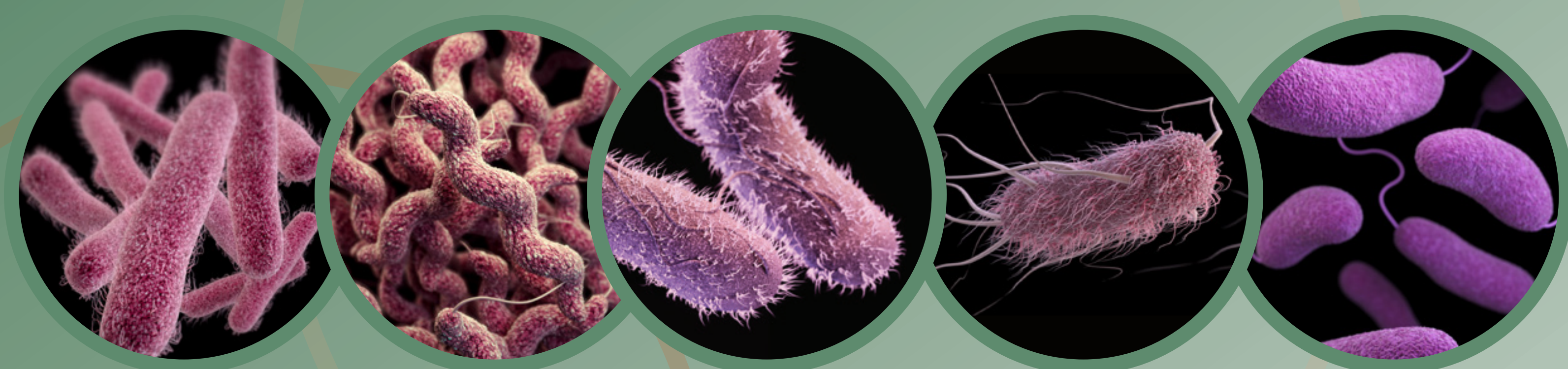
National Antimicrobial Resistance Monitoring System

NARMS

2014 Human Isolates Surveillance Report



National Center for Emerging and Zoonotic Infectious Diseases

Division of Foodborne, Waterborne, and Environmental Diseases

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Table of Contents

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Information Available Online: Previous reports and additional information about NARMS are posted on the CDC NARMS website: http://www.cdc.gov/narms. Interactive data displays and data downloads are available on the NARMS Now: Human Data website: http://wwwn.cdc.gov/narmsnow/

List of Tables

List of Figures

List of Abbreviations and Acronyms

AAuCx	Resistance to at least ampicillin, amoxicillin-clavulanic acid, and ceftriaxone
ACSSuT	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline
ACSSuTAuCx	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone
ACT/S	Resistance to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole
ANT/S	Resistance to at least ampicillin, nalidixic acid and trimethoprim-sulfamethoxazole
ASSuT	Resistance to at least ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline
AT/S	Resistance to at least ampicillin and trimethoprim-sulfamethoxazole
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CLSI	Clinical and Laboratory Standards Institute
CxNal	Resistance to at least ceftriaxone and nalidixic acid
DSC	Decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL for *Salmonella*)
ECV	Epidemiological cutoff value*
EIP	Emerging Infections Program
ELC	Epidemiology and Laboratory Capacity for Infectious Diseases
ESBL	Extended-spectrum β-lactamase
FDA-CVM	Food and Drug Administration-Center for Veterinary Medicine
FoodNet	Foodborne Diseases Active Surveillance Network
MIC	Minimum inhibitory concentration
NARMS	National Antimicrobial Resistance Monitoring System for Enteric Bacteria
OR	Odds ratio
S-DD	Susceptible-dose dependent
USDA-ARS	United States Department of Agriculture-Agricultural Research Service
USDA-FSIS	United States Department of Agriculture-Food Safety and Inspection Service
WHO	World Health Organization
WGS	Whole genome sequencing

*For a description of epidemiological cutoff values (previously abbreviated as ECOFFs) see NARMS 2012 Annual Report pages 17–18

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Introduction

The primary purpose of the National Antimicrobial Resistance Monitoring System (NARMS) at the Centers for Disease Control and Prevention (CDC) is to monitor antimicrobial resistance among enteric bacteria isolated from humans. Other components of the interagency NARMS program include surveillance for resistance in enteric bacteria isolated from retail meats, conducted by the U.S. Food and Drug Administration's Center for Veterinary Medicine (FDA-CVM), and for resistance in enteric bacteria isolated from food-producing animals, conducted by the U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS) and Food Safety and Inspection Service (USDA-FSIS).

Many NARMS activities are conducted within the framework of two CDC programs: the Foodborne Diseases Active Surveillance Network (FoodNet), which is part of CDC's Emerging Infections Program (EIP), and the Epidemiology and Laboratory Capacity (ELC) Program. In addition to population-wide surveillance of resistance in enteric pathogens, the NARMS program at CDC also conducts research into the mechanisms of resistance and performs susceptibility testing of isolates of pathogens that have caused outbreaks.

Before NARMS was established, CDC monitored antimicrobial resistance in *Salmonella, Shigella*, and *Campylobacter* through periodic surveys of isolates from a panel of sentinel counties. NARMS at CDC began in 1996 with ongoing monitoring of antimicrobial resistance among clinical isolates of non-Typhi *Salmonella* (refers to all serotypes other than Typhi, which causes typhoid fever) and *Escherichia coli* O157 in 14 sites. In 1997, testing of clinical isolates of *Campylobacter* was initiated in the five sites then participating in FoodNet. Testing of clinical *Salmonella* ser. Typhi and *Shigella* isolates was added in 1999. Starting in 2003, all 50 states forwarded all *Salmonella* ser. Typhi isolates and a representative sample of non-Typhi *Salmonella, Shigella*, and *E. coli* O157 isolates to NARMS for antimicrobial susceptibility testing, and 10 states now participating in FoodNet have been conducting *Campylobacter* surveillance. Since 2008, all 50 states have also been forwarding every *Salmonella* ser. Paratyphi A and C to NARMS for antimicrobial susceptibility testing. Beginning in 2009, NARMS also performed susceptibility testing on isolates of *Vibrio* species other than *V*. *cholerae.* Public health laboratories are asked to forward every isolate of *Vibrio* species that they receive to CDC. All toxigenic *V. cholerae* isolates are tested for antimicrobial susceptibility by the National Enteric Laboratory Diagnostic Outbreak Team; results are available in the Cholera and Other *Vibrio* Illness Surveillance system (COVIS) reports beginning with the 2013 Annual Summary. NARMS conducts antimicrobial susceptibility testing for isolates of species other than *V*. *cholerae*; results are included in this report.

This annual report includes CDC's surveillance data for 2014 for nontyphoidal *Salmonella*, typhoidal *Salmonella* (serotypes Typhi, Paratyphi A, Paratyphi B [tartrate negative], and Paratyphi C)*, Shigella*, *Campylobacter, E. coli* O157, and *Vibrio* species other than *V. cholerae*. Surveillance data include the number of isolates of each pathogen tested by NARMS and the number and percentage of isolates that were resistant to each of the antimicrobial agents tested. Data for earlier years are presented in tables and graphs when appropriate. Antimicrobial classes defined by the Clinical and Laboratory Standards Institute (CLSI) are used in data presentation and analysis.

This report uses the World Health Organization's categorization of antimicrobials of critical importance to human medicine (Appendix A) in the tables that present minimum inhibitory concentrations (MIC) and resistant percentages.

Previous annual reports and information about NARMS activities are available at the CDC NARMS website: http://www.cdc.gov/narms/. Interactive data displays and data downloads are available on the NARMS Now: Human Data website: http://wwwn.cdc.gov/narmsnow/.

What is New in the NARMS Report for 2014

Whole Genome Sequencing of *Salmonella*

For the first time, NARMS is reporting whole genome sequencing (WGS) data for *Salmonella* isolated from humans. Sequencing of bacteria has become relatively inexpensive and rapid, resulting in its recent adoption as a surveillance tool. The genetic data provided by WGS can be used for multiple purposes, including identifying outbreaks, helping with source trace-back investigations, determining virulence factors, and predicting antimicrobial resistance. We sequenced nontyphoidal *Salmonella* isolated in 2014 that were phenotypically resistant to at least one agent on the NARMS panel to identify resistance genes and mutations. The results of this analysis can be found in the Highlight section beginning on page 17.

Azithromycin Epidemiological Cutoff Values for *Shigella sonnei* and *flexneri*

In 2015, microbiologists from NARMS, along with other CDC and international collaborators, worked with the Clinical and Laboratory Standards Institute (CLSI) to establish azithromycin epidemiological cutoff values (ECVs) for *Shigella sonnei* and *flexneri*. This approach separates bacterial populations, by their MICs, into wild-type and non-wild-type (referred to in this report as susceptible and resistant, respectively) groups. (For more details regarding ECVs, see NARMS 2012 Annual Report pages 17–18). In this report, we apply the newly-adopted non-wild-type ECVs of ≥32 µg/mL for *S. sonnei* and ≥16 µg/mL for *S. flexneri*.

Reporting Decreased Susceptibility to Ciprofloxacin for *Salmonella*

In this report, we categorized *Salmonella* isolates with intermediate or resistant MICs (≥0.12 µg/mL) for ciprofloxacin as having decreased susceptibility to ciprofloxacin (DSC). We included DSC in tables of *Salmonella* resistance. In our analysis to assess changes in the prevalence of resistance for *Salmonella*, we switched from using nalidixic acid resistance as a proxy to assess changes in fluoroquinolone resistance to using DSC.

NARMS Now: Human Data

Since publication of our last report, CDC launched NARMS Now: Human Data, an interactive web tool for viewing and downloading antimicrobial resistance data for *Salmonella*, *Shigella*, *E. coli* O157, and *Campylobacter*. Surveillance data from this report and historical data since 1996 are available to view and download. The site will be will be updated periodically. See the Highlight section on page 21.

Summary of NARMS 2014 Surveillance Data

Surveillance Population

In 2014, all 50 states and the District of Columbia participated in NARMS, representing the entire US population of approximately 319 million persons (Table 1). Surveillance was conducted in all states for *Salmonella* (typhoidal and nontyphoidal), *Shigella*, *Escherichia coli* O157, and *Vibrio* species other than *V. cholerae*. For *Campylobacter*, surveillance was conducted in the 10 states that comprise the Foodborne Diseases Active Surveillance Network (FoodNet), representing approximately 49 million persons (15% of the US population).

Clinically Important Antimicrobial Resistance Patterns

In the United States, fluoroquinolones (e.g., ciprofloxacin) and third-generation cephalosporins (e.g., ceftriaxone) are commonly used to treat severe *Salmonella* infections, including typhoid and paratyphoid fever as well as severe nontyphoidal infections. In *Enterobacteriaceae*, (e.g., *Salmonella* and *Shigella*) resistance to nalidixic acid, an elementary quinolone, usually correlates with decreased susceptibility to ciprofloxacin (DSC) and fluoroquinolone treatment failure. However, over the last 10 years, we observed an increasing percentage of *Salmonella* isolates with DSC that are susceptible to nalidixic acid, which often indicates plasmid-mediated quinolone resistance. Macrolides (e.g., azithromycin), penicillins (e.g., ampicillin), and trimethoprim-sulfamethoxazole are also of clinical importance. A substantial proportion of *Enterobacteriaceae* isolates tested in 2014 demonstrated clinically important resistance.

In *Salmonella*, antimicrobial resistance varies by serotype. Overall changes in resistance among nontyphoidal *Salmonella* may reflect changes in resistance within serotypes, changes in serotype distribution, or both.

- 4.3% (92/2127) of nontyphoidal *Salmonella* isolates had decreased susceptibility to ciprofloxacin. Enteritidis was the most common serotype among nontyphoidal *Salmonella* isolates with decreased susceptibility to ciprofloxacin.
    - 38.0% (35/92) of isolates with decreased susceptibility to ciprofloxacin were ser. Enteritidis
    - 8.0% (35/438) of ser. Enteritidis isolates had decreased susceptibility to ciprofloxacin
- 2.4% (51/2127) of nontyphoidal *Salmonella* isolates were resistant to ceftriaxone. The most common serotypes among the 51 ceftriaxone-resistant isolates are listed in order below. Resistance to ceftriaxone occurred in
    - 5.3% (14/262) of ser. Typhimurium isolates
    - 3.0% (7/235) of ser. Newport isolates
    - 60.0% (6/10) of ser. Dublin isolates
    - 8.5% (6/71) of ser. Heidelberg isolates
    - 4.5% (5/110) of ser. I 4,[5],12:i:- isolates
- 74.0% (248/335) of *Salmonella* ser. Typhi isolates had decreased susceptibility to ciprofloxacin
- 79.6% (86/108) of *Salmonella* ser. Paratyphi A isolates had decreased susceptibility to ciprofloxacin
- No *Salmonella* ser. Typhi or Paratyphi A isolates were resistant to ceftriaxone

For *Shigella*, fluoroquinolones and macrolides (e.g., azithromycin) are important agents in the treatment of severe infections. (Note: In 2016, CLSI established epidemiologic cutoff values for azithromycin for *Shigella flexneri* and *sonnei*. The epidemiologic cutoff values should not be used as clinical breakpoints.)

- 2.4% (13/531) of *Shigella* isolates were resistant to ciprofloxacin, including
    - 5.9% (4/68) of *Shigella flexneri* isolates
    - 2.0% (9/458) of *Shigella sonnei* isolates
- 6.2% (33/531) of *Shigella* isolates were resistant to nalidixic acid, including
    - 14.7% (10/68) of *Shigella flexneri* isolates
    - 5.0% (23/458) of *Shigella sonnei* isolates
- 4.7% (25/531) of *Shigella* isolates were resistant to azithromycin, including
    - 22.1% (15/68) of *Shigella flexneri* isolates
    - 2.0% (9/458) of *Shigella sonnei* isolates

For *Campylobacte*r, fluoroquinolones and macrolides are important treatment options for severe infections. Epidemiologic cutoff values (ECVs) are used for interpreting antimicrobial susceptibility data. Because ECVs differ between *Campylobacter* species, the percentage of all resistant infections is not reported.

- 26.7% (334/1251) of *Campylobacter jejuni* isolates and 35.6% (52/146) of *Campylobacter coli* isolates were resistant to ciprofloxacin
- 1.8% (23/1251) of *Campylobacter jejuni* isolates and 10.3% (15/146) of *Campylobacter coli* isolates were resistant to macrolides (azithromycin or erythromycin)

Multidrug Resistance

Multidrug resistance is reported in NARMS in several ways, including resistance to various numbers of classes of antimicrobial agents and also by specific co-resistance phenotypes.

For nontyphoidal *Salmonella*, an important multidrug-resistance phenotype includes resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide (sulfamethoxazole/sulfisoxazole), and tetracycline (ACSSuT); these agents represent five CLSI classes. A similar pattern of resistance to at least ASSuT but not chloramphenicol has emerged in recent years. Another important phenotype includes ACSSuT resistance plus at least amoxicillin-clavulanic acid and ceftriaxone (ACSSuTAuCx); these agents represent seven CLSI classes.

- 3.1% (67/2127) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuT. The most common serotypes are listed in order below. ACSSuT resistance occurred in
  - 14.5% (38/262) of ser. Typhimurium isolates
  - 9.9% (7/71) of ser. Heidelberg isolates
  - 3.0% (7/235) of ser. Newport isolates
  - 60% (6/10) of ser. Dublin isolates

- 3% (64/2127) of nontyphoidal *Salmonella* isolates were resistant to at least ASSuT but not chloramphenicol. The most common serotype was I 4,[5],12:i:- (47 isolates), accounting for 73% of all isolates with this resistance pattern.
  - 42.7% (47/110) of ser. I 4,[5],12:i:- isolates were resistant to ASSuT but not chloramphenicol

- 1.2% (26/2127) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuTAuCx. The most common serotypes are listed in order below. ACSSuTAuCx resistance occurred in
  - 4.2% (11/262) of ser. Typhimurium isolates
  - 3.0% (7/235) of ser. Newport isolates
  - 60% (6/10) of ser. Dublin isolates

- 9.3% (197/2127) of nontyphoidal *Salmonella* isolates were resistant to three or more CLSI classes. The most common serotypes with this resistance are listed in order below. Resistance to three or more classes occurred in
  - 21.8% (57/262) of ser. Typhimurium isolates
  - 50% (55/110) of ser. I 4,[5],12:i:- isolates
  - 21.1% (15/71) of ser. Heidelberg isolates
  - 4.7% (11/235) of ser. Newport isolates
  - 2.1% (9/438) of ser. Enteritidis isolates
  - 60% (6/10) of ser. Dublin isolates

For *Salmonella* ser. Typhi, an important multidrug-resistance pattern includes resistance to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole (ACT/S).

- 11.3% (38/335) of isolates were resistant to at least ACT/S
- 14.3% (48/335) of isolates were resistant to three or more classes

For *Shigella*, an important multidrug-resistance phenotype includes resistance to at least ampicillin and trimethoprim-sulfamethoxazole (AT/S).

- 15.3% (81/531) of isolates were resistant to at least AT/S
- 42.4% (225/531) of isolates were resistant to three or more classes

Highlight:
Whole Genome Sequencing of Resistant Nontyphoidal *Salmonella*

The genetic data provided by whole genome sequencing (WGS) can be used for multiple purposes, including identifying outbreaks, source trace-back investigations, virulence factor determination, and predicting antimicrobial resistance. In 2014, 376 nontyphoidal *Salmonella* isolates were resistant to ≥1 antimicrobial agents via phenotypic testing. To analyze sequence data and identify all known acquired resistance genes (using ResFinder 2.1 tool) and mutational resistance determinants (see Methods), we performed WGS on the HiSeq (Illumina, Inc.) system, using CLC Genomics Workbench 8.0 (Qiagen, Inc.) and BioNumerics 7.5 (Applied Maths, Inc.). Nineteen isolates that lost resistance between phenotypic testing and WGS (confirmed by repeated phenotypic testing) were excluded from the analysis. The genes identified among the remaining 357 isolates are shown in Figure H1.

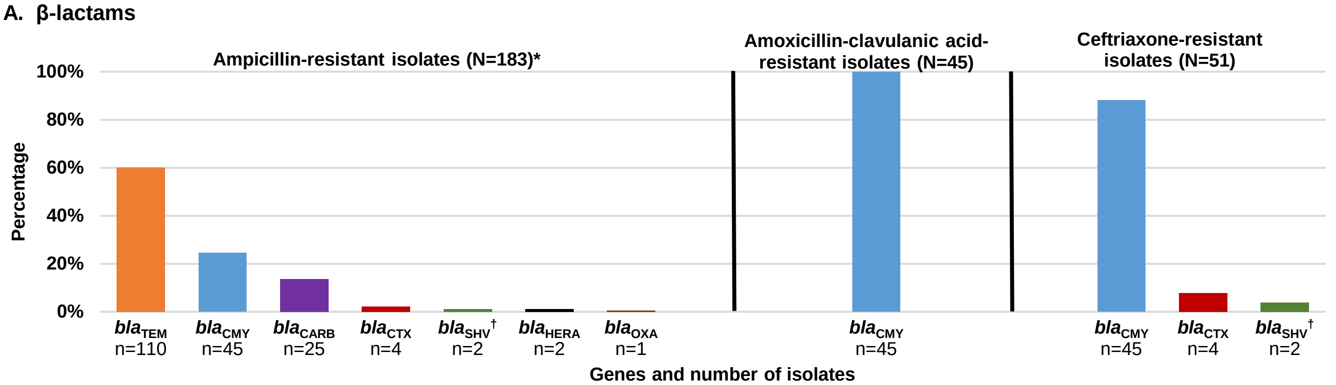
Resistance to most drugs was mediated by common resistance determinants, for example, ampicillin resistance by $bla_{\text{TEM-1b}}$, tetracycline by *tetA/B*, sulfisoxazole by *sul1/2*, and chloramphenicol by *floR*. Resistance to ceftriaxone/ceftiofur was mostly mediated by $bla_{\text{CMY-2}}$, an AmpC-type β-lactamase; however, we found several extended-spectrum β-lactamases (ESBLs), including $bla_{\text{SHV-12}}$, $_{\text{SHV-30}}$, $_{\text{CTX-M-1}}$, $_{\text{CTX-M-55}}$ and two $bla_{\text{CTX-M-65}}$. The one isolate resistant to the macrolide azithromycin contained *mphA*, a macrolide resistance determinant. Decreased susceptibility to ciprofloxacin was mainly mediated by mutations in the quinolone resistance-determining region (QRDR). Most ciprofloxacin-resistant isolates had both QRDR mutations and plasmid-mediated quinolone resistance (PMQR) genes.

Some phenotypically resistant isolates lacked genes known to confer that resistance to that agent, suggesting they have novel resistance determinants. This highlights the need for both genotypic testing and phenotypic testing, at least for a subset of isolates. Overall, a known resistance gene was identified that accounted for 93% of all resistant phenotypic test results, showing the effectiveness of WGS analysis for resistance prediction in *Salmonella*.

Figure H1. Prevalence of antimicrobial resistance genes identified among resistant nontyphoidal *Salmonella* isolates, by agent, 2014

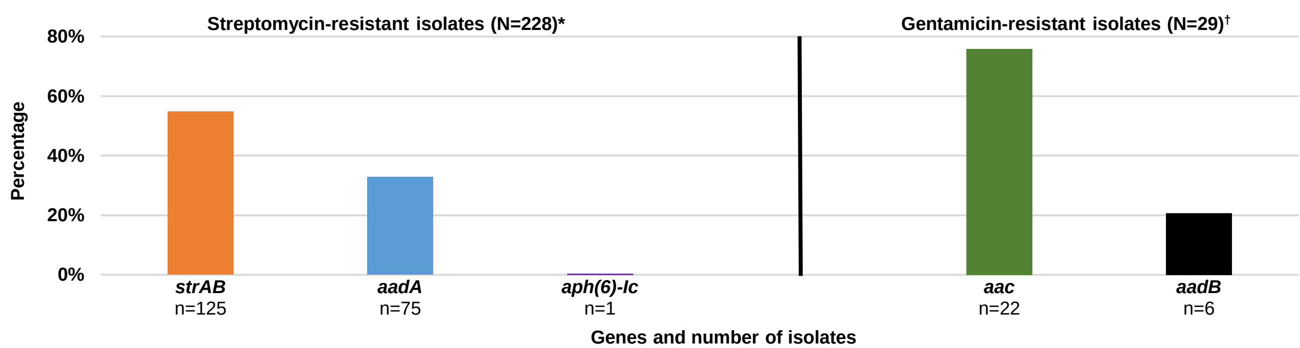
Note: Only identified genes known to confer resistance to the agents specified in each figure are listed

A. β-lactams



* 4 isolates lacked genes known to confer ampicililn resistance
† Both isolates had ESBL variants of SHV (1 SHV-12 and 1 SHV-30)

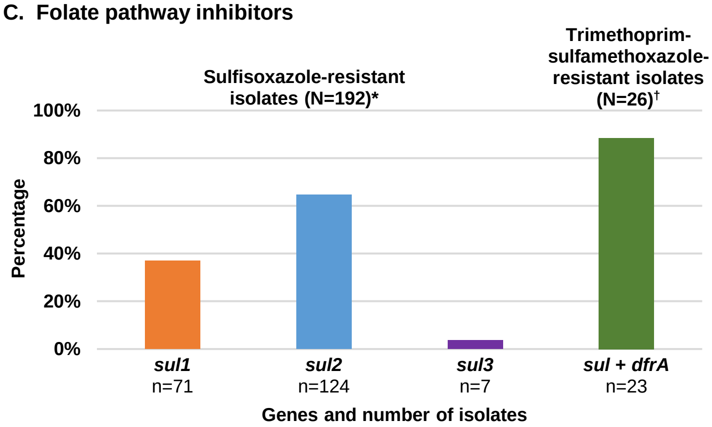
B. Aminoglycosides



* 49 isolates lacked genes known to confer streptomycin resistance
† 1 isolate lacked genes known to confer gentamicin resistance

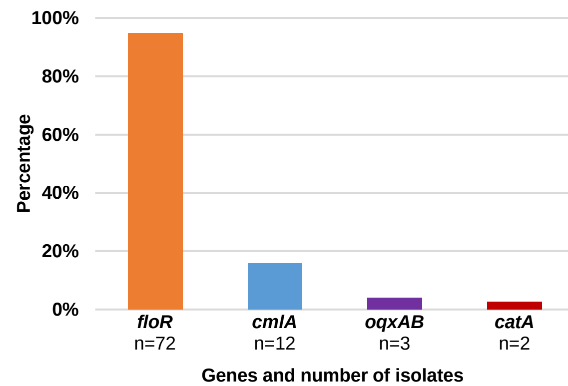
Highlight:
Whole Genome Sequencing of Resistant Nontyphoidal *Salmonella*

C. Folate pathway inhibitors

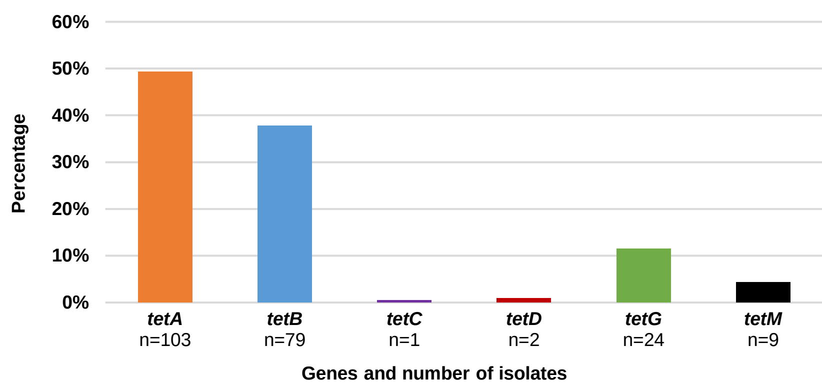


* 5 isolates lacked genes known to confer sulfisoxazole resistance
† 3 isolates lacked genes known to confer trimethoprim resistance or sulfamethoxazole resistance

D. Chloramphenicol-resistant isolates (N=76)

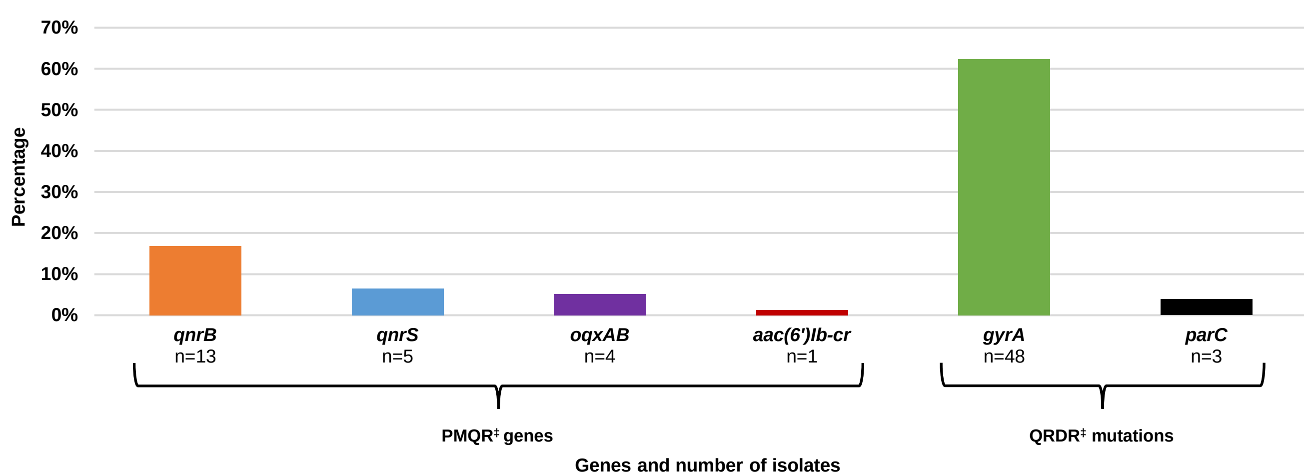


E. Tetracycline-resistant isolates (N=209)*



* 4 isolates lacked genes known to confer tetracycline resistance

F. Isolates with decreased susceptibility to ciprofloxacin* (N=77)†



* Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)
† 12 isolates lacked genes or mutations known to confer decreased susceptibility to ciprofloxacin
‡ PMQR: plasmid-mediated quinolone resistance; QRDR: quinolone resistance-determining region of topoisomerase

Highlight:
Changes in Antimicrobial Resistance: 2014 vs. 2004–2008 and 2009–2013

To understand changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter*, we used logistic regression to model annual data from 2004–2014. Since 2003, all 50 states have participated in *Salmonella* and *Shigella* surveillance, and all 10 FoodNet sites have participated in *Campylobacter* surveillance. We compared the prevalence of selected resistance patterns among bacteria isolated in 2014 with the average prevalence of resistance from two reference periods: 2004–2008 and 2009–2013. (These methods are detailed in the Data Analysis section.)

We defined the prevalence of resistance as the percentage of resistant isolates among all isolates tested. Changes in the percentage of isolates that are resistant may not reflect changes in the incidence of resistant infections because of fluctuations in the incidence of illness caused by the pathogen or serotype from year to year. The incidence and relative changes in the incidence of *Salmonella, Shigella,* and *Campylobacter* infections are reported annually from surveillance in FoodNet sites (CDC, 2014).

2014 vs. 2004–2008

The differences between the prevalence of resistance in 2014 and the average prevalence of resistance in 2004–2008 (Figure H2, A) were statistically significant for the following pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Decreased susceptibility to ciprofloxacin was higher (4.3% vs. 2.4%; odds ratio [OR]=2.0, 95% confidence interval [CI] 1.5–2.5)
- Among *Salmonella* of particular serotypes
  - ACSSuT resistance in ser. Typhimurium was lower (14.5% vs. 22.3%; OR=0.6, 95% CI 0.4–0.9)
  - ACSSuTAuCx resistance in ser. Newport was lower (3.0% vs. 11.7%; OR=0.3, 95% CI 0.1–0.6)
  - Decreased susceptibility to ciprofloxacin in ser. Typhi was higher (74.0% vs. 53.3%; OR=2.6, 95% CI 2.0–3.4)
- Among *Campylobacter jejuni*
  - Resistance to ciprofloxacin was higher (26.7% vs. 21.6%; OR=1.4, 95% CI 1.2–1.6)
- Among *Shigella* spp.
  - Nalidixic acid resistance was higher (6.2% vs. 2.0%; OR=4.1, 95% CI 2.5–6.7)

The differences between the prevalence of resistance in 2014 and the average prevalence of resistance in 2004–2008 (Figure H2, A) were *not* statistically significant for the following pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Ceftriaxone resistance (2.4% vs. 3.2%; OR=0.8, 95% CI 0.6–1.1)
  - Resistance to one or more classes (17.7% vs. 18.7%; OR=1.0, 95% CI 0.9–1.1)
  - Resistance to three or more classes (9.3% vs. 11.1%; OR=0.9, 95% CI 0.7–1.0)
- Among *Salmonella* of particular serotypes
  - Decreased susceptibility to ciprofloxacin in ser. Enteritidis (8.0% vs. 6.2%; OR=1.3, 95% CI 0.9–2.0)
  - Ceftriaxone resistance in ser. Heidelberg (8.5% vs. 8.5%; OR=1.1, 95% CI 0.4–2.8)
- Among *Campylobacter coli*
  - Ciprofloxacin resistance (35.6% vs. 27.6%; OR=1.5, 95% CI 1.0–2.3)

2014 vs. 2009–2013

The differences between the prevalence of resistance in 2014 and the average prevalence of resistance in 2009–2013 (Figure H2, B) were statistically significant for the following selected pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Decreased susceptibility to ciprofloxacin was higher (4.3% vs. 3.0%; OR=1.5, 95% CI 1.2–1.9)
- Among *Salmonella* of particular serotypes
  - Decreased susceptibility to ciprofloxacin in ser. Typhi was higher (74.0% vs. 67.7%; OR=1.4, 95% CI 1.1–1.8)
- Among *Shigella* spp.
  - Nalidixic acid resistance was higher (6.2% vs. 4.5%; OR=1.9, 95% CI 1.2–3.0)

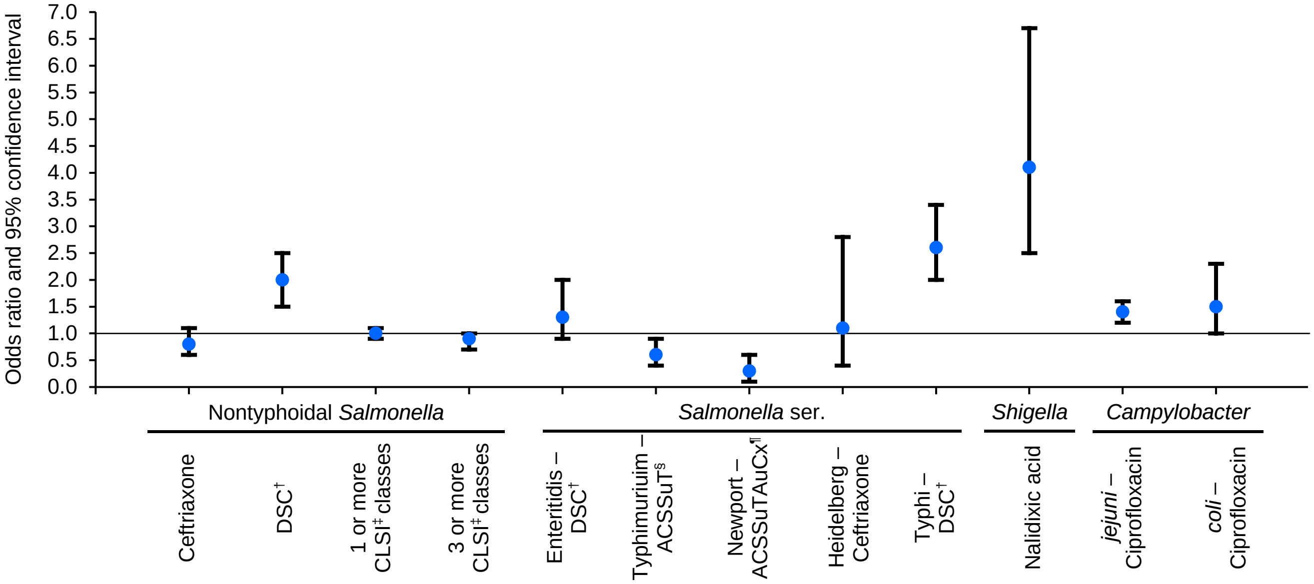
The differences between the prevalence of resistance in 2014 and the average prevalence of resistance in 2009–2013 (Figure H2, B) were *not* statistically significant for the following selected pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Ceftriaxone resistance (2.4% vs. 2.8%; OR=0.9, 95% CI 0.6–1.2)
  - Resistance to one or more classes (17.7% vs. 16.3%; OR=1.1, 95% CI 1.0–1.3)
  - Resistance to three or more classes (9.3% vs. 9.3%; OR=1.0, 95% CI 0.9–1.2)
- Among *Salmonella* of particular serotypes
  - Decreased susceptibility to ciprofloxacin in ser. Enteritidis (8.0% vs. 5.9%; OR=1.4, 95% CI 1.0–2.1)
  - ACSSuT resistance in ser. Typhimurium (14.5% vs. 17.4%; OR=0.8, 95% CI 0.6–1.2)
  - ACSSuTAuCx resistance in ser. Newport (3.0% vs. 5.4%; OR=0.6, 95% CI 0.3–1.3)
  - Ceftriaxone resistance in ser. Heidelberg (8.5% vs. 18.1%; OR=0.5, 95% CI 0.2–1.2)
- Among *Campylobacter jejuni* and *C. coli*
  - Ciprofloxacin resistance in *C. jejuni* (26.7% vs. 23.3%; OR=1.2, 95% CI 1.0–1.4)
  - Ciprofloxacin resistance in *C. coli* (35.6% vs. 31.8%; OR=1.3, 95% CI 0.9–1.9)

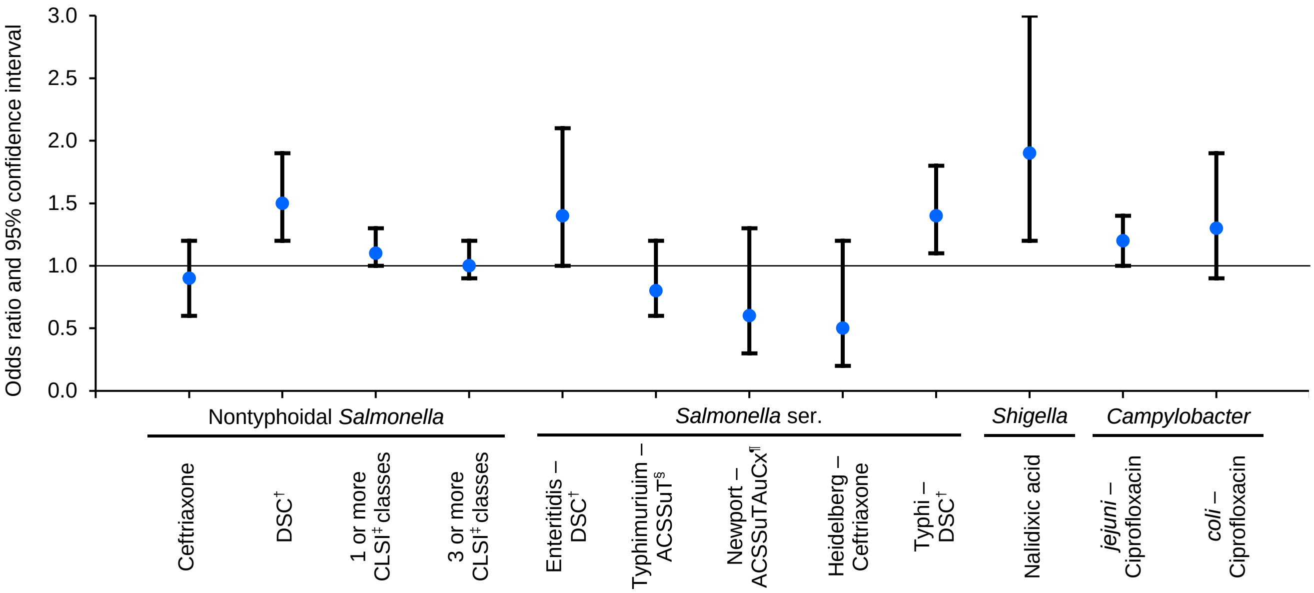
Highlight:
Changes in Antimicrobial Resistance: 2014 vs. 2004–2008 and 2009–2013

Figure H2. Changes in prevalence of selected resistance patterns among *Salmonella, Shigella,* and *Campylobacter* isolates, 2014 compared with 2004–2008 and 2009–2013*

A. 2014 compared with 2004–2008*



B. 2014 compared with 2009–2013*



● Odds Ratio* ▬ Upper and Lower 95% CI*

* The prevalence of resistance in 2014 was compared with the average prevalence from two reference periods, 2004–2008 and 2009–2013. Logistic regression models adjusted for site using a 9-level categorical variable (9 US census divisions) for *Salmonella* and *Shigella* and 10-level categorical variable (10 FoodNet states) for *Campylobacter*. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. ORs that do not include 1.0 in the 95% CIs are reported as statistically significant.

† DSC: Decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL for *Salmonella*)

‡ Antimicrobial classes of agents are those defined by the Clinical and Laboratory Standards Institute (CLSI)

§ ACSSuT: resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline

¶ ACSSuTAuCx: resistance to at least ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone

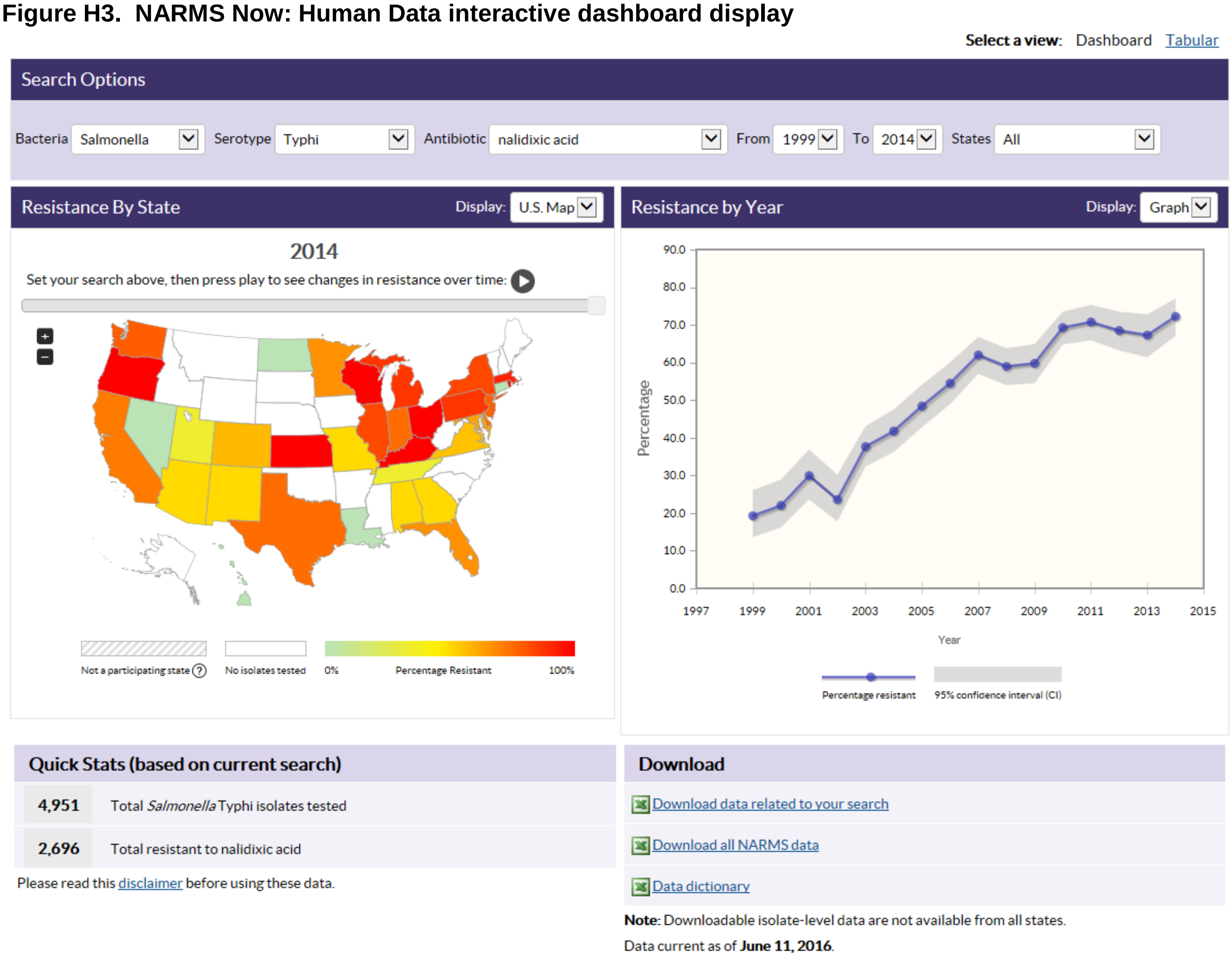
Highlight:
NARMS Now: Human Data – An Interactive Web Tool for Antimicrobial Resistance Data

In August 2015, CDC launched NARMS Now: Human Data, an interactive online tool that allows users (e.g., state health officials, the public, academia, industry, and other government agencies) to view and access antimicrobial resistance data from the past two decades for four bacteria (*Campylobacter*, *Escherichia coli* O157, *Salmonella*, and *Shigella*) transmitted commonly through food. The tool allows users to explore and analyze resistance data by bacteria, antimicrobial agent, year (1996–2014), and geographic region. It has an interactive dashboard display and users can download isolate-level datasets. Whole genome sequencing data for resistant nontypoidal *Salmonella* isolated in 2014 are also available in the downloadable dataset.

NARMS Now: Human Data can be used to
- examine the geographic distribution of resistance
- monitor trends in resistance
- inform and evaluation prevention measures including regulatory actions

NARMS integrated antimicrobial resistance surveillance data for humans, retail meat, and animal samples is available via NARMS Now: Integrated Data on FDA's Center for Veterinary Medicine's website. Users can download these data in a spreadsheet format and analyze using a statistical software application of their choice.

Figure H3. NARMS Now: Human Data interactive dashboard display



Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2014, NARMS conducted nationwide surveillance among the approximately 319 million persons living in the United States (2014 estimates published in the 2014 U.S. Census Bureau report). Public health laboratories systematically selected every 20th nontyphoidal *Salmonella, Shigella*, and *Escherichia coli* O157 isolate and every *Salmonella* ser. Typhi, *Salmonella* ser. Paratyphi A, and *Salmonella* ser. Paratyphi C isolate received at their laboratories and forwarded these isolates to CDC for antimicrobial susceptibility testing. With few exceptions, serotyping was performed at the public health laboratories and not further confirmed at CDC. *Salmonella* ser. Paratyphi B was included in the sampling for nontyphoidal *Salmonella* because laboratory methods are not always available to reliably distinguish between ser. Paratyphi B (which typically causes typhoidal illness) and ser. Paratyphi B var. L(+) tartrate+ (which does not typically cause typhoidal illness). Serotype Paratyphi B isolates for which the results of tartrate fermentation testing are reported as either “negative” or “missing” are retested and confirmed at CDC. Those identified as ser. Paratyphi B var. L(+) tartrate+ are included with other nontyphoidal *Salmonella* serotypes in this report. Because the number of ser. Paratyphi B (tartrate negative) and ser. Paratyphi C isolates is very small, this report includes susceptibility results only for ser. Paratyphi A.

Since 1997, NARMS has performed antimicrobial susceptibility testing on *Campylobacter* isolates submitted by the public health laboratories participating in CDC’s Foodborne Diseases Active Surveillance Network (FoodNet). The FoodNet sites, representing approximately 49 million persons (2014 estimates published in 2014 U.S. Census Bureau report), include Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, and selected counties in California, Colorado, and New York. From 1997 to 2004, public health laboratories then participating in FoodNet forwarded one *Campylobacter* isolate each week to CDC for susceptibility testing. In 2005, a new scheme was introduced and sites began forwarding a sample of *Campylobacter* isolates based on the number of isolates received. They submitted every isolate (Connecticut, Georgia, Maryland, New Mexico, Oregon, and Tennessee), every other isolate (California, Colorado, and New York), or every fifth isolate (Minnesota) received. Starting in 2010, Georgia and Maryland submitted every other isolate received, and New Mexico submitted every third isolate received. State public health laboratories in FoodNet sites receive *Campylobacter* isolates from a convenience sample of reference and clinical laboratories in their state. Of the laboratories in each site that perform on-site testing for *Campylobacter* (range,18 to 78 per site in 2014), the number submitting isolates to the state public health laboratory ranged from one to all in 2014. After June 2014, California stopped submitting *Camplylobacter* isolates to NARMS because the clinical laboratory that had provided isolates stopped culturing for *Campylobacter*. As a result, the number of *Campylobacter* isolates received and tested from California decreased from 74 in 2013 to 42 in 2014.

Beginning in 2009, we asked sites to forward every non-*cholerae Vibrio* isolate, and NARMS performed susceptibility testing on all isolates of *Vibrio* species other than *V. cholerae*. (All *Vibrio* isolates are first speciated and characterized by CDC’s National Enteric Reference Laboratory.) Beginning in mid-2013, we selected every other *Vibrio parahaemolyticus* isolate received, by site, for antimicrobial susceptibility testing due to a high number of *Vibrio parahaemolyticus* submissions and limited laboratory capacity. We continued to test every isolate of species other than *V. cholerae*. For information on resistance testing of toxigenic *Vibrio cholerae*, refer to the Cholera and Other *Vibrio* Illness Surveillance System (COVIS) annual summaries.

Table 1. Population size and number of isolates received and tested, 2014

State/Site	Population Size*		Nontyphoidal *Salmonella*		Typhoidal† *Salmonella*		*Shigella*		*E. coli* O157		*Campylobacter* ‡		*Vibrio* species other than *V. cholerae*	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Alabama	4,846,411	(1.5)	57	(2.7)	2	(0.5)	19	(3.6)	3	(1.9)			6	(1.2)
Alaska	737,046	(0.2)	4	(0.2)	0	(0)	1	(0.2)	1	(0.6)			2	(0.4)
Arizona	6,728,783	(2.1)	53	(2.5)	6	(1.4)	0	(0)	0	(0)			6	(1.2)
Arkansas	2,966,835	(0.9)	28	(1.3)	0	(0)	23	(4.3)	0	(0)			1	(0.2)
California§	28,675,586	(9.0)	55	(2.6)	100	(22.6)	2	(0.4)	13	(8.4)	42	(2.9)	24	(4.9)
Colorado	5,355,588	(1.7)	32	(1.5)	10	(2.3)	4	(0.8)	2	(1.3)	39	(2.7)	5	(1.0)
Connecticut	3,594,762	(1.1)	24	(1.1)	4	(0.9)	3	(0.6)	2	(1.3)	188	(13.0)	5	(1.0)
Delaware	935,968	(0.3)	11	(0.5)	6	(1.4)	4	(0.8)	1	(0.6)			1	(0.2)
District of Columbia	659,836	(0.2)	15	(0.7)	1	(0.2)	17	(3.2)	2	(1.3)			0	(0)
Florida	19,905,569	(6.2)	64	(3.0)	12	(2.7)	0	(0)	0	(0)			102	(20.7)
Georgia	10,097,132	(3.2)	119	(5.6)	13	(2.9)	56	(10.5)	2	(1.3)	196	(13.6)	10	(2.0)
Hawaii	1,420,257	(0.4)	14	(0.7)	2	(0.5)	2	(0.4)	2	(1.3)			27	(5.5)
Houston, Texas¶	2,239,558	(0.7)	52	(2.4)	13	(2.9)	10	(1.9)	1	(0.6)			0	(0)
Idaho	1,634,806	(0.5)	9	(0.4)	1	(0.2)	0	(0)	2	(1.3)			0	(0)
Illinois	12,882,189	(4.0)	90	(4.2)	19	(4.3)	38	(7.2)	7	(4.5)			2	(0.4)
Indiana	6,597,880	(2.1)	38	(1.8)	5	(1.1)	12	(2.3)	4	(2.6)			1	(0.2)
Iowa	3,109,481	(1.0)	23	(1.1)	0	(0)	3	(0.6)	5	(3.2)			0	(0)
Kansas	2,902,507	(0.9)	15	(0.7)	1	(0.2)	2	(0.4)	2	(1.3)			0	(0)
Kentucky	4,412,617	(1.4)	28	(1.3)	1	(0.2)	3	(0.6)	1	(0.6)			4	(0.8)
Los Angeles**	10,116,705	(3.2)	60	(2.8)	18	(4.1)	3	(0.6)	1	(0.6)			0	(0)
Louisiana	4,648,990	(1.5)	50	(2.4)	1	(0.2)	4	(0.8)	1	(0.6)			27	(5.5)
Maine	1,330,256	(0.4)	7	(0.3)	0	(0)	5	(0.9)	4	(2.6)			5	(1.0)
Maryland	5,975,346	(1.9)	48	(2.3)	17	(3.8)	6	(1.1)	5	(3.2)	266	(18.4)	23	(4.7)
Massachusetts	6,755,124	(2.1)	58	(2.7)	18	(4.1)	8	(1.5)	3	(1.9)			18	(3.7)
Michigan	9,916,306	(3.1)	48	(2.3)	8	(1.8)	13	(2.4)	2	(1.3)			2	(0.4)
Minnesota	5,457,125	(1.7)	36	(1.7)	5	(1.1)	4	(0.8)	7	(4.5)	153	(10.6)	13	(2.6)
Mississippi	2,993,443	(0.9)	52	(2.4)	1	(0.2)	7	(1.3)	1	(0.6)			7	(1.4)
Missouri	6,063,827	(1.9)	62	(2.9)	5	(1.1)	60	(11.3)	10	(6.5)			0	(0)
Montana	1,023,252	(0.3)	6	(0.3)	0	(0)	2	(0.4)	2	(1.3)			0	(0)
Nebraska	1,882,980	(0.6)	12	(0.6)	0	(0)	9	(1.7)	4	(2.6)			1	(0.2)
Nevada	2,838,281	(0.9)	11	(0.5)	3	(0.7)	3	(0.6)	1	(0.6)			1	(0.2)
New Hampshire	1,327,996	(0.4)	8	(0.4)	0	(0)	1	(0.2)	1	(0.6)			1	(0.2)
New Jersey	8,938,844	(2.8)	58	(2.7)	25	(5.6)	11	(2.1)	2	(1.3)			15	(3.0)
New Mexico	2,085,567	(0.7)	17	(0.8)	2	(0.5)	4	(0.8)	1	(0.6)	93	(6.4)	0	(0)
New York††	11,257,779	(3.5)	75	(3.5)	16	(3.6)	6	(1.1)	3	(1.9)	228	(15.8)	25	(5.1)
New York City‡‡	8,491,079	(2.7)	61	(2.9)	44	(9.9)	24	(4.5)	4	(2.6)			7	(1.4)
North Carolina	9,940,387	(3.1)	0	(0)	0	(0)	0	(0)	0	(0)			6	(1.2)
North Dakota	740,040	(0.2)	6	(0.3)	2	(0.5)	2	(0.4)	0	(0)			1	(0.2)
Ohio	11,596,998	(3.6)	64	(3.0)	13	(2.9)	11	(2.1)	9	(5.8)			3	(0.6)
Oklahoma	3,879,610	(1.2)	33	(1.6)	0	(0)	4	(0.8)	4	(2.6)			0	(0)
Oregon	3,971,202	(1.2)	23	(1.1)	4	(0.9)	3	(0.6)	5	(3.2)	164	(11.4)	18	(3.7)
Pennsylvania	12,793,767	(4.0)	73	(3.4)	10	(2.3)	9	(1.7)	3	(1.9)			6	(1.2)
Rhode Island	1,054,907	(0.3)	9	(0.4)	2	(0.5)	2	(0.4)	1	(0.6)			4	(0.8)
South Carolina	4,829,160	(1.5)	65	(3.1)	2	(0.5)	6	(1.1)	1	(0.6)			5	(1.0)
South Dakota	853,304	(0.3)	8	(0.4)	0	(0)	16	(3.0)	1	(0.6)			0	(0)
Tennessee	6,547,779	(2.1)	58	(2.7)	3	(0.7)	40	(7.5)	6	(3.9)	75	(5.2)	6	(1.2)
Texas§§	24,739,520	(7.8)	175	(8.2)	11	(2.5)	24	(4.5)	2	(1.3)			26	(5.3)
Utah	2,944,498	(0.9)	19	(0.9)	3	(0.7)	1	(0.2)	2	(1.3)			0	(0)
Vermont	626,767	(0.2)	8	(0.4)	0	(0)	1	(0.2)	0	(0)			0	(0)
Virginia	8,328,098	(2.6)	56	(2.6)	10	(2.3)	8	(1.5)	2	(1.3)			15	(3.0)
Washington	7,063,166	(2.2)	38	(1.8)	22	(5.0)	7	(1.3)	8	(5.2)			51	(10.4)
West Virginia	1,848,751	(0.6)	35	(1.6)	0	(0)	8	(1.5)	3	(1.9)			0	(0)
Wisconsin	5,759,432	(1.8)	53	(2.5)	2	(0.5)	17	(3.2)	5	(3.2)			9	(1.8)
Wyoming	584,304	(0.2)	4	(0.2)	0	(0)	3	(0.6)	1	(0.6)			1	(0.2)
Total	**318,907,401**	**(100)**	**2,127**	**(100)**	**443**	**(100)**	**531**	**(100)**	**155**	**(100)**	**1,444**	**(100)**	**492**	**(100)**

* Published in 2014 U.S. Census Bureau population estimates

† Typhoidal *Salmonella* includes serotypes Typhi, Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C. Because the number of ser. Paratyphi B (tartrate negative) and ser. Paratyphi C isolates is very small, susceptibility results for them are not reported.

‡ *Campylobacter* isolates are submitted only from FoodNet sites, which are Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, and selected counties in California, Colorado, and New York. Of the clinical laboratories in each site that perform on-site testing for *Campylobacter* (range,18 to 78 per site in 2014), the number submitting isolates to the state public health laboratory ranged from one to all. After June 2014, California no longer submitted *Camplylobacter* isolates to NARMS as the clinical laboratory that provided California isolates stopped culturing for *Campylobacter.*

§ Excluding Los Angeles County

¶ Houston City

** Los Angeles County, CA

†† Excluding New York City

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

§§ Excluding Houston, Texas

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

Antimicrobial Susceptibility Testing

Salmonella, *Shigella*, and *E. coli* O157 isolates were tested using broth microdilution (Sensititre®, Trek Diagnostics, part of Thermo Fisher Scientific, Cleveland, OH) according to manufacturer's instructions to determine the minimum inhibitory concentrations (MICs) for each of 14 antimicrobial agents: ampicillin, amoxicillin-clavulanic acid, azithromycin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, nalidixic acid, streptomycin, sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole (Table 2). Interpretive criteria defined by the Clinical Laboratory Standards Institute (CLSI) were used when available. Before 2004, sulfamethoxazole was used instead of sulfisoxazole to represent the sulfonamides. In 2011, azithromycin replaced amikacin on the panel of drugs tested for *Salmonella*, *Shigella*, and *E. coli* O157. In 2014, kanamycin was removed from the panel to allow for lower concentrations of streptomycin to be tested (concentration range was 32–64 µg/mL before 2014, compared with a range of 2–64 µg/mL in 2014). Only historical susceptibility data are provided for amikacin and kanamycin.

CLSI breakpoints for streptomycin are not established. In the past, we used a NARMS-established breakpoint of ≥64 µg/mL for resistance. After examining newly-available streptomycin MIC and *Salmonella* genetic data from 2014, we lowered the resistance breakpoint to ≥32 µg/mL and applied it to all *Enterobacteriaceae*. However, due to the limited streptomycin concentration range used in testing before 2014 (32–64 µg/mL), MICs of less than 32 µg/mL could not be differentiated from MICs equal to 32, and all isolates inhibited at the lowest concentration are categorized as having an MIC ≤32. As a result, the new breakpoint could only be applied to isolates tested during 2014 and the resistance breakpoint of ≥64 µg/mL was maintained for isolates tested during 1996–2013. The impact of the streptomycin breakpoint change on 2014 data is summarized in Appendix C.

In January 2010, CLSI published revised interpretive criteria for ceftriaxone and *Enterobacteriaceae;* the revised resistance breakpoint for ceftriaxone is MIC ≥4 µg/mL. NARMS has used the revised breakpoint years starting with 2009 data. In January 2012, CLSI published revised ciprofloxacin breakpoints for invasive *Salmonella* infections. For those infections, ciprofloxacin susceptibility is defined as ≤0.06 µg/mL; the intermediate category is 0.12 to 0.5 µg/mL; and resistance is ≥1 µg/mL. In 2012, we applied this breakpoint to all *Salmonella*, including non-invasive isolates. In 2013, CLSI decided to apply these ciprofloxacin breakpoints to all subspecies and serotypes of *Salmonella*. In January 2014, CLSI added azithromycin MIC interpretive criteria for *Salmonella* ser. Typhi. Azithromycin susceptibility is defined as ≤16 µg/mL and resistance is ≥32 µg/mL. These breakpoints match the NARMS-established breakpoints used for *Enterobacteriaceae* since azithromycin testing began in 2011. In this report, NARMS continued to apply these breakpoints to MIC data for all *Salmonella* and *E. coli* O157 (Table 2). In December 2015, CLSI established azithromycin MIC interpretive criteria for *Shigella sonnei* and *flexneri* after adopting a proposal from the *Shigella* Azithromycin Breakpoint Working Group, which included participants from CDC NARMS. Based on MIC and genetic data provided by the working group, epidemiological cutoff values of ≥32 µg/mL for *S. sonnei* and ≥16 µg/mL for *S. flexneri* were established as non-wild-type. In this report, we refer to non-wild-type as resistant for simplicity and continue to apply the breakpoint for resistance of ≥32 µg/mL for the remaining *Shigella* species (Table 2).

Repeat testing of isolates was done based on criteria in Appendix B.

Table 2. Antimicrobial agents used for susceptibility testing for *Salmonella*, *Shigella*, and *Escherichia coli* O157 isolates, 1996–2014

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
				Susceptible	Intermediate*/ S-DD†	Resistant
Aminoglycosides	Amikacin	1997–2010	0.5–64	≤16	32	≥64
	Gentamicin	all	0.25–16	≤4	8	≥16
	Kanamycin	1996–2013	8–64	≤16	32	≥64
	Streptomycin‡	1996–2013	32–64	≤32	N/A*	≥64
		2014–present	2–64	≤16	N/A*	≥32
β–lactam / β–lactamase inhibitor combinations	Amoxicillin-clavulanic acid	all	1/0.5–32/16	≤8/4	16/8	≥32/16
	Piperacillin-tazobactam§	2011–present	0.5–128	≤16/4	32/4–64/4	≥128/4
Cephems	Cefepime†,§	2011–present	0.06–32	≤2	4–8†	≥16
	Cefotaxime§	2011–present	0.06–128	≤1	2	≥4
	Cefoxitin	2000–present	0.5–32	≤8	16	≥32
	Ceftazidime§	2011–present	0.06–128	≤4	8	≥16
	Ceftiofur	all	0.12–8	≤2	4	≥8
	Ceftriaxone¶	all	0.25–64	≤1	2	≥4
	Cephalothin	1996–2003	2–32	≤8	16	≥32
Folate pathway inhibitors	Sulfamethoxazole	1996–2003	16–512	≤256	N/A*	≥512
	Sulfisoxazole	2004–present	16–256	≤256	N/A*	≥512
	Trimethoprim-sulfamethoxazole	all	0.12/2.38–4/76	≤2/38	N/A*	≥4/76
Macrolides	Azithromycin** (*Salmonella* serotypes, *Shigella* species other than *S. flexneri*, and *E. coli* O157)	2011–present	0.12–16	≤16	N/A*	≥32
	Azithromycin** (*Shigella flexneri*)	2011–present	0.12–16	≤8	N/A*	≥16
Monobactams	Aztreonam§	2011–present	0.06–32	≤4	8	≥16
Penems	Imipenem§	2011–present	0.06–16	≤1	2	≥4
Penicillins	Ampicillin	all	1–32	≤8	16	≥32
Phenicols	Chloramphenicol	all	2–32	≤8	16	≥32
Quinolones	Ciprofloxacin (*Shigella* and *E. coli* O157)	all	0.015–4	≤1	2	≥4
	Ciprofloxacin†† (*Salmonella* serotypes)	all	0.015–4	≤0.06	0.12–0.5	≥1
	Nalidixic acid	all	0.5–32	≤16	N/A*	≥32
Tetracyclines	Tetracycline	all	4–32	≤4	8	≥16

* N/A indicates that no MIC range of intermediate susceptibility exists

† Cefepime MICs above the susceptible range, but below the resistant range are designated by CLSI to be susceptible-dose dependent (S-DD)

‡ CLSI breakpoints are not established for streptomycin; breakpoints used in this report are NARMS-established breakpoints for resistance monitoring and should not be used to predict clinical efficacy. During 1996–2013 resistance was defined as ≥64 µg/mL; the breakpoint was updated to ≥32 µg/mL in 2014. The 2014 breakpoint could not be applied to previous years (see Methods for further explanation).

§ Broad-spectrum β-lactam antimicrobial agent only tested for nontyphoidal *Salmonella* isolates displaying ceftriaxone and/or ceftiofur resistance

¶ CLSI updated the ceftriaxone interpretive standards in January, 2010. NARMS Human Isolate Reports for 1996 through 2008 used susceptible ≤8 µg/mL, intermediate 16-32 µg/mL, and resistant ≥64 µg/mL.

** CLSI breakpoints for azithromycin are only established for *Salmonella* ser. Typhi, *Shigella sonnei,* and *Shigella flexneri*. Interpretive criteria for *Salmonella* ser. Typhi are based on MIC distribution data. In December 2015, CLSI established epidemiological cutoff values (ECVs) for *Shigella* species *sonnei* and *flexneri*. The ECVs should not be used as clinical breakpoints and CLSI uses the terms "wild-type" and "non-wild-type" instead of susceptible and resistant, respectively, to reflect the nature of the populations of bacteria in each group and to highlight that these categories are not to be used to predict clinical efficacy. The azithromycin breakpoints used elsewhere in this report for other *Shigella* species, non-Typhi *Salmonella*, and *E.coli* O157 isolates are NARMS-established breakpoints for resistance monitoring and should not be used to predict clinical efficacy.

†† CLSI updated the ciprofloxacin interpretive standards for *Salmonella* in January, 2012. NARMS Human Isolate Reports for 1996 through 2010 used susceptible ≤1 µg/mL, intermediate 2 µg/mL, and resistant ≥4 µg/mL.

Additional Testing of *Salmonella* Strains

Whole Genome Sequencing

In 2014, nontyphoidal *Salmonella* displaying resistance to at least one antimicrobial agent on the Trek Sensititre® gram-negative panel were sequenced to identify genetic resistance determinants. Genomic DNA was purified using an NXP Genomic DNA Extraction System or Qiagen Blood & Tissue Genomic Kit. Whole genome sequencing was performed on a HiSeq with 2 x 250bp reads (Illumina, Inc.). *De novo* assemblies were performed in CLC genomics workbench 8.0. Contigs having less than 10% the average genome coverage were discarded and genomes with less than 20X coverage or N50 values less than 30kb were excluded using a custom perl script. Antimicrobial resistance genes were identified using the Resfinder 2.1 database (Center for Genomic Epidemiology, DTU - last accessed on 1/22/2016) (megaBLAST using 90% ID and 60% gene coverage cutoffs). The colistin-resistance genes *mcr-1* and *mcr-2* were later added to our version of the Resfinder 2.1 database and neither were detected among the isolates tested. For mutational resistance, *gyrA* and *parC* were extracted from genome assemblies using perl scripts (https://github.com/lskatz/lskScripts/blob/ master/blastAndExtract.pl), imported into CLC workbench, and aligned to identify mutations.

β-lactam Panel Testing

Since 2011, nontyphoidal *Salmonella* isolates displaying resistance to either ceftriaxone (MIC ≥4 µg/mL) or ceftiofur (MIC ≥8 µg/mL) on the Trek Sensititre® gram-negative panel were subsequently tested by broth microdilution for resistance to additional broad-spectrum β-lactam drugs (aztreonam, cefepime, cefotaxime, ceftazidime, imipenem, and piperacillin-tazobactam) using the Trek Sensititre® β-lactam panel (Table 2). Briefly, each isolate was suspended in water to a McFarland standard equivalency of 0.5, and 10µL of each suspension was then used to inoculate a 10mL tube of cation-adjusted Mueller-Hinton (MH) broth. Inoculated MH broth was dosed at 50 µL/ well into the 96-well Trek β-lactam panel plate, and results were read manually after 18–20 hours of incubation at 35°C. Quality control isolates for this testing were *E. coli* (ATCC 25922), *Klebsiella pneumoniae* (ATCC 700603), *Pseudomonas aeruginosa* (ATCC 27853), and *Staphylococcus aureus* (ATCC 29213).

Cephalosporin Retesting of Isolates from 1996–1998

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

Serotype Confirmation/Categorization

The *Salmonella* serotype reported by the submitting laboratory was used for reporting with few exceptions. The serotype was confirmed by CDC for isolates that underwent subsequent molecular analysis. Because of challenges in interpretation of tartrate fermentation assays, ability to ferment tartrate was confirmed for isolates reported as *Salmonella* ser. Paratyphi B by the submitting laboratory (ser. Paratyphi B is by definition unable to ferment L(+) tartrate). To distinguish *Salmonella* ser. Paratyphi B and ser. Paratyphi B var. L(+) tartrate+ (formerly ser. Java), CDC performed Jordan's tartrate test or Kauffmann's tartrate test or both tests on all *Salmonella* ser. Paratyphi B isolates for which the tartrate result was not reported or was reported to be negative. Isolates negative for tartrate fermentation by all assays conducted were categorized as ser. Paratyphi B; as noted above, because the number of ser. Paratyphi B (tartrate negative) is very small, this report does not include susceptibility results for this serotype. Isolates that were positive for tartrate fermentation by either assay were categorized as ser. Paratyphi B var. L(+) tartrate+ and were included with other nontyphoidal *Salmonella* in this report. CDC did not confirm other biochemical reactions or somatic and flagellar antigens.

Because of increased submissions of *Salmonella* ser. I 4,[5],12:i:- noted in previous years and recognition of the possibility that this serotype may have been underreported in previous years, antigen results provided for isolates reported only as serogroup B and tested in NARMS during 1996 to 2012 were reviewed; isolates that could be clearly identified as serogroup B, first-phase flagellar antigen "i," second phase flagellar antigen absent, were categorized as *Salmonella* ser. I 4,[5],12:i:-.

Testing of *Campylobacter*

Changes in Identification, Speciation, and Antimicrobial Susceptibility Testing Over Time

From 1997 to 2002, isolates were confirmed as *Campylobacter* by determination of typical morphology and motility using dark-field microscopy and a positive oxidase test reaction. *C. jejuni* bacteria were identified using colorimetric detection of their ability to hydrolyze hippurate. *Campylobacter* species unable to hydrolyze hippurate were subject to PCR using primers targeting species-specific genetic loci, including *mapA* or *hipO* (*C. jejuni) and ceuE (C. coli)* or other species-specific primers (Linton et al., 1997; Gonzales et al., 1997; Pruckler et al., 2006) followed by Sanger sequencing and identification by comparative sequence analyses. From 2003 to 2004, *Campylobacter* isolates were identified as *C. jejuni* or *C. coli* using BAX® System PCR Assay according to the manufacturer's instructions (DuPont, Wilmington, DE). Isolates not identified as *C. jejuni* or *C. coli* were further characterized using a standard set phenotypic and molecular identification tests including species-specific PCR assays (Linton et al., 1996). Between 2005 and 2009, dark-field microscopy and biochemical tests were reinstituted as a means of *Campylobacter* identification, along with traditional PCR. Beginning in 2010, the *ceuE* PCR was discontinued, and a multiplex PCR (Vandamme et al., 1997) was used to confirm speciation of *C. jejuni* and suspected *C. coli* isolates. Since 2012, all genus-confirmed *Campylobacter* isolates were identified at the species level through a combination of multiplex PCR, biochemical tests, and other species-specific PCRs as needed.

Methods for susceptibility testing of *Campylobacter* and criteria for interpreting the results have also changed during the course of NARMS surveillance. From 1997 to 2004, Etest® (AB bioMerieux, Solna, Sweden) was used for susceptibility testing of *Campylobacter* isolates. *Campylobacter*-specific CLSI interpretive criteria were first used to determine susceptibility to erythromycin, ciprofloxacin, and tetracycline in 2004. NARMS breakpoints were used for agents for which CLSI breakpoints were not available; these were based on the MIC distributions of NARMS isolates, as well as the presence of known resistance genes or mutations. Before 2004, NARMS reported non-CLSI breakpoints based on those of similar bacterial organisms. The establishment of NARMS breakpoints based on MIC distributions resulted in higher resistance cutoffs for azithromycin and erythromycin compared with those reported for isolates obtained before 2004. In 2005, NARMS instituted the Trek Sensititre® system to determine the MICs for *Campylobacter* against a panel of nine antimicrobial agents: azithromycin, ciprofloxacin, clindamycin, erythromycin, florfenicol, gentamicin, nalidixic acid, telithromycin, and tetracycline (Table 3). Broth microdilution was performed according to manufacturer's instructions and CLSI recommendations, and recommended quality control strains and procedures were followed. In 2012, the criteria for interpretation of results were changed from the previously used breakpoints to European Committee on Antimicrobial Susceptibility Testing (EUCAST) epidemiological cutoff values (ECVs). The interpretive criteria listed in Table 3 have been applied to MIC data collected for all years so that resistance prevalence is comparable over time. Repeat testing of isolates was based on criteria in Appendix B.

Table 3. Antimicrobial agents used for susceptibility testing of *Campylobacter* isolates, 1997–2014

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)†			
				C. jejuni		*C. coli*	
				Susceptible	Resistant	Susceptible	Resistant
Aminoglycosides	Gentamicin	1998–present	0.12–32 0.016–256*	≤2	≥4	≤2	≥4
Ketolides	Telithromycin‡	2005–present	0.015–8	≤4	≥8	≤4‡	≥8‡
Lincosamides	Clindamycin	all	0.03–16 0.016–256*	≤0.5	≥1	≤1	≥2
Macrolides	Azithromycin	1998–present	0.015–64 0.016–256*	≤0.25	≥0.5	≤0.5	≥1
	Erythromycin	all	0.03–64 0.016–256*	≤4	≥8	≤8	≥16
Phenicols	Chloramphenicol	1997–2004	0.016–256*	≤16	≥32	≤16	≥32
	Florfenicol	2005–present	0.03–64	≤4	≥8	≤4	≥8
Quinolones	Ciprofloxacin	all	0.015–64 0.002–32*	≤0.5	≥1	≤0.5	≥1
	Nalidixic acid	all	4–64 0.016–256*	≤16	≥32	≤16	≥32
Tetracyclines	Tetracycline	all	0.06–64 0.016–256*	≤1	≥2	≤2	≥4

* Etest dilution range used from 1997–2004

† MIC interpretative standard is based on epidemiological cutoff values (ECVs) established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST – last accessed on 8/4/2016). This approach was adopted in 2012 and applied to all years. EUCAST uses the terms “wild-type” and “non-wild-type” instead of susceptible and resistant, respectively, to reflect the nature of the populations of bacteria in each group and to highlight that these categories are not to be used to predict clinical efficacy.

‡ A telithromycin ECV for *Campylobacter coli* is not currently published by EUCAST. In this report, we applied the previously published ECV of 4 µg/mL to all *C. coli* isolates, designating “wild-type” isolates (MIC ≤4 µg/mL) as sensitive and “non-wild-type” isolates (MIC ≥8 µg/mL) as resistant.

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

Sampling of *Vibrio* species other than *V. cholerae* is described in the Surveillance Sites and Isolate Submissions section. Minimum inhibitory concentrations were determined by Etest® (AB bioMerieux, Solna, Sweden) according to manufacturer's instructions for ten antimicrobial agents: ampicillin, cefotaxime, ceftazidime, chloramphenicol, ciprofloxacin, gentamicin, imipenem, nalidixic acid, tetracycline, and trimethoprim-sulfamethoxazole (Table 4). In 2013, cefotaxime, ceftazidime, gentamicin, and imipenem were added to the panel of drugs tested, and cephalothin, kanamycin, and streptomycin were removed. In 2014, not all *Vibrio* isolates could be tested against nalidixic acid and imipenem due to a manufacturer shortage of Etest® strips. Of 492 isolates included in this report, 183 could not be tested against nalidixic acid; 116 of those also lacked imipenem testing. Overall, 309 (63%) isolates have results for nalidixic acid and 376 (76%) have results for imipenem.

CLSI breakpoints specific for *Vibrio* species other than *V. cholerae* were available for ampicillin, cefotaxime, ceftazidime, ciprofloxacin, gentamicin, imipenem, tetracycline, and trimethoprim-sulfamethoxazole. In October 2015, CLSI published revised interpretive criteria for imipenem and *Vibrio* species; the revised resistance breakpoint for imipenem is MIC ≥4 µg/mL. The percentage of isolates in 2014 that are susceptible, intermediate, and resistant to agents with CLSI interpretive standards, including MIC distributions for all agents, are shown in this report (Table 58). Historical resistance data are shown for ampicillin only, as resistance to the other tested drugs is extremely low. For information on toxigenic *Vibrio cholerae*, refer to the Cholera and Other *Vibrio* Illness Surveillance System (COVIS) annual summaries.

Repeat testing of isolates was done based on criteria in Appendix B.

Table 4. Antimicrobial agents used for susceptibility testing of *Vibrio* species other than *V. cholerae* isolates, 2009–2014

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
				Susceptible	Intermediate*	Resistant
Aminoglycosides	Gentamicin	2013–present	0.064–1024	≤4	8	≥16
	Kanamycin	2009–2012	0.016–256	No CLSI or NARMS breakpoints		
	Streptomycin	2009–2012	0.064–1024	No CLSI or NARMS breakpoints		
Cephems	Cefotaxime	2013–present	0.016–256	≤1	2	≥4
	Ceftazidime	2013–present	0.016–256	≤4	8	≥16
	Cephalothin	2009–2012	0.016–256	No CLSI or NARMS breakpoints		
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	all	0.002–32	≤2/38	N/A*	≥4/76
Penems	Imipenem†	2013–present	0.002–32	≤1	2	≥4
Penicillins	Ampicillin	all	0.016–256	≤8	16	≥32
Phenicols	Chloramphenicol	all	0.016–256	No CLSI or NARMS breakpoints		
Quinolones	Ciprofloxacin	all	0.002–32	≤1	2	≥4
	Nalidixic acid	all	0.016–256	No CLSI or NARMS breakpoints		
Tetracyclines	Tetracycline	all	0.016–256	≤4	8	≥16

* N/A indicates that no MIC range of intermediate susceptibility exists

† CLSI updated the imipenem interpretive standards in October, 2015. The 2013 NARMS Human Isolate Report used susceptible ≤4 µg/mL, intermediate 8 µg/mL, and resistant ≥16 µg/mL.

Data Analysis

For all pathogens, isolates were categorized as resistant, intermediate (if applicable), or susceptible. For *Salmonella*, isolates with ciprofloxacin MICs categorized as intermediate or resistant (MIC ≥0.12 µg/mL) were defined as having decreased susceptibility to ciprofloxacin (DSC). For *Campylobacter*, epidemiological cutoff values (ECVs) established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST- last accessed on 8/4/2016) were used to interpret MICs. For *Shigella sonnei* and *flexneri,* ECVs established by CLSI were used to interpret azithromycin MICs. This approach assigns bacteria to one of two groups: wild-type or non-wild-type. For simplicity, the EUCAST and CLSI wild-type and non-wild-type categories are referred to in this report as susceptible and resistant, respectively.

Analysis was restricted to the first isolate received per patient in the calendar year (per serotype for *Salmonella*, per species for *Campylobacter, Shigella,* and *Vibrio* species other than *Vibrio cholerae*). If two or more *Salmonella* ser. Typhi isolates were received for the same patient, the first blood isolate, or other isolate from a normally sterile site collected, was included in the analysis. If no blood isolate or other isolate from a normally sterile site was submitted, the first isolate collected was included in analysis. The 95% confidence intervals (CIs) for the percentage resistant, which were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method, are included in the MIC distribution tables.

In the analysis of antimicrobial class resistance among *Salmonella, Shigella,* and *E. coli* O157, nine CLSI classes (Table 2) were represented by the following agents: amoxicillin-clavulanic acid, ampicillin, azithromycin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, nalidixic acid, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole. Isolates that were not resistant to any of these agents were considered to have no resistance detected. In the analysis of antimicrobial class resistance among *Campylobacter*, seven CLSI classes were represented by azithromycin, ciprofloxacin, chloramphenicol/florfenicol, clindamycin, erythromycin, gentamicin, nalidixic acid, telithromycin, and tetracycline (Table 3). Isolates that were not resistant to any of these agents were considered to have no resistance detected.

Using logistic regression, we modelled annual data from 2004–2014 to assess changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* isolates. We compared the prevalence of resistance among isolates tested in 2014 with the average prevalence from two reference periods, 2004–2008 and the previous five years, 2009–2013. The 2004–2008 reference period begins with the second year that all 50 states participated in *Salmonella* and *Shigella* surveillance and all 10 FoodNet sites participated in NARMS *Campylobacter* surveillance. The additional 2009–2013 reference period allows for comparisons with more recent years. We defined the prevalence of resistance as the percentage of resistant isolates among the total number of isolates tested. Changes in the percentage of isolates that are resistant may not reflect changes in the incidence of resistant infections because of fluctuations in the incidence of illness caused by the pathogen or serotype from year to year. The incidence and relative changes in the incidence of *Salmonella, Shigella,* and *Campylobacter* infections are reported annually from surveillance in FoodNet sites (CDC, 2016). Comparisons were made for the following:

- Nontyphoidal *Salmonella*: decreased susceptibility to ciprofloxacin, resistance to ceftriaxone, resistance to one or more CLSI classes, and resistance to three or more CLSI classes
- *Salmonella* of particular serotypes
    - *Salmonella* ser. Enteritidis: decreased susceptibility to ciprofloxacin
    - *Salmonella* ser. Typhimurium: resistance to at least ACSSuT (ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline)
    - *Salmonella* ser. Newport: resistance to at least ACSSuTAuCx (ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone)
    - *Salmonella* ser. Heidelberg: resistance to ceftriaxone
    - *Salmonella* ser. Typhi: decreased susceptibility to ciprofloxacin
- *Shigella*: resistance to nalidixic acid
- *Campylobacter jejuni, C. coli*: resistance to ciprofloxacin

In the logistic regression analysis for main effects, year was modelled as a 10-level categorical variable. To account for site-to-site variation in the prevalence of antimicrobial resistance, we included adjustments for site. The final regression models for *Salmonella* and *Shigella* adjusted for the submitting site using the nine division categories described by the U.S. Census Bureau: East North Central, East South Central, Middle Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central. For *Campylobacter*, the final regression models adjusted for the submitting site using the 10 FoodNet states. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. The adequacy of model fit was assessed in several ways (Fleiss et al., 2004; Kleinbaum et al., 2008). 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. When the main effect of year was significant, we report ORs with 95% CIs (for 2014 compared with 2004-2008 and 2009–2013) that did not include 1.0 as statistically significant.

MIC Distribution Tables and Proportional Figures

An explanation of “how to read a squashtogram” has been provided to assist the reader with the table (Figure 1). A squashtogram shows the distribution of MICs for antimicrobial agents tested. Proportional figures visually display data from squashtograms for an immediate comparative summary of resistance in specific pathogens and serotypes. These figures are a visual aid for the interpretation of MIC values. For most antimicrobial agents tested, three categories (susceptible, intermediate, and resistant) are used to interpret MICs. The proportion representing each category is shown in a horizontal proportional bar chart (Figure 2).

Figure 1. How to read a squashtogram

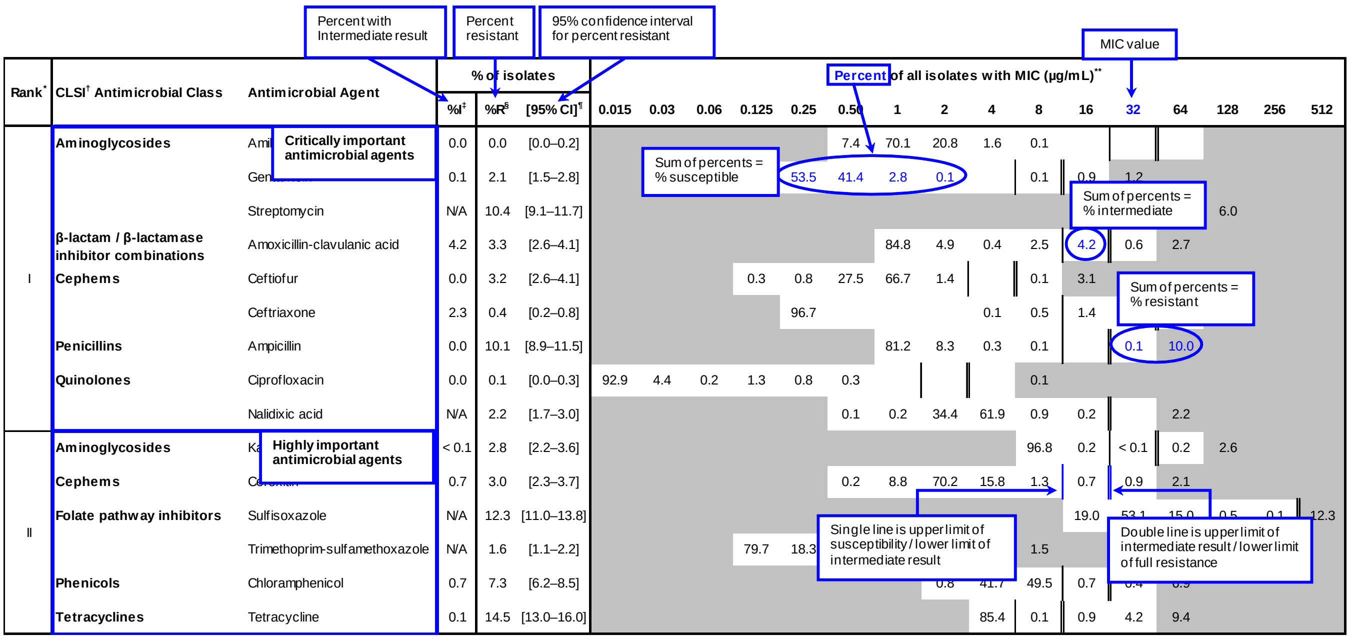
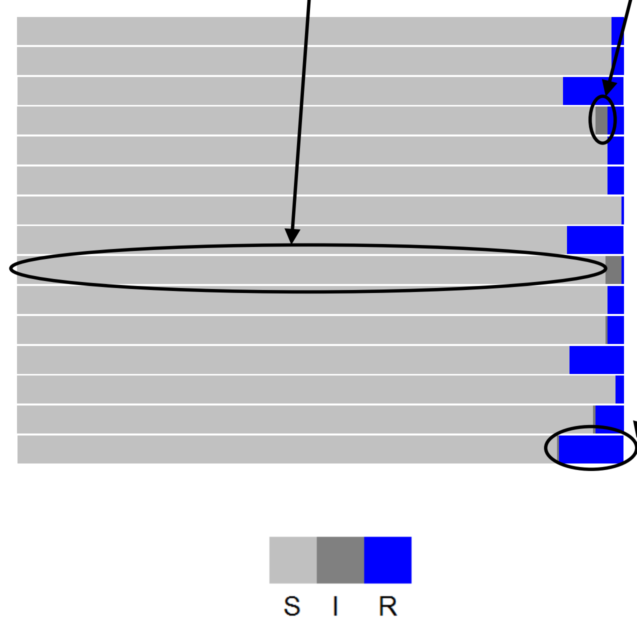


Figure 2. Proportional chart, a categorical graph of a squashtogram

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates %I‡	%R§	[95% CI]¶	Percentage of all isolates with MIC (µg/mL)** 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	<0.1	1.7	[1.2 - 2.3]					8.3	76.4	13.1	0.5		<0.1	0.2	1.5				
		Kanamycin	<0.1	1.7	[1.2 - 2.3]										98.2	0.1	<0.1	<0.1	1.6		
		Streptomycin	N/A	9.8	[8.6 - 11.1]												90.2	2.3	7.5		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.0	2.6	[2.0 - 3.3]							89.2	1.7	0.6	3.9	2.0	0.8	1.8			
	Cephems	Ceftiofur	<0.1	2.5	[1.9 - 3.2]				0.3	0.8	37.7	57.7	1.0	<0.1	0.2	2.3					
		Ceftriaxone	<0.1	2.5	[1.9 - 3.2]					97.5			<0.1	0.1	0.3	1.0	0.8	0.3	0.1		
	Macrolide	Azithromycin	N/A	0.2	[0.1 - 0.5]						0.2	0.4	11.2	80.4	7.3	0.2	0.2				
	Penicillins	Ampicillin	0.1	9.1	[8.0 - 10.3]							86.9	3.5	0.3	0.1	0.1	0.2	8.9			
	Quinolones	Ciprofloxacin	2.8	0.2	[0.0 - 0.4]	91.9	4.9	0.2	1.0	0.9	0.9	0.1			0.1						
		Nalidixic acid	N/A	2.4	[1.8 - 3.1]						0.2	0.6	47.4	48.1	0.9	0.4	0.1	2.3			
II	**Cephems**	Cefoxitin	0.2	2.6	[2.0 - 3.3]						0.4	31.1	53.7	10.7	1.3	0.2	1.1	1.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	8.6	[7.5 - 9.8]											5.9	46.1	37.8	1.5		8.6
		Trimethoprim-sulfamethoxazole	N/A	1.2	[0.8 - 1.7]				96.8	1.7	0.2		<0.1	<0.1	1.2						
	Phenicols	Chloramphenicol	0.6	4.4	[3.6 - 5.3]								0.9	51.0	43.1	0.6	0.1	4.3			
	Tetracyclines	Tetracycline	0.2	10.5	[9.2 - 11.8]									89.4	0.2	0.3	1.9	8.2			

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



Results

1. Nontyphoidal *Salmonella*

Table 5. Number of nontyphoidal *Salmonella* isolates among the most common serotypes* tested with the number of resistant isolates by class and agent, 2014

	Isolates		Number of Isolates: Number of CLSI[†] Antimicrobial Classes to which Isolates are Resistant						Number of Resistant Isolates by CLSI[†] Antimicrobial Class and Agent[‡]: Aminoglycosides		β-lactam/β-lactamase inhibitor combinations	Cephems			Folate pathway inhibitors		Macrolides	Penicillins	Phenicols	Quinolones		Tetracyclines
Serotype*	**N**	**(%)**	**0**	**1**	**2–3**	**4–5**	**6–7**	**8**	**GEN**	**STR**	**AMC**	**FOX**	**TIO**	**AXO**	**FIS**	**COT**	**AZI**	**AMP**	**CHL**	**CIP**	**NAL**	**TET**
Enteritidis	438	(20.6)	384	38	10	4	1	1	0	13	2	3	2	2	8	2	0	14	5	1	35	11
Typhimurium	262	(12.3)	180	13	20	38	10	1	8	65	14	14	14	14	66	6	1	52	42	1	7	59
Newport	235	(11.0)	219	5	1	3	7	0	1	11	7	7	7	7	11	1	0	9	10	0	1	12
Javiana	128	(6.0)	115	9	4	0	0	0	0	10	1	1	1	1	2	2	0	3	0	0	0	3
I 4,[5],12:i:-	110	(5.2)	42	6	10	50	2	0	2	58	3	3	5	5	55	2	0	56	4	2	7	59
Infantis	73	(3.4)	62	6	1	2	2	0	1	5	1	1	3	3	4	2	0	5	3	0	3	6
Heidelberg	71	(3.3)	44	8	10	9	0	0	11	18	6	6	6	6	11	2	0	16	7	0	3	11
Saintpaul	52	(2.4)	42	4	5	1	0	0	3	3	1	1	2	2	3	2	0	5	0	0	2	6
Muenchen	45	(2.1)	44	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1
Montevideo	44	(2.1)	42	1	1	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	1
Oranienburg	36	(1.7)	35	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1
Braenderup	31	(1.5)	29	1	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0
Mississippi	26	(1.2)	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agona	25	(1.2)	19	1	3	1	1	0	1	5	1	1	1	1	5	2	0	2	2	0	0	4
Thompson	24	(1.1)	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Berta	19	(0.9)	15	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
Rubislaw	19	(0.9)	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratyphi B var. L(+) tartrate+	18	(0.8)	15	2	0	1	0	0	0	1	0	0	0	0	1	0	0	1	1	0	1	2
Poona	18	(0.8)	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bareilly	16	(0.8)	15	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1
Panama	16	(0.8)	14	0	1	1	0	0	0	0	1	1	1	1	1	1	0	2	1	0	0	1
Anatum	13	(0.6)	11	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Norwich	13	(0.6)	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schwarzengrund	13	(0.6)	12	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Stanley	13	(0.6)	7	2	3	1	0	0	0	0	0	0	0	0	1	1	0	6	1	0	0	4
I 4,[5],12:b:-	12	(0.6)	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Litchfield	12	(0.6)	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hartford	11	(0.5)	10	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1
Dublin	10	(0.5)	3	0	1	0	6	0	0	7	6	5	6	6	6	0	0	6	6	0	1	6
I 13,23:b:-	10	(0.5)	9	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mbandaka	10	(0.5)	7	0	1	2	0	0	0	2	0	0	0	0	3	0	0	2	1	0	0	2
Subtotal	**1823**	**(85.7)**	**1498**	**104**	**76**	**114**	**29**	**2**	**27**	**205**	**44**	**44**	**50**	**50**	**182**	**26**	**1**	**183**	**83**	**4**	**61**	**196**
All other serotypes	271	(12.7)	225	17	22	7	0	0	3	31	1	2	1	1	18	2	0	10	2	5	13	24
Partially serotyped	2	(0.1)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rough/Nonmotile isolates	6	(0.3)	5	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Unknown serotype	25	(1.2)	21	4	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1
Total	**2127**	**(100)**	**1751**	**125**	**99**	**121**	**29**	**2**	**30**	**239**	**45**	**46**	**51**	**51**	**201**	**28**	**1**	**194**	**85**	**9**	**74**	**221**

* Only serotypes with at least 10 isolates are listed individually

† CLSI: Clinical and Laboratory Standards Institute

‡ Antimicrobial agent abbreviations: GEN, gentamicin; STR, streptomycin; AMC, amoxicillin-clavulanic acid; FOX, cefoxitin; TIO, ceftiofur; AXO, ceftriaxone; FIS, sulfisoxazole; COT, trimethoprim-sulfamethoxazole; AZI, azithromycin; AMP, ampicillin; CHL, chloramphenicol; CIP, ciprofloxacin; NAL, nalidixic acid; TET, tetracycline

Table 6. Percentage and number of nontyphoidal *Salmonella* isolates with selected resistance patterns, by serotype, 2014

			At least ACSSuT*		At least ACT/S†		At least ACSSuTAuCx‡		At least DSC§		At least ceftriaxone		At least DSC§ and ceftriaxone	
		N	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes														
1	Enteritidis	438	2	(3.0)	0	(0)	1	(3.8)	35	(38.0)	2	(3.9)	1	(14.3)
2	Typhimurium	262	38	(56.7)	4	(33.3)	11	(42.3)	9	(9.8)	14	(27.5)	1	(14.3)
3	Newport	235	7	(10.4)	0	(0)	7	(26.9)	2	(2.2)	7	(13.7)	1	(14.3)
4	Javiana	128	0	(0)	0	(0)	0	(0)	1	(1.1)	1	(2.0)	0	(0)
5	I 4,[5],12:i:-	110	4	(6.0)	1	(8.3)	0	(0)	9	(9.8)	5	(9.8)	1	(14.3)
6	Infantis	73	1	(1.5)	2	(16.7)	0	(0)	3	(3.3)	3	(5.9)	2	(28.6)
7	Heidelberg	71	7	(10.4)	1	(8.3)	0	(0)	3	(3.3)	6	(11.8)	1	(14.3)
8	Saintpaul	52	0	(0)	0	(0)	0	(0)	3	(3.3)	2	(3.9)	0	(0)
9	Muenchen	45	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
10	Montevideo	44	0	(0)	0	(0)	0	(0)	0	(0)	1	(2.0)	0	(0)
11	Oranienburg	36	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
12	Braenderup	31	0	(0)	0	(0)	0	(0)	0	(0)	1	(2.0)	0	(0)
13	Mississippi	26	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
14	Agona	25	1	(1.5)	1	(8.3)	1	(3.8)	0	(0)	1	(2.0)	0	(0)
15	Thompson	24	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
16	Berta	19	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Rubislaw	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
18	Paratyphi B var. L(+) tartrate+	18	1	(1.5)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Poona	18	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
20	Bareilly	16	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Panama	16	0	(0)	1	(8.3)	0	(0)	0	(0)	1	(2.0)	0	(0)
Additional serotypes¶														
	Stanley	13	0	(0)	1	(8.3)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Dublin	10	6	(9.0)	0	(0)	6	(23.1)	1	(1.1)	6	(11.8)	0	(0)
	Give	9	0	(0)	1	(8.3)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Kentucky	9	0	(0)	0	(0)	0	(0)	3	(3.3)	0	(0)	0	(0)
	Hadar	8	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Oslo	5	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Potsdam	5	0	(0)	0	(0)	0	(0)	2	(2.2)	0	(0)	0	(0)
	Urbana	4	0	(0)	0	(0)	0	(0)	2	(2.2)	0	(0)	0	(0)
	Virchow	3	0	(0)	0	(0)	0	(0)	2	(2.2)	0	(0)	0	(0)
	Guinea	2	0	(0)	0	(0)	0	(0)	2	(2.2)	0	(0)	0	(0)
	I 4,[5],12:-:1,2	2	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	IV 44:z4,z23:-	2	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Telelkebir	2	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Apapa	1	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Grumpensis	1	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	I 4,[5],12:r:-	1	0	(0)	0	(0)	0	(0)	0	(0)	1	(2.0)	0	(0)
	Isangi	1	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
	Ituri	1	0	(0)	0	(0)	0	(0)	1	(1.1)	0	(0)	0	(0)
Subtotal		1785	67	(100)	12	(100)	26	(100)	92	(100)	51	(100)	7	(100)
	All other serotypes	309	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Partially serotyped	2	0	(0)	0	(0)	0	(0)	0	(0.0)	0	(0)	0	(0)
	Rough/Nonmotile isolates	6	0	(0)	0	(0)	0	(0)	0	(0.0)	0	(0)	0	(0)
	Unknown serotype	25	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total		2127	67	(100)	12	(100)	26	(100)	92	(100)	51	(100)	7	(100)

* ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfisoxazole, tetracycline
† ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
‡ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone
§ DSC: decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL); includes MICs categorized as intermediate or resistant
¶ Additional serotypes that displayed resistance to at least one of the selected patterns

Table 7. Percentage and number of nontyphoidal *Salmonella* isolates with resistance, by number of CLSI* classes and serotype, 2014

			≥ 3 CLSI classes*		≥ 4 CLSI classes*		≥ 5 CLSI classes*		≥ 6 CLSI classes*		≥ 7 CLSI classes*		≥ 8 CLSI classes*		≥ 9 CLSI classes*	
		N	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes																
1	Enteritidis	438	9	(4.6)	6	(3.9)	4	(4.9)	2	(6.5)	1	(3.7)	1	(50.0)	0	-
2	Typhimurium	262	57	(28.9)	49	(32.2)	41	(50.0)	11	(35.5)	11	(40.7)	1	(50.0)	0	-
3	Newport	235	11	(5.6)	10	(6.6)	7	(8.5)	7	(22.6)	7	(25.9)	0	(0)	0	-
4	Javiana	128	3	(1.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
5	I 4,[5],12:i:-	110	55	(27.9)	52	(34.2)	8	(9.8)	2	(6.5)	0	(0)	0	(0)	0	-
6	Infantis	73	5	(2.5)	4	(2.6)	3	(3.7)	2	(6.5)	1	(3.7)	0	(0)	0	-
7	Heidelberg	71	15	(7.6)	9	(5.9)	8	(9.8)	0	(0)	0	(0)	0	(0)	0	-
8	Saintpaul	52	4	(2.0)	1	(0.7)	1	(1.2)	0	(0)	0	(0)	0	(0)	0	-
9	Muenchen	45	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
10	Montevideo	44	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
11	Oranienburg	36	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
12	Braenderup	31	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
13	Mississippi	26	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
14	Agona	25	4	(2.0)	2	(1.3)	1	(1.2)	1	(3.2)	1	(3.7)	0	(0)	0	-
15	Thompson	24	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
16	Berta	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Rubislaw	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
18	Paratyphi B var. L(+) tartrate+	18	1	(0.5)	1	(0.7)	1	(1.2)	0	(0)	0	(0)	0	(0)	0	-
	Poona	18	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
20	Bareilly	16	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Panama	16	2	(1.0)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Additional serotypes†																
	Stanley	13	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Hartford	11	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Dublin	10	6	(3.0)	6	(3.9)	6	(7.3)	6	(19.4)	6	(22.2)	0	(0)	0	-
	Mbandaka	10	2	(1.0)	2	(1.3)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Give	9	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Kentucky	9	1	(0.5)	1	(0.7)	1	(1.2)	0	(0)	0	(0)	0	(0)	0	-
	Reading	9	4	(2.0)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Hadar	8	2	(1.0)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Derby	7	4	(2.0)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Monschaui	7	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Hvittingfoss	5	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Oslo	5	1	(0.5)	1	(0.7)	1	(1.2)	0	(0)	0	(0)	0	(0)	0	-
	Agbeni	4	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	I 4,[5],12:r:-	1	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Subtotal		1814	197	(100)	152	(100)	82	(100)	31	(100)	27	(100)	2	(100)	0	-
	All other serotypes	280	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Partially serotyped	2	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Rough/Nonmotile isolates	6	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Unknown serotype	25	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Total		2127	197	(100)	152	(100)	82	(100)	31	(100)	27	(100)	2	(100)	0	-

* CLSI: Clinical and Laboratory Standards Institute
† Additional serotypes that displayed resistance to at least three CLSI classes

Table 8. Minimum inhibitory concentrations (MICs) and resistance of nontyphoidal *Salmonella* isolates to antimicrobial agents, 2014 (N=2127)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.2	1.4	[1.0 - 2.0]					21.9	64.8	11.3	0.4		0.2	0.3	1.1				
		Streptomycin	N/A	11.2	[9.9 - 12.7]								13.3	16.5	47.9	11.0	2.5	2.1	6.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.1	2.1	[1.5 - 2.8]							87.1	3.2	1.4	4.0	2.1		2.1			
	Cephems	Ceftiofur	0.1	2.4	[1.8 - 3.1]				0.1	0.3	29.0	66.3	1.7	0.1	0.2	2.2					
		Ceftriaxone	0.0	2.4	[1.8 - 3.1]					97.4	0.2			<0.1	0.2	1.1	0.6	0.2	0.2		
	Macrolides	Azithromycin	N/A	<0.1	[0.0 - 0.3]						0.1	0.1	39.5	55.3	4.5	0.4	<0.1				
	Penicillins	Ampicillin	0.0	9.1	[7.9 - 10.4]							80.6	9.4	0.7	0.2		0.2	8.9			
	Quinolones	Ciprofloxacin	3.9	0.4	[0.2 - 0.8]	90.6	4.7	0.4	1.6	1.1	1.2	0.3			0.1						
		Nalidixic acid	N/A	3.5	[2.7 - 4.3]						<0.1	0.1	27.1	67.0	1.7	0.6	0.5	3.0			
II	**Cephems**	Cefoxitin	0.2	2.2	[1.6 - 2.9]						<0.1	5.6	71.1	19.7	1.2	0.2	1.0	1.1			
	Folate pathway inhibitors	Sulfisoxazole	N/A	9.4	[8.2 - 10.8]											11.5	44.2	31.1	3.4	0.3	9.4
		Trimethoprim-sulfamethoxazole	N/A	1.3	[0.9 - 1.9]				96.0	2.4	0.2		0.1		1.3						
	Phenicols	Chloramphenicol	1.2	4.0	[3.2 - 4.9]								0.5	52.8	41.5	1.2	0.3	3.7			
	Tetracyclines	Tetracycline	0.8	10.4	[9.1 - 11.8]									88.8	0.8	0.2	1.1	9.1			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 3. Antimicrobial resistance pattern for nontyphoidal *Salmonella*, 2014

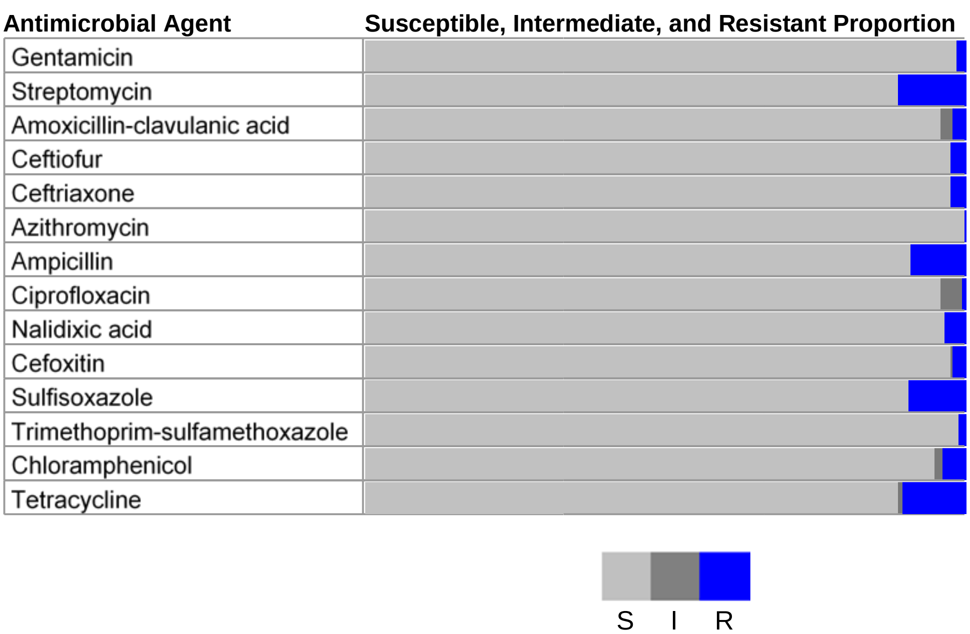


Table 9. Percentage and number of nontyphoidal *Salmonella* isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 2036	2006 2170	2007 2145	2008 2384	2009 2192	2010 2448	2011 2335	2012 2233	2013 2178	2014 2127
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	< 0.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	2.2% 44	2.0% 44	2.1% 45	1.5% 35	1.3% 28	1.0% 24	1.7% 40	1.2% 26	2.0% 43	1.4% 30
		Kanamycin (MIC ≥ 64)	3.4% 70	2.9% 63	2.8% 61	2.1% 50	2.5% 54	2.2% 54	1.7% 39	1.1% 24	1.6% 35	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	11.1% 225	10.7% 233	10.3% 222	10.0% 238	8.9% 196	8.6% 210	9.8% 229	8.4% 187	11.5% 251	11.2% 239
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	3.2% 65	3.7% 81	3.3% 70	3.1% 73	3.4% 75	2.9% 70	2.6% 60	2.9% 65	2.4% 53	2.1% 45
	Cephems	Ceftiofur (MIC ≥ 8)	2.9% 59	3.6% 79	3.3% 70	3.1% 73	3.4% 75	2.8% 69	2.5% 58	2.9% 64	2.5% 55	2.4% 51
		Ceftriaxone (MIC ≥ 4)	2.9% 59	3.6% 79	3.3% 70	3.1% 73	3.4% 75	2.9% 70	2.5% 58	2.9% 64	2.5% 55	2.4% 51
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.2% 5	< 0.1% 1	0.2% 5	< 0.1% 1
	Penicillins	Ampicillin (MIC ≥ 32)	11.3% 231	10.9% 237	10.1% 217	9.7% 232	9.9% 216	9.1% 223	9.1% 213	8.8% 196	10.4% 227	9.1% 194
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.1% 2	0.1% 3	0.1% 2	0.2% 5	0.3% 7	0.2% 6	0.2% 4	0.3% 7	0.5% 11	0.4% 9
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	2.0% 40	2.7% 59	2.5% 54	2.5% 60	2.3% 51	2.7% 67	2.7% 63	3.6% 80	3.5% 76	4.3% 92
		Nalidixic acid (MIC ≥ 32)	1.9% 38	2.4% 51	2.2% 48	2.1% 49	1.8% 39	2.0% 48	2.2% 51	2.4% 54	2.8% 61	3.5% 74
II	Cephems	Cefoxitin (MIC ≥ 32)	3.0% 62	3.5% 77	2.9% 63	3.0% 72	3.2% 71	2.6% 63	2.6% 60	2.7% 61	2.4% 53	2.2% 46
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	12.6% 256	12.1% 263	12.3% 264	10.1% 240	9.9% 217	9.0% 221	8.6% 201	8.4% 188	10.3% 225	9.4% 201
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.7% 34	1.7% 36	1.5% 33	1.6% 37	1.7% 38	1.6% 38	1.2% 28	1.3% 29	1.4% 31	1.3% 28
	Phenicols	Chloramphenicol (MIC ≥ 32)	7.8% 159	6.4% 139	7.3% 156	6.1% 146	5.7% 125	5.0% 122	4.4% 103	3.9% 87	3.9% 85	4.0% 85
	Tetracyclines	Tetracycline (MIC ≥ 16)	13.9% 282	13.5% 293	14.5% 310	11.5% 275	11.9% 261	11.0% 270	10.5% 245	11.1% 247	12.6% 275	10.4% 221

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 10. Resistance patterns of nontyphoidal *Salmonella* isolates, 2005–2014

Year Total Isolates	2005 2036	2006 2170	2007 2145	2008 2384	2009 2192	2010 2448	2011 2335	2012 2233	2013 2178	2014 2127
Resistance Pattern										
No resistance detected	81.0% 1649	80.6% 1749	81.1% 1739	83.9% 2001	83.3% 1825	84.7% 2073	84.9% 1982	84.7% 1892	80.8% 1760	82.3% 1751
Resistance ≥ 1 CLSI* class	19.0% 387	19.4% 421	18.9% 406	16.1% 383	16.7% 367	15.3% 375	15.1% 353	15.3% 341	19.2% 418	17.7% 376
Resistance ≥ 2 CLSI* classes	14.5% 295	14.6% 317	14.0% 300	12.5% 298	12.8% 281	11.1% 271	11.0% 258	11.8% 263	13.2% 288	11.8% 251
Resistance ≥ 3 CLSI* classes	11.8% 240	11.7% 253	11.0% 236	9.5% 226	9.6% 210	9.1% 223	9.1% 213	8.6% 193	9.8% 214	9.3% 197
Resistance ≥ 4 CLSI* classes	8.8% 180	7.9% 171	8.1% 174	7.4% 176	7.2% 157	6.8% 166	6.5% 152	6.1% 137	7.7% 167	7.1% 152
Resistance ≥ 5 CLSI* classes	7.2% 146	6.3% 137	6.9% 149	6.6% 157	6.1% 133	5.2% 128	4.6% 108	3.9% 87	4.0% 87	3.9% 82
At least ACSSuT†	6.9% 141	5.6% 121	6.3% 136	5.8% 138	5.1% 112	4.4% 107	3.9% 91	3.4% 77	3.4% 74	3.1% 67
At least ASSuT‡ and not resistant to chloramphenicol	0.8% 16	1.0% 22	0.8% 17	0.7% 17	0.6% 14	1.7% 42	1.8% 42	2.0% 44	3.4% 74	3.0% 64
At least ACT/S§	0.9% 18	0.7% 15	0.7% 16	0.5% 11	0.7% 15	0.4% 11	0.4% 9	0.3% 7	0.5% 10	0.6% 12
At least ACSSuTAuCx¶	2.0% 41	2.0% 43	2.1% 46	1.8% 44	1.4% 30	1.3% 33	1.5% 36	1.5% 34	1.4% 31	1.2% 26
At least AAuCx**	2.9% 59	3.6% 78	3.0% 65	2.9% 69	3.3% 73	2.5% 62	2.5% 58	2.8% 62	2.3% 51	2.1% 45
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	< 0.1% 1	0.1% 3	0.3% 6	0.1% 3	0.2% 4	0.2% 4	0.1% 3	0.5% 12	0.3% 7	0.3% 7
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.1% 3	0.0% 0	0.1% 3	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	< 0.1% 1	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

Table 11. Broad-Spectrum β-lactam resistance among all ceftriaxone or ceftiofur-resistant nontyphoidal *Salmonella* isolates, 2011 (N=58), 2012 (N=64), 2013 (N=55), and 2014 (N=51)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Year (# of isolates)	Percentage of isolates: %I‡ (or S-DD§)	%R¶	[95% CI]**	Percentage of all isolates with MIC (µg/mL)††: 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	β-lactam / β-lactamase inhibitor combinations	Piperacillin-tazobactam	2011 (58)	15.5	10.3	[3.9 - 21.2]							1.7	5.2	15.5	39.7	12.1	5.2	10.3	3.4	6.9	
			2012 (64)	9.4	6.3	[1.7 - 15.2]								3.1	12.5	56.3	12.5	7.8	1.6	3.1	3.1	
			2013 (55)	10.9	1.8	[0.0 - 9.7]								5.5	25.5	40.0	16.4	3.6	7.3	1.8		
			2014 (51)	5.9	2.0	[0.0 - 10.4]								5.9	35.3	37.3	13.7	2.0	3.9		2.0	
	Cephems	Cefepime§	2011 (58)	(1.7§)	1.7	[0.0 - 9.2]				3.4	32.8	41.4	13.8	5.2		1.7§			1.7			
			2012 (64)	(4.7§)	0.0	[0.0 - 5.6]				1.6	12.5	56.3	17.2	7.8	1.6§	3.1§						
			2013 (55)	(3.6§)	1.8	[0.0 - 9.7]				3.6	16.4	58.2	10.9	5.5	1.8§	1.8§	1.8					
			2014 (51)	(3.9§)	3.9	[0.5 - 13.5]				3.9	41.7	29.4	11.8	5.9	2.0§	2.0§	2.0	2.0				
		Cefotaxime	2011 (58)	0.0	100	[93.8 - 100]									1.7	10.3	37.9	34.5	10.3	3.4	1.7	
			2012 (64)	0.0	100	[94.4 - 100]									3.1	4.7	50.0	34.4	4.7	1.6	1.6	
			2013 (55)	0.0	100	[93.5 - 100]									1.8	10.9	43.6	36.4	5.5	1.8		
			2014 (51)	0.0	100	[93.0 - 100]									5.9	11.8	52.9	17.6	5.9	5.9		
		Ceftazidime	2011 (58)	3.4	96.6	[88.1 - 99.6]										3.4	22.4	53.4	12.1	6.9	1.7	
			2012 (64)	4.7	90.6	[80.7 - 96.5]									4.7	4.7	40.6	37.5	9.4	3.1		
			2013 (55)	5.5	89.1	[77.8 - 95.9]								3.6	1.8	5.5	25.5	47.3	16.4			
			2014 (51)	3.9	90.2	[78.6 - 96.7]								2.0	3.9	3.9	54.9	23.5	11.8			
	Monobactams	Aztreonam	2011 (58)	43.1	41.4	[28.6 - 55.1]								6.9	8.6	43.1	27.6	8.6	5.2			
			2012 (64)	56.3	28.1	[17.6 - 40.8]						1.6		1.6	12.5	56.3	18.8	7.8	1.6			
			2013 (55)	43.6	32.7	[20.7 - 46.7]							3.6		20.0	43.6	21.8	9.1	1.8			
			2014 (51)	47.1	27.5	[15.9 - 41.7]							2.0	2.0	21.6	47.1	17.6	2.0	7.8			
	Penems	Imipenem	2011 (58)	0.0	1.7	[0.0 - 9.2]				1.7	77.6	19.0			1.7							
			2012 (64)	0.0	0.0	[0.0 - 5.6]				3.1	56.3	40.6										
			2013 (55)	0.0	0.0	[0.0 - 6.5]			1.8	7.3	87.3	3.6										
			2014 (51)	0.0	0.0	[0.0 - 7.0]				2.0	68.6	29.4										

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Percentage of isolates with intermediate susceptibility

§ Percentage of isolates that are susceptible-dose dependent (S-DD). Cefepime MICs above the susceptible range but below the resistant range are now designated by CLSI to be S-DD. Corresponding dilution ranges are shaded in orange.

¶ Percentage of isolates that were resistant

** The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Clopper-Pearson exact method

†† The unshaded and orange-shaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Orange-shaded areas also indicate the dilution range for susceptible-dose dependent (S-DD). Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the gray shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

A. *Salmonella* ser. Enteritidis

Table 12. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Enteritidis isolates to antimicrobial agents, 2014 (N=438)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.5	0.0	[0.0 - 0.8]					46.8	49.1	3.7			0.5						
		Streptomycin	N/A	3.0	[1.6 - 5.0]								61.0	32.0	2.7	1.4	1.1	0.9	0.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.7	0.5	[0.1 - 1.6]							92.7	3.4	0.9	1.8	0.7		0.5			
	Cephems	Ceftiofur	0.2	0.5	[0.1 - 1.6]						7.1	90.9	1.4	0.2		0.5					
		Ceftriaxone	0.0	0.5	[0.1 - 1.6]					99.1	0.5						0.5				
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 0.8]							0.2	56.2	41.8	1.6	0.2					
	Penicillins	Ampicillin	0.0	3.2	[1.8 - 5.3]							74.2	21.5	0.9	0.2		0.2	3.0			
	Quinolones	Ciprofloxacin	7.8	0.2	[0.0 - 1.3]	79.7	11.6	0.7	5.0	2.5	0.2	0.2									
		Nalidixic acid	N/A	8.0	[5.6 - 10.9]								14.8	75.1	1.8	0.2	0.2	7.8			
II	Cephems	Cefoxitin	0.0	0.7	[0.1 - 2.0]							0.9	86.1	11.9	0.5		0.2	0.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	1.8	[0.8 - 3.6]											7.5	55.7	31.7	3.2		1.8
		Trimethoprim-sulfamethoxazole	N/A	0.5	[0.1 - 1.6]				97.7	1.8					0.5						
	Phenicols	Chloramphenicol	0.5	1.1	[0.4 - 2.6]									71.0	27.4	0.5	0.7	0.5			
	Tetracyclines	Tetracycline	0.7	2.5	[1.3 - 4.4]									96.8	0.7	0.2		2.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 4. Antimicrobial resistance pattern for *Salmonella ser.* Enteritidis, 2014

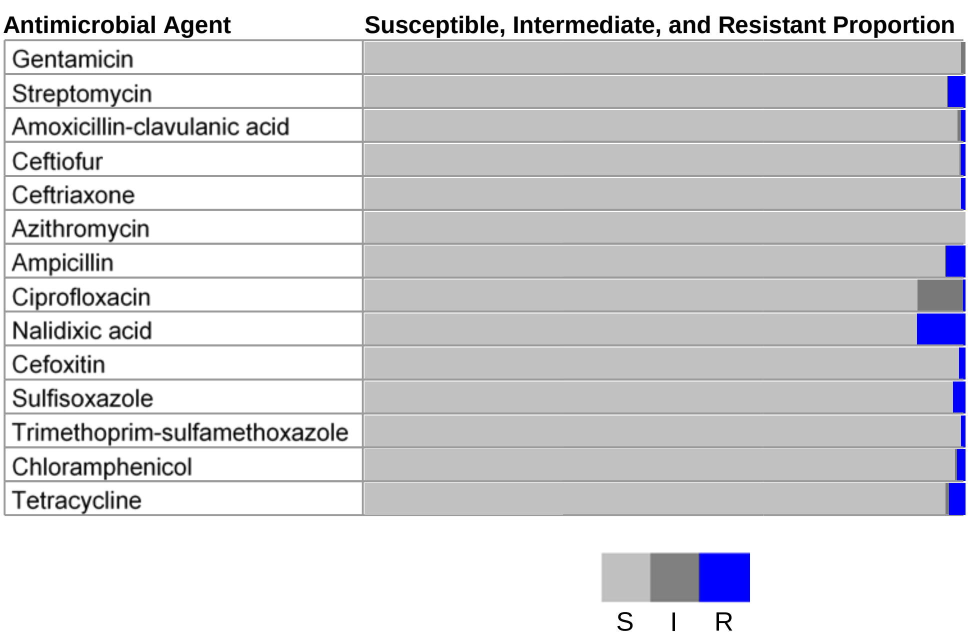


Table 13. Percentage and number of *Salmonella ser.* Enteritidis isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 384	2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382	2014 438
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.8% 3	0.2% 1	0.0% 0	0.2% 1	0.0% 0	0.2% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.3% 1	0.2% 1	0.5% 2	0.0% 0	0.2% 1	0.2% 1	0.3% 1	0.0% 0	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	1.0% 4	1.2% 5	0.5% 2	0.7% 3	1.2% 5	0.6% 3	1.8% 7	1.9% 7	2.6% 10	3.0% 13
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.8% 3	0.5% 2	0.5% 2	0.0% 0	0.0% 0	0.4% 2	0.3% 1	0.5% 2	0.0% 0	0.5% 2
	Cephems	Ceftiofur (MIC ≥ 8)	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.5% 2
		Ceftriaxone (MIC ≥ 4)	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.5% 2
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	2.6% 10	4.1% 17	2.1% 8	4.1% 18	3.9% 16	2.3% 12	5.1% 20	4.1% 15	5.8% 22	3.2% 14
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.2% 1
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	3.9% 15	7.0% 29	6.0% 23	7.2% 32	3.7% 15	5.1% 26	7.2% 28	8.0% 29	5.5% 21	8.0% 35
		Nalidixic acid (MIC ≥ 32)	4.7% 18	7.0% 29	5.7% 22	7.2% 32	3.7% 15	5.3% 27	7.2% 28	7.7% 28	5.8% 22	8.0% 35
II	Cephems	Cefoxitin (MIC ≥ 32)	1.0% 4	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0	0.7% 3
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	1.6% 6	1.5% 6	1.6% 6	1.4% 6	1.7% 7	1.9% 10	2.0% 8	2.7% 10	1.6% 6	1.8% 8
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.5% 2	0.5% 2	1.0% 4	0.9% 4	0.7% 3	1.0% 5	0.5% 2	1.1% 4	0.5% 2	0.5% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.5% 2	0.0% 0	0.5% 2	0.5% 2	0.0% 0	0.6% 3	0.0% 0	0.5% 2	0.3% 1	1.1% 5
	Tetracyclines	Tetracycline (MIC ≥ 16)	2.3% 9	1.7% 7	3.9% 15	1.8% 8	1.2% 5	2.1% 11	1.8% 7	3.6% 13	4.5% 17	2.5% 11

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 14. Resistance patterns of *Salmonella* ser. Enteritidis isolates, 2005–2014

Year Total Isolates	2005 384	2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382	2014 438
Resistance Pattern										
No resistance detected	91.4% 351	88.8% 366	90.4% 348	87.3% 386	92.2% 378	92.0% 472	88.0% 344	88.2% 321	87.4% 334	87.7% 384
Resistance ≥ 1 CLSI* class	8.6% 33	11.2% 46	9.6% 37	12.7% 56	7.8% 32	8.0% 41	12.0% 47	11.8% 43	12.6% 48	12.3% 54
Resistance ≥ 2 CLSI* classes	3.1% 12	2.9% 12	3.4% 13	2.3% 10	2.4% 10	2.9% 15	2.6% 10	4.9% 18	4.5% 17	3.7% 16
Resistance ≥ 3 CLSI* classes	1.3% 5	1.7% 7	0.8% 3	0.7% 3	1.0% 4	2.1% 11	2.3% 9	2.7% 10	1.6% 6	2.1% 9
Resistance ≥ 4 CLSI* classes	1.0% 4	0.7% 3	0.3% 1	0.2% 1	0.5% 2	0.4% 2	1.3% 5	1.6% 6	1.6% 6	1.4% 6
Resistance ≥ 5 CLSI* classes	0.5% 2	0.2% 1	0.3% 1	0.0% 0	0.2% 1	0.0% 0	0.5% 2	0.5% 2	0.3% 1	0.9% 4
At least ACSSuT†	0.5% 2	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.2% 1	0.4% 2	1.3% 5	1.1% 4	0.8% 3	0.2% 1
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx¶	0.3% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
At least AAuCx**	0.3% 1	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0	0.5% 2
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.2% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

B. *Salmonella* ser. Typhimurium

Table 15. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhimurium isolates to antimicrobial agents, 2014 (N=262)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	3.1	[1.3 - 5.9]					12.2	69.1	15.3	0.4			0.4	2.7				
		Streptomycin	N/A	24.8	[19.7 - 30.5]									4.2	55.3	15.6	3.1	8.0	13.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	11.1	5.3	[2.9 - 8.8]							78.2	2.3	0.4	2.7	11.1		5.3			
	Cephems	Ceftiofur	0.0	5.3	[2.9 - 8.8]						24.4	68.7	1.5			5.3					
		Ceftriaxone	0.0	5.3	[2.9 - 8.8]					94.7					1.1	2.7	1.1	0.4			
	Macrolides	Azithromycin	N/A	0.4	[0.0 - 2.1]						0.4	0.4	51.5	45.8	1.5		0.4				
	Penicillins	Ampicillin	0.0	19.8	[15.2 - 25.2]							72.1	7.6	0.4			0.4	19.5			
	Quinolones	Ciprofloxacin	3.1	0.4	[0.0 - 2.1]	93.5	3.1		0.8		2.3	0.4									
		Nalidixic acid	N/A	2.7	[1.1 - 5.4]								25.6	70.2	1.1	0.4		2.7			
II	Cephems	Cefoxitin	0.8	5.3	[2.9 - 8.8]							3.1	76.7	13.7	0.4	0.8	2.7	2.7			
	Folate pathway inhibitors	Sulfisoxazole	N/A	25.2	[20.1 - 30.9]											8.8	45.4	20.6			25.2
		Trimethoprim-sulfamethoxazole	N/A	2.3	[0.8 - 4.9]				89.7	7.3	0.8				2.3						
	Phenicols	Chloramphenicol	0.4	16.0	[11.8 - 21.0]								0.8	48.1	34.7	0.4	0.4	15.6			
	Tetracyclines	Tetracycline	0.4	22.5	[17.6 - 28.1]									77.1	0.4	1.1	6.9	14.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 5. Antimicrobial resistance pattern for *Salmonella* ser. Typhimurium, 2014

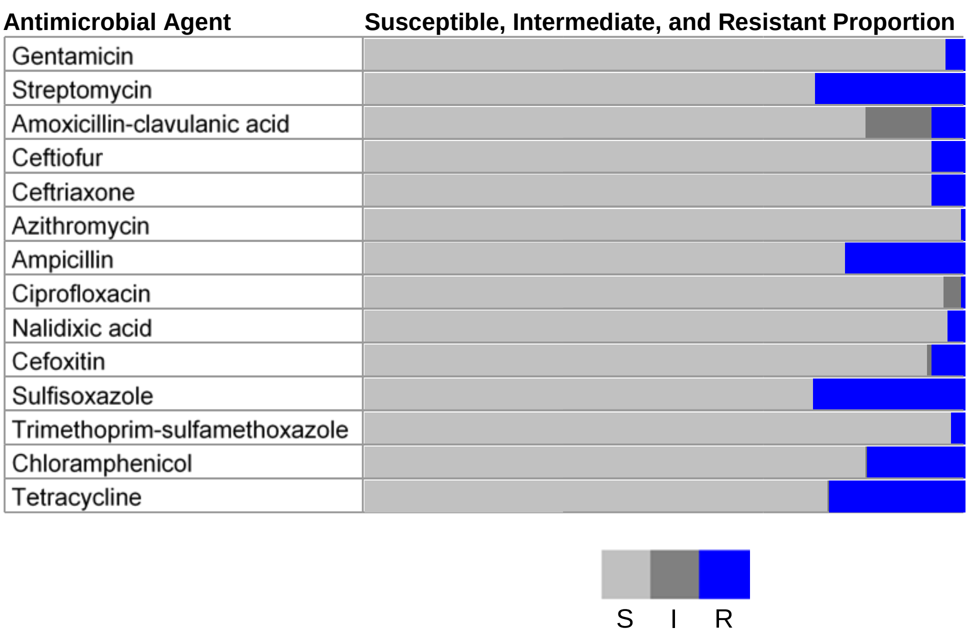


Table 16. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 438	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325	2014 262
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	1.8% 8	2.7% 11	2.5% 10	1.5% 6	1.9% 7	0.8% 3	1.9% 6	3.0% 9	1.2% 4	3.1% 8
		Kanamycin (MIC ≥ 64)	5.7% 25	5.1% 21	5.9% 24	2.5% 10	4.9% 18	7.2% 26	4.0% 13	2.0% 6	0.3% 1	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	28.1% 123	29.4% 120	32.3% 131	28.5% 113	25.9% 96	25.6% 92	25.7% 83	24.0% 71	20.6% 67	24.8% 65
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	3.2% 14	4.4% 18	6.7% 27	3.5% 14	6.2% 23	4.2% 15	7.1% 23	5.7% 17	3.4% 11	5.3% 14
	Cephems	Ceftiofur (MIC ≥ 8)	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.7% 17	3.4% 11	5.3% 14
		Ceftriaxone (MIC ≥ 4)	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.7% 17	3.4% 11	5.3% 14
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.4% 1
	Penicillins	Ampicillin (MIC ≥ 32)	29.0% 127	28.2% 115	31.6% 128	26.3% 104	28.1% 104	26.2% 94	26.0% 84	23.6% 70	16.6% 54	19.8% 52
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.2% 1	0.2% 1	0.0% 0	0.0% 0	0.8% 3	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.4% 1
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	1.4% 6	1.7% 7	2.0% 8	2.3% 9	2.4% 9	1.9% 7	1.9% 6	1.7% 5	2.5% 8	3.4% 9
		Nalidixic acid (MIC ≥ 32)	0.9% 4	0.7% 3	1.5% 6	1.0% 4	2.2% 8	1.4% 5	0.3% 1	1.7% 5	1.5% 5	2.7% 7
II	Cephems	Cefoxitin (MIC ≥ 32)	2.5% 11	3.9% 16	5.7% 23	3.5% 14	5.4% 20	3.3% 12	6.8% 22	5.4% 16	3.4% 11	5.3% 14
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	32.0% 140	33.3% 136	37.3% 151	30.3% 120	30.0% 111	28.7% 103	27.2% 88	27.0% 80	20.9% 68	25.2% 66
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.7% 12	2.2% 9	2.5% 10	1.8% 7	3.0% 11	1.9% 7	1.9% 6	1.7% 5	1.2% 4	2.3% 6
	Phenicols	Chloramphenicol (MIC ≥ 32)	24.4% 107	22.1% 90	25.4% 103	23.5% 93	20.5% 76	20.3% 73	19.8% 64	18.2% 54	13.5% 44	16.0% 42
	Tetracyclines	Tetracycline (MIC ≥ 16)	30.4% 133	31.6% 129	36.8% 149	27.8% 110	28.9% 107	29.0% 104	27.2% 88	27.0% 80	21.2% 69	22.5% 59

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 17. Resistance patterns of *Salmonella* ser. Typhimurium isolates, 2005–2014

Year Total Isolates	2005 438	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325	2014 262
Resistance Pattern										
No resistance detected	65.3% 286	62.5% 255	57.5% 233	68.2% 270	63.5% 235	66.9% 240	69.0% 223	68.6% 203	69.5% 226	68.7% 180
Resistance ≥ 1 CLSI* class	34.7% 152	37.5% 153	42.5% 172	31.8% 126	36.5% 135	33.1% 119	31.0% 100	31.4% 93	30.5% 99	31.3% 82
Resistance ≥ 2 CLSI* classes	32.6% 143	34.1% 139	38.3% 155	31.3% 124	32.7% 121	29.2% 105	28.8% 93	29.1% 86	22.8% 74	26.3% 69
Resistance ≥ 3 CLSI* classes	29.9% 131	30.4% 124	33.8% 137	27.5% 109	28.1% 104	27.0% 97	26.3% 85	24.7% 73	16.9% 55	21.8% 57
Resistance ≥ 4 CLSI* classes	26.7% 117	25.7% 105	29.6% 120	24.7% 98	24.1% 89	24.2% 87	22.0% 71	20.9% 62	14.8% 48	18.7% 49
Resistance ≥ 5 CLSI* classes	22.8% 100	20.8% 85	24.9% 101	24.0% 95	21.9% 81	20.9% 75	21.1% 68	18.6% 55	12.3% 40	15.6% 41
At least ACSSuT†	22.4% 98	19.6% 80	22.7% 92	23.2% 92	19.5% 72	18.7% 67	19.8% 64	17.2% 51	12.0% 39	14.5% 38
At least ASSuT‡ and not resistant to chloramphenicol	2.3% 10	3.2% 13	3.7% 15	0.3% 1	1.6% 6	3.6% 13	1.2% 4	1.7% 5	1.2% 4	2.3% 6
At least ACT/S§	2.1% 9	0.7% 3	2.0% 8	0.5% 2	2.2% 8	1.1% 4	0.6% 2	0.7% 2	0.0% 0	1.5% 4
At least ACSSuTAuCx¶	1.8% 8	2.9% 12	3.7% 15	2.3% 9	1.6% 6	1.7% 6	5.3% 17	4.1% 12	2.2% 7	4.2% 11
At least AAuCx**	2.5% 11	4.2% 17	6.2% 25	3.5% 14	6.2% 23	3.6% 13	6.8% 22	5.7% 17	3.4% 11	5.3% 14
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.5% 2	0.3% 1	0.0% 0	0.7% 2	0.0% 0	0.4% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

C. *Salmonella* ser. Newport

Table 18. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Newport isolates to antimicrobial agents, 2014 (N=235)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates: %I‡	%R§	[95% CI]¶	Percentage of all isolates with MIC (µg/mL)**: 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.4	[0.0 - 2.3]					11.1	77.4	11.1					0.4				
		Streptomycin	N/A	4.7	[2.4 - 8.2]									17.0	72.3	6.0	0.4		4.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.4	3.0	[1.2 - 6.0]							94.5	1.7		0.4	0.4		3.0			
	Cephems	Ceftiofur	0.0	3.0	[1.2 - 6.0]				0.4	0.4	34.9	61.3				3.0					
		Ceftriaxone	0.0	3.0	[1.2 - 6.0]					97.0						0.9	1.3	0.4	0.4		
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 1.6]							0.4	66.0	33.2		0.4					
	Penicillins	Ampicillin	0.0	3.8	[1.8 - 7.1]							92.8	3.0	0.4				3.8			
	Quinolones	Ciprofloxacin	0.9	0.0	[0.0 - 1.6]	99.1			0.4		0.4										
		Nalidixic acid	N/A	0.4	[0.0 - 2.3]							0.4	26.4	72.3		0.4	0.4				
II	Cephems	Cefoxitin	0.4	3.0	[1.2 - 6.0]							6.8	86.8	3.0		0.4	1.7	1.3			
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.7	[2.4 - 8.2]											2.6	37.9	47.2	7.2	0.4	4.7
		Trimethoprim-sulfamethoxazole	N/A	0.4	[0.0 - 2.3]				98.7	0.9					0.4						
	Phenicols	Chloramphenicol	0.0	4.3	[2.1 - 7.7]								1.3	86.8	7.7			4.3			
	Tetracyclines	Tetracycline	0.4	5.1	[2.7 - 8.8]									94.5	0.4			5.1			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 6. Antimicrobial resistance pattern for *Salmonella* ser. Newport, 2014

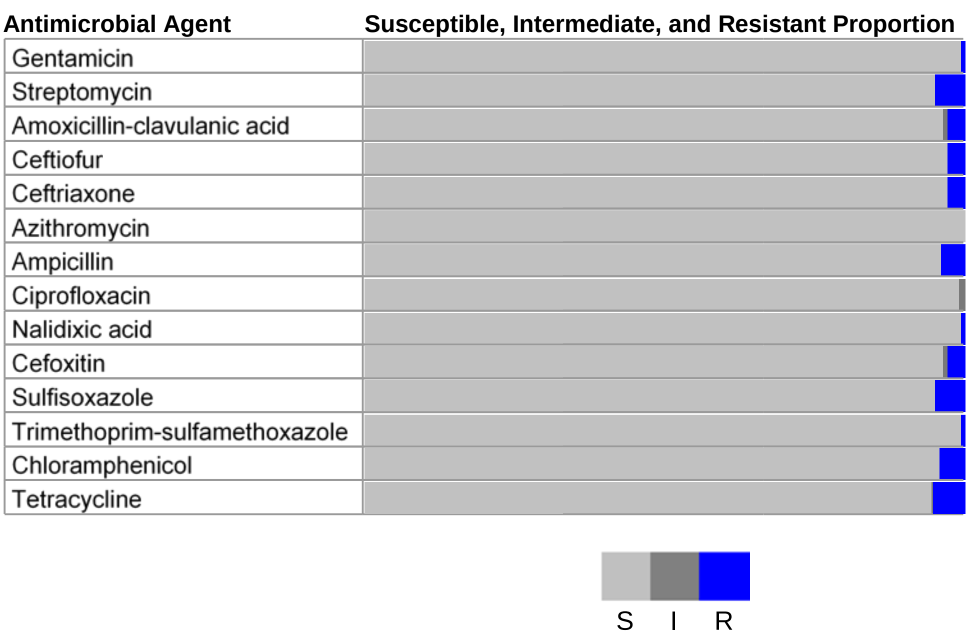


Table 19. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 207	2006 218	2007 222	2008 258	2009 239	2010 306	2011 286	2012 258	2013 209	2014 235
Rank*	CLSI[†] Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	1.0% 2	0.9% 2	0.9% 2	0.4% 1	0.4% 1	0.3% 1	0.7% 2	0.0% 0	0.5% 1	0.4% 1
		Kanamycin (MIC ≥ 64)	1.9% 4	2.8% 6	0.9% 2	3.5% 9	1.7% 4	0.7% 2	0.3% 1	0.0% 0	0.5% 1	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	14.0% 29	14.2% 31	10.4% 23	13.6% 35	8.4% 20	8.5% 26	4.2% 12	3.9% 10	5.7% 12	4.7% 11
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.5% 18	7.8% 24	3.8% 11	6.2% 16	5.3% 11	3.0% 7
	Cephems	Ceftiofur (MIC ≥ 8)	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.8% 11	6.2% 16	5.3% 11	3.0% 7
		Ceftriaxone (MIC ≥ 4)	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.8% 11	6.2% 16	5.3% 11	3.0% 7
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	14.0% 29	15.6% 34	9.9% 22	14.3% 37	8.4% 20	7.8% 24	3.8% 11	7.0% 18	6.2% 13	3.8% 9
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Decreased susceptibility to ciprofloxacin[‡] (MIC ≥ 0.12)	0.0% 0	0.5% 1	0.0% 0	0.4% 1	0.0% 0	1.0% 3	0.7% 2	3.1% 8	1.9% 4	0.9% 2
		Nalidixic acid (MIC ≥ 32)	0.0% 0	0.5% 1	0.0% 0	0.4% 1	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.0% 0	0.4% 1
II	Cephems	Cefoxitin (MIC ≥ 32)	12.6% 26	13.3% 29	8.1% 18	12.4% 32	6.7% 16	7.5% 23	3.8% 11	6.2% 16	5.3% 11	3.0% 7
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	15.5% 32	15.6% 34	10.4% 23	13.2% 34	8.8% 21	7.8% 24	4.5% 13	3.9% 10	4.8% 10	4.7% 11
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.9% 4	3.7% 8	1.8% 4	3.1% 8	1.3% 3	1.3% 4	0.0% 0	0.4% 1	0.5% 1	0.4% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	13.5% 28	12.8% 28	9.5% 21	12.0% 31	7.5% 18	7.5% 23	3.5% 10	3.9% 10	4.8% 10	4.3% 10
	Tetracyclines	Tetracycline (MIC ≥ 16)	14.5% 30	14.7% 32	9.9% 22	14.0% 36	8.8% 21	8.5% 26	4.9% 14	4.3% 11	6.2% 13	5.1% 12

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 20. Resistance patterns of *Salmonella* ser. Newport isolates, 2005–2014

Year Total Isolates	2005 207	2006 218	2007 222	2008 258	2009 239	2010 306	2011 286	2012 258	2013 209	2014 235
Resistance Pattern										
No resistance detected	84.1% 174	82.6% 180	89.2% 198	85.3% 220	89.5% 214	90.5% 277	94.1% 269	93.0% 240	91.9% 192	93.2% 219
Resistance ≥ 1 CLSI* class	15.9% 33	17.4% 38	10.8% 24	14.7% 38	10.5% 25	9.5% 29	5.9% 17	7.0% 18	8.1% 17	6.8% 16
Resistance ≥ 2 CLSI* classes	15.0% 31	16.5% 36	10.8% 24	13.6% 35	9.2% 22	8.2% 25	4.5% 13	6.6% 17	5.7% 12	4.7% 11
Resistance ≥ 3 CLSI* classes	14.5% 30	15.6% 34	10.8% 24	13.6% 35	8.4% 20	7.8% 24	3.8% 11	6.2% 16	5.7% 12	4.7% 11
Resistance ≥ 4 CLSI* classes	14.0% 29	13.8% 30	9.5% 21	13.6% 35	7.5% 18	7.8% 24	3.8% 11	3.9% 10	4.8% 10	4.3% 10
Resistance ≥ 5 CLSI* classes	12.6% 26	13.3% 29	8.6% 19	12.8% 33	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10	3.0% 7
At least ACSSuT[†]	12.6% 26	12.4% 27	8.6% 19	11.6% 30	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10	3.0% 7
At least ASSuT[‡] and not resistant to chloramphenicol	0.5% 1	1.4% 3	0.5% 1	1.6% 4	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.4% 1
At least ACT/S[§]	1.9% 4	2.8% 6	0.5% 1	2.7% 7	1.3% 3	1.3% 4	0.0% 0	0.4% 1	0.5% 1	0.0% 0
At least ACSSuTAuCx[¶]	12.6% 26	11.0% 24	8.1% 18	11.6% 30	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10	3.0% 7
At least AAuCx**	12.6% 26	12.4% 27	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.8% 11	6.2% 16	5.3% 11	3.0% 7
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin[††]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.3% 1	1.9% 5	1.0% 2	0.4% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin[††]	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

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

Table 21. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. I 4,[5],12:i:- isolates to antimicrobial agents, 2014 (N=110)

Rank*	CLSI[†] Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I[‡]	%R[§]	[95% CI][¶]	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	1.8	[0.2 - 6.4]					18.2	63.6	15.5	0.9			0.9	0.9				
		Streptomycin	N/A	52.7	[43.0 - 62.3]									1.8	39.1	6.4	3.6	1.8	47.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.9	2.7	[0.6 - 7.8]							47.3	1.8	5.5	41.8	0.9		2.7			
	Cephems	Ceftiofur	0.0	4.5	[1.5 - 10.3]						34.5	58.2	2.7			4.5					
		Ceftriaxone	0.0	4.5	[1.5 - 10.3]					95.5						2.7		0.9	0.9		
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 3.3]								46.4	48.2	4.5	0.9					
	Penicillins	Ampicillin	0.0	50.9	[41.2 - 60.6]							45.5	3.6				0.9	50.0			
	Quinolones	Ciprofloxacin	6.4	1.8	[0.2 - 6.4]	87.3	3.6	0.9		1.8	4.5	1.8									
		Nalidixic acid	N/A	6.4	[2.6 - 12.7]								23.6	66.4	3.6		4.5	1.8			
II	Cephems	Cefoxitin	0.0	2.7	[0.6 - 7.8]							7.3	74.5	15.5			1.8	0.9			
	Folate pathway inhibitors	Sulfisoxazole	N/A	50.0	[40.3 - 59.7]											2.7	23.6	23.6			50.0
		Trimethoprim-sulfamethoxazole	N/A	1.8	[0.2 - 6.4]				94.5	2.7			0.9		1.8						
	Phenicols	Chloramphenicol	3.6	3.6	[1.0 - 9.0]									39.1	53.6	3.6		3.6			
	Tetracyclines	Tetracycline	0.0	53.6	[43.9 - 63.2]									46.4				53.6			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 7. Antimicrobial resistance pattern for *Salmonella* ser. I 4,[5],12:i:-, 2014

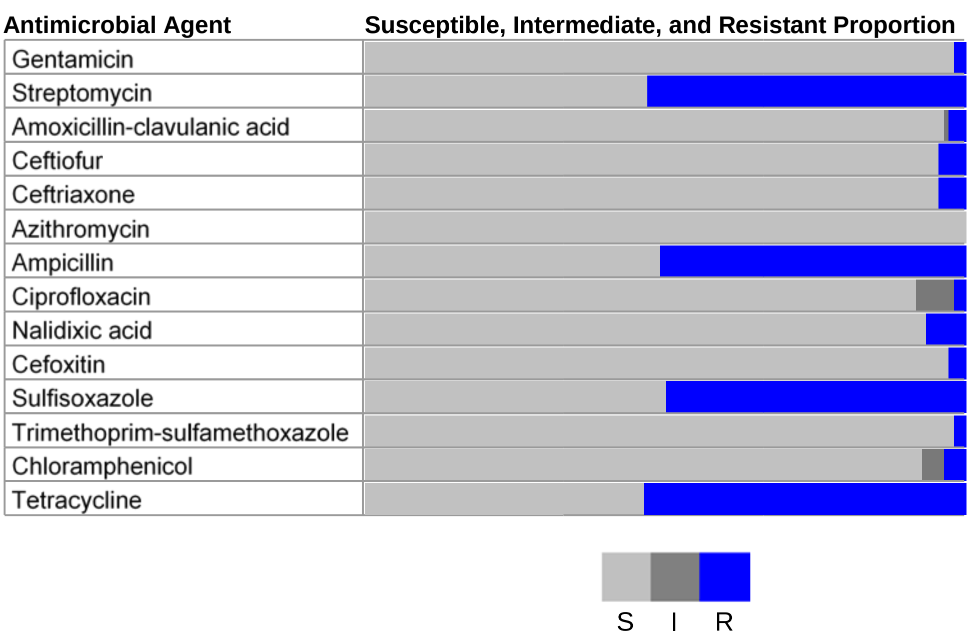


Table 22. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 33	2006 105	2007 73	2008 84	2009 72	2010 78	2011 82	2012 117	2013 127	2014 110
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	4.8% 5	1.4% 1	3.6% 3	2.8% 2	1.3% 1	2.4% 2	2.6% 3	4.7% 6	1.8% 2
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	1.4% 1	1.2% 1	0.0% 0	1.3% 1	0.0% 0	0.0% 0	0.8% 1	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	3.0% 1	3.8% 4	8.2% 6	10.7% 9	12.5% 9	19.2% 15	24.4% 20	29.1% 34	53.5% 68	52.7% 58
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	3.0% 1	3.8% 4	1.4% 1	4.8% 4	4.2% 3	3.8% 3	3.7% 3	1.7% 2	1.6% 2	2.7% 3
	Cephems	Ceftiofur (MIC ≥ 8)	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2	4.5% 5
		Ceftriaxone (MIC ≥ 4)	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2	4.5% 5
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 2	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	6.1% 2	6.7% 7	5.5% 4	9.5% 8	11.1% 8	21.8% 17	25.6% 21	29.1% 34	49.6% 63	50.9% 56
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1	0.0% 0	0.0% 0	0.8% 1	1.8% 2
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	0.0% 0	1.0% 1	1.4% 1	1.2% 1	0.0% 0	2.6% 2	0.0% 0	0.0% 0	2.4% 3	8.2% 9
		Nalidixic acid (MIC ≥ 32)	0.0% 0	1.0% 1	1.4% 1	1.2% 1	0.0% 0	2.6% 2	0.0% 0	0.0% 0	0.8% 1	6.4% 7
II	Cephems	Cefoxitin (MIC ≥ 32)	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	4.9% 4	0.9% 1	1.6% 2	2.7% 3
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	0.0% 0	8.6% 9	4.1% 3	13.1% 11	13.9% 10	19.2% 15	23.2% 19	29.1% 34	53.5% 68	50.0% 55
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.0% 0	1.4% 1	4.8% 4	1.4% 1	1.3% 1	1.2% 1	0.0% 0	2.4% 3	1.8% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	1.9% 2	1.4% 1	6.0% 5	8.3% 6	1.3% 1	1.2% 1	0.0% 0	2.4% 3	3.6% 4
	Tetracyclines	Tetracycline (MIC ≥ 16)	3.0% 1	8.6% 9	9.6% 7	16.7% 14	16.7% 12	28.2% 22	25.6% 21	33.3% 39	55.1% 70	53.6% 59

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 23. Resistance patterns of *Salmonella* ser. I 4,[5],12:i:- isolates, 2005–2014

Year Total Isolates	2005 33	2006 105	2007 73	2008 84	2009 72	2010 78	2011 82	2012 117	2013 127	2014 110
Resistance Pattern										
No resistance detected	87.9% 29	85.7% 90	82.2% 60	76.2% 64	76.4% 55	66.7% 52	65.9% 54	62.4% 73	39.4% 50	38.2% 42
Resistance ≥ 1 CLSI* class	12.1% 4	14.3% 15	17.8% 13	23.8% 20	23.6% 17	33.3% 26	34.1% 28	37.6% 44	60.6% 77	61.8% 68
Resistance ≥ 2 CLSI* classes	3.0% 1	11.4% 12	6.8% 5	17.9% 15	16.7% 12	21.8% 17	28.0% 23	31.6% 37	54.3% 69	56.4% 62
Resistance ≥ 3 CLSI* classes	3.0% 1	9.5% 10	5.5% 4	9.5% 8	12.5% 9	21.8% 17	26.8% 22	28.2% 33	51.2% 65	50.0% 55
Resistance ≥ 4 CLSI* classes	0.0% 0	3.8% 4	2.7% 2	7.1% 6	9.7% 7	19.2% 15	19.5% 16	26.5% 31	48.8% 62	47.3% 52
Resistance ≥ 5 CLSI* classes	0.0% 0	2.9% 3	1.4% 1	4.8% 4	6.9% 5	3.8% 3	0.0% 0	0.9% 1	2.4% 3	7.3% 8
At least ACSSuT†	0.0% 0	1.9% 2	1.4% 1	3.6% 3	6.9% 5	1.3% 1	0.0% 0	0.0% 0	0.8% 1	3.6% 4
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	1.0% 1	0.0% 0	1.2% 1	1.4% 1	16.7% 13	18.3% 15	26.5% 31	46.5% 59	42.7% 47
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.8% 1	0.9% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	2.4% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least AAuCx**	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2	2.7% 3
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.8% 1	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

E. *Salmonella* ser. Infantis

Table 24. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Infantis isolates to antimicrobial agents, 2014 (N=73)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	2.7	1.4	[0.0 - 7.4]					28.8	65.8	1.4			2.7	1.4					
		Streptomycin	N/A	6.8	[2.2 - 15.3]								1.4	19.2	60.3	12.3	5.5		1.4		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	1.4	[0.0 - 7.4]							89.0	6.8	2.7				1.4			
	Cephems	Ceftiofur	0.0	4.1	[0.8 - 11.5]						2.7	89.0	4.1			4.1					
		Ceftriaxone	0.0	4.1	[0.8 - 11.5]					95.9							1.4		2.7		
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 4.9]								15.1	76.7	6.8	1.4					
	Penicillins	Ampicillin	0.0	6.8	[2.2 - 15.3]							86.3	5.5	1.4				6.8			
	Quinolones	Ciprofloxacin	4.1	0.0	[0.0 - 4.9]	91.8	2.7	1.4	2.7		1.4										
		Nalidixic acid	N/A	4.1	[0.8 - 11.5]								47.9	47.9				4.1			
II	Cephems	Cefoxitin	0.0	1.4	[0.0 - 7.4]								5.5	87.7	5.5			1.4			
	Folate pathway inhibitors	Sulfisoxazole	N/A	5.5	[1.5 - 13.4]											12.3	39.7	39.7	2.7		5.5
		Trimethoprim-sulfamethoxazole	N/A	2.7	[0.3 - 9.5]				97.3						2.7						
	Phenicols	Chloramphenicol	2.7	4.1	[0.8 - 11.5]									9.6	83.6	2.7	1.4	2.7			
	Tetracyclines	Tetracycline	1.4	8.2	[3.1 - 17.0]									90.4	1.4			8.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 8. Antimicrobial resistance pattern for *Salmonella* ser. Infantis, 2014

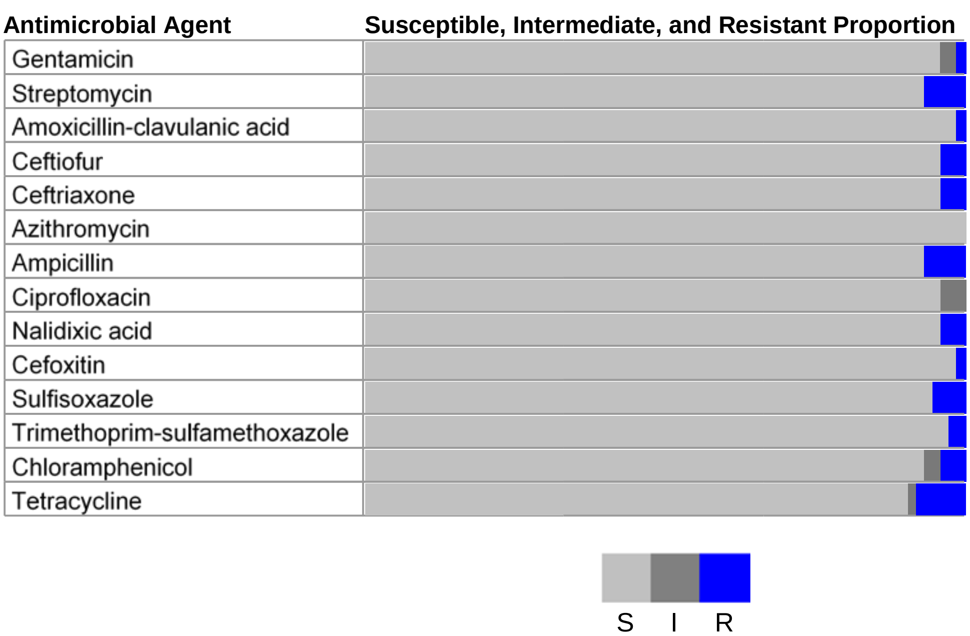


Table 25. Percentage and number of *Salmonella* ser. Infantis isolates resistant to antimicrobial agents, 2005–2014

Rank*	CLSI[†] Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Year / Total Isolates		**30**	**22**	**26**	**51**	**44**	**53**	**63**	**90**	**76**	**73**
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
I		Gentamicin (MIC ≥ 16)	0.0% 0	4.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.6% 1	0.0% 0	3.9% 3	1.4% 1
I		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	6.8% 3	0.0% 0	0.0% 0	2.2% 2	3.9% 3	Not Tested
I		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	3.3% 1	4.5% 1	3.8% 1	2.0% 1	6.8% 3	1.9% 1	4.8% 3	0.0% 0	3.9% 3	6.8% 5
I	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	9.1% 4	3.8% 2	1.6% 1	1.1% 1	3.9% 3	1.4% 1
I	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	3.8% 1	0.0% 0	11.4% 5	3.8% 2	1.6% 1	2.2% 2	6.6% 5	4.1% 3
I		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	3.8% 1	0.0% 0	11.4% 5	3.8% 2	1.6% 1	2.2% 2	6.6% 5	4.1% 3
I	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
I	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	3.8% 1	2.0% 1	13.6% 6	5.7% 3	1.6% 1	2.2% 2	9.2% 7	6.8% 5
I	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
I		Decreased susceptibility to ciprofloxacin[‡] (MIC ≥ 0.12)	3.3% 1	0.0% 0	0.0% 0	2.0% 1	2.3% 1	0.0% 0	1.6% 1	4.4% 4	3.9% 3	4.1% 3
I		Nalidixic acid (MIC ≥ 32)	3.3% 1	0.0% 0	0.0% 0	2.0% 1	2.3% 1	0.0% 0	1.6% 1	4.4% 4	5.3% 4	4.1% 3
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	11.4% 5	3.8% 2	1.6% 1	1.1% 1	3.9% 3	1.4% 1
II	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	6.7% 2	9.1% 2	3.8% 1	3.9% 2	6.8% 3	7.5% 4	4.8% 3	3.3% 3	9.2% 7	5.5% 4
II		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.0% 0	0.0% 0	2.0% 1	2.3% 1	1.9% 1	1.6% 1	4.4% 4	3.9% 3	2.7% 2
II	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	3.8% 2	1.6% 1	1.1% 1	3.9% 3	4.1% 3
II	Tetracyclines	Tetracycline (MIC ≥ 16)	3.3% 1	4.5% 1	7.7% 2	3.9% 2	11.4% 5	3.8% 2	4.8% 3	4.4% 4	13.2% 10	8.2% 6

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 26. Resistance patterns of *Salmonella* ser. Infantis isolates, 2005–2014

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Isolates	**30**	**22**	**26**	**51**	**44**	**53**	**63**	**90**	**76**	**73**
Resistance Pattern										
No resistance detected	90.0% 27	90.9% 20	92.3% 24	96.1% 49	84.1% 37	88.7% 47	93.7% 59	92.2% 83	81.6% 62	84.9% 62
Resistance ≥ 1 CLSI* class	10.0% 3	9.1% 2	7.7% 2	3.9% 2	15.9% 7	11.3% 6	6.3% 4	7.8% 7	18.4% 14	15.1% 11
Resistance ≥ 2 CLSI* classes	3.3% 1	9.1% 2	7.7% 2	3.9% 2	15.9% 7	7.5% 4	6.3% 4	4.4% 4	11.8% 9	6.8% 5
Resistance ≥ 3 CLSI* classes	3.3% 1	4.5% 1	7.7% 2	3.9% 2	13.6% 6	3.8% 2	6.3% 4	4.4% 4	10.5% 8	6.8% 5
Resistance ≥ 4 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	2.0% 1	6.8% 3	1.9% 1	3.2% 2	2.2% 2	5.3% 4	5.5% 4
Resistance ≥ 5 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	1.9% 1	0.0% 0	1.1% 1	5.3% 4	4.1% 3
At least ACSSuT[†]	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	1.9% 1	0.0% 0	0.0% 0	1.3% 1	1.4% 1
At least ASSuT[‡] and not resistant to chloramphenicol	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1	1.4% 1
At least ACT/S[§]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1	2.7% 2
At least ACSSuTAuCx[¶]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	4.5% 2	1.9% 1	0.0% 0	0.0% 0	1.3% 1	0.0% 0
At least AAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	9.1% 4	3.8% 2	1.6% 1	1.1% 1	3.9% 3	1.4% 1
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin[††]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.1% 1	2.6% 2	2.7% 2
At least azithromycin resistant and decreased susceptibility to ciprofloxacin[††]	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

F. *Salmonella* ser. Heidelberg

Table 27. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Heidelberg isolates to antimicrobial agents, 2014 (N=71)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	15.5	[8.0 - 26.0]					8.5	54.9	19.7	1.4			2.8	12.7				
		Streptomycin	N/A	25.4	[15.8 - 37.1]										38.0	36.6	5.6	8.5	11.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.8	8.5	[3.2 - 17.5]							70.4	5.6	1.4	11.3	2.8		8.5			
	Cephems	Ceftiofur	0.0	8.5	[3.2 - 17.5]						21.1	69.0	1.4			8.5					
		Ceftriaxone	0.0	8.5	[3.2 - 17.5]					91.5						5.6	1.4	1.4			
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 5.1]									85.9	14.1						
	Penicillins	Ampicillin	0.0	22.5	[13.5 - 34.0]							69.0	7.0	1.4				22.5			
	Quinolones	Ciprofloxacin	4.2	0.0	[0.0 - 5.1]	93.0	1.4	1.4	1.4	1.4	1.4										
		Nalidixic acid	N/A	4.2	[0.9 - 11.9]								8.5	85.9	1.4		1.4	2.8			
II	Cephems	Cefoxitin	0.0	8.5	[3.2 - 17.5]							26.8	56.3	8.5			4.2	4.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	15.5	[8.0 - 26.0]											29.6	43.7	11.3			15.5
		Trimethoprim-sulfamethoxazole	N/A	2.8	[0.3 - 9.8]				97.2						2.8						
	Phenicols	Chloramphenicol	1.4	9.9	[4.0 - 19.3]									23.9	64.8	1.4		9.9			
	Tetracyclines	Tetracycline	2.8	15.5	[8.0 - 26.0]									81.7	2.8		2.8	12.7			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 9. Antimicrobial resistance pattern for *Salmonella* ser. Heidelberg, 2014

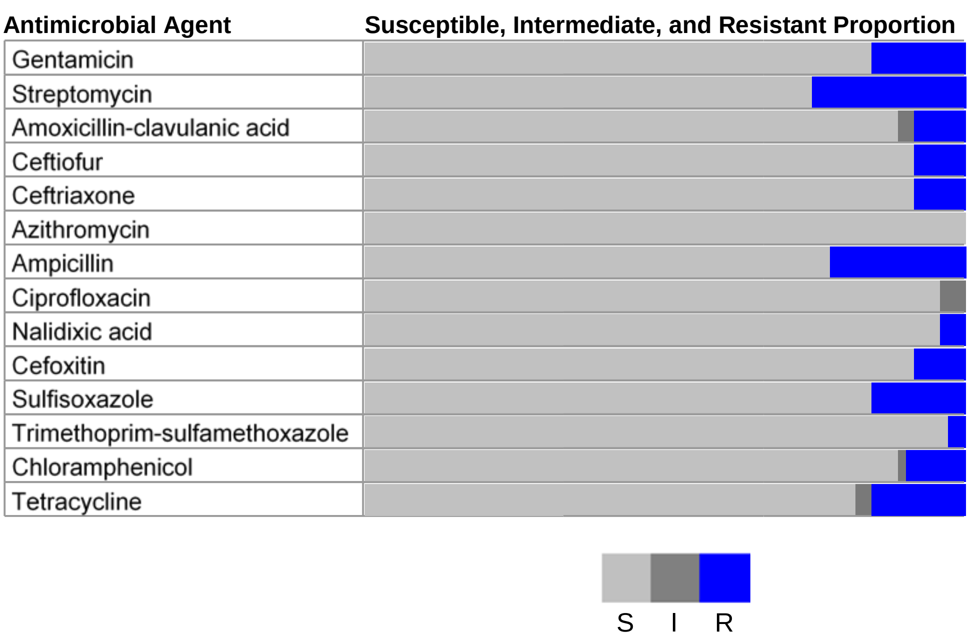


Table 28. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60	2014 71
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	6.4% 8	4.9% 5	16.3% 16	14.7% 11	2.3% 2	8.1% 5	20.0% 14	7.3% 3	21.7% 13	15.5% 11
		Kanamycin (MIC ≥ 64)	12.8% 16	8.8% 9	11.2% 11	26.7% 20	20.9% 18	21.0% 13	21.4% 15	9.8% 4	26.7% 16	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	13.6% 17	11.8% 12	12.2% 12	30.7% 23	23.3% 20	25.8% 16	37.1% 26	17.1% 7	40.0% 24	25.4% 18
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	10.0% 7	22.0% 9	13.3% 8	8.5% 6
	Cephems	Ceftiofur (MIC ≥ 8)	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	15.0% 9	8.5% 6
		Ceftriaxone (MIC ≥ 4)	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	15.0% 9	8.5% 6
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	20.0% 25	18.6% 19	18.4% 18	28.0% 21	27.9% 24	38.7% 24	30.0% 21	26.8% 11	33.3% 20	22.5% 16
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	0.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.4% 1	0.0% 0	4.2% 3
		Nalidixic acid (MIC ≥ 32)	0.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	4.2% 3
II	Cephems	Cefoxitin (MIC ≥ 32)	8.8% 11	8.8% 9	7.1% 7	8.0% 6	19.8% 17	24.2% 15	8.6% 6	22.0% 9	15.0% 9	8.5% 6
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	8.0% 10	4.9% 5	18.4% 18	12.0% 9	7.0% 6	11.3% 7	7.1% 5	2.4% 1	15.0% 9	15.5% 11
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.8% 1	0.0% 0	0.0% 0	2.7% 2	3.5% 3	0.0% 0	1.4% 1	0.0% 0	1.7% 1	2.8% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.8% 1	0.0% 0	3.1% 3	1.3% 1	4.7% 4	1.6% 1	4.3% 3	0.0% 0	6.7% 4	9.9% 7
	Tetracyclines	Tetracycline (MIC ≥ 16)	18.4% 23	13.7% 14	22.4% 22	36.0% 27	27.9% 24	22.6% 14	34.3% 24	14.6% 6	33.3% 20	15.5% 11

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 29. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2005–2014

Year Total Isolates	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60	2014 71
Resistance Pattern										
No resistance detected	62.4% 78	67.6% 69	58.2% 57	57.3% 43	60.5% 52	53.2% 33	55.7% 39	61.0% 25	46.7% 28	62.0% 44
Resistance ≥ 1 CLSI* class	37.6% 47	32.4% 33	41.8% 41	42.7% 32	39.5% 34	46.8% 29	44.3% 31	39.0% 16	53.3% 32	38.0% 27
Resistance ≥ 2 CLSI* classes	23.2% 29	21.6% 22	27.6% 27	40.0% 30	34.9% 30	41.9% 26	44.3% 31	39.0% 16	51.7% 31	26.8% 19
Resistance ≥ 3 CLSI* classes	15.2% 19	12.7% 13	17.3% 17	28.0% 21	25.6% 22	33.9% 21	30.0% 21	26.8% 11	33.3% 20	21.1% 15
Resistance ≥ 4 CLSI* classes	4.0% 5	2.0% 2	5.1% 5	13.3% 10	17.4% 15	11.3% 7	4.3% 3	2.4% 1	8.3% 5	12.7% 9
Resistance ≥ 5 CLSI* classes	1.6% 2	2.0% 2	4.1% 4	6.7% 5	11.6% 10	9.7% 6	4.3% 3	0.0% 0	6.7% 4	11.3% 8
At least ACSSuT†	0.0% 0	0.0% 0	3.1% 3	1.3% 1	3.5% 3	1.6% 1	1.4% 1	0.0% 0	6.7% 4	9.9% 7
At least ASSuT‡ and not resistant to chloramphenicol	0.8% 1	0.0% 0	0.0% 0	6.7% 5	2.3% 2	6.5% 4	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	3.5% 3	0.0% 0	1.4% 1	0.0% 0	1.7% 1	1.4% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.2% 1	0.0% 0	1.4% 1	0.0% 0	1.7% 1	0.0% 0
At least AAuCx**	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	13.3% 8	8.5% 6
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.4% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

2. Typhoidal *Salmonella*

A. *Salmonella* ser. Typhi

Table 30. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhi isolates to antimicrobial agents, 2014 (N=335)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	0.0	[0.0 - 1.1]					76.1	23.0	0.9									
		Streptomycin	N/A	14.3	[10.8 - 18.5]								0.6	2.4	43.6	39.1	3.0	0.6	10.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.6	0.0	[0.0 - 1.1]							87.2		2.1	10.1	0.6					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 1.1]				0.3	6.0	77.0	15.8	0.9								
		Ceftriaxone	0.0	0.0	[0.0 - 1.1]					100.0											
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 1.1]							0.6	31.0	64.2	3.9	0.3					
	Penicillins	Ampicillin	0.0	12.8	[9.4 - 16.9]							86.6	0.6					12.8			
	Quinolones	Ciprofloxacin	68.7	5.4	[3.2 - 8.4]	23.9	0.3	1.8	13.7	41.8	13.1	0.3	0.6	0.3	4.2						
		Nalidixic acid	N/A	72.2	[67.1 - 77.0]						0.6	6.0	17.9	0.9	2.4		1.5	70.7			
II	**Cephems**	Cefoxitin	0.0	0.0	[0.0 - 1.1]						1.8	30.4	11.3	43.3	13.1						
	Folate pathway inhibitors	Sulfisoxazole	N/A	13.4	[10.0 - 17.6]											61.5	18.5	5.7		0.9	13.4
		Trimethoprim-sulfamethoxazole	N/A	13.4	[10.0 - 17.6]				86.3				0.3		13.4						
	Phenicols	Chloramphenicol	0.0	13.1	[9.7 - 17.2]								3.0	69.9	14.0			13.1			
	Tetracyclines	Tetracycline	0.0	3.3	[1.6 - 5.8]									96.7				3.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 10. Antimicrobial resistance pattern for *Salmonella* ser. Typhi, 2014

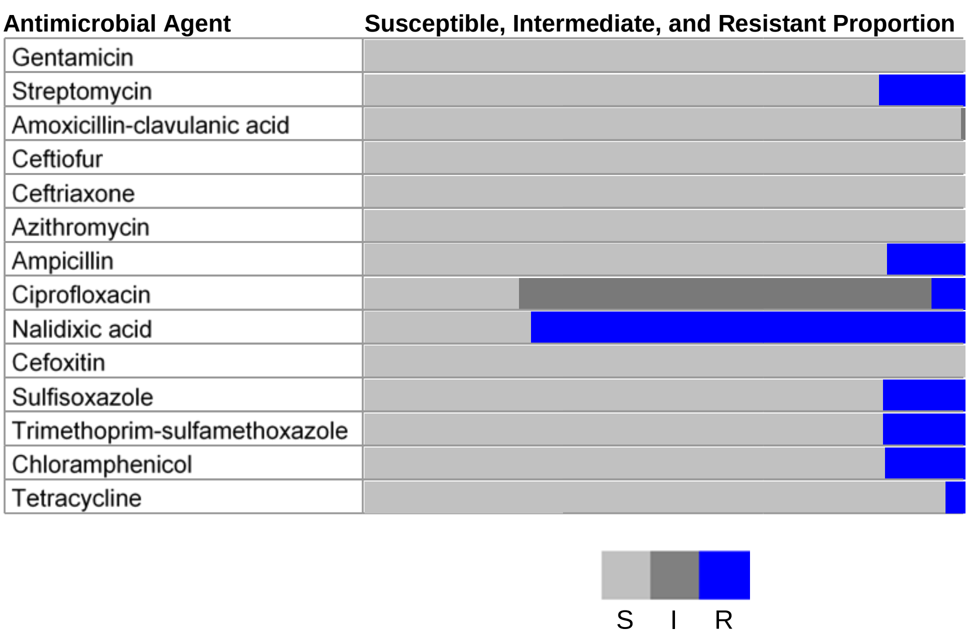


Table 31. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 278	2014 335
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	13.2% 42	18.9% 61	15.8% 63	11.5% 47	10.7% 39	10.1% 45	10.7% 41	9.2% 30	7.9% 22	14.3% 48
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	13.2% 42	20.4% 66	17.0% 68	13.0% 53	12.7% 46	12.3% 55	11.2% 43	10.1% 33	10.4% 29	12.8% 43
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.3% 1	0.9% 3	2.0% 8	0.7% 3	3.9% 14	4.3% 19	7.3% 28	6.7% 22	8.6% 24	5.4% 18
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	48.1% 153	54.8% 177	63.0% 252	58.0% 236	59.8% 217	69.1% 308	71.5% 274	68.5% 224	69.4% 193	74.0% 248
		Nalidixic acid (MIC ≥ 32)	48.4% 154	54.5% 176	62.0% 248	59.0% 240	59.8% 217	69.3% 309	70.8% 271	68.5% 224	67.3% 187	72.2% 242
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.3% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	14.2% 45	20.7% 67	17.5% 70	13.0% 53	13.8% 50	12.3% 55	12.0% 46	10.4% 34	11.2% 31	13.4% 45
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	14.5% 46	20.7% 67	16.3% 65	12.5% 51	12.7% 46	11.9% 53	11.7% 45	10.1% 33	10.8% 30	13.4% 45
	Phenicols	Chloramphenicol (MIC ≥ 32)	13.2% 42	19.5% 63	15.8% 63	12.8% 52	11.8% 43	11.7% 52	10.7% 41	10.1% 33	9.4% 26	13.1% 44
	Tetracyclines	Tetracycline (MIC ≥ 16)	10.1% 32	8.4% 27	6.3% 25	4.4% 18	6.1% 22	3.6% 16	4.4% 17	1.5% 5	2.2% 6	3.3% 11

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 32. Resistance patterns of *Salmonella* ser. Typhi isolates, 2005–2014

Year Total Isolates	2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 278	2014 335
Resistance Pattern										
No resistance detected	48.1% 153	40.2% 130	35.5% 142	38.3% 156	37.5% 136	29.4% 131	27.9% 107	30.6% 100	29.5% 82	24.5% 82
Resistance ≥ 1 CLSI* class	51.9% 165	59.8% 193	64.5% 258	61.7% 251	62.5% 227	70.6% 315	72.1% 276	69.4% 227	70.5% 196	75.5% 253
Resistance ≥ 2 CLSI* classes	14.5% 46	21.7% 70	18.0% 72	14.3% 58	14.6% 53	13.7% 61	12.5% 48	11.0% 36	11.5% 32	17.0% 57
Resistance ≥ 3 CLSI* classes	13.8% 44	20.7% 67	17.5% 70	13.3% 54	13.2% 48	13.5% 60	12.3% 47	10.4% 34	10.4% 29	14.3% 48
Resistance ≥ 4 CLSI* classes	12.9% 41	19.2% 62	17.0% 68	12.8% 52	12.7% 46	11.7% 52	11.2% 43	9.5% 31	9.0% 25	12.8% 43
Resistance ≥ 5 CLSI* classes	11.9% 38	16.7% 54	14.8% 59	10.8% 44	10.2% 37	9.6% 43	9.9% 38	8.9% 29	7.2% 20	9.9% 33
At least ACSSuT†	9.1% 29	5.9% 19	3.8% 15	2.5% 10	2.8% 10	1.6% 7	2.3% 9	0.9% 3	0.4% 1	0.9% 3
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.6% 2	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0
At least ACT/S§	12.9% 41	18.6% 60	15.2% 61	12.0% 49	11.0% 40	10.5% 47	10.4% 40	9.2% 30	8.3% 23	11.3% 38
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least AAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

B. *Salmonella* ser. Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C

Table 33. Frequency* of *Salmonella* ser. Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C, 2014

Serotype*	n	(%)
Paratyphi A	108	(100)
Paratyphi B	0	(0)
Paratyphi C	0	(0)
Total	**108**	**(100)**

*See Methods for varying sampling method by serotype

Table 34. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Paratyphi A isolates to antimicrobial agents, 2014 (N=108)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.0	[0.0 - 3.4]					96.3	3.7										
		Streptomycin	N/A	1.9	[0.2 - 6.5]								0.9	1.9	55.6	39.8	0.9	0.9			
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 3.4]							25.0	73.1	1.9							
	Cephems	Ceftiofur	0.9	0.0	[0.0 - 3.4]						0.9	97.2	0.9	0.9							
		Ceftriaxone	0.0	0.0	[0.0 - 3.4]					99.1		0.9									
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 3.4]								0.9	35.2	59.3	4.6					
	Penicillins	Ampicillin	0.0	0.9	[0.0 - 5.0]							0.9	93.5	4.6			0.9				
	Quinolones	Ciprofloxacin	79.6	0.0	[0.0 - 3.4]	12.0	7.4	0.9		1.9	77.8										
		Nalidixic acid	N/A	79.6	[70.8 - 86.8]									19.4	0.9			79.6			
II	Cephems	Cefoxitin	0.0	0.9	[0.0 - 5.0]								0.9	76.9	21.3			0.9			
	Folate pathway inhibitors	Sulfisoxazole	N/A	0.9	[0.0 - 5.0]											25.9	60.2	11.1	1.9		0.9
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 3.4]				98.1	1.9											
	Phenicols	Chloramphenicol	4.6	1.9	[0.2 - 6.5]									1.9	91.7	4.6	1.9				
	Tetracyclines	Tetracycline	0.9	0.9	[0.0 - 5.0]									98.1	0.9			0.9			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 11. Antimicrobial resistance pattern for *Salmonella* ser. Paratyphi A, 2014

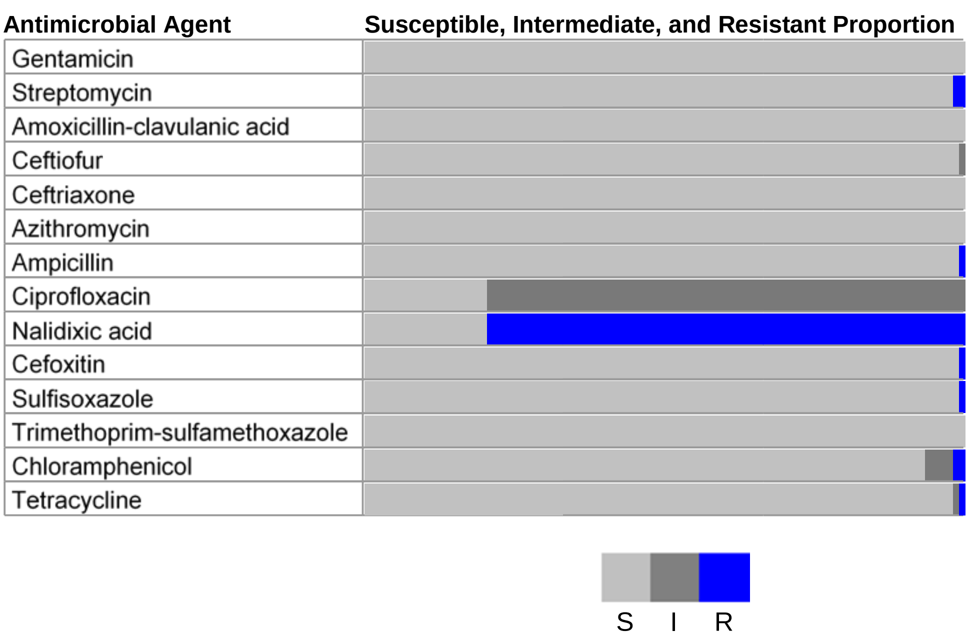


Table 35. Percentage and number of *Salmonella* ser. Paratyphi A isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 13	2006 10	2007 16	2008 116	2009 100	2010 145	2011 152	2012 110	2013 101	2014 108
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	0.0% 0	0.0% 0	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3	0.0% 0	0.0% 0	1.0% 1	1.9% 2
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0	0.9% 1
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.9% 1	0.0% 0	2.8% 4	2.0% 3	2.7% 3	4.0% 4	0.0% 0
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	92.3% 12	80.0% 8	93.8% 15	88.8% 103	88.0% 88	92.4% 134	97.4% 148	95.5% 105	81.2% 82	79.6% 86
		Nalidixic acid (MIC ≥ 32)	92.3% 12	80.0% 8	93.8% 15	88.8% 103	86.0% 86	92.4% 134	96.7% 147	94.5% 104	80.2% 81	79.6% 86
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 1
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0	0.9% 1
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0	1.9% 2
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.9% 1	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0	0.9% 1

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 36. Resistance patterns of *Salmonella* ser. Paratyphi A isolates, 2005–2014

Year Total Isolates	2005 13	2006 10	2007 16	2008 116	2009 100	2010 145	2011 152	2012 110	2013 101	2014 108
Resistance Pattern										
No resistance detected	7.7% 1	20.0% 2	6.3% 1	10.3% 12	13.0% 13	5.5% 8	3.3% 5	5.5% 6	19.8% 20	19.4% 21
Resistance ≥ 1 CLSI* class	92.3% 12	80.0% 8	93.8% 15	89.7% 104	87.0% 87	94.5% 137	96.7% 147	94.5% 104	80.2% 81	80.6% 87
Resistance ≥ 2 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.8% 4	0.0% 0	0.9% 1	1.0% 1	3.7% 4
Resistance ≥ 3 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0	2.8% 3
Resistance ≥ 4 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0
Resistance ≥ 5 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuT†	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least AAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin††	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin resistant and decreased susceptibility to ciprofloxacin††	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ASSuT: resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone
** AAuCx: resistance to ampicillin, amoxicillin-clavulanic acid, ceftriaxone
†† Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

3. *Shigella*

Table 37. Frequency of *Shigella* species, 2014

Species	n	(%)
Shigella sonnei	458	(86.3)
Shigella flexneri	68	(12.8)
Other	5	(0.9)
Total	**531**	**(100)**

Table 38. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2014 (N=531)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates %I‡	%R§	[95% CI]¶	Percentage of all isolates with MIC (µg/mL)** 0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.0	[0.0 - 0.7]					0.2	6.0	83.1	10.7								
		Streptomycin	N/A	95.9	[93.8 - 97.4]								0.2	0.6	2.4	0.9	3.0	52.2	40.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	9.4	9.8	[7.4 - 12.6]							0.9	2.8	55.2	21.8	9.4	4.7	5.1			
	Cephems	Ceftiofur	0.0	0.4	[0.0 - 1.4]				5.5	73.3	10.7	10.0	0.2			0.4					
		Ceftriaxone	0.0	0.4	[0.0 - 1.4]					94.7	4.7	0.2						0.2	0.2		
	Macrolides	Azithromycin††	N/A	4.7	[3.1 - 6.9]						2.6	3.2	11.3	73.1	4.9	0.4	4.5				
	Penicillins	Ampicillin	0.4	33.9	[29.9 - 38.1]							3.8	39.9	21.5	0.6	0.4		33.9			
	Quinolones	Ciprofloxacin	0.0	2.4	[1.3 - 4.2]	91.9		0.4	2.4	2.3	0.2	0.4		1.3	1.1						
		Nalidixic acid	N/A	6.2	[4.3 - 8.6]						2.3	70.4	18.1	2.1	0.9		0.4	5.8			
II	Cephems	Cefoxitin	3.8	5.6	[3.8 - 8.0]							0.8	62.3	26.0	1.5	3.8	5.1	0.6			
	Folate pathway inhibitors	Sulfisoxazole	N/A	30.1	[26.3 - 34.2]											60.6	7.5	1.7			30.1
		Trimethoprim-sulfamethoxazole	N/A	40.9	[36.7 - 45.2]				4.1	2.4	12.4	24.3	15.8	7.7	33.1						
	Phenicols	Chloramphenicol	0.2	8.5	[6.2 - 11.2]								5.5	77.8	8.1	0.2	0.6	7.9			
	Tetracyclines	Tetracycline	0.9	27.3	[23.6 - 31.3]									71.8	0.9	0.2	1.3	25.8			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.
†† Breakpoints for azithromycin resistance differ between *Shigella flexneri* (MIC ≥16 µg/mL) and other *Shigella* species (MIC ≥32 µg/mL). Double vertical bars indicating breakpoints for azithromycin resistance are ommited here, but shown in subsequent species-specific *Shigella* MIC distribution tables.

Figure 12. Antimicrobial resistance pattern for *Shigella*, 2014

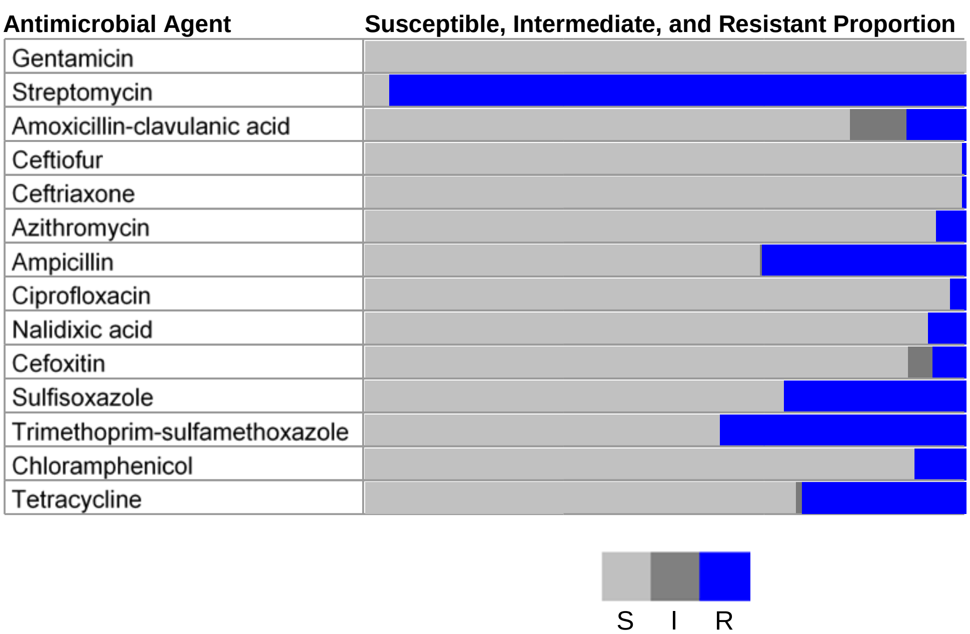


Table 39. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 396	2006 402	2007 480	2008 551	2009 473	2010 411	2011 293	2012 353	2013 344	2014 531
Rank*	CLSI[†] Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	1.0% 4	0.2% 1	0.8% 4	0.4% 2	0.6% 3	0.5% 2	0.7% 2	0.0% 0	0.3% 1	0.0% 0
		Kanamycin (MIC ≥ 64)	0.8% 3	0.0% 0	0.2% 1	0.5% 3	0.4% 2	0.0% 0	0.0% 0	0.3% 1	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	68.7% 272	60.7% 244	73.3% 352	80.6% 444	89.2% 422	91.0% 374	87.7% 257	83.0% 293	91.6% 315	95.9% 509
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.0% 4	1.5% 6	0.4% 2	3.3% 18	2.1% 10	0.0% 0	2.0% 6	1.7% 6	2.9% 10	9.8% 52
	Cephems	Ceftiofur (MIC ≥ 8)	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1	1.7% 5	1.1% 4	1.2% 4	0.4% 2
		Ceftriaxone (MIC ≥ 4)	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1	1.7% 5	1.1% 4	1.2% 4	0.4% 2
	Macrolides	Azithromycin (MIC ≥ 32; *S. flexneri*: MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	3.4% 10	4.5% 16	3.8% 13	4.7% 25
	Penicillins	Ampicillin (MIC ≥ 32)	70.7% 280	62.4% 251	63.8% 306	62.4% 344	46.3% 219	40.9% 168	33.8% 99	25.5% 90	36.0% 124	33.9% 180
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.2% 1	0.2% 1	0.7% 4	0.6% 3	1.7% 7	2.4% 7	2.0% 7	3.5% 12	2.4% 13
		Nalidixic acid (MIC ≥ 32)	1.5% 6	3.5% 14	1.7% 8	1.6% 9	2.1% 10	4.4% 18	6.1% 18	4.5% 16	5.2% 18	6.2% 33
II	Cephems	Cefoxitin (MIC ≥ 32)	0.5% 2	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.0% 3	0.6% 2	1.7% 6	5.6% 30
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	57.6% 228	40.3% 162	25.8% 124	28.5% 157	30.4% 144	29.9% 123	44.7% 131	34.8% 123	48.0% 165	30.1% 160
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	53.3% 211	46.0% 185	25.8% 124	31.2% 172	40.4% 191	47.7% 196	66.9% 196	43.3% 153	49.7% 171	40.9% 217
	Phenicols	Chloramphenicol (MIC ≥ 32)	10.9% 43	10.9% 44	8.3% 40	6.9% 38	9.1% 43	10.0% 41	12.3% 36	11.3% 40	11.6% 40	8.5% 45
	Tetracyclines	Tetracycline (MIC ≥ 16)	38.4% 152	34.6% 139	25.6% 123	24.3% 134	29.4% 139	31.4% 129	40.6% 119	37.1% 131	43.6% 150	27.3% 145

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

Table 40. Resistance patterns of *Shigella* isolates, 2005–2014

Year Total Isolates	2005 396	2006 402	2007 480	2008 551	2009 473	2010 411	2011 293	2012 353	2013 344	2014 531
Resistance Pattern										
No resistance detected	4.5% 18	6.5% 26	7.1% 34	4.5% 25	3.8% 18	3.6% 15	4.4% 13	7.4% 26	4.1% 14	1.9% 10
Resistance ≥ 1 CLSI* class	95.5% 378	93.5% 376	92.9% 446	95.5% 526	96.2% 455	96.4% 396	95.6% 280	92.6% 327	95.9% 330	98.1% 521
Resistance ≥ 2 CLSI* classes	72.0% 285	64.7% 260	65.4% 314	68.2% 376	68.1% 322	69.8% 287	74.4% 218	53.8% 190	61.0% 210	59.1% 314
Resistance ≥ 3 CLSI* classes	58.6% 232	43.8% 176	27.7% 133	35.2% 194	36.4% 172	39.7% 163	51.2% 150	37.7% 133	53.5% 184	42.4% 225
Resistance ≥ 4 CLSI* classes	19.2% 76	15.4% 62	11.7% 56	10.3% 57	12.9% 61	14.1% 58	22.2% 65	19.5% 69	23.8% 82	23.0% 122
Resistance ≥ 5 CLSI* classes	4.8% 19	5.2% 21	4.6% 22	2.7% 15	6.3% 30	4.6% 19	9.9% 29	7.6% 27	9.9% 34	7.9% 42
At least ACSSuT[†]	4.0% 16	5.0% 20	3.8% 18	2.2% 12	5.7% 27	4.4% 18	6.1% 18	5.7% 20	7.3% 25	4.7% 25
At least ACT/S[‡]	6.3% 25	6.0% 24	4.0% 19	2.9% 16	6.6% 31	4.9% 20	7.8% 23	7.4% 26	8.1% 28	4.7% 25
At least AT/S[§]	35.6% 141	26.6% 107	12.9% 62	16.0% 88	17.3% 82	17.8% 73	25.9% 76	15.6% 55	25.6% 88	15.3% 81
At least ANT/S[¶]	0.5% 2	0.5% 2	0.8% 4	0.0% 0	0.2% 1	1.2% 5	2.4% 7	0.8% 3	1.2% 4	0.9% 5
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.2% 1	1.4% 4	0.8% 3	0.3% 1	0.4% 2
At least azithromycin and nalidixic acid resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.3% 1	0.3% 1	0.3% 1	0.6% 3
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.2% 1

* CLSI: Clinical and Laboratory Standards Institute

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

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

§ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole

¶ ANT/S: resistance to AT/S, nalidixic acid

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

Table 41. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2014 (N=458)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	0.0	[0.0 - 0.8]						4.1	84.3	11.6								
		Streptomycin	N/A	98.3	[96.6 - 99.2]									0.2	0.7	0.9	2.0	57.4	38.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.2	11.1	[8.4 - 14.4]							0.7	0.2	62.2	23.6	2.2	5.2	5.9			
	Cephems	Ceftiofur	0.0	0.2	[0.0 - 1.2]				0.4	76.6	11.1	11.4	0.2			0.2					
		Ceftriaxone	0.0	0.2	[0.0 - 1.2]					94.1	5.5	0.2							0.2		
	Macrolides	Azithromycin	N/A	2.0	[0.9 - 3.7]							0.2	8.3	83.6	5.7	0.2	2.0				
	Penicillins	Ampicillin	0.4	28.2	[24.1 - 32.5]							0.7	45.4	24.7	0.7	0.4		28.2			
	Quinolones	Ciprofloxacin	0.0	2.0	[0.9 - 3.7]	93.4		0.4	2.8	1.3				1.1	0.9						
		Nalidixic acid	N/A	5.0	[3.2 - 7.4]						2.4	76.9	12.9	2.0	0.9		0.4	4.6			
II	**Cephems**	Cefoxitin	4.4	6.6	[4.5 - 9.2]							0.4	68.6	18.8	1.3	4.4	5.9	0.7			
	Folate pathway inhibitors	Sulfisoxazole	N/A	26.2	[22.2 - 30.5]											63.8	8.1	2.0			26.2
		Trimethoprim-sulfamethoxazole	N/A	39.1	[34.6 - 43.7]				0.2	0.4	13.8	28.2	18.3	9.0	30.1						
	Phenicols	Chloramphenicol	0.2	0.7	[0.1 - 1.9]								1.5	88.4	9.2	0.2		0.7			
	Tetracyclines	Tetracycline	1.1	20.1	[16.5 - 24.1]									78.8	1.1	0.2	1.3	18.6			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 13. Antimicrobial resistance pattern for *Shigella sonnei*, 2014

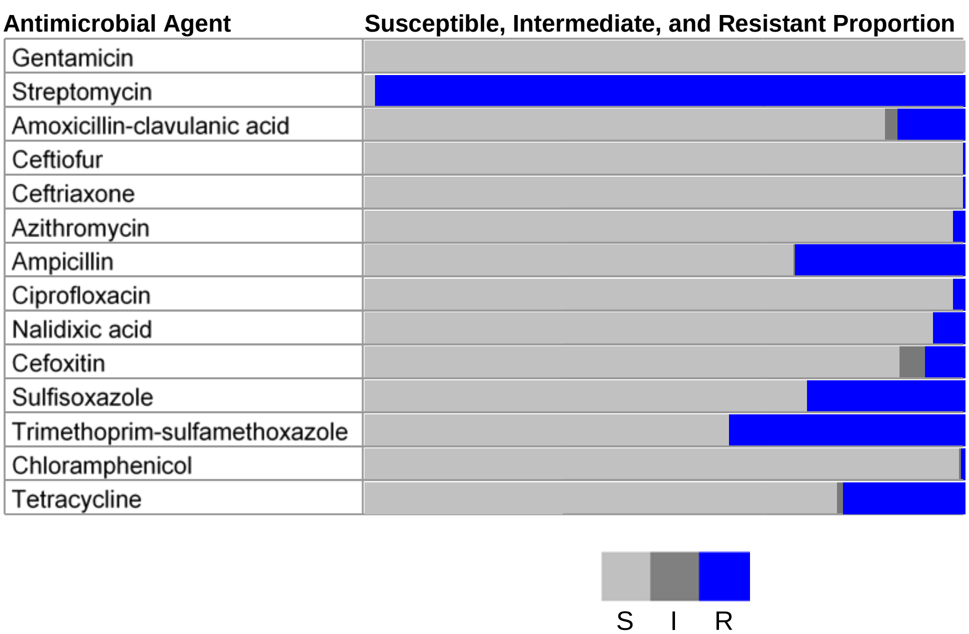


Table 42. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 226	2012 287	2013 275	2014 458
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	1.2% 4	0.0% 0	1.0% 4	0.4% 2	0.7% 3	0.0% 0	0.9% 2	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.2% 1	0.6% 3	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	70.3% 239	61.7% 198	76.8% 318	82.4% 407	91.5% 375	96.1% 324	95.6% 216	89.2% 256	97.8% 269	98.3% 450
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.2% 4	1.9% 6	0.5% 2	3.2% 16	2.0% 8	0.0% 0	2.7% 6	1.7% 5	3.6% 10	11.1% 51
	Cephems	Ceftiofur (MIC ≥ 8)	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1	1.8% 4	1.0% 3	0.7% 2	0.2% 1
		Ceftriaxone (MIC ≥ 4)	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1	1.8% 4	1.0% 3	0.7% 2	0.2% 1
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.9% 2	2.1% 6	1.1% 3	2.0% 9
	Penicillins	Ampicillin (MIC ≥ 32)	70.6% 240	62.6% 201	64.0% 265	61.3% 303	43.2% 177	36.8% 124	27.4% 62	18.1% 52	28.0% 77	28.2% 129
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.5% 5	1.3% 3	2.1% 6	2.9% 8	2.0% 9
		Nalidixic acid (MIC ≥ 32)	1.2% 4	2.8% 9	1.2% 5	1.6% 8	1.7% 7	3.3% 11	3.5% 8	4.2% 12	3.3% 9	5.0% 23
II	Cephems	Cefoxitin (MIC ≥ 32)	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.7% 3	0.0% 0	1.3% 3	0.7% 2	2.2% 6	6.6% 30
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	57.9% 197	33.3% 107	20.0% 83	24.5% 121	23.9% 98	25.2% 85	39.4% 89	30.0% 86	45.1% 124	26.2% 120
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	55.0% 187	42.7% 137	22.0% 91	29.1% 144	36.1% 148	46.9% 158	68.6% 155	41.8% 120	47.6% 131	39.1% 179
	Phenicols	Chloramphenicol (MIC ≥ 32)	2.4% 8	0.9% 3	1.2% 5	0.8% 4	1.2% 5	1.5% 5	2.7% 6	3.1% 9	0.7% 2	0.7% 3
	Tetracyclines	Tetracycline (MIC ≥ 16)	29.4% 100	22.7% 73	16.2% 67	16.8% 83	20.7% 85	21.4% 72	29.6% 67	27.5% 79	34.9% 96	20.1% 92

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute

Table 43. Resistance patterns of *Shigella sonnei* isolates, 2005–2014

Year Total Isolates	2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 226	2012 287	2013 275	2014 458
Resistance Pattern										
No resistance detected	4.4% 15	6.2% 20	6.8% 28	4.7% 23	3.7% 15	1.5% 5	0.9% 2	5.9% 17	0.7% 2	0.2% 1
Resistance ≥ 1 CLSI* class	95.6% 325	93.8% 301	93.2% 386	95.3% 471	96.3% 395	98.5% 332	99.1% 224	94.1% 270	99.3% 273	99.8% 457
Resistance ≥ 2 CLSI* classes	70.6% 240	59.8% 192	63.0% 261	65.4% 323	65.4% 268	68.0% 229	73.5% 166	49.1% 141	56.4% 155	55.5% 254
Resistance ≥ 3 CLSI* classes	55.3% 188	35.8% 115	21.3% 88	29.4% 145	29.8% 122	32.6% 110	44.7% 101	31.0% 89	48.0% 132	36.9% 169
Resistance ≥ 4 CLSI* classes	12.4% 42	8.1% 26	5.1% 21	5.3% 26	5.6% 23	6.5% 22	13.3% 30	11.5% 33	14.5% 40	15.7% 72
Resistance ≥ 5 CLSI* classes	0.9% 3	0.0% 0	1.2% 5	0.4% 2	0.5% 2	0.6% 2	3.5% 8	2.8% 8	1.8% 5	2.6% 12
At least ACSSuT†	0.3% 1	0.0% 0	0.5% 2	0.2% 1	0.0% 0	0.6% 2	0.4% 1	1.0% 3	0.4% 1	0.7% 3
At least ACT/S‡	2.4% 8	0.9% 3	0.5% 2	0.8% 4	1.0% 4	0.9% 3	2.2% 5	2.8% 8	0.7% 2	0.7% 3
At least AT/S§	35.6% 121	22.7% 73	9.4% 39	14.2% 70	12.2% 50	14.2% 48	22.1% 50	10.8% 31	19.3% 53	11.6% 53
At least ANT/S¶	0.3% 1	0.0% 0	0.7% 3	0.0% 0	0.0% 0	0.0% 0	1.3% 3	1.0% 3	0.0% 0	0.4% 2
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	1.3% 3	0.7% 2	0.0% 0	0.2% 1
At least azithromycin and nalidixic acid resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.3% 1	0.0% 0	0.2% 1
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0

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

Table 44. Minimum inhibitory concentrations and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2014 (N=68)

Rank*	CLSI[†] Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I[‡]	%R[§]	[95% CI][¶]	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.0	[0.0 - 5.3]					1.5	19.1	73.5	5.9								
		Streptomycin	N/A	83.8	[72.9 - 91.6]								1.5	2.9	10.3	1.5	10.3	20.6	52.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	58.8	1.5	[0.0 - 7.9]							2.9	17.6	8.8	10.3	58.8	1.5				
	Cephems	Ceftiofur	0.0	1.5	[0.0 - 7.9]				33.8	54.4	8.8	1.5				1.5					
		Ceftriaxone	0.0	1.5	[0.0 - 7.9]					98.5								1.5			
	Macrolides	Azithromycin	N/A	22.1	[12.9 - 33.8]						20.6	22.1	27.9	7.4		1.5	20.6				
	Penicillins	Ampicillin	0.0	73.5	[61.4 - 83.5]							22.1	2.9	1.5				73.5			
	Quinolones	Ciprofloxacin	0.0	5.9	[1.6 - 14.4]	82.4				7.4	1.5	2.9		2.9	2.9						
		Nalidixic acid	N/A	14.7	[7.3 - 25.4]							27.9	54.4	1.5	1.5			14.7			
II	Cephems	Cefoxitin	0.0	0.0	[0.0 - 5.3]								25	72.1	2.9						
	Folate pathway inhibitors	Sulfisoxazole	N/A	55.9	[43.3 - 67.9]											39.7	4.4				55.9
		Trimethoprim-sulfamethoxazole	N/A	52.9	[40.4 - 65.2]				26.5	16.2	4.4				52.9						
	Phenicols	Chloramphenicol	0.0	61.8	[49.2 - 73.3]								29.4	7.4	1.5		4.4	57.4			
	Tetracyclines	Tetracycline	0.0	77.9	[66.2 - 87.1]									22.1			1.5	76.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 14. Antimicrobial resistance pattern for *Shigella flexneri*, 2014

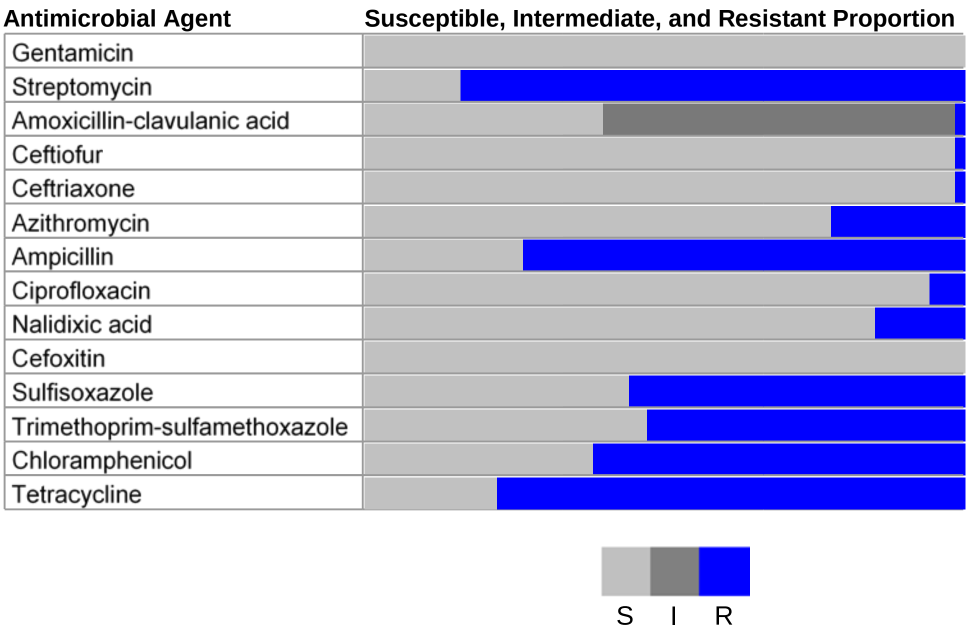


Table 45. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64	2014 68
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	3.3% 2	0.0% 0	0.0% 0	1.6% 1	0.0% 0
		Kanamycin (MIC ≥ 64)	3.8% 2	0.0% 0	0.0% 0	0.0% 0	1.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	57.7% 30	58.1% 43	52.5% 32	63.3% 31	73.7% 42	68.9% 42	58.6% 34	55.9% 33	67.2% 43	83.8% 57
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	4.1% 2	3.5% 2	0.0% 0	0.0% 0	1.7% 1	0.0% 0	1.5% 1
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0	1.7% 1	1.7% 1	3.1% 2	1.5% 1
		Ceftriaxone (MIC ≥ 4)	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0	1.7% 1	1.7% 1	3.1% 2	1.5% 1
	Macrolides	Azithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	12.1% 7	16.9% 10	15.6% 10	22.1% 15
	Penicillins	Ampicillin (MIC ≥ 32)	75.0% 39	63.5% 47	63.9% 39	75.5% 37	70.2% 40	67.2% 41	60.3% 35	61.0% 36	70.3% 45	73.5% 50
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	1.4% 1	1.6% 1	2.0% 1	3.5% 2	3.3% 2	6.9% 4	1.7% 1	6.3% 4	5.9% 4
		Nalidixic acid (MIC ≥ 32)	3.8% 2	5.4% 4	4.9% 3	2.0% 1	3.5% 2	11.5% 7	12.1% 7	5.1% 3	12.5% 8	14.7% 10
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	55.8% 29	68.9% 51	62.3% 38	63.3% 31	73.7% 42	55.7% 34	60.3% 35	55.9% 33	59.4% 38	55.9% 38
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	44.2% 23	59.5% 44	49.2% 30	49.0% 24	68.4% 39	55.7% 34	58.6% 34	50.8% 30	57.8% 37	52.9% 36
	Phenicols	Chloramphenicol (MIC ≥ 32)	65.4% 34	54.1% 40	55.7% 34	65.3% 32	66.7% 38	55.7% 34	50.0% 29	52.5% 31	59.4% 38	61.8% 42
	Tetracyclines	Tetracycline (MIC ≥ 16)	94.2% 49	83.8% 62	83.6% 51	87.8% 43	87.7% 50	86.9% 53	79.3% 46	84.7% 50	81.3% 52	77.9% 53

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute

Table 46. Resistance patterns of *Shigella flexneri* isolates, 2005–2014

Year Total Isolates	2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64	2014 68
Resistance Pattern										
No resistance detected	5.8% 3	5.4% 4	9.8% 6	4.1% 2	5.3% 3	9.8% 6	17.2% 10	11.9% 7	15.6% 10	8.8% 6
Resistance ≥ 1 CLSI* class	94.2% 49	94.6% 70	90.2% 55	95.9% 47	94.7% 54	90.2% 55	82.8% 48	88.1% 52	84.4% 54	91.2% 62
Resistance ≥ 2 CLSI* classes	80.8% 42	85.1% 63	80.3% 49	93.9% 46	86.0% 49	83.6% 51	77.6% 45	76.3% 45	81.3% 52	85.3% 58
Resistance ≥ 3 CLSI* classes	78.8% 41	75.7% 56	68.9% 42	85.7% 42	82.5% 47	80.3% 49	72.4% 42	69.5% 41	76.6% 49	80.9% 55
Resistance ≥ 4 CLSI* classes	65.4% 34	47.3% 35	55.7% 34	57.1% 28	63.2% 36	57.4% 35	56.9% 33	59.3% 35	62.5% 40	72.1% 49
Resistance ≥ 5 CLSI* classes	30.8% 16	28.4% 21	27.9% 17	26.5% 13	49.1% 28	27.9% 17	32.8% 19	32.2% 19	45.3% 29	44.1% 30
At least ACSSuT†	28.8% 15	27.0% 20	26.2% 16	22.4% 11	47.4% 27	26.2% 16	27.6% 16	28.8% 17	37.5% 24	32.4% 22
At least ACT/S‡	32.7% 17	28.4% 21	26.2% 16	24.5% 12	47.4% 27	27.9% 17	29.3% 17	30.5% 18	40.6% 26	32.4% 22
At least AT/S§	38.5% 20	43.2% 32	36.1% 22	32.7% 16	52.6% 30	41.0% 25	41.4% 24	37.3% 22	51.6% 33	39.7% 27
At least ANT/S¶	1.9% 1	2.7% 2	1.6% 1	0.0% 0	1.8% 1	8.2% 5	5.2% 3	0.0% 0	6.2% 4	4.4% 3
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.7% 1	1.7% 1	1.6% 1	1.5% 1
At least azithromycin and nalidixic acid resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 1	2.9% 2
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	1.5% 1

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

4. *Escherichia coli* O157

Table 47. Minimum inhibitory concentrations (MICs) and resistance of *Escherichia coli* O157 isolates to antimicrobial agents, 2014 (N=155)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	0.0	[0.0 - 2.4]					9.7	63.2	25.2	1.9								
		Streptomycin	N/A	5.8	[2.7 - 10.7]								7.1	74.8	9.7	2.6	1.3	2.6	1.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.6	0.0	[0.0 - 2.4]								3.9	94.2	1.3	0.6					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 2.4]				0.6	5.8	93.5										
		Ceftriaxone	0.0	0.0	[0.0 - 2.4]					100.0											
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 2.4]						0.6	14.2	78.7	6.5							
	Penicillins	Ampicillin	0.0	1.9	[0.4 - 5.6]							0.6	64.5	32.9				1.9			
	Quinolones	Ciprofloxacin	0.0	0.6	[0.0 - 3.5]	94.2			0.6	3.9	0.6				0.6						
		Nalidixic acid	N/A	5.8	[2.7 - 10.7]						0.6		74.2	19.4			0.6	5.2			
II	**Cephems**	Cefoxitin	0.0	0.0	[0.0 - 2.4]							0.6	3.2	74.2	21.9						
	Folate pathway inhibitors	Sulfisoxazole	N/A	7.1	[3.6 - 12.3]											79.4	11.0	2.6			7.1
		Trimethoprim-sulfamethoxazole	N/A	1.3	[0.1 - 4.6]				96.8	1.9					1.3						
	Phenicols	Chloramphenicol	1.9	0.0	[0.0 - 2.4]								1.3	11.0	85.8	1.9					
	Tetracyclines	Tetracycline	1.3	7.1	[3.6 - 12.3]									91.6	1.3		1.3	5.8			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

Figure 15. Antimicrobial resistance pattern for *Escherichia coli* O157, 2014

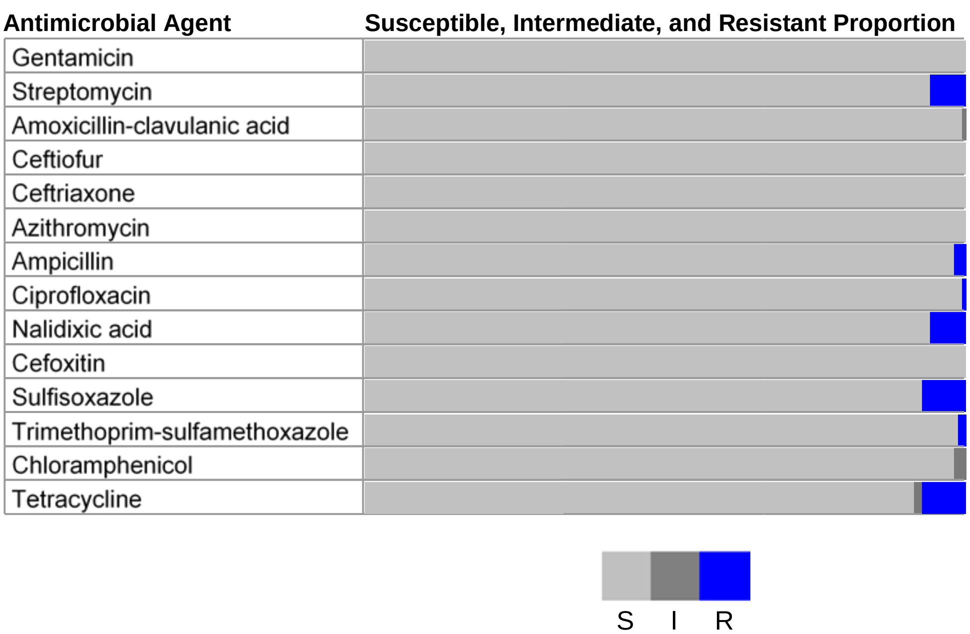


Table 48. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 194	2006 233	2007 189	2008 161	2009 187	2010 170	2011 162	2012 166	2013 177	2014 155
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.5% 1	0.0% 0	0.0% 0	1.2% 2	0.5% 1	0.6% 1	0.6% 1	0.6% 1	0.6% 1	0.0% 0
		Kanamycin (MIC ≥ 64)	0.5% 1	0.4% 1	0.0% 0	0.0% 0	0.5% 1	1.2% 2	1.9% 3	0.0% 0	0.0% 0	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	2.1% 4	2.6% 6	2.1% 4	1.9% 3	4.8% 9	2.4% 4	4.3% 7	2.4% 4	6.8% 12	5.8% 9
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.5% 1	0.0% 0	0.0% 0	0.6% 1	1.1% 2	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.6% 1	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.6% 1	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.6% 1	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	4.1% 8	2.6% 6	2.1% 4	3.7% 6	4.3% 8	1.8% 3	3.7% 6	1.8% 3	4.5% 8	1.9% 3
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.4% 1	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.6% 1	0.0% 0	0.6% 1	0.6% 1
		Nalidixic acid (MIC ≥ 32)	1.5% 3	2.1% 5	2.1% 4	1.2% 2	2.1% 4	1.2% 2	1.2% 2	2.4% 4	2.8% 5	5.8% 9
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	1.3% 3	0.0% 0	1.2% 2	0.5% 1	0.0% 0	0.0% 0	0.6% 1	1.1% 2	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	6.7% 13	3.0% 7	2.6% 5	3.1% 5	6.4% 12	4.7% 8	4.9% 8	3.6% 6	5.6% 10	7.1% 11
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.5% 1	0.4% 1	1.1% 2	1.2% 2	4.3% 8	1.2% 2	2.5% 4	1.2% 2	1.7% 3	1.3% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.0% 2	1.3% 3	0.5% 1	0.6% 1	1.1% 2	0.6% 1	1.2% 2	1.8% 3	2.8% 5	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	8.8% 17	4.7% 11	4.2% 8	1.9% 3	7.5% 14	4.7% 8	4.9% 8	5.4% 9	8.5% 15	7.1% 11

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute

Table 49. Resistance patterns of *Escherichia coli* O157 isolates, 2005–2014

Year Total Isolates	2005 194	2006 233	2007 189	2008 161	2009 187	2010 170	2011 162	2012 166	2013 177	2014 155
Resistance Pattern										
No resistance detected	88.1% 171	91.8% 214	92.6% 175	91.9% 148	89.8% 168	93.5% 159	92.6% 150	92.2% 153	84.7% 150	87.1% 135
Resistance ≥ 1 CLSI* class	11.9% 23	8.2% 19	7.4% 14	8.1% 13	10.2% 19	6.5% 11	7.4% 12	7.8% 13	15.3% 27	12.9% 20
Resistance ≥ 2 CLSI* classes	6.7% 13	4.7% 11	2.6% 5	3.1% 5	7.5% 14	4.7% 8	4.9% 8	4.2% 7	7.9% 14	6.5% 10
Resistance ≥ 3 CLSI* classes	5.2% 10	3.4% 8	2.1% 4	2.5% 4	5.9% 11	4.1% 7	4.3% 7	3.0% 5	6.2% 11	5.8% 9
Resistance ≥ 4 CLSI* classes	1.0% 2	2.1% 5	1.1% 2	1.2% 2	3.7% 7	0.6% 1	2.5% 4	1.8% 3	2.3% 4	2.6% 4
Resistance ≥ 5 CLSI* classes	0.0% 0	0.9% 2	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.6% 1	1.2% 2	1.1% 2	0.0% 0
At least ACSSuT†	0.0% 0	0.9% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 1	1.2% 2	1.1% 2	0.0% 0
At least ACT/S‡	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.0% 0	0.0% 0	1.2% 2	0.6% 1	1.1% 2	0.0% 0
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

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

5. *Campylobacter*

Table 50. Frequency of *Campylobacter* species, 2014

Species	n	(%)
Campylobacter jejuni	1251	(86.6)
Campylobacter coli	146	(10.1)
Other	47	(3.3)
Total	**1444**	**(100)**

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2014 (N=1251)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	N/A	1.4	[0.8 - 2.2]					0.2	31.7	63.9	3.0					1.4			
I	**Ketolide**	Telithromycin	N/A	1.8	[1.2 - 2.7]				0.1	3.2	19.3	54.6	19.4	1.5	0.1	1.8					
I	**Macrolides**	Azithromycin	N/A	1.8	[1.2 - 2.7]	0.1	13.4	54.0	27.7	3.0									1.8		
I		Erythromycin	N/A	1.8	[1.2 - 2.7]			0.1	1.6	21.9	52.2	20.1	2.2	0.2					1.8		
I	**Quinolones**	Ciprofloxacin	N/A	26.7	[24.3 - 29.2]		0.3	19.5	44.9	7.4	1.1	0.1	0.2	0.6	10.4	9.0	3.7	1.8	0.9		
I		Nalidixic acid	N/A	26.5	[24.1 - 29.1]									58.3	13.4	1.8	0.2	0.2	26.2		
II	**Lincosamides**	Clindamycin	N/A	2.6	[1.8 - 3.6]		0.1	8.1	57.5	26.9	5.0	0.6	0.1	0.3	0.6	0.3	0.7				
II	**Phenicols**	Florfenicol	N/A	1.0	[0.5 - 1.7]						2.7	75.7	17.1	3.5	1.0						
II	**Tetracyclines**	Tetracycline	N/A	48.6	[45.8 - 51.4]			0.2	17.7	26.5	5.0	2.0	0.5	0.1	0.1	0.1	0.6	6.1	41.2		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. ECOFFs were used when available.

Figure 16. Antimicrobial resistance pattern for *Campylobacter jejuni*, 2014

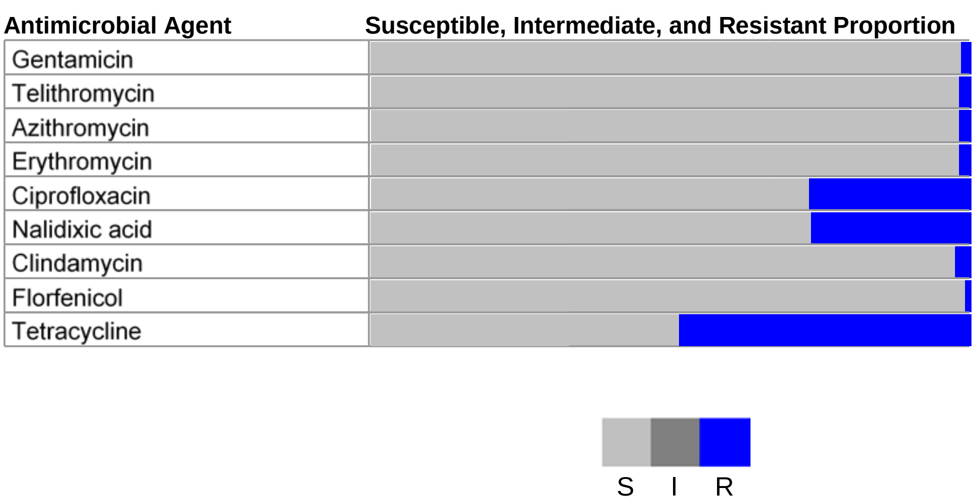


Table 52. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2005–2014

Rank*	CLSI[†] Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Total Isolates		**788**	**709**	**991**	**1033**	**1350**	**1159**	**1282**	**1190**	**1183**	**1251**
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	0.1% 1	0.0% 0	0.8% 8	1.1% 11	0.6% 8	0.6% 7	1.0% 13	1.0% 12	1.6% 19	1.4% 17
	Ketolides	Telithromycin (MIC ≥ 8)	0.8% 6	1.0% 7	1.3% 13	2.2% 23	1.9% 25	2.4% 28	2.6% 33	1.4% 17	2.0% 24	1.8% 23
	Macrolides	Azithromycin (MIC ≥ 0.5)	2.7% 21	1.3% 9	1.8% 18	2.6% 27	1.9% 26	2.7% 31	4.9% 63	1.8% 21	2.2% 26	1.8% 23
		Erythromycin (MIC ≥ 8)	1.5% 12	0.8% 6	1.6% 16	2.2% 23	1.5% 20	1.2% 14	1.8% 23	1.5% 18	2.2% 26	1.8% 23
	Quinolones	Ciprofloxacin (MIC ≥ 1)	21.6% 170	19.6% 139	26.0% 258	22.6% 233	23.1% 312	22.0% 255	24.1% 309	25.3% 301	22.2% 263	26.7% 334
		Nalidixic acid (MIC ≥ 32)	22.5% 177	19.5% 138	26.4% 262	22.8% 236	23.1% 312	22.1% 256	24.1% 309	25.5% 303	22.1% 262	26.5% 332
II	Lincosamides	Clindamycin (MIC ≥ 1)	3.2% 25	2.4% 17	3.4% 34	3.8% 39	2.9% 39	14.1% 163	21.4% 274	10.8% 129	3.2% 38	2.6% 32
	Phenicols	Florfenicol (MIC ≥ 8)	0.4% 3	0.0% 0	0.0% 0	0.6% 6	0.6% 8	1.5% 17	2.1% 27	1.4% 17	1.2% 14	1.0% 12
	Tetracyclines	Tetracycline (MIC ≥ 2)	43.7% 344	48.7% 345	45.6% 452	45.3% 468	44.1% 595	44.2% 512	48.4% 621	47.8% 569	49.1% 581	48.6% 608

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute

Table 53. Resistance patterns of *Campylobacter jejuni* isolates, 2005–2014

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Isolates	**788**	**709**	**991**	**1033**	**1350**	**1159**	**1282**	**1190**	**1183**	**1251**
Resistance Pattern										
No resistance detected	46.3% 365	42.5% 301	44.3% 439	45.2% 467	45.9% 620	39.5% 458	33.0% 423	38.7% 460	44.5% 527	44.2% 553
Resistance ≥ 1 CLSI* class	53.7% 423	57.5% 408	55.7% 552	54.8% 566	54.1% 730	60.5% 701	67.0% 859	61.3% 730	55.5% 656	55.8% 698
Resistance ≥ 2 CLSI* classes	16.2% 128	13.1% 93	18.8% 186	15.8% 163	15.1% 204	19.0% 220	23.6% 302	20.0% 238	17.2% 204	20.9% 262
Resistance ≥ 3 CLSI* classes	2.4% 19	1.3% 9	1.9% 19	3.5% 36	2.7% 37	4.2% 49	7.5% 96	4.8% 57	3.1% 37	3.0% 37
Resistance ≥ 4 CLSI* classes	1.0% 8	0.7% 5	1.3% 13	1.9% 20	1.6% 21	1.9% 22	3.6% 46	1.8% 21	2.2% 26	2.0% 25
Resistance ≥ 5 CLSI* classes	0.0% 0	0.3% 2	1.1% 11	1.5% 16	1.0% 13	1.0% 12	1.9% 24	0.9% 11	1.8% 21	1.2% 15
At least macrolide and quinolone resistant	1.4% 11	0.7% 5	1.4% 14	1.5% 15	1.2% 16	1.3% 15	3.0% 38	1.3% 16	1.9% 22	1.4% 18

* CLSI: Clinical and Laboratory Standards Institute

Table 54. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2014 (N=146)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates %I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	N/A	3.4	[1.1 - 7.8]						8.9	67.8	19.9					3.4			
	Ketolide	Telithromycin	N/A	19.9	[13.7 - 27.3]				1.4	11.6	15.1	15.1	18.5	18.5	9.6	10.3					
	Macrolides	Azithromycin	N/A	10.3	[5.9 - 16.4]		2.1	13.7	37.7	31.5	4.8								10.3		
		Erythromycin	N/A	10.3	[5.9 - 16.4]					4.1	28.8	19.9	21.9	14.4	0.7				10.3		
	Quinolones	Ciprofloxacin	N/A	35.6	[27.9 - 44.0]			8.2	26.0	20.5	9.6		0.7	1.4	6.8	15.1	8.2	3.4			
		Nalidixic acid	N/A	35.6	[27.9 - 44.0]									21.9	35.6	6.8		2.1	33.6		
II	**Lincosamides**	Clindamycin	N/A	13.7	[8.6 - 20.4]				11.0	28.8	30.8	15.8	2.7	0.7	6.2	2.7	1.4				
	Phenicols	Florfenicol	N/A	0.0	[0.0 - 2.5]						4.1	43.8	37.7	14.4							
	Tetracyclines	Tetracycline	N/A	50.0	[41.6 - 58.4]				3.4	18.5	17.8	8.2	2.1		0.7	0.7	1.4		47.3		

Columns 0.015 through 512: Percentage of all isolates with MIC (µg/mL)**

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists
§ Percentage of isolates that were resistant
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method
** The unshaded areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. ECOFFs were used when available.

Figure 17. Antimicrobial resistance pattern for *Campylobacter coli*, 2014

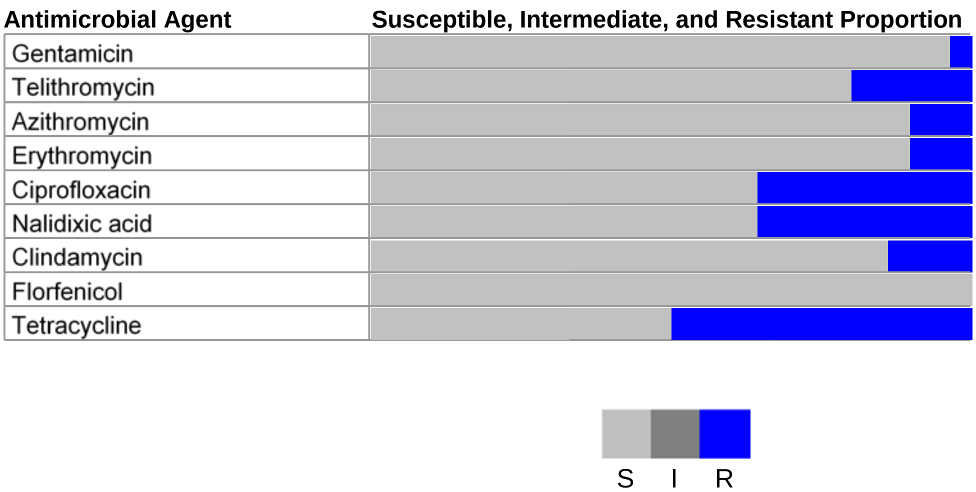


Table 55. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2005–2014

Year Total Isolates			2005 98	2006 96	2007 104	2008 115	2009 141	2010 115	2011 149	2012 134	2013 142	2014 146
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	3.1% 3	1.0% 1	0.0% 0	1.7% 2	3.5% 5	12.2% 14	12.1% 18	6.0% 8	2.1% 3	3.4% 5
	Ketolides	Telithromycin (MIC ≥ 8)	8.2% 8	8.3% 8	9.6% 10	10.4% 12	7.1% 10	13.9% 16	10.7% 16	11.2% 15	21.8% 31	19.9% 29
	Macrolides	Azithromycin (MIC ≥ 1)	4.1% 4	9.4% 9	5.8% 6	10.4% 12	3.5% 5	7.0% 8	5.4% 8	9.0% 12	16.9% 24	10.3% 15
		Erythromycin (MIC ≥ 16)	4.1% 4	8.3% 8	5.8% 6	10.4% 12	3.5% 5	5.2% 6	2.7% 4	9.0% 12	17.6% 25	10.3% 15
	Quinolones	Ciprofloxacin (MIC ≥ 1)	24.5% 24	21.9% 21	29.8% 31	29.6% 34	24.1% 34	30.4% 35	36.2% 54	33.6% 45	34.5% 49	35.6% 52
		Nalidixic acid (MIC ≥ 32)	26.5% 26	22.9% 22	29.8% 31	29.6% 34	24.1% 34	30.4% 35	36.2% 54	33.6% 45	35.2% 50	35.6% 52
II	Lincosamides	Clindamycin (MIC ≥ 2)	8.2% 8	13.5% 13	9.6% 10	14.8% 17	7.8% 11	17.4% 20	16.8% 25	16.4% 22	21.1% 30	13.7% 20
	Phenicols	Florfenicol (MIC ≥ 8)	1.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	1.5% 2	0.7% 1	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 4)	31.6% 31	39.6% 38	44.2% 46	39.1% 45	45.4% 64	50.4% 58	50.3% 75	45.5% 61	51.4% 73	50.0% 73

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute

Table 56. Resistance patterns of *Campylobacter coli* isolates, 2005–2014

Year Total Isolates	2005 98	2006 96	2007 104	2008 115	2009 141	2010 115	2011 149	2012 134	2013 142	2014 146
Resistance Pattern										
No resistance detected	50.0% 49	43.8% 42	38.5% 40	43.5% 50	44.0% 62	33.9% 39	30.9% 46	42.5% 57	31.7% 45	28.1% 41
Resistance ≥ 1 CLSI* class	50.0% 49	56.3% 54	61.5% 64	56.5% 65	56.0% 79	66.1% 76	69.1% 103	57.5% 77	68.3% 97	71.9% 105
Resistance ≥ 2 CLSI* classes	19.4% 19	19.8% 19	22.1% 23	28.7% 33	21.3% 30	38.3% 44	43.0% 64	32.8% 44	35.9% 51	34.2% 50
Resistance ≥ 3 CLSI* classes	7.1% 7	9.4% 9	8.7% 9	8.7% 10	7.1% 10	13.9% 16	14.8% 22	12.7% 17	21.1% 30	13.7% 20
Resistance ≥ 4 CLSI* classes	4.1% 4	6.3% 6	5.8% 6	7.0% 8	4.3% 6	7.0% 8	4.7% 7	9.0% 12	14.1% 20	6.2% 9
Resistance ≥ 5 CLSI* classes	2.0% 2	2.1% 2	1.0% 1	3.5% 4	2.8% 4	3.5% 4	1.3% 2	6.0% 8	8.5% 12	5.5% 8
At least macrolide and quinolone resistant	2.0% 2	4.2% 4	1.9% 2	4.3% 5	2.8% 4	3.5% 4	3.4% 5	8.2% 11	9.2% 13	5.5% 8

* CLSI: Clinical and Laboratory Standards Institute

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

Table 57. Frequency of *Vibrio* species other than *V. cholerae*, 2009–2014

	2009		2010		2011		2012		2013*		2014*	
Species	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
Vibrio parahaemolyticus	149	(53.0)	179	(54.4)	201	(50.5)	370	(61.4)	315	(52.1)	200	(40.7)
Vibrio alginolyticus	46	(16.4)	49	(14.9)	103	(25.9)	117	(19.4)	122	(20.2)	127	(25.8)
Vibrio vulnificus	50	(17.8)	61	(18.5)	63	(15.8)	65	(10.8)	87	(14.4)	80	(16.3)
Vibrio fluvialis	21	(7.5)	24	(7.3)	18	(4.5)	28	(4.6)	40	(6.6)	45	(9.1)
Vibrio mimicus	11	(3.9)	9	(2.7)	9	(2.3)	11	(1.8)	27	(4.5)	22	(4.5)
Vibrio harveyi	0	(0)	2	(0.6)	4	(1.0)	3	(0.5)	5	(0.8)	6	(1.2)
Other	4	(1.4)	5	(1.5)	0	(0)	9	(1.5)	9	(1.5)	12	(2.4)
Total	**281**	**(100)**	**329**	**(100)**	**398**	**(100)**	**603**	**(100)**	**605**	**(100)**	**492**	**(100)**

* Frequencies reflect the number of isolates tested, not number of culture-confirmed cases. See Methods for varying sampling method by species.

Table 58. Minimum inhibitory concentrations (MICs) and resistance of isolates of *Vibrio* species other than *V. cholerae* to antimicrobial agents, 2014 (N=492)

Rank*	CLSI† Antimicrobial Class		Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**																				
	Antimicrobial Agent	Species (# of isolates)	%I‡	%R§	[95% CI]¶	0.002	0.004	0.007	0.015	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	512	1024	2048
I	**Aminoglycosides**																									
	Gentamicin	**All** (492)	0.0	0.0	[0.0 - 0.7]								0.6	6.5	38.4	51.4	3.0									
		parahaemolyticus (200)	0.0	0.0	[0.0 - 1.8]									0.5	35.5	62.0	2.0									
		alginolyticus (127)	0.0	0.0	[0.0 - 2.9]									1.6	55.1	41.7	1.6									
		vulnificus (80)	0.0	0.0	[0.0 - 4.5]										7.5	81.3	11.3									
	Cephems																									
	Cefotaxime	**All** (492)	0.6	1.4	[0.6 - 2.9]					4.1	9.1	50.2	27.6	3.5	3.5	0.6		0.4		0.2	0.6			0.2		
		parahaemolyticus (200)	0.0	0.0	[0.0 - 1.8]						7.0	50.5	39.5	2.5	0.5											
		alginolyticus (127)	0.0	0.0	[0.0 - 2.9]							58.3	38.6	2.4	0.8											
		vulnificus (80)	0.0	0.0	[0.0 - 4.5]						20.0	78.8		1.3												
	Ceftazidime	**All** (492)	0.0	0.2	[0.0 - 1.1]							4.1	25.8	37.6	31.3	1.0								0.2		
		parahaemolyticus (200)	0.0	0.0	[0.0 - 1.8]							4.5	30.0	22.5	41.0	2.0										
		alginolyticus (127)	0.0	0.0	[0.0 - 2.9]							8.7	26.8	52.0	12.6											
		vulnificus (80)	0.0	0.0	[0.0 - 4.5]								12.5	48.8	38.8											
	Penems																									
	Imipenem††	**All** (376)	11.2	2.7	[1.3 - 4.8]					0.3	0.3	48.4	34.6	1.9	0.8	11.2	2.7									
		parahaemolyticus (148)	0.0	0.0	[0.0 - 2.5]						0.7	75.0	24.3													
		alginolyticus (100)	0.0	1.0	[0.0 - 5.4]							67.0	32.0				1.0									
		vulnificus (69)	0.0	0.0	[0.0 - 5.2]							2.9	87.0	10.1												
	Penicillins																									
	Ampicillin	**All** (492)	10.2	47.8	[43.3 - 52.3]									0.2	6.3	10.2	11.6	13.8	10.2	10.6	6.1	2.0	1.4	27.6		
		parahaemolyticus (200)	21.0	37.0	[30.3 - 44.1]									0.5		1.0	19.0	21.5	21.0	19.5	10.0	2.0	1.0	4.5		
		alginolyticus (127)	0.8	97.6	[93.3 - 99.5]										0.8			0.8	0.8	3.1	4.7	3.1	3.1	83.5		
		vulnificus (80)	0.0	2.5	[0.3 - 8.7]										36.3	58.8	1.3	1.3		1.3	1.3					
	Quinolones																									
	Ciprofloxacin	**All** (492)	0.0	0.0	[0.0 - 0.7]		0.8	3.3	7.9	3.7	15.4	39.6	27.4	1.8												
		parahaemolyticus (200)	0.0	0.0	[0.0 - 1.8]				0.5	1.0	2.0	64.0	31.5	1.0												
		alginolyticus (127)	0.0	0.0	[0.0 - 2.9]				0.8	0.8	4.7	38.6	52.8	2.4												
		vulnificus (80)	0.0	0.0	[0.0 - 4.5]					10.0	76.3	11.3	2.5													
	Nalidixic acid††,‡‡	**All** (309)	N/A	N/A	N/A								0.6	1.9	34.6	53.7	8.4	0.3						0.3		
		parahaemolyticus (112)	N/A	N/A	N/A								0.9	0.9	33.9	56.3	6.3	0.9						0.9		
		alginolyticus (86)	N/A	N/A	N/A									1.2	20.9	62.8	15.1									
		vulnificus (60)	N/A	N/A	N/A									1.7	40.0	48.3	10									
II	**Folate pathway inhibitors**																									
	Trimethoprim-sulfamethoxazole	**All** (492)	N/A	0.2	[0.0 - 1.1]				0.2	0.8	3.3	58.7	36.4	0.4							0.2					
		parahaemolyticus (200)	N/A	0.0	[0.0 - 1.8]							22.5	76.5	1.0												
		alginolyticus (127)	N/A	0.8	[0.0 - 4.3]				0.8	3.1	3.9	78.0	13.4								0.8					
		vulnificus (80)	N/A	0.0	[0.0 - 4.5]						7.5	87.5	5.0													
	Phenicols																									
	Chloramphenicol‡‡	**All** (492)	N/A	N/A	N/A									4.9	89.4	5.7										
		parahaemolyticus (200)	N/A	N/A	N/A									1.0	89.0	10.0										
		alginolyticus (127)	N/A	N/A	N/A									3.1	91.3	5.5										
		vulnificus (80)	N/A	N/A	N/A									16.3	83.8											
	Tetracyclines																									
	Tetracycline	**All** (492)	0.0	0.0	[0.0 - 0.7]								0.8	10.6	74.2	14.0	0.4									
		parahaemolyticus (200)	0.0	0.0	[0.0 - 1.8]									2.0	86.0	12.0										
		alginolyticus (127)	0.0	0.0	[0.0 - 2.9]									5.5	89.0	5.5										
		vulnificus (80)	0.0	0.0	[0.0 - 4.5]								3.8	38.8	56.3	1.3										

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important

† CLSI: Clinical and Laboratory Standards Institute

‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists or no CLSI breakpoints have been established

§ Percentage of isolates that were resistant; N/A indicates that no CLSI breakpoints have been established

¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method; N/A indicates that no CLSI breakpoints have been established

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

†† Results for all 492 isolates are not available due to a manufacturer shortage of Etest® strips during 2014 testing. A total of 183 isolates could not be tested against nalidixic acid; 116 of those also lacked imipenem testing. Percentages shown are based on the number of isolates that were tested for each agent (overall N=376 for imipenem; overall N=309 for nalidixic acid).

‡‡ CLSI MIC interpretive criteria have not been established

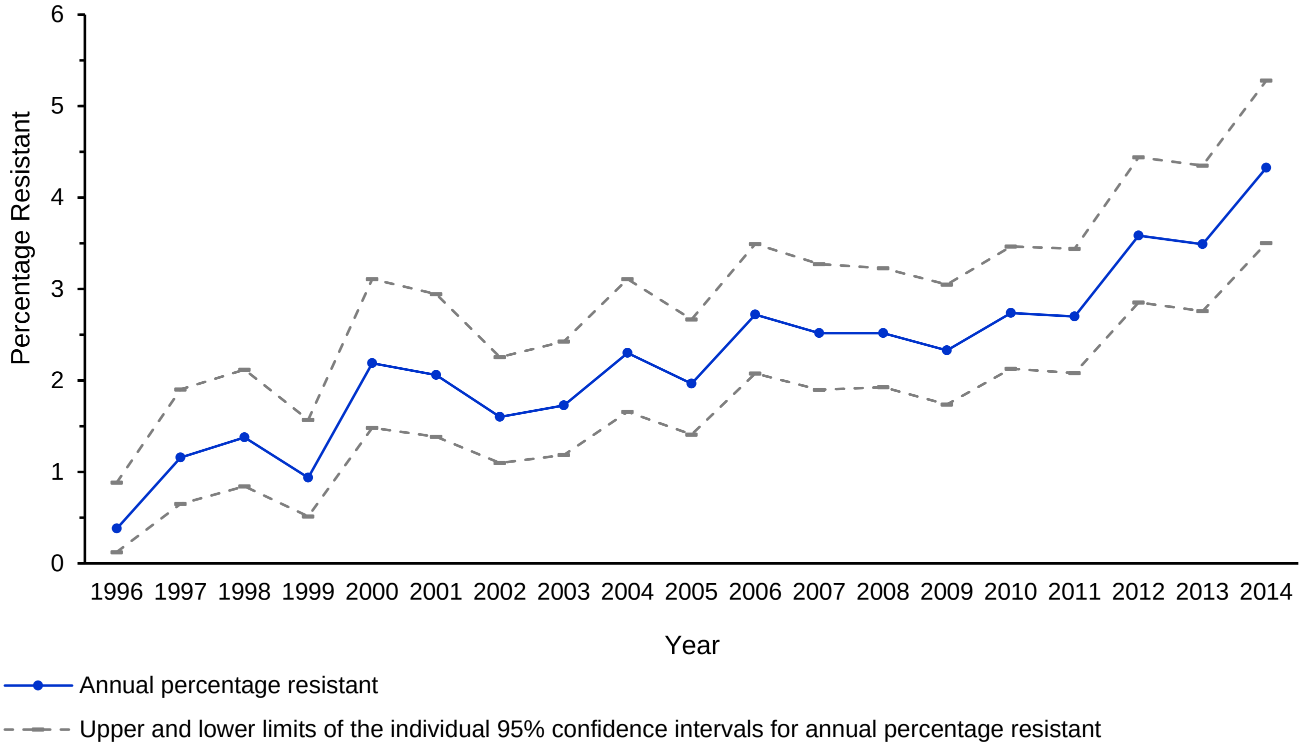
Table 59. Percentage and number of isolates of *Vibrio* species other than *V. cholerae* resistant to ampicillin, 2009–2014

Species	2009	2010	2011	2012	2013	2014
Vibrio parahaemolyticus	9.4% 14	8.4% 15	40.3% 81	14.1% 52	41.0% 129	37.0% 74
Vibrio alginolyticus	82.6% 38	89.8% 44	95.1% 98	98.3% 115	95.9% 117	97.6% 124
Vibrio vulnificus	2.0% 1	0% 0	4.8% 3	1.5% 1	2.3% 2	2.5% 2
Vibrio fluvialis	33.3% 7	12.5% 3	44.4% 8	21.4% 6	50.0% 20	55.6% 25
Vibrio mimicus	9.1% 1	0% 0	0% 0	9.1% 1	7.4% 2	0% 0
Vibrio harveyi	N/A* 0	50.0% 1	100% 4	100% 3	80.0% 4	100% 6
Other	25.0% 1	0% 0	N/A* 0	22.2% 2	55.6% 5	33.3% 4
Total	22.1% 62	19.1% 63	48.7% 194	29.9% 180	46.1% 279	47.8% 235

* N/A indicates that no isolates were received and tested

The following figures display resistance to selected agents and combinations of agents from 1996–2014 for nontyphoidal *Salmonella*, 1999–2014 for *Salmonella* ser. Typhi and *Shigella*, and 1997–2014 for *Campylobacter*.

Figure 18. Percentage of nontyphoidal *Salmonella* isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1996–2014



* Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

Figure 19. Percentage of nontyphoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2014

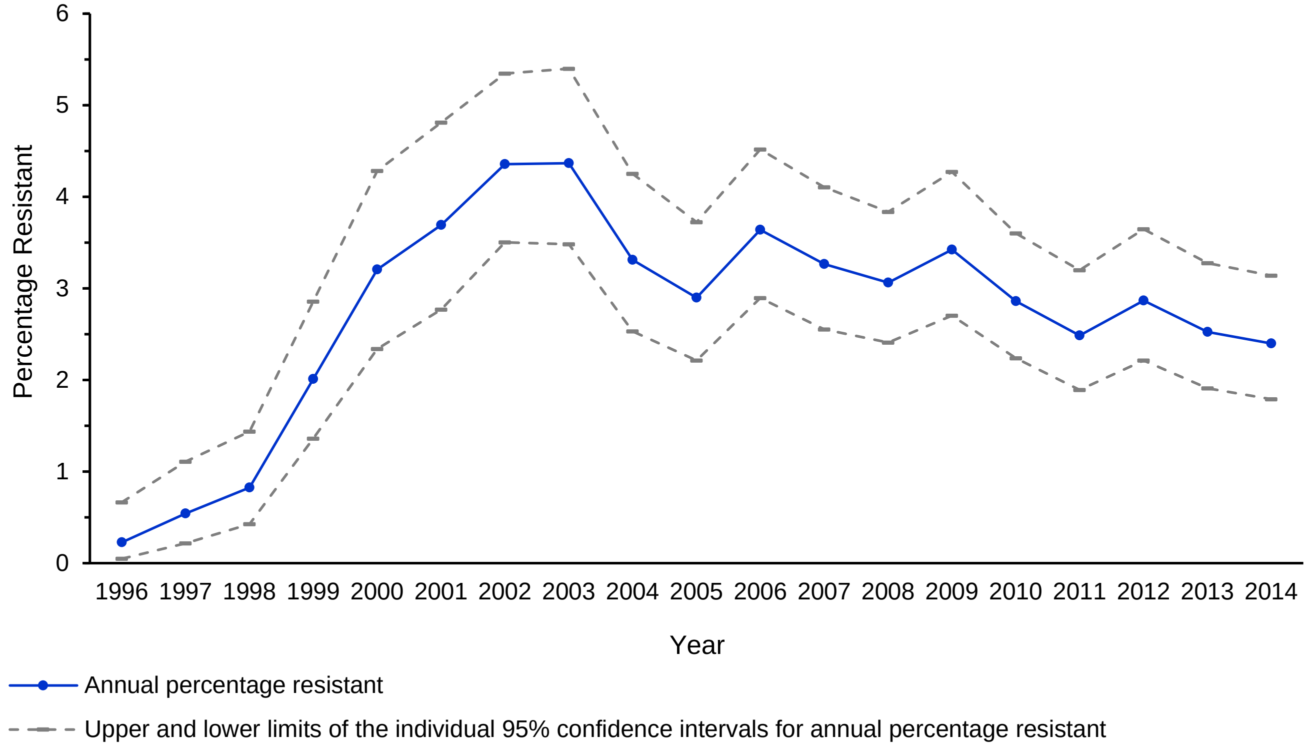
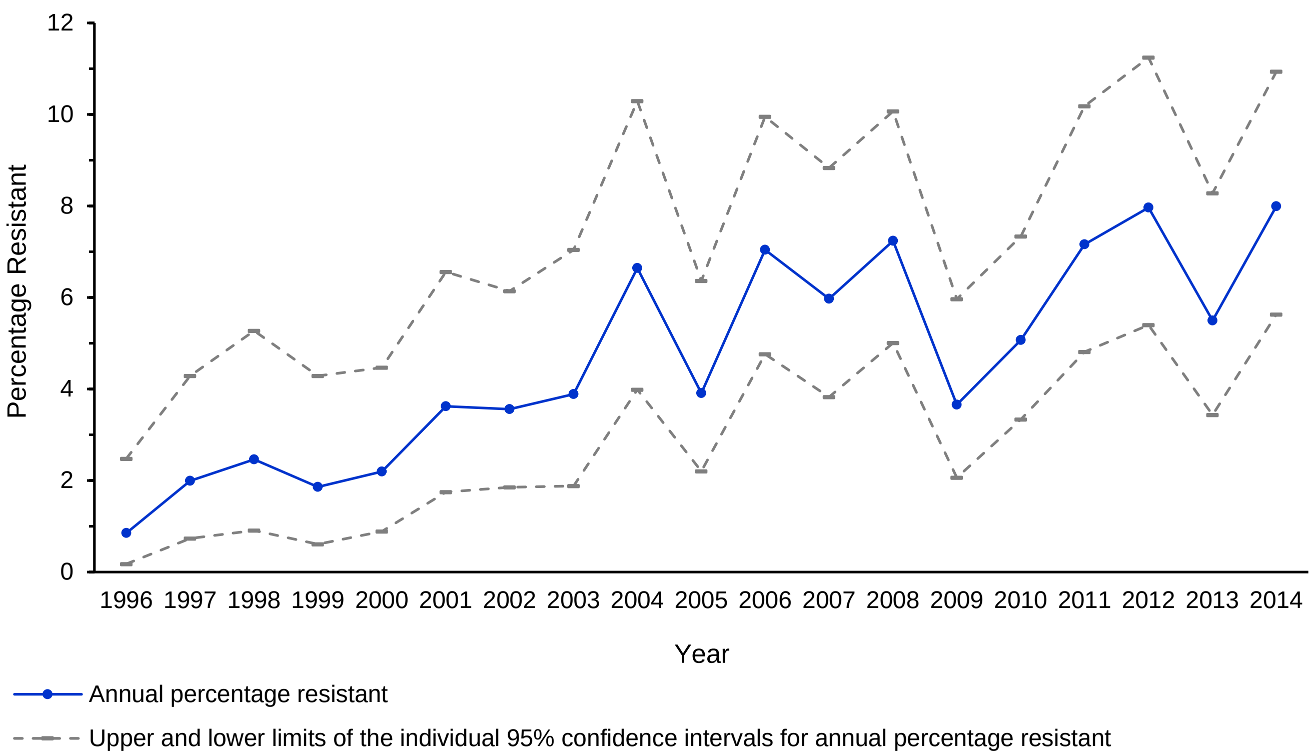


Figure 20. Percentage of *Salmonella* ser. Enteritidis isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1996–2014



* Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

Figure 21. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2014

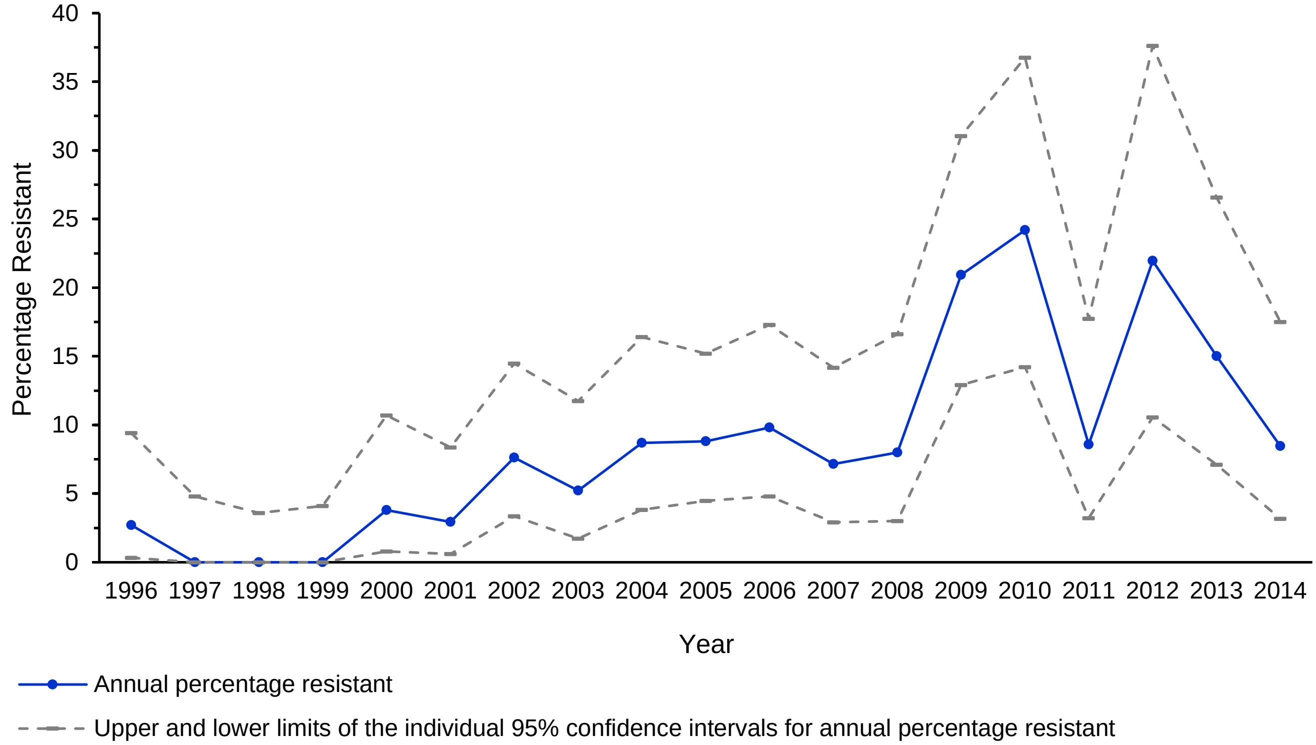


Figure 22. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2014

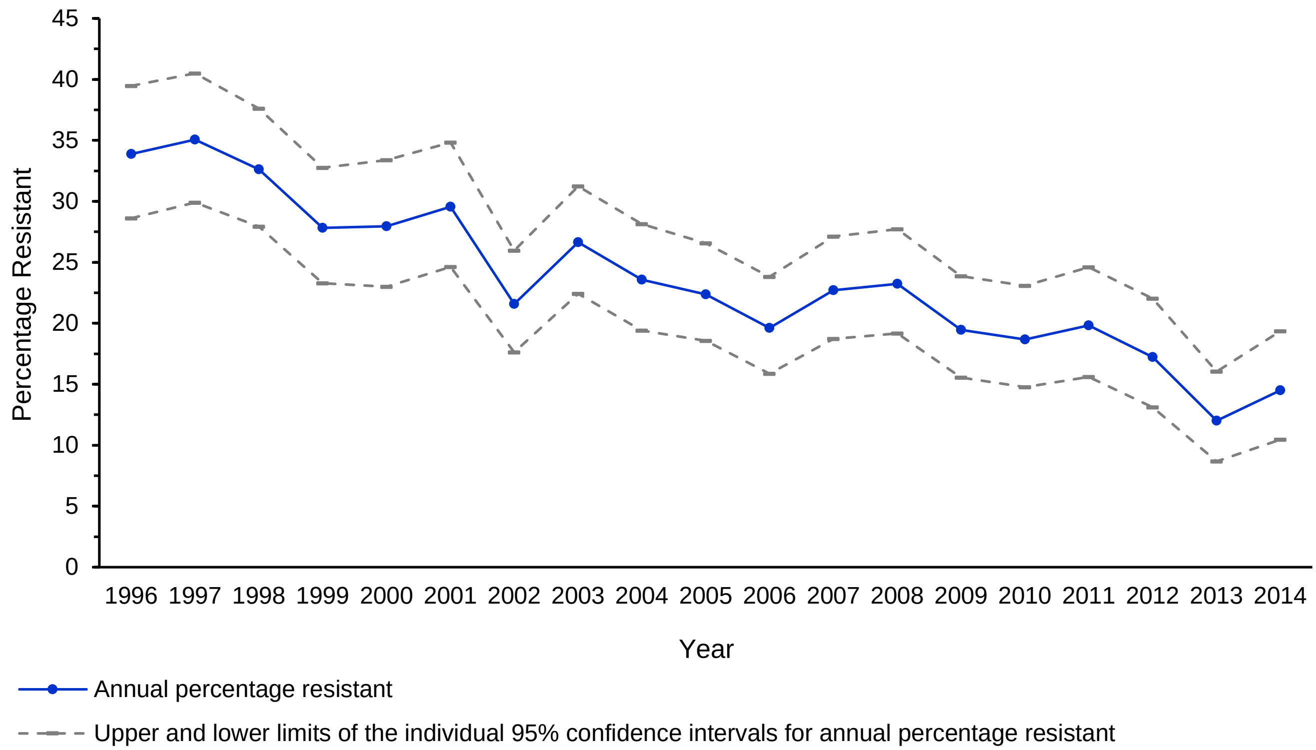


Figure 23. Percentage of *Salmonella* ser. Newport isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx), by year, 1996–2014

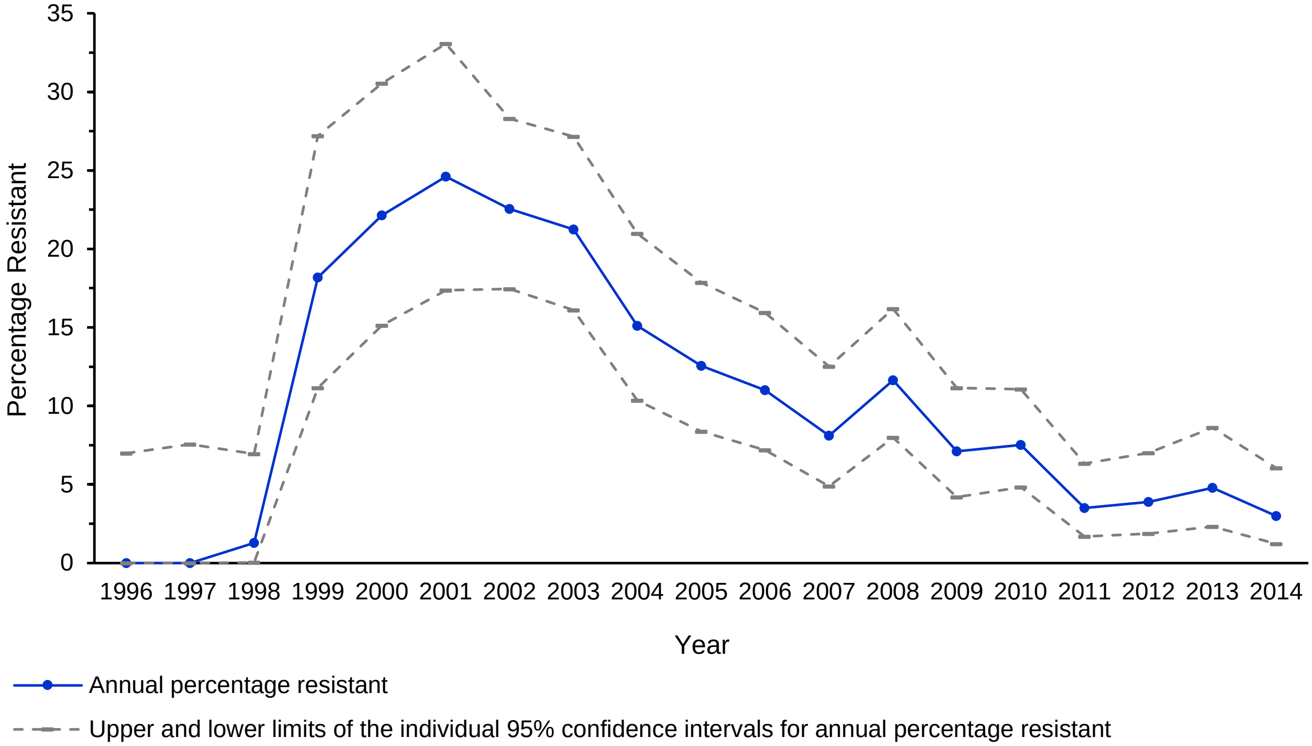
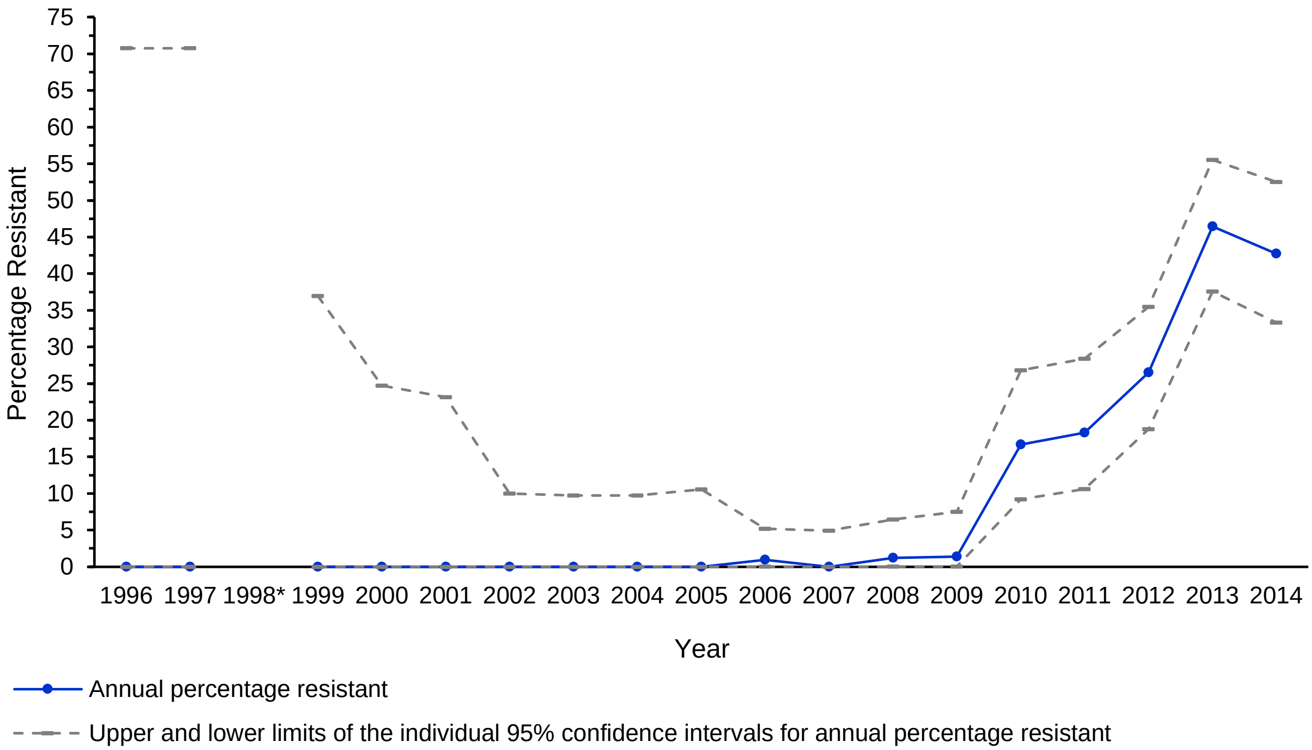


Figure 24. Percentage of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to at least ampicillin, streptomycin, sulfonamide, and tetracycline (ASSuT), but not chloramphenicol, 1996–2014*



* No *Salmonella* ser. I 4,[5],12:i:- isolates were received for testing in 1998

Figure 25. Percentage of nontyphoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2014

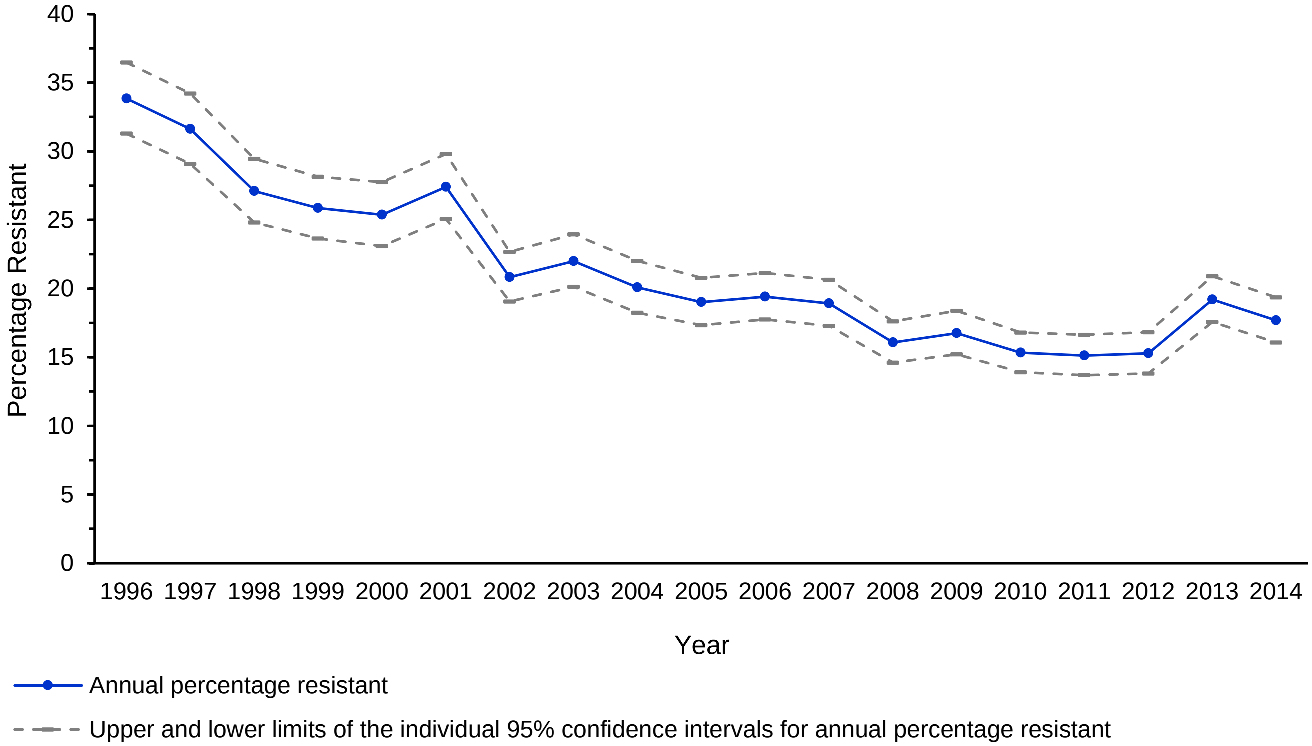


Figure 26. Percentage of nontyphoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2014

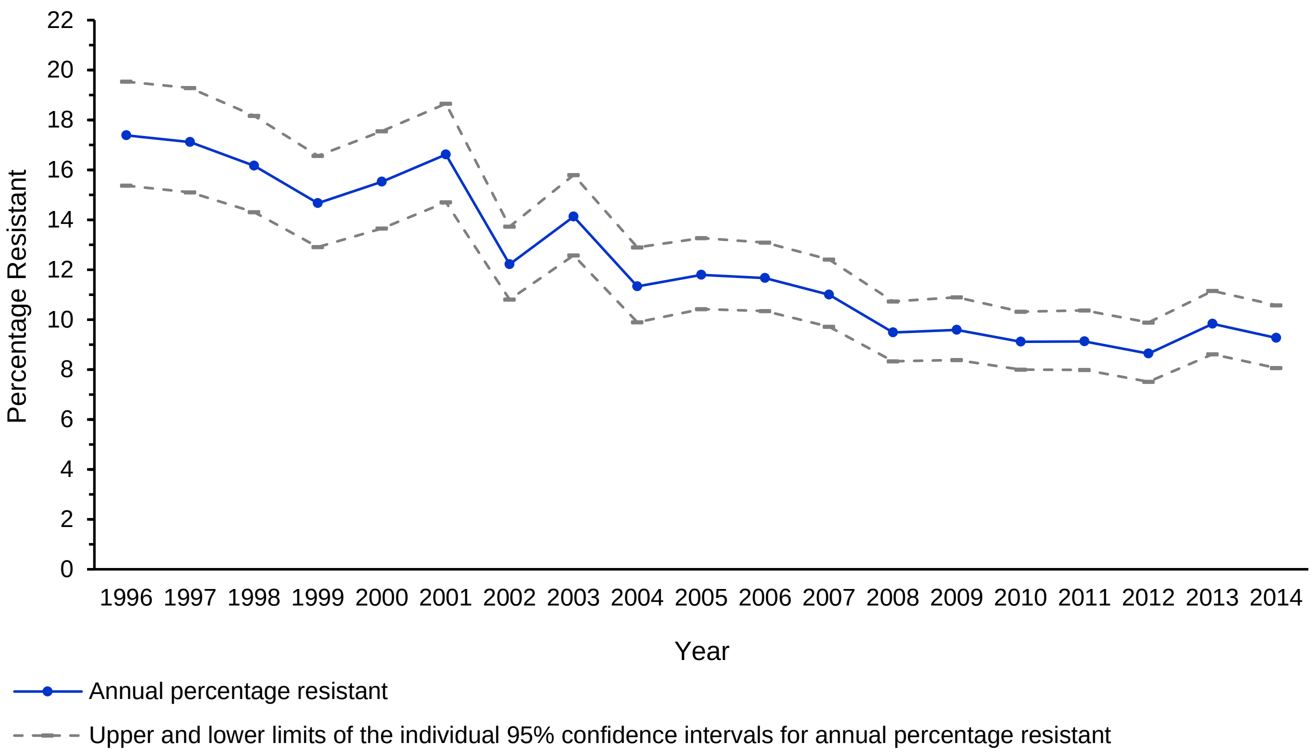
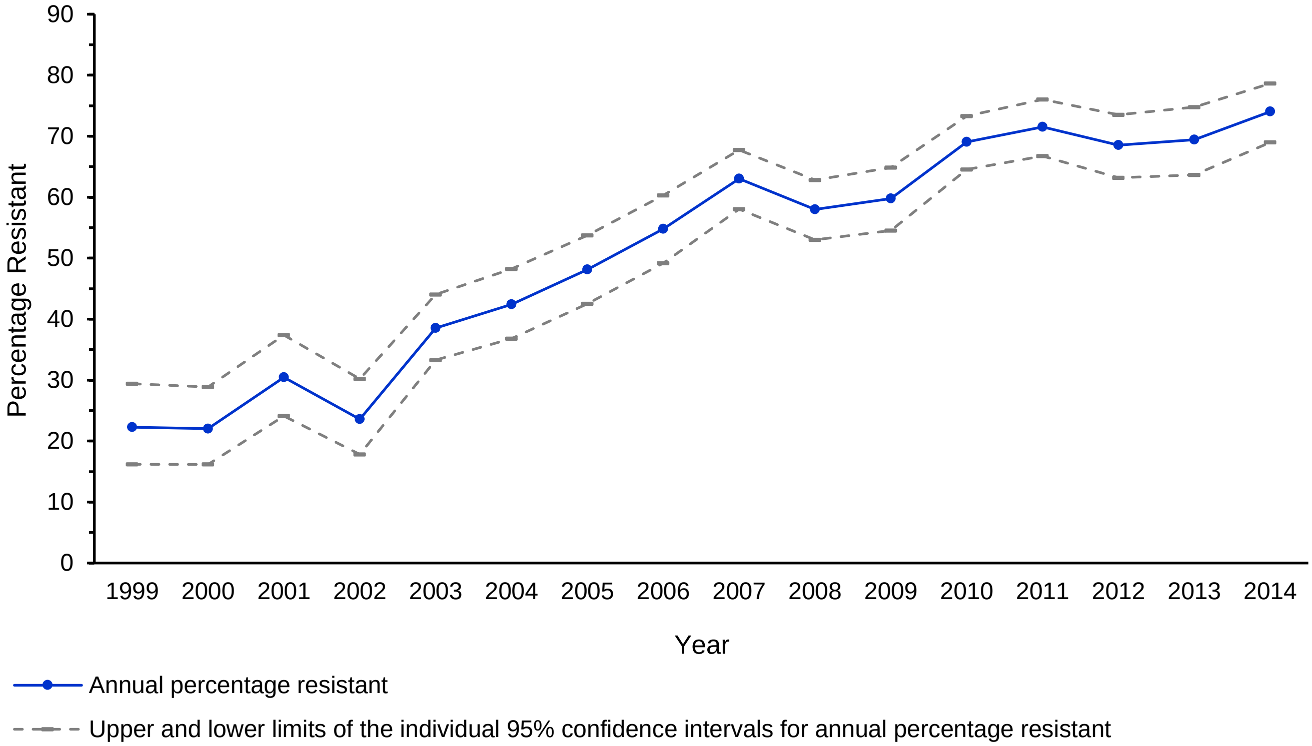


Figure 27. Percentage of *Salmonella* ser. Typhi isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1999–2014



* Includes isolates with MICs categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)

Figure 28. Percentage of *Shigella* isolates resistant to nalidixic acid, 1999–2014

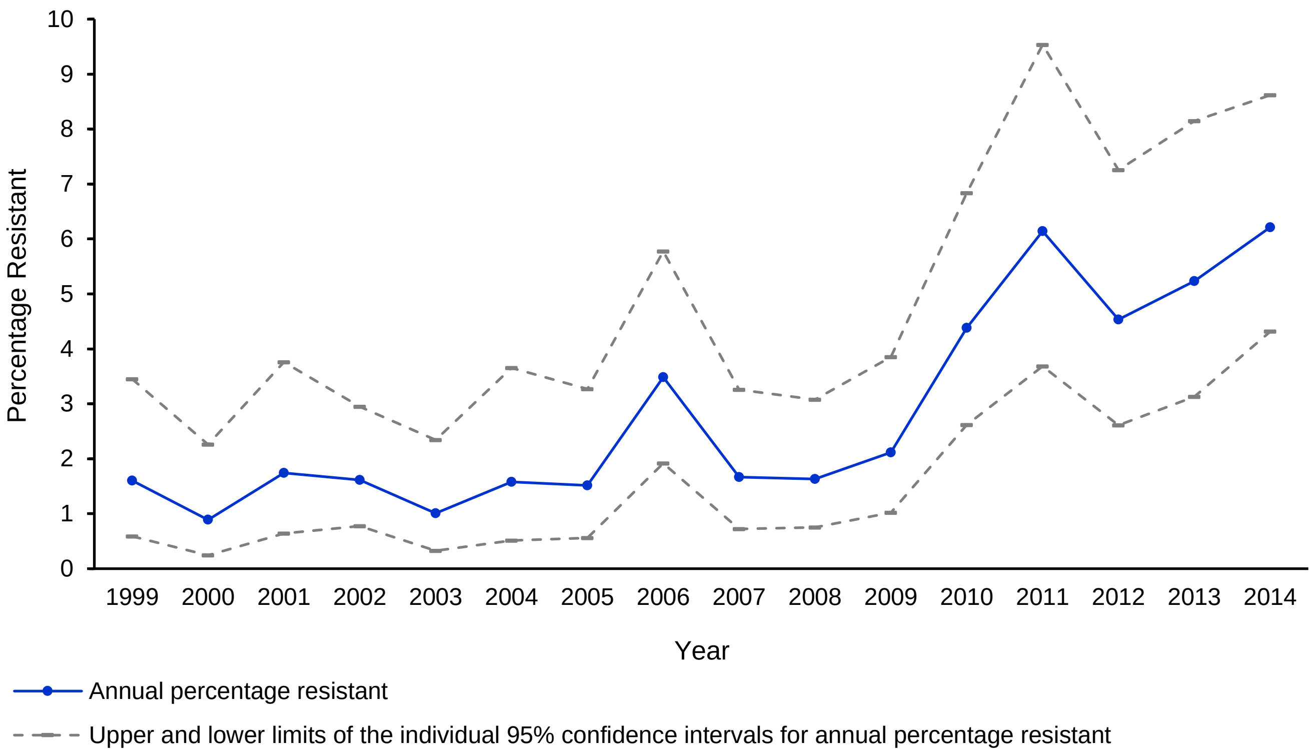


Figure 29. Percentage of *Campylobacter jejuni* isolates resistant to ciprofloxacin, by year, 1997–2014

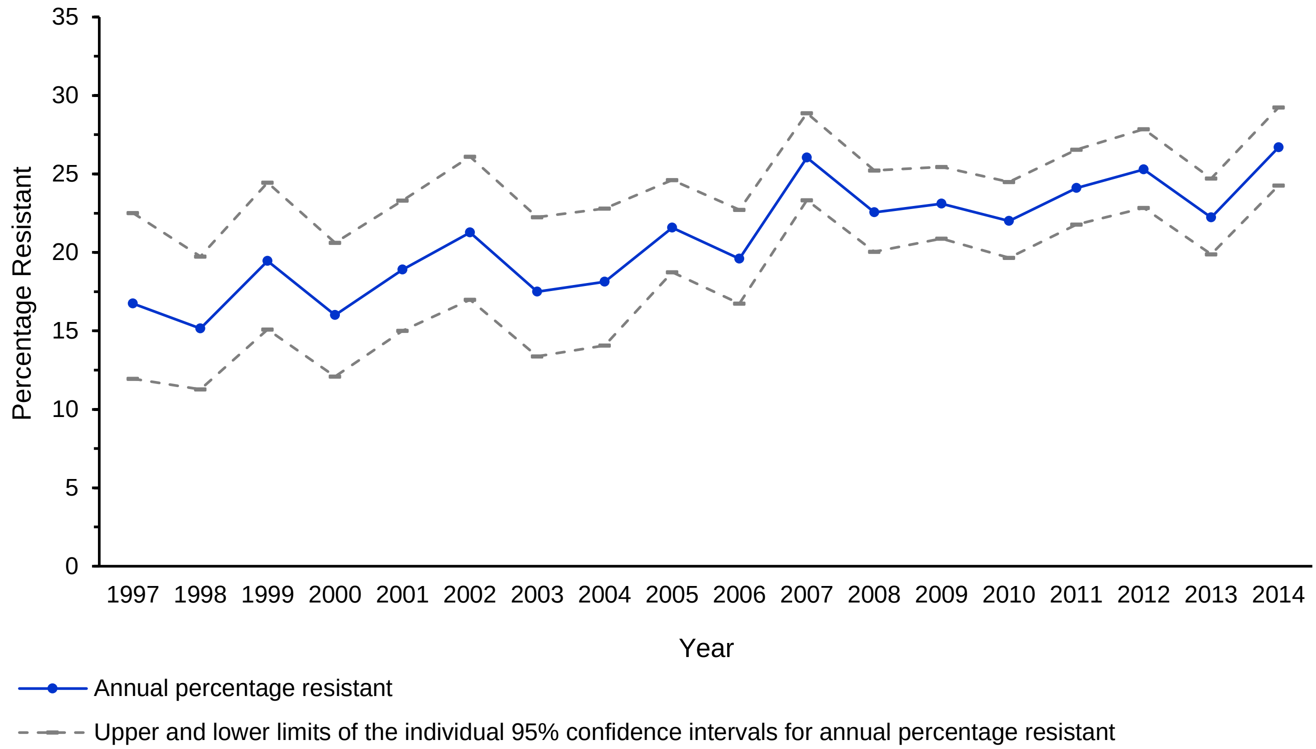


Figure 30. Percentage of *Campylobacter coli* isolates resistant to ciprofloxacin, by year, 1997–2014

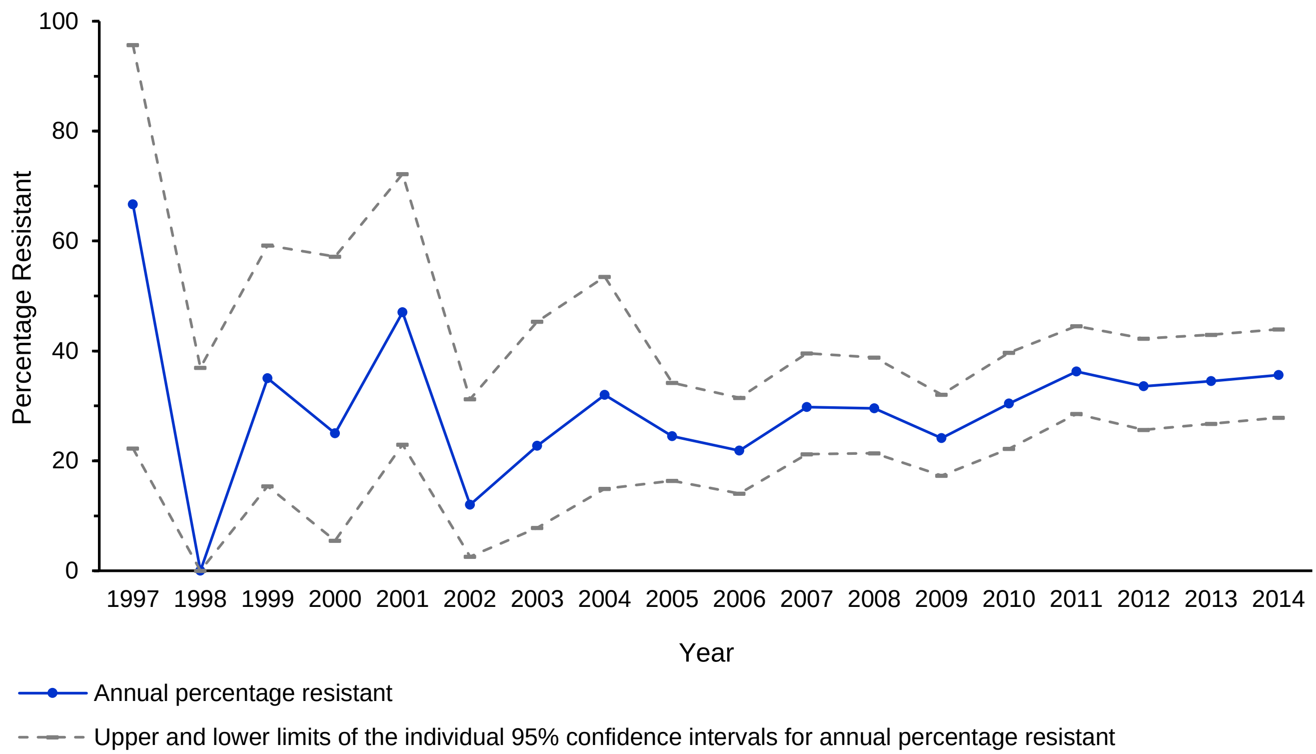
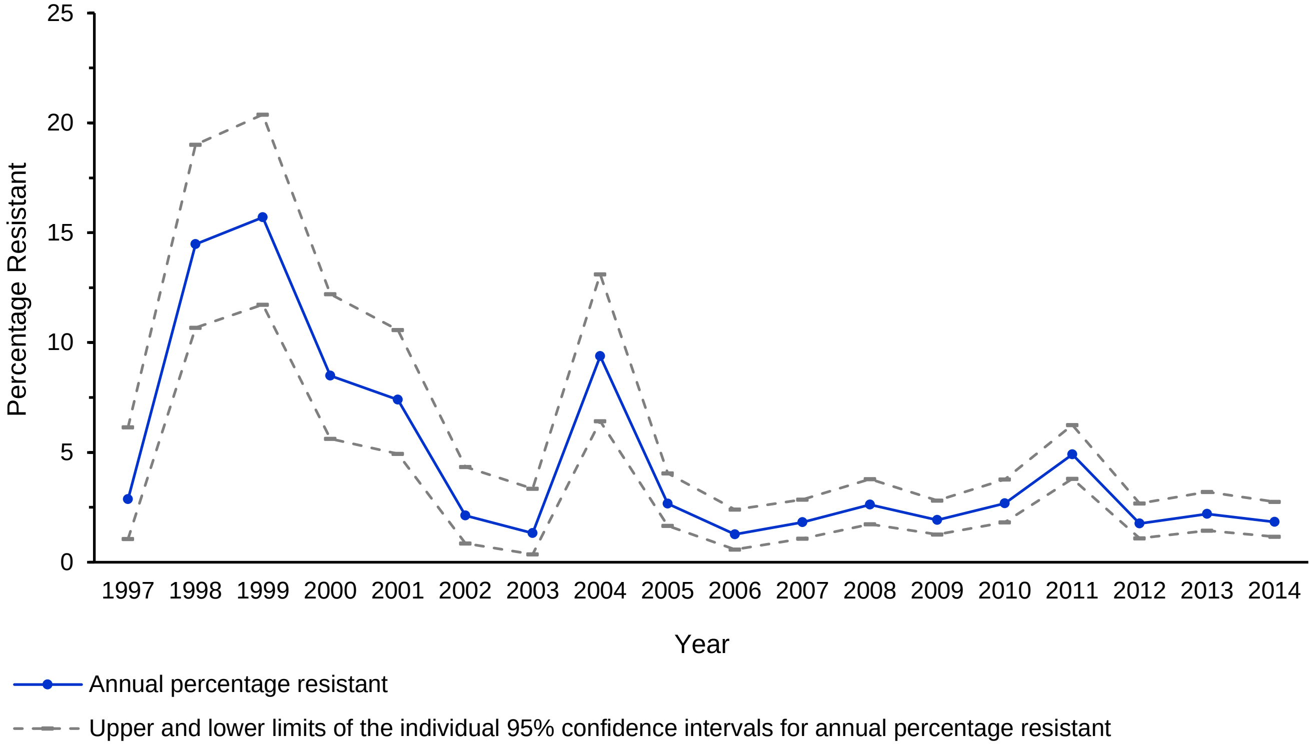
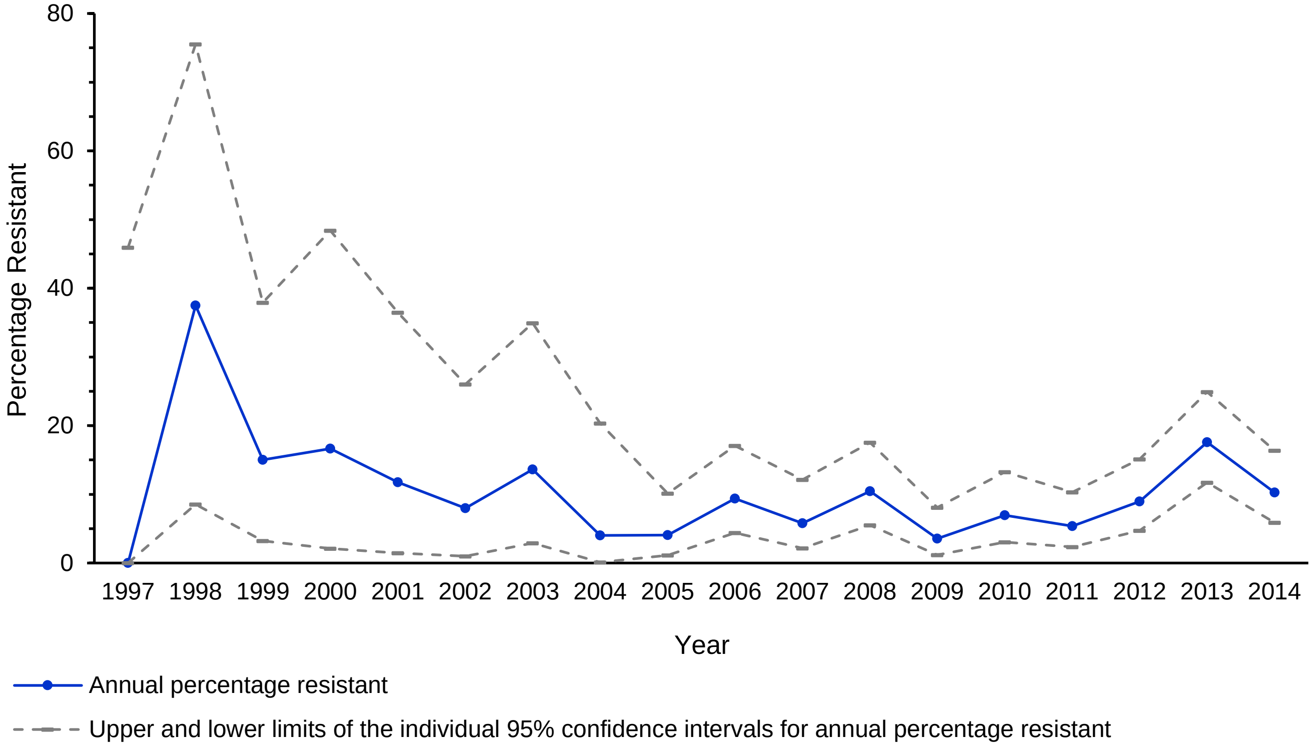


Figure 31. Percentage of *Campylobacter jejuni* isolates with resistance to macrolides*, 1997–2014



* Resistance to azithromycin or erythromycin

Figure 32. Percentage of *Campylobacter coli* isolates with resistance to macrolides*, 1997–2014



* Resistance to azithromycin or erythromycin

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Appendix A. WHO Categorization of Antimicrobial Agents

The World Health Organization (WHO) has developed criteria to rank antimicrobial agents according to their relative importance to human medicine. Participants in the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (AGISAR) provide updates to these rankings (WHO, 2011; Collignon et al., 2016). The participants categorize antimicrobial agents as either Critically Important, Highly Important, or Important based upon two criteria: (1) used as sole therapy or one of the few alternatives to treat serious human disease and (2) used to treat disease caused by either organisms that may be transmitted via non–human sources or diseases caused by organisms that may acquire resistance genes from non–human sources Antimicrobial agents tested in NARMS have been included in the WHO categorization table.

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

Table A1. WHO categorization of antimicrobials of critical importance to human medicine

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

* CLSI: Clinical and Laboratory Standards Institute

Appendix B. Criteria for Retesting of Isolates

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

- No growth on panel
- Growth in all wells
- Multiple skip patterns
- Apparent contamination in wells or isolate preparation
- Unlikely or discordant susceptibility results (Table B1)

If an isolate is retested, data for <u>all</u> antimicrobial agents should be replaced with the new test results. Categorical changes may require a third test (and may indicate a mixed culture).

Uncommon but possible test results (Table B2) may represent emerging resistance phenotypes. Retesting is encouraged.

Table B1. Retest criteria for unlikely or discordant resistance phenotypes

Organism(s)	Resistance phenotype (MIC values in µg/mL)	Comments
Salmonella* / *E. coli* O157 / *Shigella	ceftiofur^{R} (≥8) **OR** ceftriaxone^{R} (≥4) **AND** ampicillin^{S} (≤8)	The presence of an ESBL[*] or AmpC beta-lactamase should confer resistance to ampicillin
	ceftiofur^{R} (≥8) **AND** ceftriaxone^{S} (≤1) **OR** ceftiofur^{S} (≤2) **AND** ceftriaxone^{R} (≥4)	Both antimicrobial agents are 3rd generation β-lactams and should have equal susceptibility interpretations
	ampicillin^{S} (≤8) **AND** amoxicillin-clavulanic acid^{R} (≥32/16)	
***Salmonella* and *E. coli* O157**	sulfisoxazole^{S} (≤256) **AND** trimethoprim-sulfamethoxazole^{R} (≥4/76)	
Salmonella	nalidixic acid^{S} (≤16) **AND** ciprofloxacin^{R} (≥1)	The stepwise selection of mutations in the QRDR[†] does not support this phenotype, although it may occur with plasmid-mediated mechanisms
E. coli* O157 and *Shigella	nalidixic acid^{S} (≤16) **AND** ciprofloxacin^{R} (≥4)	The stepwise selection of mutations in the QRDR[†] does not support this phenotype
Campylobacter jejuni* and *coli	nalidixic acid^{S} (≤16) **AND** ciprofloxacin^{R} (≥1)	In *Campylobacter*, one mutation is sufficient to confer resistance to both nalidixic acid and ciprofloxacin
	nalidixic acid^{R} (≥32) **AND** ciprofloxacin^{S} (≤0.5)	
Campylobacter jejuni	erythromycin^{S} (≤4) **AND** azithromycin^{R} (≥0.5)	Erythromycin is class representative for 14- and 15-membered macrolides (azithromycin, clarithromycin, roxithromycin, and dirithromycin)
	erythromycin^{R} (≥8) **AND** azithromycin^{S} (≤0.25)	
Campylobacter coli	erythromycin^{S} (≤8) **AND** azithromycin^{R} (≥1)	
	erythromycin^{R} (≥16) **AND** azithromycin^{S} (≤0.5)	

* Extended-spectrum beta-lactamase
† Quinolone resistance-determining regions

Table B2. Uncommon resistance phenotypes for which retesting is encouraged

Organism(s)	Resistance phenotype (MIC values in µg/mL)
Salmonella* / *E. coli* O157 / *Shigella	Pan-resistance
	Resistance to azithromycin (>16)
	ceftriaxone and/or ceftiofur MIC ≥2 **AND** ciprofloxacin MIC ≥0.125 and/or nalidixic acid MIC ≥32
Campylobacter jejuni* and *coli	Pan-resistance
	Resistance to gentamicin (≥4)
	Resistance to florfenicol (≥8)
Vibrio	Resistance to ciprofloxacin (>2)
	Resistance to tetracycline (>8)
	Resistance to trimethoprim-sulfamethoxazole (>2)

Appendix C. Impact of the Streptomycin Breakpoint Change on 2014 Data

CLSI breakpoints for streptomycin are not established; in past years, a NARMS-established resistance breakpoint of ≥64 µg/mL has been used. After examining newly-available streptomycin MIC and *Salmonella* genetic data from 2014, the NARMS program lowered the resistance breakpoint to ≥32 µg/mL and applied it to all *Enterobacteriaceae*. However, due to the limited streptomycin concentration range used in testing before 2014 (32–64 µg/mL), the new breakpoint could only be applied to isolates tested during 2014 and the resistance breakpoint of ≥64 µg/mL was maintained for isolates tested during 1996–2013. The impact of the streptomycin breakpoint change on select 2014 data is summarized in Table C1. Positive percentage differences indicate the breakpoint of ≥64 µg/mL underestimated resistance.

Table C1. Impact of the streptomycin breakpoint change on the number and percentage of *Enterobacteriaceae* isolates with select resistance, 2014

Pathogen (N in 2014)	Streptomycin resistance				*at least* 3 classes				*at least* ACSSuT†				*at least* ACSSuTAuCx‡				No resistance detected			
	Pre-2014 BP (≥64)*	2014 BP (≥32)*	Relative % difference	% point difference	Pre-2014 BP (≥64)*	2014 BP (≥32)*	Relative % difference	% point difference	Pre-2014 BP (≥64)*	2014 BP (≥32)*	Relative % difference	% point difference	Pre-2014 BP (≥64)*	2014 BP (≥32)*	Relative % difference	% point difference	Pre-2014 BP (≥64)*	2014 BP (≥32)*	Relative % difference	% point difference
NTS (2127)	8.7%	11.2%	28.5%	**2.5%**	9.1%	9.3%	1.5%	**0.1%**	3.1%	3.1%	1.5%	**0.0%**	1.2%	1.2%	0.0%	**0.0%**	84.1%	82.3%	-2.1%	**-1.8%**
	186	239			194	197			66	67			26	26			1789	1751		
Enteritidis (438)	1.8%	3.0%	62.5%	**1.1%**	2.1%	2.1%	0.0%	**0.0%**	0.5%	0.5%	0.0%	**0.0%**	0.2%	0.2%	0.0%	**0.0%**	87.9%	87.7%	-0.3%	**-0.2%**
	8	13			9	9			2	2			1	1			385	384		
Typhimurium (262)	21.8%	24.8%	14.0%	**3.1%**	21.8%	21.8%	0.0%	**0.0%**	14.5%	14.5%	0.0%	**0.0%**	4.2%	4.2%	0.0%	**0.0%**	71.0%	68.7%	-3.2%	**-2.3%**
	57	65			57	57			38	38			11	11			186	180		
Newport (235)	4.3%	4.7%	10.0%	**0.4%**	4.7%	4.7%	0.0%	**0.0%**	3.0%	3.0%	0.0%	**0.0%**	3.0%	3.0%	0.0%	**0.0%**	93.6%	93.2%	-0.5%	**-0.4%**
	10	11			11	11			7	7			7	7			220	219		
I 4,[5],12:i:- (110)	49.1%	52.7%	7.4%	**3.6%**	50.0%	50.0%	0.0%	**0.0%**	3.6%	3.6%	0.0%	**0.0%**	0.0%	0.0%	—	**0.0%**	40.9%	38.2%	-6.7%	**-2.7%**
	54	58			55	55			4	4			0	0			45	42		
Infantis (73)	1.4%	6.8%	400.0%	**5.5%**	6.8%	6.8%	0.0%	**0.0%**	0.0%	1.4%	—	**1.4%**	0.0%	0.0%	—	**0.0%**	89.0%	84.9%	-4.6%	**-4.1%**
	1	5			5	5			0	1			0	0			65	62		
Heidelberg (71)	19.7%	25.4%	28.6%	**5.6%**	21.1%	21.1%	0.0%	**0.0%**	9.9%	9.9%	0.0%	**0.0%**	0.0%	0.0%	—	**0.0%**	66.2%	62.0%	-6.4%	**-4.2%**
	14	18			15	15			7	7			0	0			47	44		
Typhi (335)	11.3%	14.3%	26.3%	**3.0%**	14.0%	14.3%	2.1%	**0.3%**	0.9%	0.9%	0.0%	**0.0%**	0.0%	0.0%	—	**0.0%**	25.1%	24.5%	-2.4%	**-0.6%**
	38	48			47	48			3	3			0	0			84	82		
Paratyphi A (108)	0.9%	1.9%	100.0%	**0.9%**	1.9%	2.8%	50.0%	**0.9%**	0.0%	0.0%	—	**0.0%**	0.0%	0.0%	—	**0.0%**	19.4%	19.4%	0.0%	**0.0%**
	1	2			2	3			0	0			0	0			21	21		
***E. coli* O157 (155)**	4.5%	5.8%	28.6%	**1.3%**	5.2%	5.8%	12.5%	**0.6%**	0.0%	0.0%	—	**0.0%**	0.0%	0.0%	—	**0.0%**	87.7%	87.1%	-0.7%	**-0.6%**
	7	9			8	9			0	0			0	0			136	135		
***Shigella* (531)**	92.8%	95.9%	3.2%	**3.0%**	42.4%	42.4%	0.0%	**0.0%**	3.4%	4.7%	38.9%	**1.3%**	0.0%	0.0%	—	**0.0%**	2.1%	1.9%	-9.1%	**-0.2%**
	493	509			225	225			18	25			0	0			11	10		

* MIC resistance breakpoint (in µg/mL)
† ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
‡ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone