - 2048	≥ 1000		<512	CLSI
Glycopeptide	Vancomycin	0.5 - 32	≥ 32	8-16	<4	CLSI
Ionophore coccidiostat	Salinomycin	1 - 32	≥ 16		<8	DanMap
Lincosamides	Lincomycin	1 - 32	≥ 8		<4	CASFM
Macrolide	Erythromycin	0.5 - 8	≥ 8	1-4	<0.5	CLSI
	Tylosin	0.25 - 32	≥ 8		<4	DanMap
Nitrofuran	Nitrofurantoin	2 - 128	≥ 128	64	<32	CLSI
Oxazolidinones	Linezolid	0.5 - 8	≥ 8	4	<2	CLSI
Penicillin	Penicillin	0.5 - 16	≥ 16		<8	CLSI
Phenicol	Chloramphenicol	2 - 32	≥ 32	16	<8	CLSI
Phosphoglycolipid	Flavomycin	1 - 32	≥ 16		<8	DanMap
Polypeptide	Bacitracin	8 - 64	≥ 64		<32	NORM-VET
Quinolone	Ciprofloxacin	0.12 - 4	≥ 4	2	<1	CLSI
Streptogramin	Quinupristin/dalfopristin	1 - 32	≥ 4	2	<1	CLSI
	Virginiamycin	1 - 32	≥ 4		<2	DanMap
Tetracycline	Tetracycline	4 - 32	≥ 16	8	<4	CLSI

When established, CLSI interpretive criteria were used [Table A.1]. The 95% confidence intervals (CI) for the percentage of resistant isolates calculated using the Clopper-Pearson exact method are included in the MIC distribution tables. Multidrug resistance by antimicrobial agent was defined as resistance to two or more agents. Similarly, multidrug resistance by CLSI antimicrobial subclass was defined as resistance two or more subclasses.

Results: 2001-2003

Predominant enterococci

From 2001-2003, a total of 1527 viable enterococci isolates (610 in 2001, 448 in 2002, and 469 in 2003) were received at CDC and tested for antimicrobial susceptibility [Table A.2]. The breakdown of isolates received by site is shown in Table A.2.

Of the enterococci isolates tested for 2001-2003, 51.1% (781/1527) were *E. faecalis,* and 37.3% (570/1527) were *E. faecium* [Table A.3].
Table A.4 provides MIC distribution results for *E. faecium, E. faecalis*, and other enterococci species for each of the 18 antimicrobial agents from 2001-2003.

Table A.2 Enterococci Isolates Received and Tested, by Site CDC NARMS, 2001-2003

Site	Enterococci isolates						
	2001		2002		2003		
	No.	(%)	No.	(%)	No.	(%)	Total
Georgia	128	21.0%	83	18.5%	96	20.5%	307
Maryland	111	18.2%	94	21.0%	92	19.6%	297
Michigan	158	25.9%	93	20.8%	91	19.4%	342
Minnesota	129	21.1%	88	19.6%	90	19.2%	307
Oregon	84	13.8%	90	20.1%	100	21.3%	274
Total	**610**	**100%**	**448**	**100%**	**469**	**100%**	**1527**

Table A.3 Enterococci Speciation Table
NARMS, 2001-2003

Species	2001		2002		2003	
	n	%	n	%	n	%
Enterococcus faecalis	315	51.6%	219	48.9%	247	52.7%
Enterococcus faecium	234	38.4%	172	38.4%	164	35.0%
Enterococcus avium	23	3.8%	24	5.4%	18	3.8%
Enterococcus raffinosus	11	1.8%	10	2.2%	3	0.6%
Enterococcus hirae	8	1.3%	9	2.0%	1	0.2%
Enterococcus durans	7	1.1%	6	1.3%	19	4.1%
Enterococcus casseliflavus	5	0.8%	5	1.1%	7	1.5%
Enterococcus gallinarum	4	0.7%	3	0.7%	6	1.3%
Enterococcus malodoratus	1	0.2%	0	0.0%	1	0.2%
Enterococcus mundtii	1	0.2%	0	0.0%	2	0.4%
Enterococcus pseudoavium	1	0.2%	0	0.0%	1	0.2%
Enterococcus dispar	0	0.0%	0	0.0%	0	0.0%
Enterococcus moraviensis	0	0.0%	0	0.0%	0	0.0%
Total isolates	**610**	**100.0%**	**448**	**100.0%**	**469**	**100.0%**

Table A.4 Enterococci MIC Distribution, CDC NARMS, 2001-2003 (N=1527)

Antimicrobial	Species	Year	% of Isolates %I	%R	95% CI	Percent of all isolates with MIC (µg/mL) of: 0.12	0.25	0.5	0.75	1	2	3	4	8	16	32	64	128	256	512	1024	2048	4096
Aminoglycosides Gentamicin	ENTFM N=571	2001 N=234	N/A	**1.7**	[0.5 - 4.3]												9.0	89.3				**1.7**	
		2002 N=172	N/A	**0.6**	[0.0 - 3.2]													91.9	7.6		**0.6**		
		2003 N=165	N/A	**0.0**	[0.0 - 2.2]													87.9	12.1				
	ENTFS N=973	2001 N=315	N/A	**5.7**	[3.4 - 8.9]												14.6	79.7			**0.3**	**5.4**	
		2002 N=219	N/A	**6.4**	[3.5 - 10.5]													75.8	17.8	**2.3**	**0.5**	**3.7**	
		2003 N=247	N/A	**2.0**	[0.7 - 4.7]													78.1	19.8	**0.4**	**0.8**	**0.8**	
	OTHER N=186	2001 N=64	N/A	**1.6**	[0.0 - 8.8]												9.8	86.9	1.6			**1.6**	
		2002 N=57	N/A	**0.0**	[0.0 - 6.3]													89.5	10.5				
		2003 N=58	N/A	**0.0**	[0.0 - 6.2]													91.4	8.6				
Kanamycin	ENTFM N=571	2001 N=234	N/A	**8.5**	[5.3 - 12.9]												0.9	29.9	27.4	22.2	11.1	**8.5**	
		2002 N=172	N/A	**9.3**	[5.4 - 14.7]													68.6	8.1	9.3	4.7	**9.3**	
		2003 N=165	N/A	**2.4**	[0.7 - 6.1]													93.3	4.2			**2.4**	
	ENTFS N=973	2001 N=315	N/A	**15.0**	[11.2 - 19.3]												13.3	70.2	0.6	0.6	0.3	**15.0**	
		2002 N=219	N/A	**14.2**	[9.8 - 19.5]													84.9	0.5	0.5		**14.2**	
		2003 N=247	N/A	**8.9**	[5.7 - 13.2]													89.9		0.4	0.8	**8.9**	
	OTHER N=186	2001 N=64	N/A	**4.9**	[1.0 - 13.7]												9.8	85.2				**4.9**	
		2002 N=57	N/A	**8.8**	[2.9 - 19.3]													89.5			1.8	**8.8**	
		2003 N=58	N/A	**3.4**	[0.4 - 11.9]													94.8	1.7			**3.4**	
Streptomycin	ENTFM N=571	2001 N=234	N/A	**4.3**	[2.1 - 7.7]													8.5		87.2	**0.9**	**0.9**	**2.6**
		2002 N=172	N/A	**7.0**	[3.7 - 11.9]															93.0	**2.3**	**2.9**	**1.7**
		2003 N=165	N/A	**2.4**	[0.7 - 6.1]															97.6	**0.6**	**1.2**	**0.6**
	ENTFS N=973	2001 N=315	N/A	**14.6**	[10.9 - 19.0]													12.4	0.3	72.7	**0.6**	**1.0**	**13.0**
		2002 N=219	N/A	**10.0**	[6.4 - 14.8]															90.0	**0.9**	**3.7**	**5.5**
		2003 N=247	N/A	**7.7**	[4.7 - 11.8]															92.3	**2.0**	**1.2**	**4.5**
	OTHER N=186	2001 N=64	N/A	**11.5**	[4.7 - 22.2]													9.8		78.7	**1.6**	**3.3**	**6.6**
		2002 N=57	N/A	**8.8**	[2.9 - 19.3]															91.2		**3.5**	**5.3**
		2003 N=58	N/A	**3.4**	[0.4 - 11.9]															96.6	**1.7**		**1.7**
Glycopeptides Vancomycin	ENTFM	2001 N=234	0.0	**1.7**	[0.5 - 4.3]			28.6		54.7	7.3		7.7				**1.7**						
		2002 N=172	0.0	**2.3**	[0.6 - 5.8]			65.1		27.3	4.7		0.6				**2.3**						
		2003 N=165	0.0	**0.0**	[0.0 - 2.2]			83.0		13.9	2.4		0.6										
	ENTFS	2001 N=315	0.0	**0.0**	[0.0 - 1.2]			1.0		41.0	37.5		20.6										
		2002 N=219	0.0	**0.0**	[0.0 - 1.7]			2.3		47.5	39.3		11.0										
		2003 N=247	0.0	**0.0**	[0.0 - 1.5]			0.4		48.6	42.5		8.5										
	OTHER	2001 N=64	9.8	**0.0**	[0.0 - 5.9]			19.7		63.9	4.9			9.8									
		2002 N=57	8.8	**0.0**	[0.0 - 6.3]			61.4		24.6	3.5		1.8	8.8									
		2003 N=58	12.1	**0.0**	[0.0 - 6.2]			65.5		12.1			10.3	12.1									

Notes:

* Vertical bars show the available CLSI Susceptible/Resistant breakpoints for each drug

* Unshaded cells indicate the dilution range of the Sensititre plate

* Figures outside the Sensititre plate range were reported as ">" the plate's highest dulition for that drug

* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

* N/A indicates no intermediate resistance available

*Single-bars indicate intermediate breakpoint; double-bars indicate breakpoint
**Enterococcus faecium* = ENTFM

**Enterococcus faecalis* = ENTFS

*All other *Enterococcus* spp. = OTHER

Table A.4 Enterococci MIC Distribution, CDC NARMS, 2001-2003 (N=1527)

			% of Isolates			Percent of all isolates with MIC (μg/mL) of:																
Antimicrobial	**Species**	**Year**	**%I**	**%R**	**95% CI**	**0.12**	**0.25**	**0.5**	**0.75**	**1**	**2**	**3**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**	**2048**	**4096**
Ionophore coccidiostat Salinomycin	ENTFM	2001	N/A	**0.0**	[0.0 - 1.6]					85.90	13.68		0.43										
		2002	N/A	**0.6**	[0.0 - 3.2]					95.93	3.49						**0.58**						
		2003	N/A	**0.0**	[0.0 - 2.2]					90.30	9.70												
	ENTFS	2001	N/A	**0.0**	[0.0 - 1.2]					97.78	0.63		1.59										
		2002	N/A	**0.0**	[0.0 - 1.7]					99.54													
		2003	N/A	**0.0**	[0.0 - 1.5]					94.33	5.67												
	OTHER	2001	N/A	**0.0**	[0.0 - 5.9]					93.44	6.56												
		2002	N/A	**1.8**	[0.0 - 9.4]					96.49	1.75						**1.75**						
		2003	N/A	**0.0**	[0.0 - 6.2]					86.21	12.07		1.72										
Lincosamides Lincomycin	ENTFM	2001	N/A	**75.6**	[69.6 - 81.0]					19.7	1.7		3.0	**22.6**	**31.6**	**14.5**	**6.8**						
		2002	N/A	**69.8**	[62.3 - 76.5]					22.7	1.2		6.4	**32.0**	**22.7**	**7.6**	**7.6**						
		2003	N/A	**73.9**	[66.5 - 80.5]					17.6	1.2		7.3	**26.1**	**35.2**	**1.2**	**11.5**						
	ENTFS	2001	N/A	**95.6**	[92.7 - 97.5]					2.9	1.0		0.6	**11.7**	**26.0**	**34.3**	**23.5**						
		2002	N/A	**98.6**	[96.0 - 99.7]					1.4				**12.8**	**29.2**	**37.4**	**19.2**						
		2003	N/A	**98.4**	[95.9 - 99.6]					0.4	0.4		0.8	**7.3**	**19.8**	**48.2**	**23.1**						
	OTHER	2001	N/A	**78.7**	[66.3 - 88.1]					13.1	1.6		6.6	**44.3**	**21.3**	**1.6**	**11.5**						
		2002	N/A	**86.0**	[74.2 - 93.7]					10.5			3.5	**43.9**	**31.6**	**3.5**	**7.0**						
		2003	N/A	**74.1**	[61.0 - 84.7]					24.1	1.7			**39.7**	**25.9**	**5.2**	**3.4**						
Macrolides Erythromycin	ENTFM	2001	64.1	**7.3**	[4.3 - 11.4]			28.6		16.7	37.2		10.3	**1.3**	**6.0**								
		2002	72.1	**15.1**	[10.1 - 21.4]			12.8		8.1	33.1		30.8	**8.7**	**6.4**								
		2003	67.9	**10.3**	[6.1 - 16.0]			21.8		10.3	23.0		34.5	**7.9**	**2.4**								
	ENTFS	2001	31.7	**21.4**	[19.8 - 29.6]			43.8		28.9	2.5		0.3	**0.6**	**20.8**								
		2002	55.7	**19.2**	[14.2 - 25.0]			25.1		29.7	22.4		3.7	**0.9**	**18.3**								
		2003	54.3	**22.7**	[17.6 - 28.4]			23.1		29.6	18.2		6.5	**2.0**	**20.6**								
	OTHER	2001	13.1	**21.3**	[11.9 - 33.7]			65.6		9.8	1.6		1.6		**21.3**								
		2002	15.8	**21.1**	[11.4 - 33.9]			63.2		5.3	5.3		5.3		**21.1**								
		2003	25.9	**10.3**	[3.9 - 21.2]			63.8		6.9	10.3		8.6	**3.4**	**6.9**								
Tylosin	ENTFM	2001	N/A	**23.5**	[18.2 - 29.5]		0.4			17.1	30.3		28.6	**17.1**	**0.4**	**0.4**	**5.6**						
		2002	N/A	**20.3**	[14.6 - 27.1]			1.2		7.6	37.8		33.1	**14.5**			**5.8**						
		2003	N/A	**6.7**	[3.4 - 11.6]					6.7	32.7		53.9	**3.6**	**0.6**		**2.4**						
	ENTFS	2001	N/A	**23.8**	[19.2 - 28.9]		0.3	2.2		58.1	14.9		0.6				**23.8**						
		2002	N/A	**20.1**	[15.0 - 26.0]		0.5	1.4		26.5	51.6						**20.1**						
		2003	N/A	**22.7**	[17.6 - 28.4]			0.4		25.9	51.0					**0.4**	**22.3**						
	OTHER	2001	N/A	**13.1**	[5.8 - 24.2]			1.6		23.0	50.8		11.5			**1.6**	**11.5**						
		2002	N/A	**10.5**	[4.0 - 21.5]			1.8		26.3	57.9		3.5				**10.5**						
		2003	N/A	**6.9**	[1.9 - 16.7]			3.4		53.4	29.3		6.9	**3.4**			**3.4**						

Notes:

* Vertical bars show the available CLSI Susceptible/Resistant breakpoints for each drug

* Unshaded cells indicate the dilution range of the Sensititre plate

* Figures outside the Sensititre plate range were reported as ">" the plate's highest dulition for that drug

* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

* N/A indicates no intermediate resistance available

*Single-bars indicate intermediate breakpoint; double-bars indicate breakpoint
**Enterococcus faecium* = ENTFM

**Enterococcus faecalis* = ENTFS

*All other *Enterococcus* spp. = OTHER

Table A.4 Enterococci MIC Distribution, CDC NARMS, 2001-2003 (N=1527)

			% of Isolates			Percent of all isolates with MIC (µg/mL) of:																
Antimicrobial	**Species**	**Year**	**%I**	**%R**	**95% CI**	**0.12**	**0.25**	**0.5**	**0.75**	**1**	**2**	**3**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**	**2048**	**4096**
Nitrofurans Nitrofurantoin	ENTFM	2001	46.2	**14.1**	[9.9 - 19.2]						2.1			6.0	14.1	8.5	46.2	**14.1**					
		2002	65.7	**2.9**	[1.0 - 6.7]										7.0	24.4	65.7	**2.9**					
		2003	77.0	**0.0**	[0.0 - 2.2]											23.0	77.0						
	ENTFS	2001	1.6	**0.3**	[0.0 - 1.8]						0.6		0.3	28.3	51.7	2.2	1.6	**0.3**					
		2002	0.5	**0.5**	[0.0 - 2.5]									37.4	54.8	6.8	0.5		**0.5**				
		2003	0.4	**0.0**	[0.0 - 1.5]									4.0	67.2	28.3	0.4						
	OTHER	2001	18.0	**13.1**	[5.8 - 24.2]						3.3		1.6	13.1	23.0	16.4	18.0	**13.1**					
		2002	43.9	**0.0**	[0.0 - 6.3]									8.8	15.8	31.6	43.9						
		2003	41.4	**0.0**	[0.0 - 6.2]									1.7	20.7	36.2	41.4						
Oxazolidinones Linezolid	ENTFM	2001	6.0	**0.0**	[0.0 - 1.6]			0.85		5.98	78.21		5.98										
		2002	0.6	**0.0**	[0.0 - 2.1]			0.58		27.33	71.51		0.58										
		2003	0.6	**0.0**	[0.0 - 2.2]					26.67	72.73		0.61										
	ENTFS	2001	0.0	**0.0**	[0.0 - 1.2]			2.22		20.00	62.86												
		2002	0.0	**0.0**	[0.0 - 1.7]			0.91		41.10	57.99												
		2003	0.0	**0.0**	[0.0 - 1.5]					47.37	52.63												
	OTHER	2001	3.3	**0.0**	[0.0 - 5.9]			1.64		9.84	73.77		3.28										
		2002	8.8	**0.0**	[0.0 - 6.3]			7.02		33.33	50.88		8.77										
		2003	5.2	**0.0**	[0.0 - 6.2]			10.34		58.62	25.86		5.17										
Penicillins Penicillin	ENTFM	2001	N/A	**4.3**	[2.1 - 7.7]			9.0		7.7	29.5		41.0	8.5	**0.9**	**3.4**							
		2002	N/A	**7.6**	[4.1 - 12.6]			15.1		5.2	12.8		39.5	19.8	**2.3**	**5.2**							
		2003	N/A	**10.3**	[6.1 - 16.0]			10.3		4.2	16.4		41.8	17.0		**10.3**							
	ENTFS	2001	N/A	**0.0**	[0.0 - 1.2]			3.2		4.4	25.4		65.1	1.9									
		2002	N/A	**2.3**	[0.7 - 5.2]			0.5			3.7		68.9	24.7	**2.3**								
		2003	N/A	**0.4**	[0.0 - 2.2]						3.2		75.3	21.1	**0.4**								
	OTHER	2001	N/A	**4.9**	[1.0 - 13.7]			14.8		19.7	50.8		6.6	3.3	**3.3**	**1.6**							
		2002	N/A	**8.8**	[2.9 - 19.3]			3.5		12.3	29.8		40.4	5.3		**8.8**							
		2003	N/A	**8.6**	[2.9 - 19.0]			10.3		20.7	39.7		19.0	1.7	**5.2**	**3.4**							
Phenicols Chloramphenicol	ENTFM	2001	0.9	**1.7**	[0.5 - 4.3]						2.1		26.9	68.4	0.9	**0.9**	**0.9**						
		2002	1.2	**0.0**	[0.0 - 2.1]						1.2		59.3	38.4	1.2								
		2003	0.0	**0.0**	[0.0 - 2.2]						1.8		66.1	32.1									
	ENTFS	2001	1.0	**6.0**	[3.7 - 9.3]						2.2		25.1	65.7	1.0	**1.3**	**4.7**						
		2002	0.0	**7.3**	[4.2 - 11.6]						1.4		49.3	42.0		**4.6**	**2.7**						
		2003	0.0	**2.0**	[0.7 - 4.7]								58.3	39.7		**0.8**	**1.2**						
	OTHER	2001	0.0	**1.6**	[0.0 - 8.8]						6.6		39.3	52.5			**1.6**						
		2002	0.0	**0.0**	[0.0 - 6.3]						7.0		47.4	45.6									
		2003	0.0	**0.0**	[0.0 - 6.2]						19.0		62.1	19.0									

Notes:

* Vertical bars show the available CLSI Susceptible/Resistant breakpoints for each drug

* Unshaded cells indicate the dilution range of the Sensititre plate

* Figures outside the Sensititre plate range were reported as ">" the plate's highest dulition for that drug

* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

* N/A indicates no intermediate resistance available

*Single-bars indicate intermediate breakpoint; double-bars indicate breakpoint
**Enterococcus faecium* = ENTFM

**Enterococcus faecalis* = ENTFS

*All other *Enterococcus* spp. = OTHER

Table A.4 Enterococci MIC Distribution, CDC NARMS, 2001-2003 (N=1527)

			% of Isolates			Percent of all isolates with MIC (µg/mL) of:																
Antimicrobial	**Species**	**Year**	**%I**	**%R**	**95% CI**	**0.12**	**0.25**	**0.5**	**0.75**	**1**	**2**	**3**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**512**	**1024**	**2048**	**4096**
		2001	N/A	**79.9**	[74.2 - 84.9]					5.6	10.7		2.1	1.7	**0.9**		**79.1**						
	ENTFM	2002	N/A	**90.1**	[84.6 - 94.1]						0.6		2.3	7.0	**7.6**	**3.5**	**79.1**						
		2003	N/A	**90.3**	[84.7 - 94.4]						0.6		1.8	7.3	**6.7**	**6.1**	**77.6**						
		2001	N/A	**2.5**	[1.1 - 4.9]					18.1	68.3		10.5	0.6	**0.3**		**2.2**						
Phosphoglycolipid Flavomycin	ENTFS	2002	N/A	**0.5**	[0.0 - 2.5]					90.9	8.7						**0.5**						
		2003	N/A	**0.0**	[0.0 - 1.5]					72.1	27.9												
		2001	N/A	**42.6**	[30.0 - 55.9]					4.9	6.6		27.9	18.0	**1.6**	**1.6**	**39.3**						
	OTHER	2002	N/A	**35.1**	[22.9 - 48.9]					15.8	8.8		22.8	17.5		**1.8**	**33.3**						
		2003	N/A	**50.0**	[36.6 - 63.4]					5.2	13.8		24.1	6.9	**6.9**		**43.1**						
		2001	N/A	**92.4**	[88.1 - 95.4]									3.8	0.9	3.0	**9.4**	**29.1**	**53.9**				
	ENTFM	2002	N/A	**93.6**	[88.8 - 96.8]									1.7	2.3	2.3	**9.3**	**41.9**	**42.4**				
		2003	N/A	**92.7**	[87.6 - 96.2]									2.4	1.2	3.6	**7.3**	**41.8**	**43.6**				
		2001	N/A	**84.5**	[80.0 - 88.3]									1.3	3.5	10.8	**41.0**	**33.3**	**10.2**				
Polypeptide Bacitracin	ENTFS	2002	N/A	**90.4**	[85.7 - 94.0]									0.5	0.5	8.7	**23.7**	**53.0**	**13.7**				
		2003	N/A	**96.0**	[92.7 - 98.0]										0.4	3.6	**19.4**	**53.4**	**23.1**				
		2001	N/A	**83.6**	[71.9 - 91.8]									1.6	9.8	4.9	**9.8**	**31.1**	**42.6**				
	OTHER	2002	N/A	**87.7**	[76.3 - 94.9]										3.5	8.8	**12.3**	**42.1**	**33.3**				
		2003	N/A	**89.7**	[78.8 - 96.1]									3.4		6.9	**22.4**	**29.3**	**37.9**				
		2001	22.2	**15.0**	[10.6 - 20.2]	2.6	5.1	27.4		27.8	22.2		**5.6**	**9.4**									
	ENTFM	2002	20.9	**12.2**	[7.7 - 18.1]	0.6	11.6	21.5		33.1	20.9		**8.7**	**3.5**									
		2003	22.4	**18.2**	[12.6 - 24.9]		1.8	24.2		33.3	22.4		**16.4**	**1.8**									
		2001	16.5	**4.4**	[2.5 - 7.3]	3.5	4.4	27.9		43.2	16.5			**4.4**									
Quinolones Ciprofloxacin	ENTFS	2002	3.7	**4.6**	[2.2 - 8.2]	0.5	6.4	57.5		27.4	3.7			**4.6**									
		2003	21.9	**3.2**	[1.4 - 6.3]			13.8		61.1	21.9			**3.2**									
		2001	14.8	**1.6**	[0.0 - 8.8]	6.6	11.5	31.1		34.4	14.8			**1.6**									
	OTHER	2002	14.0	**0.0**	[0.0 - 6.3]	1.8	14.0	35.1		35.1	14.0												
		2003	31.0	**1.7**	[0.0 - 9.2]		8.6	25.9		32.8	31.0		**1.7**										
		2001	53.8	**20.9**	[15.9 - 26.7]			0.4		24.8	53.8		**8.5**	**4.3**	**0.9**		**7.3**						
	ENTFM	2002	47.1	**1.2**	[0.6 - 5.8]				0.6	51.2	45.9	1.2	**1.2**										
		2003	50.9	**3.6**	[1.3 - 7.7]					45.5	50.9		**3.6**										
		2001	8.3	**87.0**	[82.8 - 90.5]					4.8	8.3		**40.6**	**41.6**	**2.5**	**0.3**	**1.9**						
Streptogramins Quinupristin-dalfopristin	ENTFS	2002	16.9	**76.7**	[70.5 - 82.1]					6.4	16.9		**68.5**	**7.3**	**0.5**		**0.5**						
		2003	6.5	**85.8**	[80.8 - 89.9]					7.7	6.5		**71.7**	**13.8**	**0.4**								
		2001	55.7	**8.2**	[2.7 - 18.1]			1.6		34.4	55.7		**3.3**	**3.3**			**1.6**						
	OTHER	2002	26.3	**3.5**	[0.4 - 12.1]					70.2	26.3		**3.5**										
		2003	22.4	**3.4**	[0.4 - 11.9]					74.1	22.4		**1.7**	**1.7**									
	ENTFM	2001	N/A	**0.9**	[0.1 - 3.1]			0.4		5.1	2.6				**0.4**		**0.4**						
Virginiamycin	ENTFS	2001	N/A	**11.1**	[7.9 - 15.1]					1.9	0.6		1.3	**9.2**	**1.9**								
	OTHER	2001	N/A	**0.0**	[0.0 - 5.9]			3.3		1.6	4.9		1.6										
		2001	0.0	**21.4**	[16.3 - 27.2]					6.8			71.8		**2.1**	**3.4**	**15.8**						
	ENTFM	2002	3.5	**18.0**	[12.6 - 24.6]								78.5	3.5	**2.9**	**2.3**	**12.8**						
		2003	0.0	**15.2**	[10.1 - 21.5]								84.8		**1.8**	**0.6**	**12.7**						
		2001	0.0	**56.8**	[51.2 - 62.4]					5.4			37.8		**2.9**	**7.3**	**46.7**						
Tetracyclines Tetracycline	ENTFS	2002	2.7	**57.5**	[50.7 - 64.2]								39.7	2.7	**7.3**	**26.5**	**23.7**						
		2003	0.4	**55.1**	[48.6 - 61.4]								44.5	0.4	**4.9**	**21.1**	**29.1**						
		2001	0.0	**42.6**	[30.0 - 55.9]					1.6			55.7		**1.6**	**23.0**	**18.0**						
	OTHER	2002	3.5	**47.4**	[34.0 - 61.0]								49.1	3.5	**12.3**	**24.6**	**10.5**						
		2003	1.7	**22.4**	[12.5 - 35.3]								75.9	1.7	**3.4**	**12.1**	**6.9**						

Notes:

* Vertical bars show the available CLSI Susceptible/Resistant breakpoints for each drug

* Unshaded cells indicate the dilution range of the Sensititre plate

* Figures outside the Sensititre plate range were reported as ">" the plate's highest dulition for that drug

* 95% confidence intervals for %Resistant calculated using the Clopper-Pearson exact method

* N/A indicates no intermediate resistance available

*Single-bars indicate intermediate breakpoint; double-bars indicate breakpoint

**Enterococcus faecium* = ENTFM

**Enterococcus faecalis* = ENTFS

*All other *Enterococcus* spp. = OTHER

Resistance to specific antimicrobial agents during the years 2001-2003 is also summarized in Table A.5.

E. faecium

Among the *E. faecium* isolates, 1.7% were resistant to gentamicin in 2001, 0.6% in 2002, and 0 in 2003. Resistance to penicillin increased from 4.3% in 2001, to 7.6% in 2002, and 10.3% in 2003 [Table A.5]. Resistance to quinupristin/dalfoprisitin was 20.9% in 2001, 1.2% in 2002 and 3.6% in 2003.

Vancomycin resistance among *E. faecium* (VRE) was 1.7% in 2001, and 2.3% in 2002. No *E. faecium* isolates in 2003 were vancomycin resistant.

E. faecalis

Among the *E. faecalis* isolates, 5.7% were resistant to gentamicin in 2001, 6.4% in 2002, and 2.0% in 2003. There were no *E. faecalis* isolates resistant to penicillin in 2001, 2.3% of isolates were resistant to penicillin in 2002, and 0.4% in 2003.

In 2001, 56.8% of *E. faecalis* were resistant to tetracycline, 57.5% in 2002, and 55.1% in 2003.

Table A.5 Enterococci Antimicrobial Resistance Distribution by Species, CDC NARMS, 2001-2003

		ENTFM*			ENTFS**			OTHER***		
		2001	2002	2003	2001	2002	2003	2001	2002	2003
Enterococci Isolates		234	172	165	315	219	247	61	57	58
Aminoglycosides	Gentamicin (MIC > 500)	1.7% 4	0.6% 1	0.0% 0	5.7% 18	6.4% 14	2.0% 5	1.6% 1	0.0% 0	0.0% 0
	Kanamycin (MIC ≥ 2048)	8.5% 20	9.3% 16	2.4% 4	15.0% 47	14.2% 31	8.9% 22	4.9% 3	8.8% 5	3.4% 2
	Streptomycin (MIC > 1000)	4.3% 10	7.0% 12	2.4% 4	14.6% 46	10.0% 22	7.7% 19	11.5% 7	8.8% 5	3.4% 2
Glycopeptides	Vancomycin (MIC ≥ 32)	1.7% 4	2.3% 4	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Ionophore coccidiostat	Salinomycin (MIC ≥16)	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.8% 1	0.0% 0
Lincosamides	Lincomycin (MIC ≥ 8)	75.7% 177	69.8% 120	73.9% 122	95.6% 301	98.6% 216	98.4% 243	78.7% 48	86.0% 49	74.1% 43
Macrolides	Erythromycin (MIC ≥ 8)	7.3% 17	15.1% 26	10.3% 17	21.4% 77	19.2% 42	22.7% 56	21.3% 13	21.1% 12	10.3% 6
	Tylosin (MIC ≥ 8)	23.5% 55	20.3% 35	6.7% 11	23.8% 75	20.1% 44	22.7% 56	13.1% 8	10.5% 6	6.9% 4
Nitrofurans	Nitrofurantoin (MIC ≥ 128)	14.1% 33	2.9% 5	0.0% 0	0.3% 1	0.5% 1	0.0% 0	13.1% 8	0.0% 0	0.0% 0
Oxazolidinones	Linezolid (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
Penicillins	Penicillin (MIC ≥ 16)	4.3% 10	7.6% 13	10.3% 17	0.0% 0	2.3% 5	0.4% 1	4.9% 3	8.8% 5	8.6% 5
Phenicols	Chloramphenicol (MIC ≥ 32)	1.7% 4	0.0% 0	0.0% 0	6.0% 19	7.3% 16	2.0% 5	1.6% 1	0.0% 0	0.0% 0
Phosphoglycolipid	Flavomycin (MIC ≥ 16)	79.9% 187	90.1% 155	90.3% 149	2.5% 8	0.5% 1	0.0% 0	42.6% 26	35.1% 20	50.0% 29
Polypeptide	Bacitracin (MIC ≥ 64)	92.4% 216	93.6% 161	92.7% 153	84.5% 266	90.4% 198	96.0% 237	83.6% 51	87.7% 50	89.7% 52
Quinolones	Ciprofloxacin (MIC ≥ 4)	15.0% 35	12.2% 21	18.2% 30	4.4% 14	4.6% 10	3.2% 8	1.6% 1	0.0% 0	1.7% 1
Streptogramins	Quinuprisitn-dalfopristin (MIC ≥ 4)	20.9% 49	1.2% 4	3.6% 6	(Not Reported)	(Not Reported)	(Not Reported)	8.2% 5	3.5% 2	3.4% 2
	Virginiamycin (MIC ≥ 8)	0.9% 2	(Not Tested)	(Not Tested)	11.1% 35	(Not Tested)	(Not Tested)	0.0% 0	(Not Tested)	(Not Tested)
Tetracyclines	Tetracycline (MIC ≥ 16)	21.4% 50	18.0% 31	15.2% 25	56.8% 179	57.5% 126	55.1% 136	42.6% 26	47.4% 27	22.4% 13

**Enterococcus faecium* = ENTFM

***Enterococcus faecalis* = ENTFS

***All other *Enterococcus* spp. = OTHER

Table A.6 Enterococci Antimicrobial Resistance Distribution by Species CDC NARMS, 2001-2003									
	ENTFM*			ENTFS**			OTHER***		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Total enterococci isolates	234	172	164	315	219	247	61	57	58
No resistance detected	0.9% 2	1.7% 3	0.0% 0	0.3% 1	0.5% 1	0.0% 0	1.6% 1	0.0% 0	1.7% 1
Resistance ≥ 1 antimicrobial agents	99.1% 232	98.3% 169	100.0% 164	99.7% 314	99.5% 218	100.0% 247	98.4% 60	100.0% 57	98.3% 57
Resistance ≥ 2 antimicrobial agents	97.4% 228	96.5% 166	97.0% 160	95.6% 301	96.8% 212	97.6% 241	96.7% 59	98.2% 56	89.7% 52
Resistance ≥ 3 antimicrobial agents	86.3% 202	80.8% 139	73.9% 122	85.1% 268	84.5% 185	90.3% 223	70.5% 43	61.4% 35	56.9% 33
Resistance ≥ 4 antimicrobial agents	47.4% 111	41.3% 71	30.9% 51	59.7% 188	50.2% 110	55.9% 138	34.4% 21	28.1% 16	13.8% 8
Resistance ≥ 5 antimicrobial agents	19.7% 46	12.2% 21	9.1% 15	34.6% 109	21.9% 48	24.3% 60	18.0% 11	12.3% 7	6.9% 4
Resistance ≥ 1 CLSI subclasses	99.1% 232	98.3% 169	100.0% 165	99.7% 314	99.5% 218	100.0% 247	98.4% 60	100.0% 57	98.3% 57
Resistance ≥ 2 CLSI subclasses	97.4% 228	96.5% 166	97.0% 160	95.6% 301	96.8% 212	97.6% 241	96.7% 59	98.2% 56	89.7% 52
Resistance ≥ 3 CLSI subclasses	86.3% 202	80.8% 139	73.9% 122	84.8% 267	84.5% 185	90.3% 223	70.5% 43	61.4% 35	56.9% 33
Resistance ≥ 4 CLSI subclasses	47.4% 111	41.3% 71	30.9% 51	56.8% 179	50.2% 110	54.7% 135	32.8% 20	28.1% 16	13.8% 8
Resistance ≥ 5 CLSI subclasses	19.7% 46	12.2% 21	9.1% 15	30.5% 96	21.5% 47	23.1% 57	14.8% 9	12.3% 7	6.9% 4

**Enterococcus faecium*= ENTFM
***Enterococcus faecalis*= ENTFS
***All other*Enterococcus* spp. = OTHER

Table A.6 shows the percent of isolates with no detected resistance, and the percent of isolates resistant to one or more antimicrobials, and resistant to one or more CLSI subclass from 2001 to 2003. From 2001-2003, *E. faecium* isolates resistant to ≥ 2 antimicrobial agents was 97.0% and resistance to ≥ 5 antimicrobial agents was 14.2%. From 2001-2003, *E. faecalis* isolates resistant to ≥ 2 antimicrobial agents was 96.5% and resistance to ≥ 5 antimicrobial agents was 25.6% [Table A.6].

Enrichment for vancomycin-resistant enterococci (VRE)

From 2001-2003, specimens from 19 patients yielded resistant enterococci (seven in 2001, eight in 2002, and four in 2003) on VRE media. Those isolated were received at CDC and tested for antimicrobial susceptibility. Sixteen were confirmed enterococci, three *E. faecalis* and 13 *E. faecium*. One of the three *E. faecalis* isolated was confirmed to be resistant to vancomycin. This isolate was resistant to quinupristin-dalfopristin. Eleven of the 13 *E. faecium* isolates were confirmed to be resistant to vancomycin.

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Appendix B: List of Abbreviations

NARMS	National Antimicrobial Resistance Monitoring System for Enteric Bacteria
CDC	Centers for Disease Control and Prevention
FDA	Food and Drug Administration
USDA	U. S. Department of Agriculture
EIP	Emerging Infections Program
ELC	Epidemiology and Laboratory Capacity
FoodNet	Foodborne Diseases Active Surveillance Network
CLSI	Clinical and Laboratory Standards Institute
MIC	Minimum inhibitory concentration
ACSSuT	Resistant to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline
MDR-AmpC	Resistant to at least ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, tetracycline, amoxicillin-clavulanic acid, and ceftiofur, and decreased susceptibility to ceftriaxone (MIC ≥ 2 µg/mL)
PHLIS	Public Health Laboratory Information System
OR	Odds ratio
95% CI	95% confidence interval