National Antimicrobial Resistance Monitoring System

NARMS

2015 Human Isolates Surveillance Report

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

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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/

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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
AST	Antimicrobial susceptibility testing
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
DSC	Decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL for *Salmonella, Shigella,* and *E. coli* O157)
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 (AST), 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 AST. 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 (historically by the National Enteric Laboratory Diagnostic Outbreak Team, currently by NARMS); results are available in the Cholera and Other *Vibrio* Illness Surveillance system (COVIS) reports beginning with the 2013 Annual Summary. NARMS conducts AST for isolates of species other than *V*. *cholerae*; results are included in this report.

This annual report includes CDC's surveillance data for 2015 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 2015

Whole Genome Sequencing of *Salmonella*

In the 2014 Report, NARMS first reported whole genome sequencing (WGS) data for *Salmonella* that were phenotypically resistant to at least one antimicrobial agent tested. In this report, we extended our analysis to include the sequencing of all nontyphoidal *Salmonella* received in 2015, regardless of phenotypic resistance. 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, assisting with source trace-back investigations, determining virulence factors, and predicting antimicrobial resistance. The results of this analysis can be found in the highlights section beginning on page 17.

Reporting Decreased Susceptibility to Ciprofloxacin for *Shigella and E. coli* O157

In 2017, scientists from NARMS worked with other CDC and state and local public health partners to investigate an increase in *Shigella* isolates with ciprofloxacin MIC values of 0.12–1 µg/mL (see Health Alert Network Advisory). Current CLSI criteria categorize such isolates as susceptible to ciprofloxacin, but WGS data suggest that these isolates have at least one quinolone resistance mechanism. In *Salmonella*, ciprofloxacin MICs of 0.12–1 µg/mL have been associated with reduced susceptibility, prolonged clinical illness, and treatment failures (Crump et al., 2003) and are now categorized by CLSI as intermediate or resistant to ciprofloxacin (CLSI M100 S27, 2017). Scientists from CDC met with CLSI in June 2017 and will continue to work with CLSI to determine whether any change to the current breakpoints for *Shigella* for ciprofloxacin is warranted.

In the 2014 Report, we first categorized *Salmonella* isolates with MIC ≥0.12 µg/mL for ciprofloxacin as having decreased susceptibility to ciprofloxacin (DSC). In this report, we extended that categorization to include *Shigella* and *E. coli* O157, so that all *Enterobacteriaceae* tested by NARMS use the same definition. We now include DSC in tables of *Shigella* and *E. coli* O157 resistance by year.

In our analysis to assess changes in the prevalence of resistance for *Shigella*, we switched from using nalidixic acid resistance to using DSC as a marker for emerging quinolone resistance mechanisms (see highlights section beginning on page 19).

Incorporating Decreased Susceptibility to Ciprofloxacin in Multiple Class Resistance Definitions for *Enterobacteriaceae*

Previously when determining multiple antimicrobial class resistance, isolates of *Salmonella*, *Shigella*, and *E. coli* O157 were considered resistant to quinolones if they were resistant to ciprofloxacin or nalidixic acid by CLSI interpretive criteria. In this report, when describing class resistance (e.g., Table 40, 2nd footnote), we now also include isolates with DSC, even if they are susceptible to ciprofloxacin according to CLSI interpretive criteria. We have done this to include isolates that may have emerging quinolone resistance mechanisms. For more details, please see Methods page 31.

Updates to NARMS Now: Human Data

In 2015, 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*. As an accompaniment to this report, surveillance data from 2015 and historical data since 1996 are available to view and download. Data downloads have been recently updated to include the results of whole genome sequencing, including a listing of resistance genes identified and the predicted resistance from those genes. In an effort to make data more timely, we also updated NARMS Now to include downloadable preliminary data. These include data from isolates on which tests are complete while testing for other isolates for that year are still in progress. Preliminary records are released within three months of testing and are updated weekly. Finally, we have increased the number of nontyphoidal *Salmonella* serotypes for which data are available in the interactive displays, and plan to incorporate multidrug and genetic resistance data displays soon.

Summary of NARMS 2015 Surveillance Data

Surveillance Population

In 2015, all 50 states and the District of Columbia participated in NARMS, representing the entire US population of approximately 321 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 9 of the 10 states that comprise the Foodborne Diseases Active Surveillance Network (FoodNet), representing approximately 45.4 million persons (14% of the US population).

Clinically Important Antimicrobial Resistance Patterns

A substantial proportion of *Enterobacteriaceae* isolates tested in 2015 demonstrated clinically important resistance. In the United States, fluoroquinolones (e.g., ciprofloxacin), third-generation cephalosporins (e.g., ceftriaxone), and macrolides (e.g., azithromycin) 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). Most quinolone resistance is due to chromosomal mutations, however, over the last 10 years, we have observed an increase in the percentage of *Salmonella* isolates with decreased susceptibility to ciprofloxacin that are susceptible to nalidixic acid, which often indicates the presence of plasmid-mediated quinolone resistance (see NARMS 2013 Annual Report page 20).

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.

- 5.8% (137/2364) of nontyphoidal *Salmonella* isolates had decreased susceptibility to ciprofloxacin. Enteritidis was the most common serotype among nontyphoidal *Salmonella* isolates with decreased susceptibility to ciprofloxacin.
    - 47.4% (65/137) of isolates with decreased susceptibility to ciprofloxacin were ser. Enteritidis
    - 13.8% (65/471) of ser. Enteritidis isolates had decreased susceptibility to ciprofloxacin
- 2.7% (65/2364) of nontyphoidal *Salmonella* isolates were resistant to ceftriaxone. The most common serotypes among the 65 ceftriaxone-resistant isolates are listed in order below. Resistance to ceftriaxone occurred in
    - 4.7% (11/232) of ser. Newport isolates
    - 4.0% (10/251) of ser. Typhimurium isolates
    - 6.0% (9/149) of ser. I 4,[5],12:i:- isolates
    - 66.7% (8/12) of ser. Dublin isolates
    - 6.9% (5/72) of ser. Infantis isolates
    - 4.4% (3/68) of ser. Heidelberg isolates
- 0.3% (8/2364) of nontyphoidal *Salmonella* isolates were resistant to azithromycin
- 65.8% (221/336) of *Salmonella* ser. Typhi isolates had decreased susceptibility to ciprofloxacin
- 88.6% (78/88) of *Salmonella* ser. Paratyphi A isolates had decreased susceptibility to ciprofloxacin
- No *Salmonella* ser. Typhi or Paratyphi A isolates were resistant to ceftriaxone
- One (0.3%) *Salmonella* ser. Typhi isolate was resistant to azithromycin

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 (ECVs) for azithromycin for *Shigella flexneri* and *sonnei*. CLSI uses the terms “wild-type” and “non-wild-type” 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. Below and throughout this report, we refer to non-wild-type as “resistant” to capture the full spectrum of emerging resistance mechanisms.)

- 2.5% (14/569) of *Shigella* isolates were resistant to ciprofloxacin (MIC ≥4 µg/mL), including
    - 2.5% (2/79) of *Shigella flexneri* isolates
    - 2.5% (12/489) of *Shigella sonnei* isolates
- 9.8% (56/569) of *Shigella* isolates had decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL), including
    - 13.9% (11/79) of *Shigella flexneri* isolates
    - 9.2% (45/489) of *Shigella sonnei* isolates
- 9.8% (56/569) of *Shigella* isolates were resistant to azithromycin, including
    - 32.9% (26/79) of *Shigella flexneri* isolates (MIC ≥16 µg/mL)
    - 6.1% (30/489) of *Shigella sonnei* isolates (MIC ≥32 µg/mL)

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 are not available for all *Campylobacter* species, the percentage of all resistant infections is not reported.

- 25.3% (253/1000) of *Campylobacter jejuni* isolates and 39.8% (47/118) of *Campylobacter coli* isolates were resistant to ciprofloxacin
- 2.7% (27/1000) of *Campylobacter jejuni* isolates and 12.7% (15/118) 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.

- 2.7% (65/2364) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuT. The most common serotypes are listed in order below. ACSSuT resistance occurred in
    - 10.8% (27/251) of ser. Typhimurium isolates
    - 4.7% (11/232) of ser. Newport isolates
    - 58.3% (7/12) of ser. Dublin isolates
    - 4.0% (6/149) of ser. I 4,[5],12:i:- isolates

- 5.0% (118/2364) of nontyphoidal *Salmonella* isolates were resistant to at least ASSuT but not chloramphenicol. The most common serotype was I 4,[5],12:i:- (88 isolates), accounting for 74.6% of all isolates with this resistance pattern.
    - 59.1% (88/149) of ser. I 4,[5],12:i:- isolates were resistant to ASSuT but not chloramphenicol

- 1.3% (31/2364) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuTAuCx. The most common serotypes are listed in order below. ACSSuTAuCx resistance occurred in
    - 4.7% (11/232) of ser. Newport isolates
    - 58.3% (7/12) of ser. Dublin isolates
    - 2.7% (4/149) of ser. I 4,[5],12:i:- isolates
    - 1.6% (4/251) of ser. Typhimurium isolates

- 12.4% (293/2364) 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
    - 67.8% (101/149) of ser. I 4,[5],12:i:- isolates
    - 18.3% (46/251) of ser. Typhimurium isolates
    - 4.2% (20/471) of ser. Enteritidis isolates
    - 5.6% (13/232) of ser. Newport isolates
    - 91.7% (11/12) of ser. Dublin isolates
    - 15.3% (11/72) of ser. Infantis isolates

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

- 8.9% (30/336) of isolates were resistant to at least ACT/S
- 11.6% (39/336) 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).

- 19.3% (110/569) of isolates were resistant to at least AT/S
- 41.1% (234/569) of isolates were resistant to three or more classes

For *Campylobacter*, an important multidrug-resistance phenotype includes resistance to at least a macrolide (azithromycin or erythromycin) and a quinolone (ciprofloxacin or nalidixic acid) antibiotic.

- 2.1% (21/1000) of *Campylobacter jejuni* isolates and 8.5% (10/118) of *Campylobacter coli* isolates were resistant to at least a macrolide and a quinolone

Highlight:
Whole Genome Sequencing of 2015 Nontyphoidal *Salmonella*

The genetic data obtained from whole genome sequencing (WGS) can be used for multiple purposes, including identifying outbreaks, assisting source trace-back investigations, determining virulence factors, and predicting antimicrobial resistance. NARMS received 2364 nontyphoidal *Salmonella* collected in 2015 as part of routine surveillance. To analyze WGS 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.). The genes and mutations identified are described in Figure H1.

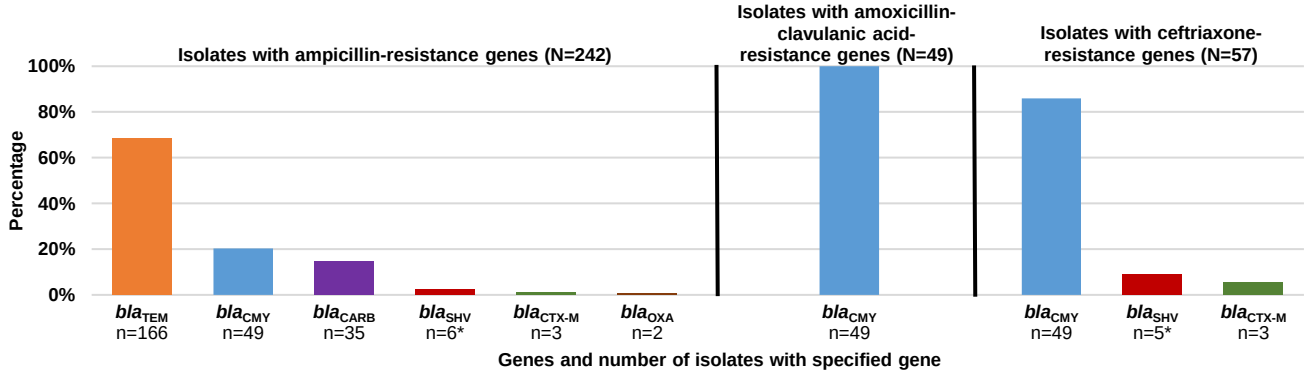
Resistance to most drugs was mediated by several common resistance determinants (e.g., resistance to ampicillin by bla_{TEM-1b}, tetracycline by *tetA/B*, sulfisoxazole by *sul1/2*, and chloramphenicol by *floR*). Resistance to ceftriaxone was most often mediated by bla_{CMY-2} (49/57), an AmpC-type β-lactamase. However, we found 8 isolates with extended-spectrum β-lactamases (ESBLs), including 5 bla_{SHV} and 3 bla_{CTX-M} genes. Among isolates with genes known to confer azithromycin resistance, 5 isolates contained *mphA*, and one isolate contained *mphE/msrE*. Decreased susceptibility to ciprofloxacin was most often mediated by mutations in the quinolone resistance-determining region (QRDR) as 64 isolates had a *gyrA* mutation. There were 32 isolates with a plasmid-mediated quinolone resistance (PMQR) gene, 30 of which contained a *qnr* gene.

Overall, 1775 (75%) of 2364 isolates were pansusceptible by AST. Of these, only 13 isolates had an identified gene or mechanism for genetic resistance, which suggests non-functional antimicrobial resistant determinants or false positives. However, 164 isolates had phenotypic resistance but no identified antimicrobial resistance genes or mechanisms. Of these, 61 were resistant to streptomycin alone, suggesting the current interpretive criteria used to define streptomycin resistance (MIC ≥32 µg/mL) categorizes some isolates without streptomycin resistance genes as resistant. Of the 103 remaining isolates, 101 were retested and 97 (96%) were found to be pansusceptible. For most of these isolates, the first round of AST showed resistance to multiple drugs and retesting showed large decreases in MIC values, suggesting that a multidrug resistance plasmid was lost before WGS was performed. However, changes in MICs can occasionally be due to natural variation. Four isolates remained resistant on retesting; they might have a novel resistance mechanism. These findings highlight the value of using both genotypic and phenotypic testing for at least a subset of isolates. Overall, including confirmatory phenotypic retests and excluding streptomycin results, a known resistance gene or mutation was identified for 96% of the resistant isolates. This demonstrates the effectiveness of WGS analysis for identification of resistance mechanisms and prediction of resistance for *Salmonella*.

Figure H1. Prevalence of various antimicrobial resistance genes identified among nontyphoidal *Salmonella* isolates, by type of resistance gene, 2015. See data table at https://www.cdc.gov/narms/files/Fig.-H1.xlsx

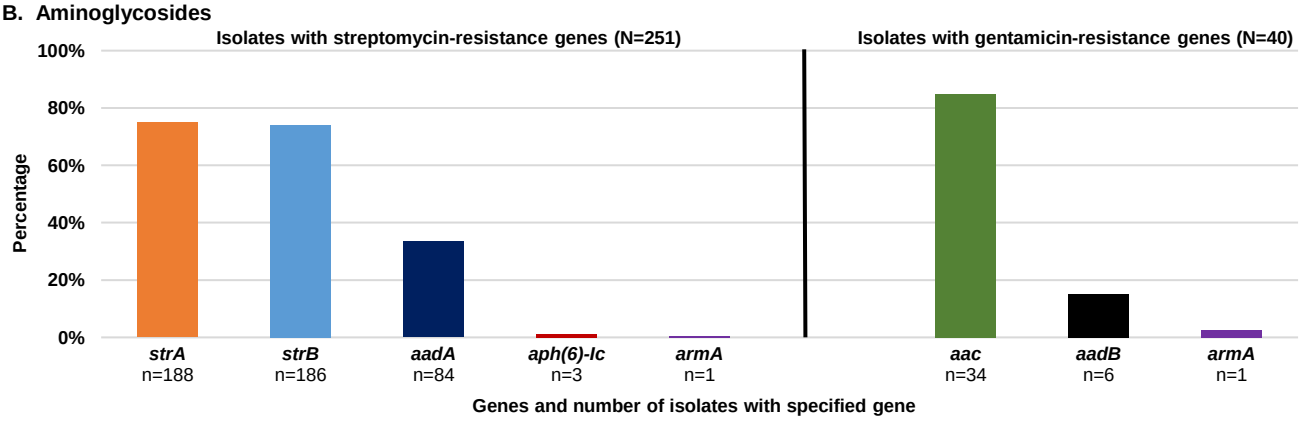
Note: Only identified genes known to confer resistance to the agents specified in each figure are listed

A. β-lactams



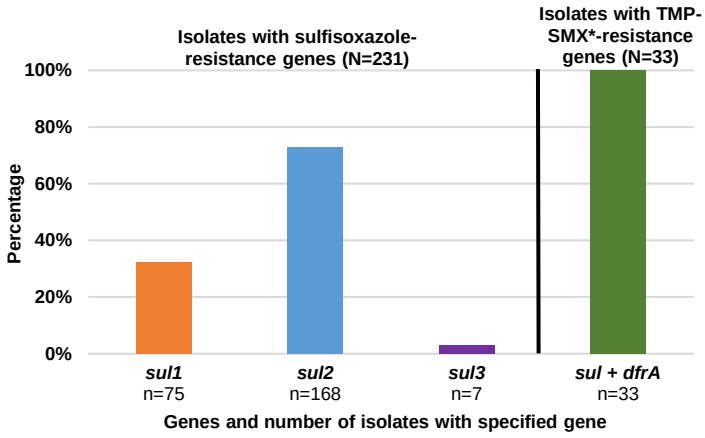
* Five isolates had ESBL variants of bla_{SHV} (three with bla_{SHV-12} and two with bla_{SHV-30})

B. Aminoglycosides



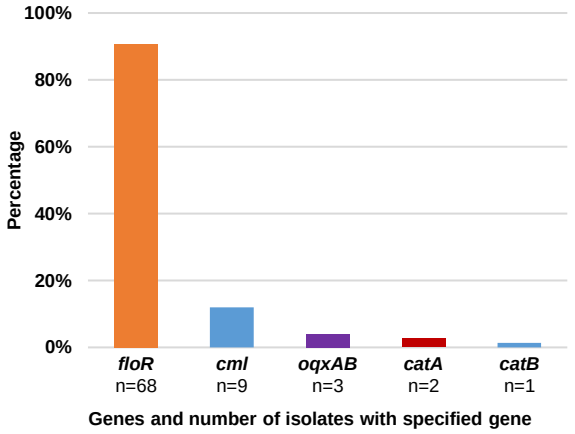
Highlight:
Whole Genome Sequencing of 2015 Nontyphoidal *Salmonella*

C. Folate pathway inhibitors

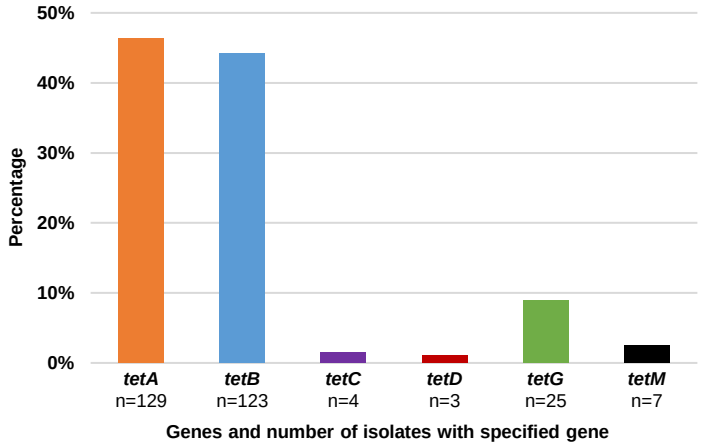


* TMP-SMX: trimethoprim-sulfamethoxazole

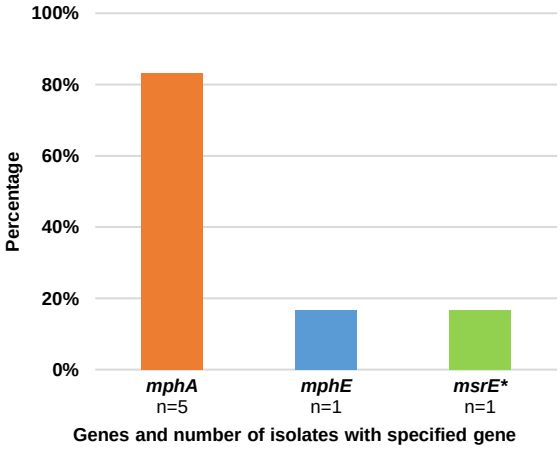
D. Isolates with chloramphenicol-resistance genes (N=75)



E. Isolates with tetracycline-resistance genes (N=278)

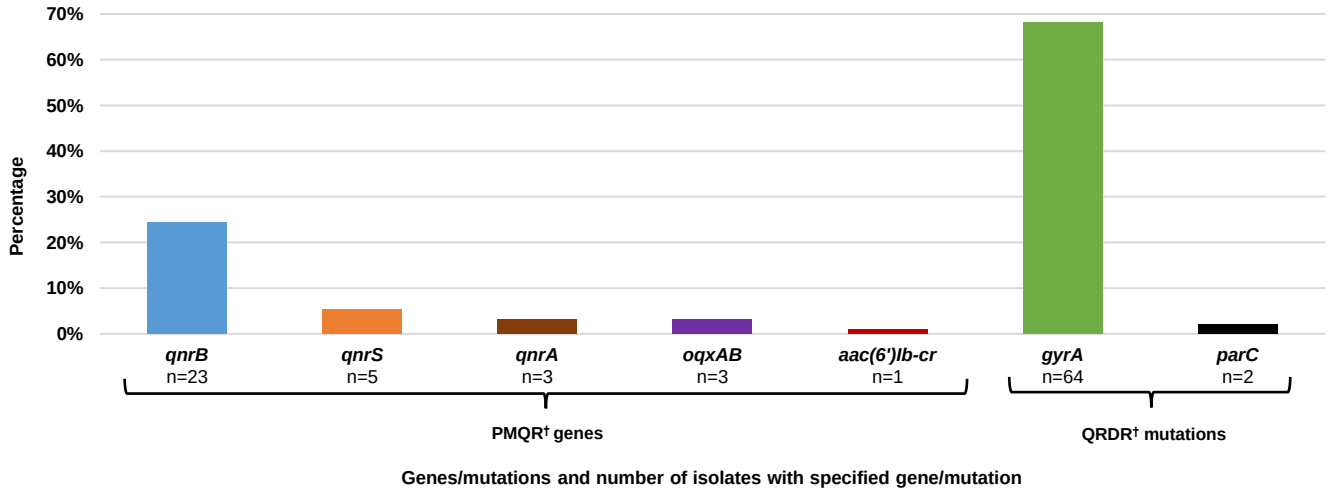


F. Isolates with azithromycin-resistance genes (N=6)



**msrE* found with *mphE*

G. Isolates with genes or mutations known to confer decreased susceptibility to ciprofloxacin* (N=94)



* Minimum inhibitory concentration categorized as intermediate or resistant for ciprofloxacin (MIC ≥0.12 µg/mL)
† PMQR: plasmid-mediated quinolone resistance; QRDR: quinolone resistance-determining region of topoisomerase

Highlight:
Changes in Antimicrobial Resistance: 2015 vs. 2004–2008 and 2010–2014

To understand changes in the prevalence of antimicrobial resistance among *Salmonella*, *Shigella,* and *Campylobacter*, we used logistic regression to model annual data from 2004–2015. Since 2003, all 50 states have participated in *Salmonella* and *Shigella* surveillance, and 9 of 10 FoodNet sites have participated in *Campylobacter* surveillance (California did not submit *Campylobacter* isolates after June 2014). We compared the prevalence of selected resistance patterns among bacteria isolated in 2015 with the average prevalence of resistance from two reference periods, 2004–2008 and 2010–2014. (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, 2017).

2015 vs. 2004–2008

The differences between the prevalence of resistance in 2015 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 (5.8% vs. 2.4%; odds ratio [OR]=2.7, 95% confidence interval [CI] 2.2–3.4)
  - Resistance to one or more antimicrobial classes was higher (23.8% vs. 18.8%; OR=1.4, 95% CI 1.3–1.6)
  - Resistance to three or more antimicrobial classes was higher (12.4% vs. 11.1%; OR=1.2, 95% CI 1.1–1.4)
- Among *Salmonella* of particular serotypes
  - Decreased susceptibility to ciprofloxacin in ser. Enteritidis was higher (13.8% vs. 6.2%; OR=2.6, 95% CI 1.9–3.6)
  - ACSSuT resistance in ser. Typhimurium was lower (10.8% vs. 22.3%; OR=0.4, 95% CI 0.3–0.7)
  - ACSSuTAuCx resistance in ser. Newport was lower (4.7% vs. 11.7%; OR=0.5, 95% CI 0.2–0.9)
  - Decreased susceptibility to ciprofloxacin in ser. Typhi was higher (65.8% vs. 53.3%; OR=1.7, 95% CI 1.3–2.2)
- Among *Campylobacter jejuni* and C. coli
  - Ciprofloxacin resistance in *C. jejuni* was higher (25.3% vs. 21.0%; OR=1.4, 95% CI 1.2–1.7)
    Ciprofloxacin resistance in *C. coli* was higher (39.8% vs. 28.0%; OR=1.8, 95% CI 1.1–2.9)
- Among *Shigella* spp.
  - Decreased susceptibility to ciprofloxacin was higher (9.8% vs. 1.7%; OR=7.0, 95% CI 4.4–11.2)

The differences between the prevalence of resistance in 2015 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 (2.7% vs. 3.2%; OR=0.9, 95% CI 0.7–1.2)
- Among *Salmonella* ser. Heidelberg
  - Ceftriaxone resistance (4.4% vs. 8.5%; OR=0.5, 95% CI 0.1–1.5)

2015 vs. 2010–2014

The differences between the prevalence of resistance in 2015 and the average prevalence of resistance in 2010–2014 (Figure H2, B) were statistically significant for the following pathogen-resistance combinations:

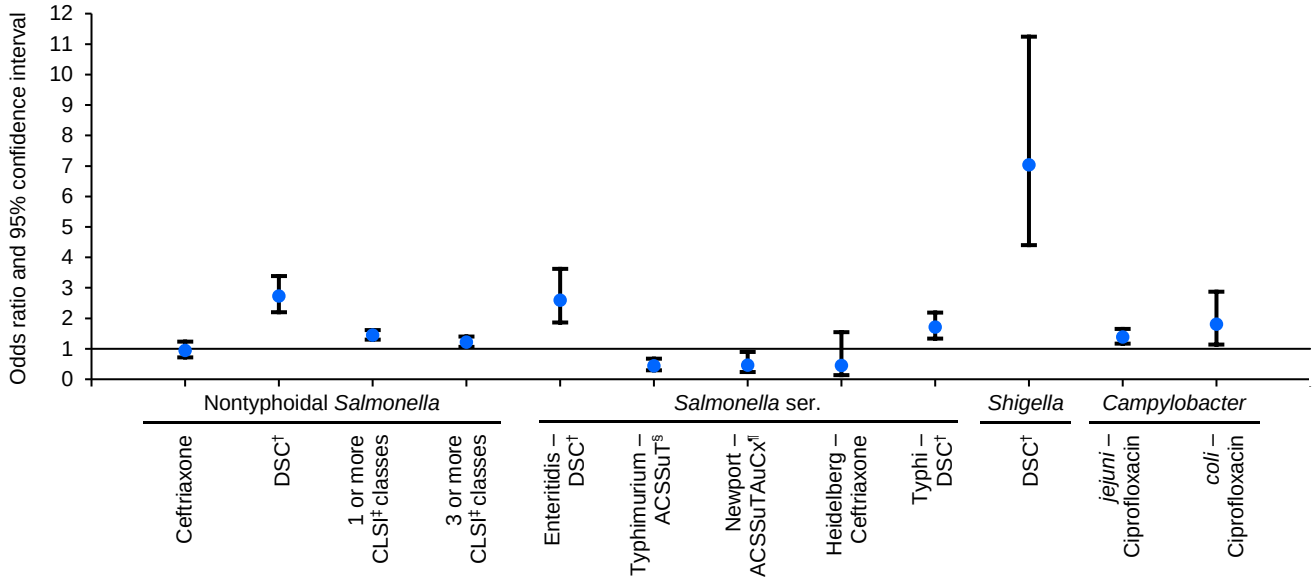
- Among nontyphoidal *Salmonella*
  - Decreased susceptibility to ciprofloxacin was higher (5.8% vs. 3.4%; OR=1.8, 95% CI 1.5–2.3)
  - Resistance to one or more antimicrobial classes was higher (23.8% vs. 16.8%; OR=1.6, 95% CI 1.4–1.8)
  - Resistance to three or more antimicrobial classes was higher (12.4% vs. 9.4%; OR=1.4, 95% CI 1.2–1.6)
- Among *Salmonella* of particular serotypes
  - Decreased susceptibility to ciprofloxacin in ser. Enteritidis was higher (13.8% vs. 6.7%; OR=2.3, 95% CI 1.7–3.2)
  - ACSSuT resistance in ser. Typhimurium was lower (10.8% vs. 16.4%; OR=0.6, 95% CI 0.4–0.98)
  - Ceftriaxone resistance in ser. Heidelberg was lower (4.4% vs. 15.6%; OR=0.2, 95% CI 0.1–0.8)
- Among *Shigella* spp.
  - Decreased susceptibility to ciprofloxacin was higher (9.8% vs. 5.8%; OR=1.9, 95% CI 1.3–2.7)

The differences between the prevalence of resistance in 2015 and the average prevalence of resistance in 2010–2014 (Figure H2, B) were *not* statistically significant for the following pathogen-resistance combinations:

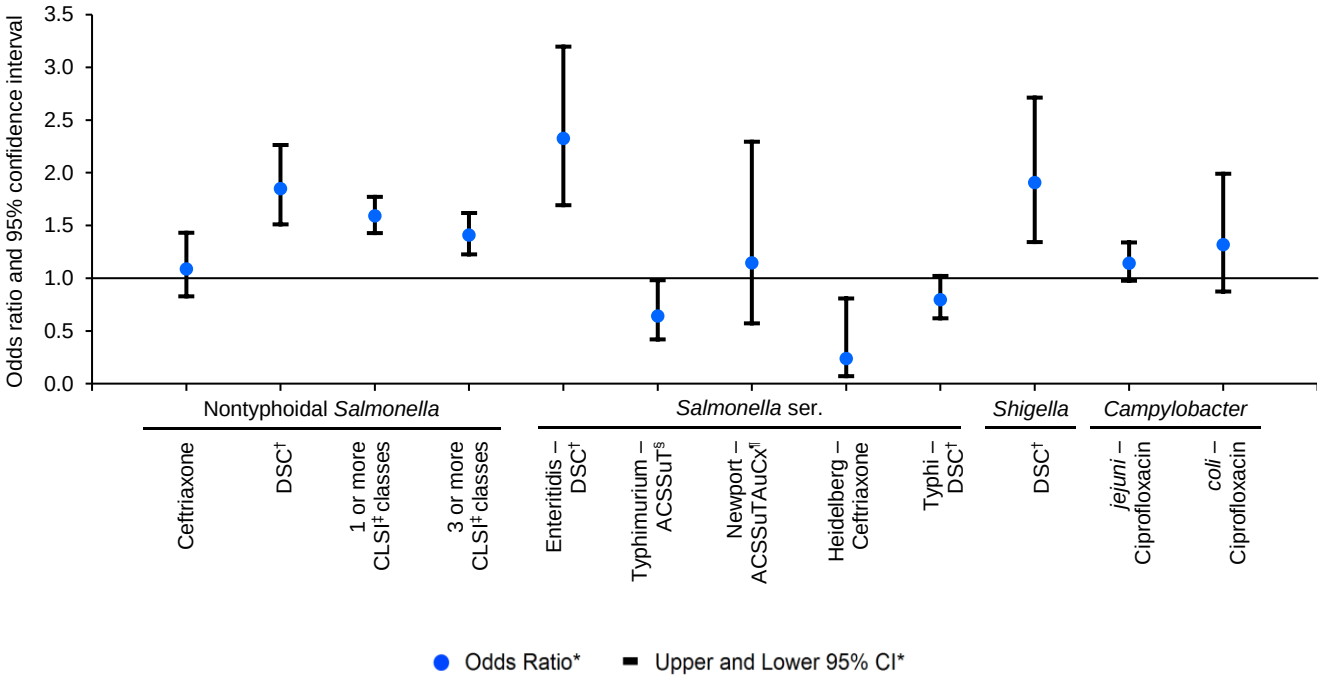
- Among nontyphoidal *Salmonella*
  - Ceftriaxone resistance (2.7% vs. 2.6%; OR=1.1, 95% CI 0.8–1.4)
- Among *Salmonella* of particular serotypes
  - ACSSuTAuCx resistance in ser. Newport (4.7% vs. 4.5%; OR=1.1, 95% CI 0.6–2.3)
  - Decreased susceptibility to ciprofloxacin in ser. Typhi (65.8% vs. 70.5%; OR=0.8, 95% CI 0.6–1.0)
- Among *Campylobacter jejuni* and *C. coli*
  - Ciprofloxacin resistance in *C. jejuni* (25.3% vs. 23.7%; OR=1.1, 95% CI 1.0–1.3)
  - Ciprofloxacin resistance in *C. coli* (39.8% vs. 34.3%; OR=1.3, 95% CI 0.9–2.0)

Figure H2. Changes in the prevalence of selected resistance patterns among *Salmonella, Shigella*, and *Campylobacter* isolates, 2015 compared with 2004–2008 and 2010–2014*. Data table at https://www.cdc.gov/narms/files/Fig.-H2.xlsx

A. 2015 compared with 2004–2008*



B. 2015 compared with 2010–2014*



* The prevalence of resistance in 2015 was compared with the average prevalence from two reference periods, 2004–2008 and 2010–2014. Logistic regression models adjusted for site using a 9-level categorical variable for *Salmonella, Shigella* (9 US census regions), and *Campylobacter* (9 FoodNet states). Of the 10 FoodNet states, California did not submit *Campylobacter* isolates in 2015 and was excluded in the analysis. 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* and *Shigella*)

‡ 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:
Azithromycin Resistance in *Salmonella*, 2011–2015

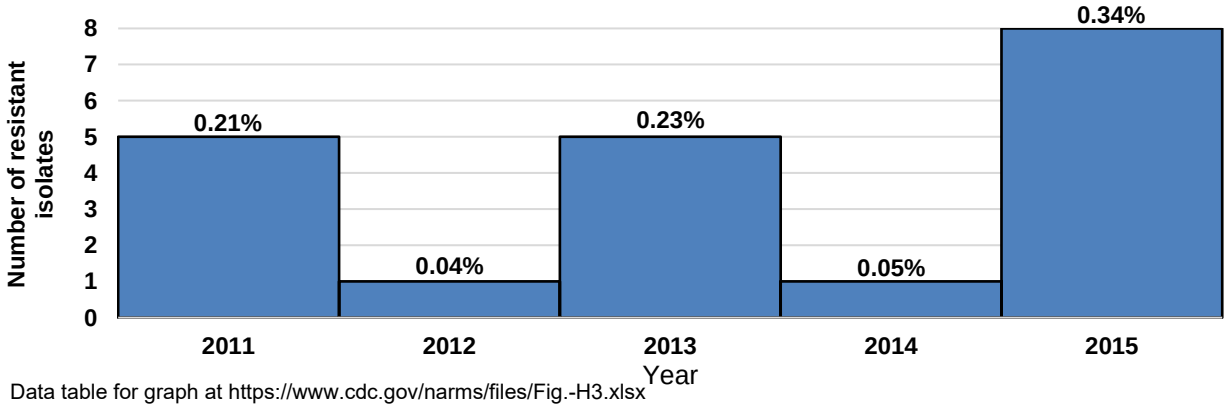
Azithromycin is a clinically important macrolide antibiotic recommended for the treatment of nontyphoidal *Salmonella* (NTS) infection.[1] In recent years, azithromycin use for NTS treatment has increased due to concerns about resistance to fluoroquinolones (e.g., ciprofloxacin) and extended-spectrum cephalosporins (e.g., ceftriaxone),[1,2,3] especially in returned travelers.[4]

Since 2011, NARMS has tested NTS isolates to determine susceptibilities to azithromycin. At the time of this report, the Clinical and Laboratory Standards Institute (CLSI) has not yet established a breakpoint for azithromycin resistance (AZM-R) in NTS. NARMS defines AZM-R in NTS as a minimum inhibitory concentration (MIC) of ≥32 µg/mL, based on the current CLSI investigational azithromycin breakpoint used for *Salmonella* Typhi. An internal NARMS assessment of genomic data that showed the presence of resistance mechanisms in NTS isolates with MICS ≥32 µg/mL further supports the use of this breakpoint.

AZM-R has rarely been detected in NTS in the United States. From 2011 through 2014, the annual percentage of overall AZM-R among NTS isolates has been ≤0.23% (Figure H3). In this same time frame, 12 (0.14%) of the total 8872 NTS isolates had AZM-R. In 2015, eight (0.34%) of 2364 isolates tested had AZM-R. This represents the largest proportion with this resistance since testing began (Figure H3). Seven of eight AZM-R isolates were resistant to additional antimicrobial agents (Table H1). Five had decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL); none were resistant to ceftriaxone. The *mphA* gene, which confers AZM-R, was found in four of eight sequenced isolates. One isolate contained *mphE/msrE*, and one isolate had no known AZM-R gene identified. Repeated antimicrobial susceptibility testing of the other two isolates showed that resistance to multiple drugs was lost and the azithromycin MIC decreased over 2-fold between phenotypic testing and WGS indicating that the plasmid had been lost.

The increase in resistance found in isolates tested in 2015 is concerning. In addition, preliminary data from 2016 and 2017 indicate a continued rise in resistance. This is especially concerning because isolates were also resistant to other clinically important agents. NARMS surveillance during 2015 also detected one AZM-R *Salmonella* Typhi isolate, the first such isolate in the NARMS database. NARMS is currently investigating the genetic mechanisms and epidemiology of sporadic and outbreak-associated infections caused by AZM-R *Salmonella* to determine the possible sources and outcomes.

Figure H3. Number and percentage of nontyphoidal *Salmonella* isolates resistant to azithromycin, 2011–2015.



Data table for graph at https://www.cdc.gov/narms/files/Fig.-H3.xlsx

Table H1. Azithromycin-resistant nontyphoidal *Salmonella* isolates obtained in 2015 (N=8)

Serotype	Additional resistance	Azithromycin resistance gene
Bareilly	ampicillin, ciprofloxacin*, streptomycin, tetracycline	*mphA*
Blockley	ciprofloxacin*, nalidixic acid, streptomycin, tetracycline	*mphA*
Braenderup	ampicillin, streptomycin, sulfisoxazole, tetracycline, trimethoprim-sulfamethoxazole	Resistance lost on retest†
Enteritidis	ampicillin, ciprofloxacin*, nalidixic acid	*mphA*
Havana	ampicillin, chloramphenicol, ciprofloxacin*, gentamicin, streptomycin, sulfisoxazole, trimethoprim-sulfamethoxazole	*mphE/msrE*
Heidelberg	streptomycin, tetracycline	Resistance lost on retest†
Oranienburg	(none)	None identified (possible novel mechanism)‡
Saintpaul	ampicillin, chloramphenicol, ciprofloxacin*, gentamicin, nalidixic acid, streptomycin, sulfisoxazole, tetracycline, trimethoprim-sulfamethoxazole	*mphA*

* Includes ciprofloxacin MICs categorized as resistant or intermediate (MIC ≥0.12 µg/mL)
† Isolate lost resistance between phenotypic testing and sequencing (confirmed by repeated phenotypic testing), indicating likely loss of plasmid
‡ Isolate displayed phenotypic azithromycin resistance (confirmed by repeated testing) but no genes were identified, indicating possible novel mechanism

References:

1. DuPont HL. Bacterial diarrhea. *N Engl J Med* 2009;361(16):1560–1569.
2. Sjölund-Karlsson M, Joyce K, Blickenstaff K, Ball T, Haro J, Medalla FM, Fedorka-Cray P, Zhao S, Crump JA, Whichard JM. Antimicrobial susceptibility to azithromycin among *Salmonella enterica* isolates from the United States. *Antimicrob Agents Chemother* 2011;55(9):3985–3989.
3. Angelo KM, Reynolds J, Karp BE, Hoekstra RM, Scheel CM, Friedman C. Antimicrobial resistance among nontyphoidal *Salmonella* isolated from blood in the United States, 2003–2013. *J Infect Dis* 2016;214(10):1565–1570.
4. Wen SC, Best E, NourseC. Non-typhoidal *Salmonella* infections in children: Review of literature and recommendations for management. Journal of Paediatrics and Child Health. *J Paediatr Child Health* 2017; DOI: 10.1111/jpc.13585.

Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2015, NARMS conducted nationwide surveillance among the approximately 321 million persons living in the United States (2015 estimates published in the 2016 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 (AST).

In 2015, nontyphoidal *Salmonella* serotyping performed at state and local public health laboratories was confirmed at CDC by analyzing raw reads from whole genome sequencing using SeqSero v.1.0 (https://github.com/denglab/SeqSero - last accessed on 9/14/2016). (Before 2015, with few exceptions, serotyping was performed at the public health laboratories and not confirmed at CDC.) *Salmonella* ser. Paratyphi B was included in sampling for nontyphoidal *Salmonella* because laboratory methods are not always available to reliably distinguish between ser. Paratyphi B (which typically causes a typhoidal illness) and ser. Paratyphi B var. L(+) tartrate+ (which does not typically cause a 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 AST 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 (2015 estimates published in 2016 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, 20 to 98 per site in 2015), the number submitting isolates to the state public health laboratory ranged from none to all in 2015. After June 2014, California stopped submitting *Campylobacter* 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 to none in 2015. Due to limited laboratory capacity in 2015, we tested every other *Campylobacter* isolate received, by site, from Connecticut, Georgia, Maryland, and New York (the top four *Campylobacter* submitting sites). We continued to test every *Campylobacter* isolate received from remaining FoodNet sites, with a goal of testing at least 1000 *C. jejuni* isolates. After this process, we randomly selected approximately 20 of the initially excluded isolates to reach the goal of 1000 *C. jejuni* isolates tested.

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* using Etest. (All *Vibrio* isolates are first speciated and characterized by CDC’s National Enteric Reference Laboratory.) Beginning in mid-2013 and throughout 2014, we selected every other *Vibrio parahaemolyticus* isolate received, by site, for AST due to a high number of *Vibrio parahaemolyticus* submissions and limited laboratory capacity. We resumed performing susceptibility testing on all *Vibrio parahaemolyticus* isolates received in 2015 when testing was done by broth microdilution. For information on susceptibility 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, 2015

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	4,853,875	(1.5)	51	(2.2)	0	(0)	24	(4.2)	8	(4.4)			1	(0.2)
Alaska	737,709	(0.2)	3	(0.1)	0	(0)	1	(0.2)	0	(0)			4	(0.6)
Arizona	6,817,565	(2.1)	52	(2.2)	3	(0.7)	0	(0)	1	(0.6)			9	(1.4)
Arkansas	2,977,853	(0.9)	38	(1.6)	2	(0.5)	2	(0.4)	2	(1.1)			0	(0)
California§	28,881,685	(9.0)	37§	(1.6)	55	(12.9)	14	(2.5)	15	(8.3)	0	(0)	41	(6.4)
Colorado	5,448,819	(1.7)	32	(1.4)	6	(1.4)	6	(1.1)	5	(2.8)	35	(3.0)	7	(1.1)
Connecticut	3,584,730	(1.1)	20	(0.8)	10	(2.3)	3	(0.5)	1	(0.6)	135	(11.6)	22	(3.4)
Delaware	944,076	(0.3)	8	(0.3)	1	(0.2)	1	(0.2)	0	(0)			1	(0.2)
District of Columbia	670,377	(0.2)	19	(0.8)	1	(0.2)	11	(1.9)	0	(0)			0	(0)
Florida	20,244,914	(6.3)	67	(2.8)	9	(2.1)	0	(0)	2	(1.1)			138	(21.6)
Georgia	10,199,398	(3.2)	122	(5.2)	8	(1.9)	49	(8.6)	1	(0.6)	149	(12.8)	11	(1.7)
Hawaii	1,425,157	(0.4)	20	(0.8)	12	(2.8)	5	(0.9)	9	(5.0)			28	(4.4)
Houston, Texas¶	2,284,816	(0.7)	57	(2.4)	1	(0.2)	7	(1.2)	1	(0.6)			2	(0.3)
Idaho	1,652,828	(0.5)	22	(0.9)	1	(0.2)	1	(0.2)	3	(1.7)			0	(0)
Illinois	12,839,047	(4.0)	103	(4.4)	26	(6.1)	41	(7.2)	7	(3.9)			9	(1.4)
Indiana	6,612,768	(2.1)	36	(1.5)	7	(1.6)	4	(0.7)	5	(2.8)			2	(0.3)
Iowa	3,121,997	(1.0)	20	(0.8)	6	(1.4)	5	(0.9)	0	(0)			1	(0.2)
Kansas	2,906,721	(0.9)	17	(0.7)	0	(0)	3	(0.5)	1	(0.6)			0	(0)
Kentucky	4,424,611	(1.4)	29	(1.2)	2	(0.5)	18	(3.2)	3	(1.7)			2	(0.3)
Los Angeles**	10,112,255	(3.2)	54	(2.3)	13	(3.0)	5	(0.9)	1	(0.6)			0	(0)
Louisiana	4,668,960	(1.5)	55	(2.3)	2	(0.5)	10	(1.8)	2	(1.1)			27	(4.2)
Maine	1,329,453	(0.4)	10	(0.4)	0	(0)	2	(0.4)	3	(1.7)			6	(0.9)
Maryland	5,994,983	(1.9)	49	(2.1)	11	(2.6)	6	(1.1)	2	(1.1)	177	(15.2)	10	(1.6)
Massachusetts	6,784,240	(2.1)	61	(2.6)	19	(4.4)	7	(1.2)	2	(1.1)			42	(6.6)
Michigan	9,917,715	(3.1)	42	(1.8)	14	(3.3)	21	(3.7)	0	(0)			5	(0.8)
Minnesota	5,482,435	(1.7)	46	(1.9)	0	(0)	15	(2.6)	6	(3.3)	176	(15.1)	16	(2.5)
Mississippi	2,989,390	(0.9)	51	(2.2)	0	(0)	5	(0.9)	1	(0.6)			12	(1.9)
Missouri	6,076,204	(1.9)	73	(3.1)	7	(1.6)	51	(9.0)	9	(5.0)			1	(0.2)
Montana	1,032,073	(0.3)	15	(0.6)	0	(0)	4	(0.7)	5	(2.8)			0	(0)
Nebraska	1,893,765	(0.6)	12	(0.5)	1	(0.2)	6	(1.1)	4	(2.2)			1	(0.2)
Nevada	2,883,758	(0.9)	15	(0.6)	2	(0.5)	2	(0.4)	2	(1.1)			2	(0.3)
New Hampshire	1,330,111	(0.4)	9	(0.4)	1	(0.2)	2	(0.4)	3	(1.7)			3	(0.5)
New Jersey	8,935,421	(2.8)	53	(2.2)	24	(5.6)	18	(3.2)	3	(1.7)			23	(3.6)
New Mexico	2,080,328	(0.6)	26	(1.1)	1	(0.2)	4	(0.7)	1	(0.6)	111	(9.5)	0	(0)
New York††	11,230,681	(3.5)	58	(2.5)	14	(3.3)	5	(0.9)	3	(1.7)	137	(11.8)	36	(5.6)
New York City‡‡	8,516,502	(2.7)	59	(2.5)	48	(11.2)	36	(6.3)	4	(2.2)			9	(1.4)
North Carolina	10,035,186	(3.1)	111	(4.7)	12	(2.8)	6	(1.1)	2	(1.1)			1	(0.2)
North Dakota	756,835	(0.2)	10	(0.4)	2	(0.5)	2	(0.4)	1	(0.6)			1	(0.2)
Ohio	11,605,090	(3.6)	76	(3.2)	8	(1.9)	10	(1.8)	10	(5.5)			6	(0.9)
Oklahoma	3,907,414	(1.2)	31	(1.3)	22	(5.2)	5	(0.9)	3	(1.7)			0	(0)
Oregon	4,024,634	(1.3)	29	(1.2)	4	(0.9)	6	(1.1)	7	(3.9)	126	(10.8)	8	(1.3)
Pennsylvania	12,791,904	(4.0)	83	(3.5)	15	(3.5)	19	(3.3)	4	(2.2)			8	(1.3)
Rhode Island	1,055,607	(0.3)	6	(0.3)	1	(0.2)	2	(0.4)	1	(0.6)			4	(0.6)
South Carolina	4,894,834	(1.5)	74	(3.1)	0	(0)	7	(1.2)	1	(0.6)			4	(0.6)
South Dakota	857,919	(0.3)	10	(0.4)	1	(0.2)	13	(2.3)	3	(1.7)			0	(0)
Tennessee	6,595,056	(2.1)	55	(2.3)	3	(0.7)	12	(2.1)	5	(2.8)	118	(10.1)	2	(0.3)
Texas§§	25,144,823	(7.8)	209	(8.8)	15	(3.5)	46	(8.1)	4	(2.2)			49	(7.7)
Utah	2,990,632	(0.9)	25	(1.1)	1	(0.2)	1	(0.2)	3	(1.7)			0	(0)
Vermont	626,088	(0.2)	5	(0.2)	0	(0)	1	(0.2)	2	(1.1)			1	(0.2)
Virginia	8,367,587	(2.6)	57	(2.4)	18	(4.2)	12	(2.1)	1	(0.6)			21	(3.3)
Washington	7,160,290	(2.2)	51	(2.2)	16	(3.7)	9	(1.6)	9	(5.0)			60	(9.4)
West Virginia	1,841,053	(0.6)	35	(1.5)	0	(0)	11	(1.9)	4	(2.2)			0	(0)
Wisconsin	5,767,891	(1.8)	49	(2.1)	2	(0.5)	12	(2.1)	5	(2.8)			4	(0.6)
Wyoming	586,555	(0.2)	7	(0.3)	0	(0)	1	(0.2)	1	(0.6)			0	(0)
Total	**320,896,618**	**(100)**	**2,364**	**(100)**	**427**	**(100)**	**569**	**(100)**	**181**	**(100)**	**1,164**	**(100)**	**640**	**(100)**

* Published in 2015 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, 20 to 98 per site in 2015), the number submitting isolates to the state public health laboratory ranged from none to all. After June 2014, California no longer submitted *Campylobacter* isolates to NARMS as the clinical laboratory that provided California isolates stopped culturing for *Campylobacter*. Only every other isolate received from Connecticut, Georgia, Maryland, and New York State were selected for antimicrobial susceptibilty testing in 2015.

§ Excluding Los Angeles County; specifically for nontyphoidal *Salmonella,* submissions were only from the California Emerging Infections Program catchment area (Alameda, Contra Costa, San Francisco, and Santa Clara counties)

¶ 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 and Laboratory Standards Institute (CLSI) were used when available (CLSI M100 S27, 2017). 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 µg/mL, and all isolates inhibited at the lowest concentration are categorized as having an MIC ≤32 µg/mL. As a result, the new breakpoint could only be applied to isolates tested since 2014 and the resistance breakpoint of ≥64 µg/mL was maintained for isolates tested during 1996–2013.

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 starting with the 2009 report and applied the revised interpretive criteria to all previously reported 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 based on MIC distribution data and limited clinical data. Azithromycin susceptibility for *Salmonella* ser. Typhi 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, we continued to apply the NARMS-established breakpoints to MIC data for *Salmonella* serotypes other than Typhi and *E. coli* O157 (Table 2), which are intended for resistance monitoring and should not be used to predict clinical efficacy

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 (ECVs) of ≥32 µg/mL for *S. sonnei* and ≥16 µg/mL for *S. flexneri* were established as non-wild-type. The ECVs should not be used as clinical breakpoints. CLSI uses the terms "wild-type" and "non-wild-type" 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. In this report, we refer to non-wild-type as resistant to capture the full spectrum of emerging resistance mechanisms, 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, 1996–2015

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)*		
				Susceptible	Intermediate† or S-DD‡	Resistant
Aminoglycosides	Amikacin	1997–2010	0.5–64	≤16	32	≥64
	Gentamicin	1996–2015	0.25–16	≤4	8	≥16
	Kanamycin	1996–2013	8–64	≤16	32	≥64
	Streptomycin§	1996–2013	32–64	≤32	N/A†	≥64
		2014–2015	2–64	≤16	N/A†	≥32
β–lactam / β–lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1996–2015	1/0.5–32/16	≤8/4	16/8	≥32/16
	Piperacillin-tazobactam¶	2011–2015	0.5–128	≤16/4	32/4–64/4	≥128/4
Cephems	Cefepime‡,¶	2011–2015	0.06–32	≤2	4–8‡	≥16
	Cefotaxime¶	2011–2015	0.06–128	≤1	2	≥4
	Cefoxitin	2000–2015	0.5–32	≤8	16	≥32
	Ceftazidime¶	2011–2015	0.06–128	≤4	8	≥16
	Ceftiofur	1996–2015	0.12–8	≤2	4	≥8
	Ceftriaxone**	1996–2015	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	2004–2015	16–256	≤256	N/A†	≥512
	Trimethoprim-sulfamethoxazole	1996–2015	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)	2011–2015	0.12–16	≤16	N/A†	≥32
	Azithromycin†† (*Shigella flexneri*)	2011–2015	0.12–16	≤8	N/A†	≥16
Monobactams	Aztreonam¶	2011–2015	0.06–32	≤4	8	≥16
Penems	Imipenem¶	2011–2015	0.06–16	≤1	2	≥4
Penicillins	Ampicillin	1996–2015	1–32	≤8	16	≥32
Phenicols	Chloramphenicol	1996–2015	2–32	≤8	16	≥32
Quinolones	Ciprofloxacin (*Shigella* and *E. coli* O157)	1996–2015	0.015–4	≤1	2	≥4
	Ciprofloxacin‡‡ (*Salmonella* serotypes)	1996–2015	0.015–4	≤0.06	0.12–0.5	≥1
	Nalidixic acid	1996–2015	0.5–32	≤16	N/A†	≥32
Tetracyclines	Tetracycline	1996–2015	4–32	≤4	8	≥16

* MIC interpretative standards defined by the Clinical and Laboratory Standards Institute (CLSI M100 S27, 2017) were used when available, otherwise, NARMS consensus breakpoints were used

† 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; interpretive standards 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 with 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. Interpretive criteria for *Salmonella* ser. Typhi are based on MIC distribution data and limited clinical 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 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 interpretive standards used elsewhere in this report for other *Shigella* species, *Salmonella* serotypes other than Typhi, 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 2015, all nontyphoidal *Salmonella* were sequenced to identify genetic resistance determinants. Genomic DNA was purified using an NXP Genomic DNA Extraction System. Whole genome sequencing was performed on a HiSeq with 2 x 250bp reads (Illumina, Inc.). *De novo* assemblies were performed in CLC genomics workbench 8.5 or 9. Contigs with 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 database (https://bitbucket.org/genomicepidemiology/resfinder_db- last accessed on 1/13/2017) (megaBLAST using 90% ID and 60% gene coverage cutoffs). The colistin resistance genes *mcr-3*, *mcr-4,* and *mcr-5* were later added to our version of the ResFinder database; none were detected among the isolates tested from 2015. For mutational resistance, *gyrA* and *parC* were extracted from genome assemblies a custom perl script (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

In 2015, nontyphoidal *Salmonella* serotyping performed at state and local public health laboratories was confirmed at CDC by analyzing raw reads from whole genome sequencing using SeqSero v.1.0 (https://github.com/denglab/SeqSero - last accessed on 9/14/2016). Before 2015, 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 since 1996 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

Sampling of *Campylobacter* is described in the Surveillance Sites and Isolate Submissions section. 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, 1997–2015

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	1998–2015	0.12–32 0.016–256†	≤2	≥4	≤2	≥4
Ketolides	Telithromycin‡	2005–2015	0.015–8	≤4	≥8	≤4‡	≥8‡
Lincosamides	Clindamycin	1997–2015	0.03–16 0.016–256†	≤0.5	≥1	≤1	≥2
Macrolides	Azithromycin	1998–2015	0.015–64 0.016–256†	≤0.25	≥0.5	≤0.5	≥1
	Erythromycin	1997–2015	0.03–64 0.016–256†	≤4	≥8	≤8	≥16
Phenicols	Chloramphenicol	1997–2004	0.016–256†	≤16	≥32	≤16	≥32
	Florfenicol	2005–2015	0.03–64	≤4	≥8	≤4	≥8
Quinolones	Ciprofloxacin	1997–2015	0.015–64 0.002–32†	≤0.5	≥1	≤0.5	≥1
	Nalidixic acid	1997–2015	4–64 0.016–256†	≤16	≥32	≤16	≥32
Tetracyclines	Tetracycline	1997–2015	0.06–64 0.016–256†	≤1	≥2	≤2	≥4

* MIC interpretative standard is based on epidemiological cutoff values (ECVs) established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST – last accessed on 1/2/2018). This approach was adopted in 2012 and applied to all years. EUCAST uses the terms “wild-type” and “non-wild-type” 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.

† Etest® dilution range used before 2005

‡ 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. In 2015, 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 4). Interpretive criteria defined by the Clinical and Laboratory Standards Institute (CLSI) were used when available.

Before 2015, MICs were determined by Etest® (AB bioMerieux, Solna, Sweden) according to manufacturer's instructions for at least the following six antimicrobial agents: ampicillin, chloramphenicol, ciprofloxacin, nalidixic acid, tetracycline, and trimethoprim-sulfamethoxazole. Additional agents tested included cephalothin, kanamycin, and streptomycin during 2009–2012. In 2013, cefotaxime, ceftazidime, gentamicin, and imipenem were added to the panel of drugs tested, and cephalothin, kanamycin, and streptomycin were removed (Table 4).

In 2015, not all *Vibrio* isolates were tested against ceftiofur due to a plate configuration change. Of 640 isolates included in this report, 60 (9.4%) lacked ceftiofur test results.

CLSI breakpoints specific for *Vibrio* species other than *V. cholerae* are available for amoxicillin-clavulanic acid, ampicillin, cefotaxime, cefoxitin ceftazidime, ciprofloxacin, gentamicin, imipenem, tetracycline, and trimethoprim-sulfamethoxazole (CLSI M45 Ed. 3, 2016). 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 2015 that are susceptible, intermediate, and resistant to agents with CLSI interpretive standards, including MIC distributions for all agents tested, 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, 2009–2015

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)*		
				Susceptible	Intermediate†	Resistant
Aminoglycosides	Gentamicin	2013–2015	0.25–16 0.064–1024‡	≤4	8	≥16
	Kanamycin	2009–2012	0.016–256‡	No CLSI or NARMS breakpoints		
	Streptomycin	2015; 2009–2012	2–64 0.064–1024‡	No CLSI or NARMS breakpoints		
β–lactam / β–lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2015	1/0.5–32/16	≤8/4	16/8	≥32/16
Cephems	Cefotaxime	2013–2014	0.016–256‡	≤1	2	≥4
	Cefoxitin	2015	0.5–32	≤8	16	≥32
	Ceftazidime	2013–2014	0.016–256‡	≤4	8	≥16
	Ceftiofur	2015	0.12–8	No CLSI or NARMS breakpoints		
	Ceftriaxone	2015	0.25–64	No CLSI or NARMS breakpoints		
	Cephalothin	2009–2012	0.016–256‡	No CLSI or NARMS breakpoints		
Folate pathway inhibitors	Sulfisoxazole	2015	16–256	No CLSI or NARMS breakpoints		
	Trimethoprim-sulfamethoxazole	2009–2015	0.12/2.38–4/76 0.002–32‡	≤2/38	N/A†	≥4/76
Macrolides	Azithromycin§	2015	0.12–16	See footnote§		
Penems	Imipenem¶	2013–2014	0.002–32‡	≤1	2	≥4
Penicillins	Ampicillin	2009–2015	1–32 0.016–256‡	≤8	16	≥32
Phenicols	Chloramphenicol	2009–2015	2–32 0.016–256‡	No CLSI or NARMS breakpoints		
Quinolones	Ciprofloxacin	2009–2015	0.015–4 0.002–32‡	≤1	2	≥4
	Nalidixic acid	2009–2015	0.5–32 0.016–256‡	No CLSI or NARMS breakpoints		
Tetracyclines	Tetracycline	2009–2015	4–32 0.016–256‡	≤4	8	≥16

* MIC interpretative standards defined by the Clinical and Laboratory Standards Institute (CLSI M45 Ed. 3, 2016) were used when available
† N/A indicates that no MIC range of intermediate susceptibility exists
‡ Etest® dilution range used before 2015
§ CLSI has only established a susceptible breakpoint (≤2 µg/mL) for azithromycin and cautions that the utility of this interpretation for *Vibrio* species other than *V. cholerae* is uncertain due to limited clinical or *in vitro* MIC data. Because of this, NARMS will not apply any interpretive criteria to azithromycin MICs for non-*cholerae Vibrio* until further data are available.
¶ CLSI updated the imipenem interpretive standards in October 2015. The previous breakpoints were 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 *Shigella* and *E. coli* O157, isolates with a ciprofloxacin MIC ≥0.12 µg/mL (which includes MICs categorized as clinically susceptible by CLSI) were also defined as having DSC. For *Campylobacter*, epidemiological cutoff values (ECVs) established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST- last accessed on 1/2/2018) were used to interpret MICs. For *Shigella sonnei* and *flexneri,* ECVs established by CLSI were used to interpret azithromycin MICs. These ECVs should not be used as clinical breakpoints. CLSI uses the terms "wild-type" and "non-wild-type" 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. To capture the full spectrum of emerging resistance mechanisms, 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.

Analysis of antimicrobial class resistance among *Salmonella, Shigella,* and *E. coli* O157 was performed using data for drugs that all isolates had been tested with; 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. In addition to isolates with nalidixic acid or ciprofloxacin resistance, or both, as defined by CLSI, we included isolates with ciprofloxacin MICs of 0.12 µg/mL up to the resistant breakpoint in the quinolone resistant category when calculating resistance to antimicrobial classes. These isolates commonly have at least one quinolone resistance mechanism, which, for *Salmonella*, is thought to complicate therapy. By including DSC when calculating resistance to multiple classes of agents we accounted for possible emerging resistance mechanisms. Isolates that were not resistant to any of the listed agents according to CLSI interpretative criteria or did not have DSC were counted in the "no resistance detected" category.

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 2004–2015 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 2015 with the average prevalence from two reference periods, 2004–2008 and the previous five years, 2010–2014. 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 2010–2014 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, 2017). 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*: decreased susceptibility to ciprofloxacin
- *Campylobacter jejuni, C. coli*: resistance to ciprofloxacin

In the logistic regression analysis for main effects, year was modelled as a 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 included data only for 9 FoodNet states that submitted *Campylobacter* isolates for all years from 2004 through 2015; one state did not submit isolates in 2015. The final models adjusted for site based on the submitting FoodNet state. 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 2015 compared with 2004-2008 and 2010–2014) 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

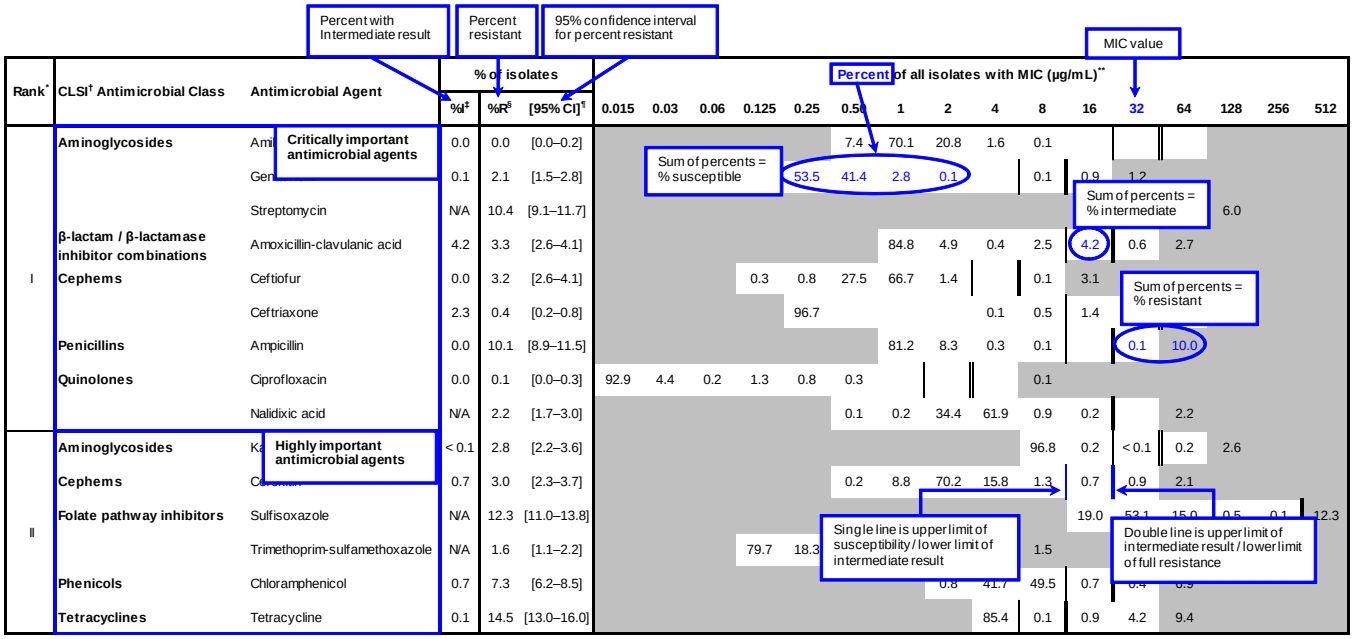
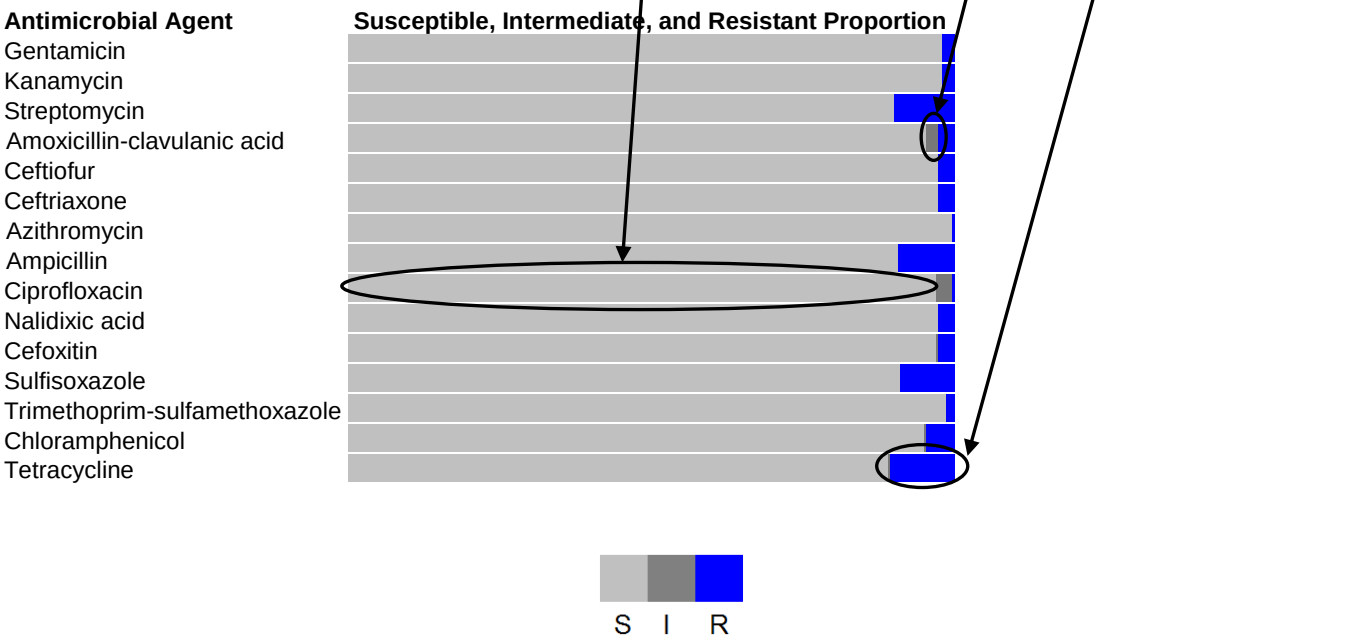


Figure 2. Proportional chart, a categorical graph of a squashtogram

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			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	<0.1	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, 2015. Data table at https://www.cdc.gov/narms/files/table5.xlsx

	Number of Isolates		Number of Resistant Isolates by CLSI† Antimicrobial Class and Agent§																			
	Isolates		Number of CLSI† Antimicrobial Classes to which Isolates are Resistant‡						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	471	(19.9)	366	71	25	9	0	0	2	27	4	2	1	1	16	9	1	28	1	0	62	22
Typhimurium	251	(10.6)	176	13	24	27	10	1	3	47	13	12	10	10	55	9	0	53	30	2	10	48
Newport	232	(9.8)	204	15	0	2	10	1	1	15	11	11	11	11	13	1	0	13	11	0	1	23
I 4,[5],12:i:-	149	(6.3)	41	4	10	86	7	1	7	101	7	7	9	9	101	6	0	98	7	0	5	100
Javiana	147	(6.2)	133	9	1	4	0	0	0	11	0	1	1	1	3	0	0	5	1	0	1	5
Muenchen	73	(3.1)	64	3	5	1	0	0	1	6	1	1	2	2	3	0	0	3	0	0	0	5
Infantis	72	(3.0)	52	5	10	3	2	0	5	12	5	4	4	5	7	3	0	12	3	0	0	12
Heidelberg	68	(2.9)	46	7	12	2	1	0	8	18	2	2	3	3	8	0	1	7	1	0	0	8
Poona	61	(2.6)	56	2	1	2	0	0	0	2	1	0	1	1	1	0	0	2	0	0	1	3
Saintpaul	60	(2.5)	50	1	7	0	2	0	4	7	0	0	0	0	3	2	1	6	2	2	6	8
Montevideo	53	(2.2)	47	2	1	3	0	0	1	3	2	2	2	2	2	0	0	4	0	0	2	1
Oranienburg	53	(2.2)	49	4	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	1
Braenderup	52	(2.2)	42	3	3	4	0	0	2	9	1	1	1	1	6	3	1	4	0	0	1	5
Mississippi	47	(2.0)	42	2	2	1	0	0	0	3	2	2	2	2	0	0	0	3	0	0	0	0
Thompson	43	(1.8)	40	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Norwich	28	(1.2)	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratyphi B var. L(+) tartrate+	28	(1.2)	17	6	0	4	1	0	0	6	0	0	0	0	5	2	0	6	4	0	2	7
I 4,[5],12:b:-	21	(0.9)	20	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bareilly	19	(0.8)	14	4	0	1	0	0	0	5	0	0	0	0	0	0	1	1	0	0	0	1
Rubislaw	17	(0.7)	14	1	2	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	1
Berta	16	(0.7)	13	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2
Panama	16	(0.7)	13	0	0	3	0	0	1	2	0	0	0	0	3	2	0	3	2	0	1	3
Agona	14	(0.6)	9	1	1	2	1	0	0	4	1	1	1	1	4	2	0	2	1	0	1	5
Hartford	14	(0.6)	11	1	1	0	1	0	0	1	1	1	1	1	2	1	0	1	1	0	2	2
Litchfield	14	(0.6)	12	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1
Stanley	14	(0.6)	7	2	3	2	0	0	0	2	0	0	1	1	2	2	0	6	0	0	1	4
Anatum	13	(0.5)	7	3	2	1	0	0	0	2	1	1	2	2	1	1	0	2	0	1	1	2
Miami	13	(0.5)	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dublin	12	(0.5)	1	0	0	3	5	3	2	10	8	8	8	8	11	2	0	8	11	0	3	10
Hadar	12	(0.5)	4	0	6	2	0	0	0	8	1	0	0	0	2	0	0	3	0	0	1	8
Schwarzengrund	11	(0.5)	5	4	2	0	0	0	0	4	0	0	0	0	2	1	0	0	0	0	0	2
Cotham	10	(0.4)	8	0	1	1	0	0	0	1	0	0	0	0	2	0	0	1	1	0	1	1
Reading	10	(0.4)	6	0	4	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0	4
Sandiego	10	(0.4)	9	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1
Subtotal	**2124**	**(89.8)**	**1619**	**170**	**126**	**163**	**40**	**6**	**38**	**321**	**61**	**56**	**60**	**61**	**256**	**46**	**6**	**274**	**76**	**5**	**103**	**295**
All other serotypes	233	(9.9)	178	25	15	13	2	0	4	44	3	3	4	4	21	10	2	19	3	4	7	24
Partially serotyped isolates	5	(0.2)	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rough/nonmotile isolates	2	(0.1)	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
Total	**2364**	**(100)**	**1802**	**196**	**142**	**176**	**42**	**6**	**43**	**366**	**64**	**59**	**64**	**65**	**278**	**56**	**8**	**293**	**79**	**9**	**110**	**319**

* Only serotypes with at least 10 isolates are listed individually

† CLSI: Clinical and Laboratory Standards Institute

‡ Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class

§ 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, 2015

		N	At least ASSuT* and not chloramphenicol		At least ACSSuT†		At least ACSSuTAuCx‡		At least DSC§		At least ceftriaxone		At least DSC§ and ceftriaxone	
			n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes														
1	Enteritidis	471	**4**	**(3.4)**	0	(0)	0	(0)	**65**	**(47.4)**	**1**	**(1.5)**	0	(0)
2	Typhimurium	251	**4**	**(3.4)**	**27**	**(41.5)**	**4**	**(12.9)**	**9**	**(6.6)**	**10**	**(15.4)**	**1**	**(7.1)**
3	Newport	232	**2**	**(1.7)**	**11**	**(16.9)**	**11**	**(35.5)**	**5**	**(3.6)**	**11**	**(16.9)**	**1**	**(7.1)**
4	I 4,[5],12:i:-	149	**88**	**(74.6)**	**6**	**(9.2)**	**4**	**(12.9)**	**8**	**(5.8)**	**9**	**(13.8)**	**3**	**(21.4)**
5	Javiana	147	**1**	**(0.8)**	**1**	**(1.5)**	0	(0)	**2**	**(1.5)**	**1**	**(1.5)**	0	(0)
6	Muenchen	73	0	(0)	0	(0)	0	(0)	0	(0)	**2**	**(3.1)**	0	(0)
7	Infantis	72	**1**	**(0.8)**	**2**	**(3.1)**	**2**	**(6.5)**	**1**	**(0.7)**	**5**	**(7.7)**	0	(0)
8	Heidelberg	68	**2**	**(1.7)**	**1**	**(1.5)**	0	(0)	**1**	**(0.7)**	**3**	**(4.6)**	**1**	**(7.1)**
9	Poona	61	**1**	**(0.8)**	0	(0)	0	(0)	**2**	**(1.5)**	**1**	**(1.5)**	**1**	**(7.1)**
10	Saintpaul	60	0	(0)	**2**	**(3.1)**	0	(0)	**6**	**(4.4)**	0	(0)	0	(0)
11	Montevideo	53	**1**	**(0.8)**	0	(0)	0	(0)	**2**	**(1.5)**	**2**	**(3.1)**	**1**	**(7.1)**
	Oranienburg	53	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
13	Braenderup	52	**3**	**(2.5)**	0	(0)	0	(0)	**2**	**(1.5)**	**1**	**(1.5)**	0	(0)
14	Mississippi	47	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	**2**	**(3.1)**	**1**	**(7.1)**
15	Thompson	43	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
16	Norwich	28	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Paratyphi B var. L(+) tartrate+	28	**1**	**(0.8)**	**4**	**(6.2)**	0	(0)	**3**	**(2.2)**	0	(0)	0	(0)
18	I 4,[5],12:b:-	21	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
19	Bareilly	19	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
20	Rubislaw	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Additional serotypes¶														
	Panama	16	**1**	**(0.8)**	**1**	**(1.5)**	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Agona	14	**1**	**(0.8)**	**1**	**(1.5)**	**1**	**(3.2)**	**2**	**(1.5)**	**1**	**(1.5)**	0	(0)
	Hartford	14	0	(0)	**1**	**(1.5)**	**1**	**(3.2)**	**1**	**(0.7)**	**1**	**(1.5)**	0	(0)
	Stanley	14	**1**	**(0.8)**	0	(0)	0	(0)	**3**	**(2.2)**	**1**	**(1.5)**	**1**	**(7.1)**
	Anatum	13	0	(0)	0	(0)	0	(0)	**2**	**(1.5)**	**2**	**(3.1)**	0	(0)
	Dublin	12	0	(0)	**7**	**(10.8)**	**7**	**(22.6)**	**3**	**(2.2)**	**8**	**(12.3)**	**3**	**(21.4)**
	Hadar	12	**1**	**(0.8)**	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Schwarzengrund	11	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Cotham	10	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Brandenburg	9	**1**	**(0.8)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Give	8	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Adelaide	7	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Blockley	7	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Baildon	6	**1**	**(0.8)**	0	(0)	0	(0)	**2**	**(1.5)**	0	(0)	0	(0)
	Havana	5	**2**	**(1.7)**	0	(0)	0	(0)	**2**	**(1.5)**	0	(0)	0	(0)
	Kentucky	5	0	(0)	0	(0)	0	(0)	**2**	**(1.5)**	**1**	**(1.5)**	0	(0)
	Weltevreden	5	0	(0)	**1**	**(1.5)**	**1**	**(3.2)**	0	(0)	**1**	**(1.5)**	0	(0)
	Cerro	4	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Isangi	3	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	**1**	**(1.5)**	**1**	**(7.1)**
	London	2	0	(0)	0	(0)	0	(0)	0	(0)	**1**	**(1.5)**	0	(0)
	IIIb 48:i:z	1	**1**	**(0.8)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Albert	1	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Krefeld	1	**1**	**(0.8)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Subtotal		**2125**	**118**	**(100)**	**65**	**(100)**	**31**	**(100)**	**136**	**(99.3)**	**65**	**(100)**	**14**	**(100)**
	All other serotypes	232	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Partially serotyped isolates	5	0	(0)	0	(0)	0	(0)	**1**	**(0.7)**	0	(0)	0	(0)
	Rough/nonmotile isolates	2	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total		**2364**	**118**	**(100)**	**65**	**(100)**	**31**	**(100)**	**137**	**(100)**	**65**	**(100)**	**14**	**(100)**

* ASSuT: resistance to ampicillin, streptomycin, sulfisoxazole, tetracycline

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

‡ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone

§ DSC: decreased susceptibility to ciprofloxacin (MIC ≥0.12 µg/mL); among *Salmonella,* 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, 2015. Data table at https://www.cdc.gov/narms/files/table7.xlsx

		N	≥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	(%)
Twenty most common serotypes																
1	Enteritidis	471	**20**	**(6.8)**	**9**	**(4.0)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
2	Typhimurium	251	**46**	**(15.7)**	**38**	**(17.0)**	**31**	**(33.7)**	**11**	**(22.9)**	**5**	**(14.3)**	**1**	**(16.7)**	0	-
3	Newport	232	**13**	**(4.4)**	**13**	**(5.8)**	**12**	**(13.0)**	**11**	**(22.9)**	**11**	**(31.4)**	**1**	**(16.7)**	0	-
4	I 4,[5],12:i:-	149	**101**	**(34.5)**	**94**	**(42.0)**	**12**	**(13.0)**	**8**	**(16.7)**	**5**	**(14.3)**	**1**	**(16.7)**	0	-
5	Javiana	147	**4**	**(1.4)**	**4**	**(1.8)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
6	Muenchen	73	**5**	**(1.7)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
7	Infantis	72	**11**	**(3.8)**	**5**	**(2.2)**	**3**	**(3.3)**	**2**	**(4.2)**	**2**	**(5.7)**	0	(0)	0	-
8	Heidelberg	68	**7**	**(2.4)**	**3**	**(1.3)**	**1**	**(1.1)**	**1**	**(2.1)**	**1**	**(2.9)**	0	(0)	0	-
9	Poona	61	**2**	**(0.7)**	**2**	**(0.9)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
10	Saintpaul	60	**7**	**(2.4)**	**2**	**(0.9)**	**2**	**(2.2)**	**2**	**(4.2)**	**1**	**(2.9)**	0	(0)	0	-
11	Montevideo	53	**4**	**(1.4)**	**3**	**(1.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Oranienburg	53	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
13	Braenderup	52	**6**	**(2.0)**	**4**	**(1.8)**	**2**	**(2.2)**	0	(0)	0	(0)	0	(0)	0	-
14	Mississippi	47	**2**	**(0.7)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
15	Thompson	43	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
16	Norwich	28	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Paratyphi B var. L(+) tartrate+	28	**5**	**(1.7)**	**5**	**(2.2)**	**4**	**(4.3)**	**1**	**(2.1)**	0	(0)	0	(0)	0	-
18	I 4,[5],12:b:-	21	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
19	Bareilly	19	**1**	**(0.3)**	**1**	**(0.4)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
20	Rubislaw	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Additional serotypes‡																
	Panama	16	**3**	**(1.0)**	**3**	**(1.3)**	**2**	**(2.2)**	0	(0)	0	(0)	0	(0)	0	-
	Agona	14	**4**	**(1.4)**	**3**	**(1.3)**	**2**	**(2.2)**	**1**	**(2.1)**	**1**	**(2.9)**	0	(0)	0	-
	Hartford	14	**2**	**(0.7)**	**1**	**(0.4)**	**1**	**(1.1)**	**1**	**(2.1)**	**1**	**(2.9)**	0	(0)	0	-
	Stanley	14	**3**	**(1.0)**	**2**	**(0.9)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	Anatum	13	**2**	**(0.7)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Dublin	12	**11**	**(3.8)**	**11**	**(4.9)**	**8**	**(8.7)**	**8**	**(16.7)**	**7**	**(20.0)**	**3**	**(50.0)**	0	-
	Hadar	12	**4**	**(1.4)**	**2**	**(0.9)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	Schwarzengrund	11	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Cotham	10	**1**	**(0.3)**	**1**	**(0.4)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	Reading	10	**4**	**(1.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Sandiego	10	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Brandenburg	9	**1**	**(0.3)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Manhattan	9	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Mbandaka	8	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Blockley	7	**1**	**(0.3)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Senftenberg	7	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Baildon	6	**2**	**(0.7)**	**2**	**(0.9)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	Derby	5	**3**	**(1.0)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Havana	5	**4**	**(1.4)**	**4**	**(1.8)**	**2**	**(2.2)**	**1**	**(2.1)**	0	(0)	0	(0)	0	-
	Kentucky	5	**2**	**(0.7)**	**2**	**(0.9)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	Weltevreden	5	**1**	**(0.3)**	**1**	**(0.4)**	**1**	**(1.1)**	**1**	**(2.1)**	**1**	**(2.9)**	0	(0)	0	-
	Isangi	3	**1**	**(0.3)**	**1**	**(0.4)**	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	0	-
	London	2	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Rissen	2	**1**	**(0.3)**	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	IIIb 48:i:z	1	**1**	**(0.3)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Albert	1	**1**	**(0.3)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Krefeld	1	**1**	**(0.3)**	**1**	**(0.4)**	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Subtotal		**2157**	**293**	**(100)**	**224**	**(100)**	**92**	**(100)**	**48**	**(100)**	**35**	**(100)**	**6**	**(100)**	0	-
	All other serotypes	200	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Partially serotyped isolates	5	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Rough/Nonmotile isolates	2	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Total		**2364**	**293**	**(100)**	**224**	**(100)**	**92**	**(100)**	**48**	**(100)**	**35**	**(100)**	**6**	**(100)**	**0**	-

* Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
† 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, 2015 (N=2364). Data table at https://www.cdc.gov/narms/files/table8.xlsx

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	1.8	[1.3 - 2.4]					42.1	51.1	4.1	0.5	0.2	0.2	0.7	1.1				
		Streptomycin	N/A	15.5	[14.0 - 17.0]								11.6	15.7	45.1	12.1	3.2	3.6	8.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.2	2.7	[2.1 - 3.4]							81.0	4.9	2.8	6.4	2.2	0.6	2.1			
	Cephems	Ceftiofur	0.3	2.7	[2.1 - 3.4]				<0.1	0.2	19.2	75.9	1.7	0.3	0.4	2.3					
		Ceftriaxone	<0.1	2.7	[2.1 - 3.5]					96.7	0.5	<0.1	<0.1	<0.1	0.8	1.4	0.4	0.1	0.1		
	Macrolides	Azithromycin	N/A	0.3	[0.1 - 0.7]					<0.1			27.7	68.7	3.0	0.3	0.3				
	Penicillins	Ampicillin	0.1	12.4	[11.1 - 13.8]							75.7	10.9	0.6	0.3	0.1	0.4	12.0			
	Quinolones	Ciprofloxacin	5.4	0.4	[0.2 - 0.7]	88.2	5.7	0.3	2.1	2.2	1.1	0.2	0.1	<0.1	0.1						
		Nalidixic acid	N/A	4.7	[3.8 - 5.6]							<0.1	20.9	71.6	1.8	1.1	0.7	3.9			
II	**Cephems**	Cefoxitin	0.4	2.5	[1.9 - 3.2]						<0.1	0.9	71.9	21.6	2.7	0.4	0.8	1.6			
	Folate pathway inhibitors	Sulfisoxazole	N/A	11.8	[10.5 - 13.1]											12.0	52.1	21.7	2.0	0.5	11.8
		Trimethoprim-sulfamethoxazole	N/A	2.4	[1.8 - 3.1]				94.3	2.5	0.4	0.2	0.1	0.1	2.2						
	Phenicols	Chloramphenicol	0.8	3.3	[2.7 - 4.1]								0.3	45.9	49.6	0.8		3.3			
	Tetracyclines	Tetracycline	1.3	13.5	[12.1 - 14.9]									85.2	1.3	0.4	1.6	11.5			

* 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 3. Antimicrobial resistance pattern for nontyphoidal *Salmonella*, 2015. Data for figure at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

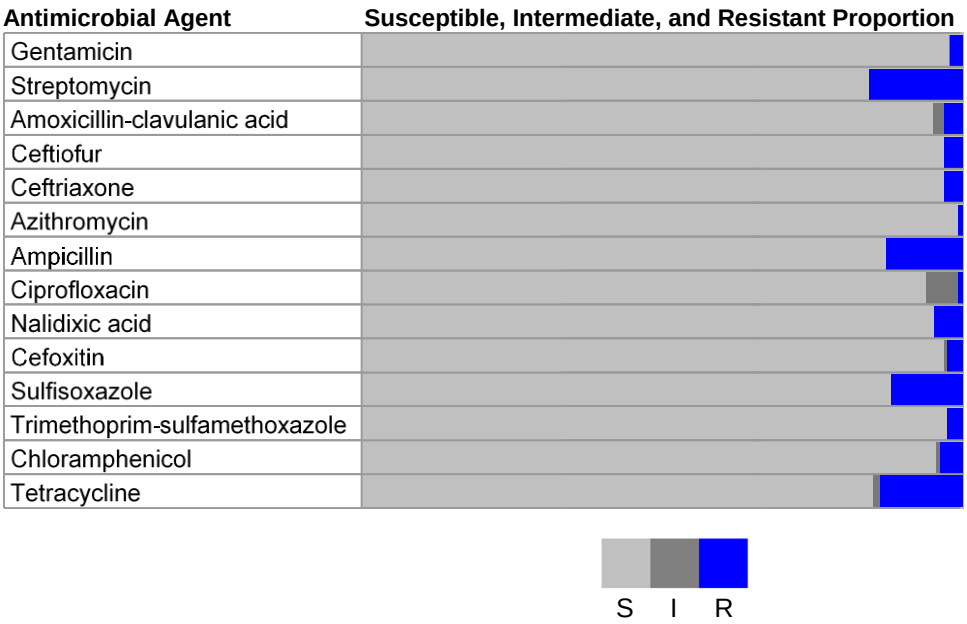


Table 9. Percentage and number of nontyphoidal *Salmonella* isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table9.xlsx

Year Total Isolates			2006 2170	2007 2144	2008 2384	2009 2192	2010 2448	2011 2335	2012 2233	2013 2178	2014 2126	2015 2364
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	1.8% 43
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	10.7% 233	10.4% 222	10.0% 238	8.9% 196	8.6% 210	9.8% 229	8.4% 187	11.5% 251	11.2% 238	15.5% 366
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	2.7% 64
	Cephems	Ceftiofur (MIC ≥ 8)	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	2.7% 64
		Ceftriaxone (MIC ≥ 4)	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	2.7% 65
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.2% 5	< 0.1% 1	0.2% 5	< 0.1% 1	0.3% 8
	Penicillins	Ampicillin (MIC ≥ 32)	10.9% 237	10.1% 216	9.7% 232	9.9% 216	9.1% 223	9.1% 213	8.8% 196	10.4% 227	9.1% 194	12.4% 293
	Quinolones	Ciprofloxacin (MIC ≥ 1)	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	0.4% 9
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	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	5.8% 137
		Nalidixic acid (MIC ≥ 32)	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	4.7% 110
II	Cephems	Cefoxitin (MIC ≥ 32)	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	2.5% 59
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	12.1% 263	12.3% 263	10.1% 240	9.9% 217	9.0% 221	8.6% 201	8.4% 188	10.3% 225	9.4% 200	11.8% 278
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.7% 36	1.5% 32	1.6% 37	1.7% 38	1.6% 38	1.2% 28	1.3% 29	1.4% 31	1.3% 27	2.4% 56
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	3.3% 79
	Tetracyclines	Tetracycline (MIC ≥ 16)	13.5% 293	14.4% 309	11.5% 275	11.9% 261	11.0% 270	10.5% 245	11.1% 247	12.6% 275	10.3% 220	13.5% 319

* 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, 2006–2015. Data table at https://www.cdc.gov/narms/files/table10.xlsx

Year Total Isolates	2006 2170	2007 2144	2008 2384	2009 2192	2010 2448	2011 2335	2012 2233	2013 2178	2014 2126	2015 2364
Resistance Pattern										
No resistance detected	80.5% 1746	81.0% 1736	83.9% 1999	83.0% 1820	84.4% 2067	84.8% 1979	84.3% 1882	80.4% 1752	81.9% 1741	76.2% 1802
Resistance ≥ 1 CLSI* class†	19.5% 424	19.0% 408	16.1% 385	17.0% 372	15.6% 381	15.2% 356	15.7% 351	19.6% 426	18.1% 385	23.8% 562
Resistance ≥ 2 CLSI* classes†	14.7% 318	13.9% 299	12.5% 298	12.8% 281	11.2% 273	11.1% 259	11.8% 263	13.3% 290	11.9% 253	15.5% 366
Resistance ≥ 3 CLSI* classes†	11.8% 257	11.0% 236	9.5% 227	9.7% 213	9.3% 227	9.3% 217	9.0% 200	10.0% 217	9.3% 197	12.4% 293
Resistance ≥ 4 CLSI* classes†	8.0% 174	8.2% 175	7.6% 181	7.2% 158	6.9% 168	6.6% 154	6.4% 143	7.7% 168	7.2% 154	9.5% 224
Resistance ≥ 5 CLSI* classes†	6.3% 137	6.9% 149	6.6% 157	6.1% 134	5.3% 130	4.7% 110	3.9% 88	4.1% 89	3.9% 83	3.9% 92
At least ACSSuT‡	5.6% 121	6.3% 136	5.8% 138	5.1% 112	4.4% 107	3.9% 91	3.4% 77	3.4% 74	3.2% 67	2.7% 65
At least ASSuT§ and not resistant to chloramphenicol	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	5.0% 118
At least ACT/S¶	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	0.7% 17
At least ACSSuTAuCx**	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	1.3% 31
At least AAuCx††	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	2.4% 56
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin‡‡	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	0.6% 14
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.1% 3	0.0% 0	0.1% 3	0.0% 0	0.2% 5
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	< 0.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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), 2014 (N=51), and 2015 (N=65)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Year (# of isolates)	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)††											
				%I‡ (or S-DD§)	%R¶	[95% CI]**	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256
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
			2015 (65)	12.3	4.6	[1.0 - 12.9]						15.4	24.6	30.8	12.3	6.2	6.2	1.5	3.1
	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			
			2015 (65)	(1.5§)	3.1	[0.4 - 10.7]	13.8	6.2	20.0	32.3	16.9	6.2	1.5§		1.5		1.5		
		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	
			2015 (65)	0.0	83.1	[71.7 - 91.2]	9.2	6.2	1.5				3.1	9.2	35.4	23.1	7.7	3.1	1.5
		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		
			2015 (65)	4.6	73.8	[61.5 - 84.0]			10.8	6.2			4.6	4.6	43.1	18.5	10.8	1.5	
	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		
			2015 (65)	32.3	33.8	[22.6 - 46.6]	16.9				1.5	1.5	13.8	32.3	20.0	6.2	7.7		
	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									
			2015 (65)	0.0	0.0	[0.0 - 5.5]		1.5	73.8	24.6									

* 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.

Data table at https://www.cdc.gov/narms/files/table11.xlsx

A. *Salmonella* ser. Enteritidis

Table 12. Minimum inhibitory concentrations (MICs) and resistance of Salmonella ser. Enteritidis isolates to antimicrobial agents, 2015 (N=471). Data table at https://www.cdc.gov/narms/files/table12.xlsx

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	0.4	[0.0 - 1.5]					70.5	26.5	2.5				0.4					
		Streptomycin	N/A	5.7	[3.8 - 8.2]								55.8	34.6	2.5	1.3	1.7	3.0	1.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.4	0.8	[0.2 - 2.2]							84.3	6.8	3.4	4.2	0.4	0.6	0.2			
	Cephems	Ceftiofur	0.0	0.2	[0.0 - 1.2]					0.4	2.8	94.1	2.5			0.2					
		Ceftriaxone	0.0	0.2	[0.0 - 1.2]					99.2	0.4	0.2			0.2						
	Macrolides	Azithromycin	N/A	0.2	[0.0 - 1.2]								35.0	62.8	1.5	0.4	0.2				
	Penicillins	Ampicillin	0.0	5.9	[4.0 - 8.5]							66.9	25.9	0.8	0.4		0.4	5.5			
	Quinolones	Ciprofloxacin	13.8	0.0	[0.0 - 0.8]	69.2	17.0		7.4	5.7	0.6										
		Nalidixic acid	N/A	13.2	[10.2 - 16.6]							0.2	6.2	78.1	2.1	0.2	0.8	12.3			
II	**Cephems**	Cefoxitin	0.6	0.4	[0.0 - 1.5]						0.2	0.4	78.6	17.8	1.9	0.6	0.2	0.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	3.4	[2.0 - 5.5]											7.4	64.3	21.4	2.8	0.6	3.4
		Trimethoprim-sulfamethoxazole	N/A	1.9	[0.9 - 3.6]				94.7	2.5	0.2	0.2	0.4	0.2	1.7						
	Phenicols	Chloramphenicol	0.6	0.2	[0.0 - 1.2]									59.7	39.5	0.6		0.2			
	Tetracyclines	Tetracycline	2.1	4.7	[2.9 - 7.0]									93.2	2.1	0.2	1.3	3.2			

* 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 4. Antimicrobial resistance pattern for *Salmonella* ser. Enteritidis, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

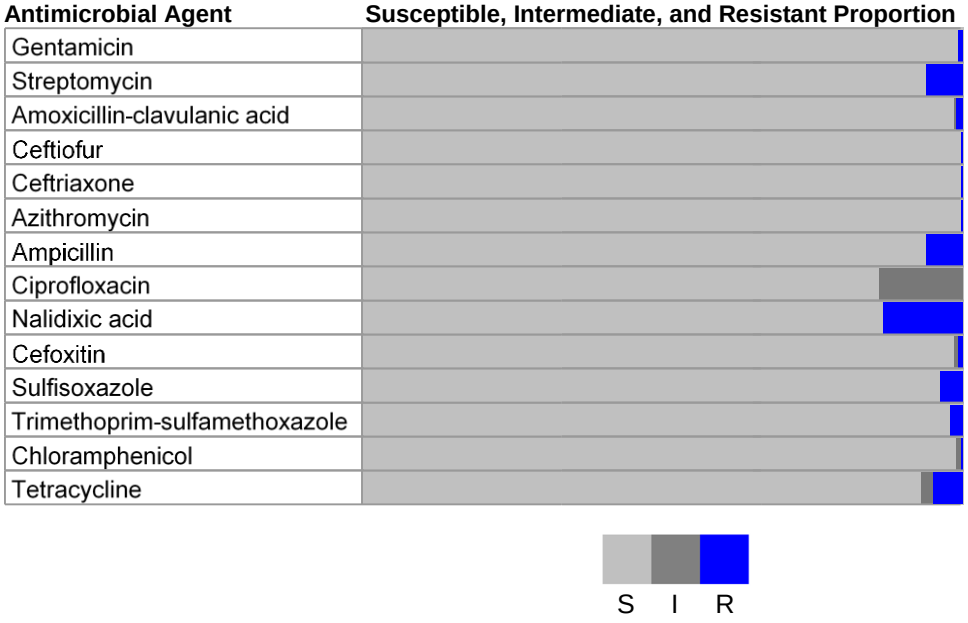


Table 13. Percentage and number of *Salmonella* ser. Enteritidis isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table13.xlsx

Year / Total Isolates			2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382	2014 438	2015 471
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	0.4% 2
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	5.7% 27
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	0.8% 4
	Cephems	Ceftiofur (MIC ≥ 8)	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	0.2% 1
		Ceftriaxone (MIC ≥ 4)	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	0.2% 1
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
	Penicillins	Ampicillin (MIC ≥ 32)	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	5.9% 28
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	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	13.8% 65
		Nalidixic acid (MIC ≥ 32)	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	13.2% 62
II	Cephems	Cefoxitin (MIC ≥ 32)	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	0.4% 2
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	3.4% 16
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	1.9% 9
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	0.2% 1
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	4.7% 22

* 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, 2006–2015. Data table at https://www.cdc.gov/narms/files/table14.xlsx

Year / Total Isolates	2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382	2014 438	2015 471
Resistance Pattern										
No resistance detected	88.8% 366	90.4% 348	87.1% 385	92.2% 378	92.0% 472	88.0% 344	87.9% 320	87.4% 334	87.4% 383	77.7% 366
Resistance ≥ 1 CLSI* class†	11.2% 46	9.6% 37	12.9% 57	7.8% 32	8.0% 41	12.0% 47	12.1% 44	12.6% 48	12.6% 55	22.3% 105
Resistance ≥ 2 CLSI* classes†	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	7.2% 34
Resistance ≥ 3 CLSI* classes†	1.9% 8	1.0% 4	0.7% 3	1.0% 4	2.1% 11	2.3% 9	2.7% 10	1.6% 6	2.1% 9	4.2% 20
Resistance ≥ 4 CLSI* classes†	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	1.9% 9
Resistance ≥ 5 CLSI* classes†	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	0.2% 1
At least ACSSuT‡	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	0.0% 0
At least ASSuT§ and not resistant to chloramphenicol	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	0.8% 4
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**	0.0% 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	0.0% 0
At least AAuCx††	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	0.2% 1
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin‡‡	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	0.0% 0
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=251).

Data table at https://www.cdc.gov/narms/files/table15.xlsx

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	1.2	[0.2 - 3.5]					30.3	64.9	2.4	1.2			0.4	0.8				
		Streptomycin	N/A	18.7	[14.1 - 24.1]									4.8	55.0	21.5	2.0	7.2	9.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	11.6	5.2	[2.8 - 8.7]							75.3	2.8	2.0	3.2	11.6	1.2	4.0			
	Cephems	Ceftiofur	0.4	4.0	[1.9 - 7.2]						7.6	86.5	1.6	0.4	0.4	3.6					
		Ceftriaxone	0.0	4.0	[1.9 - 7.2]					95.2	0.8				0.8	2.4	0.8				
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 1.5]								28.3	68.5	3.2						
	Penicillins	Ampicillin	0.0	21.1	[16.2 - 26.7]							70.9	7.6	0.4				21.1			
	Quinolones	Ciprofloxacin	2.8	0.8	[0.1 - 2.8]	92.4	2.8	1.2	0.4	0.4	2.0	0.8									
		Nalidixic acid	N/A	4.0	[1.9 - 7.2]								15.9	77.7	2.0	0.4	0.8	3.2			
II	**Cephems**	Cefoxitin	0.0	4.8	[2.5 - 8.2]								74.1	19.1	2.0		1.6	3.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	21.9	[17.0 - 27.5]											10.8	58.6	8.0	0.4	0.4	21.9
		Trimethoprim-sulfamethoxazole	N/A	3.6	[1.6 - 6.7]				89.2	5.6	1.2	0.4			3.6						
	Phenicols	Chloramphenicol	0.4	12.0	[8.2 - 16.6]								1.2	41.0	45.4	0.4		12.0			
	Tetracyclines	Tetracycline	0.8	19.1	[14.4 - 24.5]									80.1	0.8	0.4	6.8	12.0			

* 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, 2015.

Data tables at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

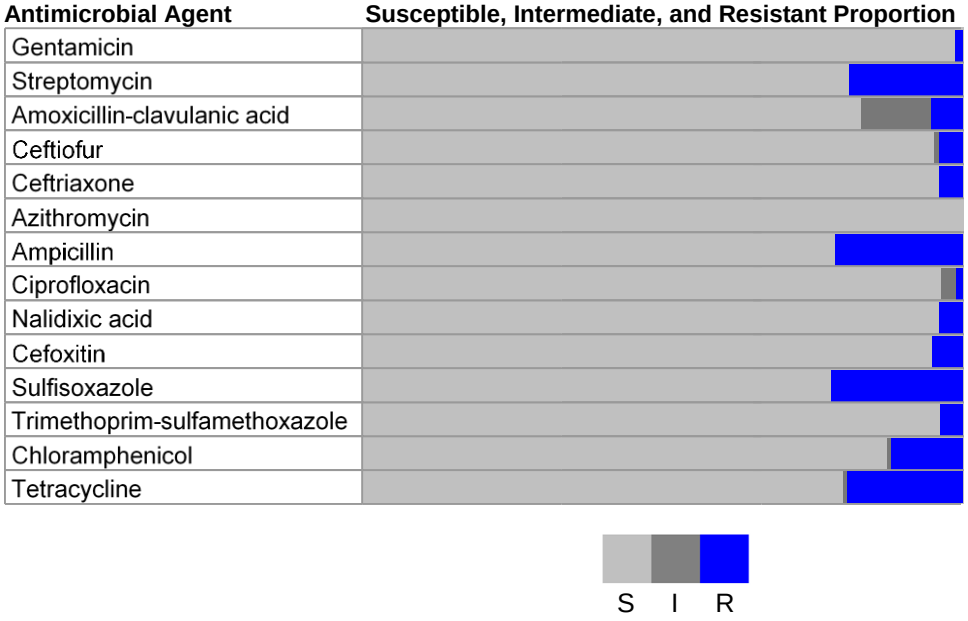


Table 16. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2006–2015

Year / Total Isolates			2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325	2014 262	2015 251
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	1.2% 3
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	18.7% 47
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	5.2% 13
	Cephems	Ceftiofur (MIC ≥ 8)	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	4.0% 10
		Ceftriaxone (MIC ≥ 4)	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	4.0% 10
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	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	21.1% 53
	Quinolones	Ciprofloxacin (MIC ≥ 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	0.8% 2
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	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	3.6% 9
		Nalidixic acid (MIC ≥ 32)	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	4.0% 10
II	Cephems	Cefoxitin (MIC ≥ 32)	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	4.8% 12
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	21.9% 55
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	3.6% 9
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	12.0% 30
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	19.1% 48

* 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, 2006–2015

Year / Total Isolates	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325	2014 262	2015 251
Resistance Pattern										
No resistance detected	62.3% 254	57.3% 232	67.9% 269	63.5% 235	66.9% 240	68.7% 222	68.6% 203	69.2% 225	68.3% 179	70.1% 176
Resistance ≥ 1 CLSI* class†	37.7% 154	42.7% 173	32.1% 127	36.5% 135	33.1% 119	31.3% 101	31.4% 93	30.8% 100	31.7% 83	29.9% 75
Resistance ≥ 2 CLSI* classes†	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	24.7% 62
Resistance ≥ 3 CLSI* classes†	30.6% 125	33.8% 137	27.5% 109	28.1% 104	27.3% 98	26.6% 86	24.7% 73	16.9% 55	21.8% 57	18.3% 46
Resistance ≥ 4 CLSI* classes†	26.2% 107	29.9% 121	25.8% 102	24.3% 90	24.2% 87	22.6% 73	20.9% 62	14.8% 48	19.1% 50	15.1% 38
Resistance ≥ 5 CLSI* classes†	20.8% 85	24.9% 101	24.0% 95	21.9% 81	21.2% 76	21.4% 69	18.6% 55	12.6% 41	15.6% 41	12.4% 31
At least ACSSuT‡	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	10.8% 27
At least ASSuT§ and not resistant to chloramphenicol	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	1.6% 4
At least ACT/S¶	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	2.0% 5
At least ACSSuTAuCx**	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	1.6% 4
At least AAuCx††	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	4.0% 10
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin‡‡	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	0.4% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=232). Data table at https://www.cdc.gov/narms/files/table18.xlsx

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	0.4	[0.0 - 2.4]					42.2	53.9	3.4					0.4				
		Streptomycin	N/A	6.5	[3.7 - 10.4]									14.7	69.8	9.1	0.4	0.4	5.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	4.7	[2.4 - 8.3]							91.4	2.6	0.9	0.4		0.4	4.3			
	Cephems	Ceftiofur	0.0	4.7	[2.4 - 8.3]						19.4	75.9				4.7					
		Ceftriaxone	0.0	4.7	[2.4 - 8.3]					94.8	0.4				0.4	3.0	0.9	0.4			
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 1.6]								51.3	47.8	0.9						
	Penicillins	Ampicillin	0.0	5.6	[3.0 - 9.4]							90.1	3.9	0.4				5.6			
	Quinolones	Ciprofloxacin	2.2	0.0	[0.0 - 1.6]	97.8			0.4	0.4	1.3										
		Nalidixic acid	N/A	0.4	[0.0 - 2.4]								23.7	74.6		1.3		0.4			
II	**Cephems**	Cefoxitin	0.0	4.7	[2.4 - 8.3]							0.4	87.5	6.0	1.3		1.7	3.0			
	Folate pathway inhibitors	Sulfisoxazole	N/A	5.6	[3.0 - 9.4]											6.0	42.7	43.5	1.7	0.4	5.6
		Trimethoprim-sulfamethoxazole	N/A	0.4	[0.0 - 2.4]				98.3	1.3					0.4						
	Phenicols	Chloramphenicol	0.0	4.7	[2.4 - 8.3]									83.2	12.1			4.7			
	Tetracyclines	Tetracycline	0.4	9.9	[6.4 - 14.5]									89.7	0.4		0.4	9.5			

* 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 6. Antimicrobial resistance pattern for *Salmonella* ser. Newport, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

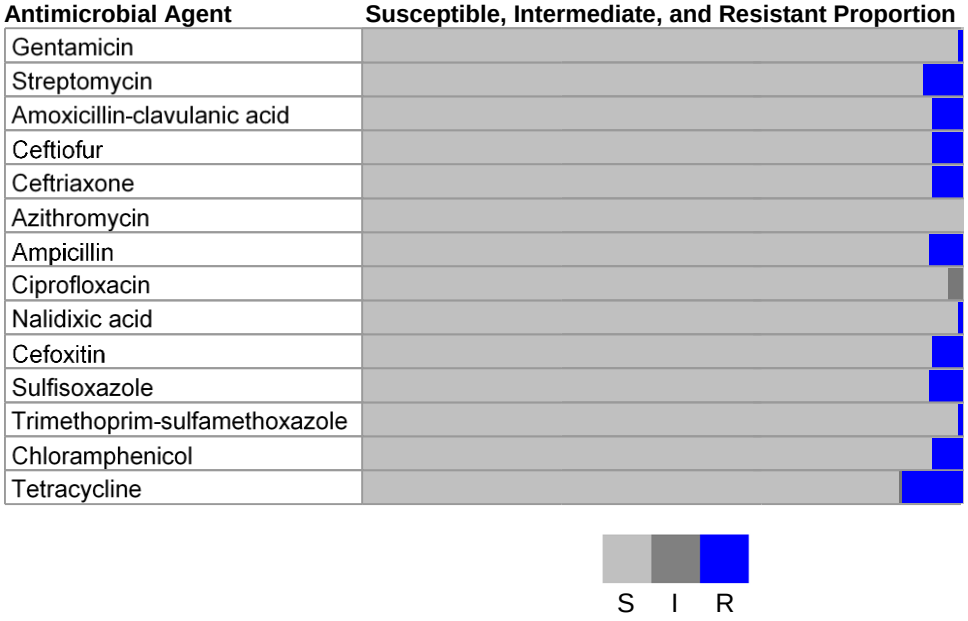


Table 19. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table19.xlsx

Year / Total Isolates			2006 218	2007 222	2008 258	2009 239	2010 306	2011 286	2012 258	2013 209	2014 235	2015 232
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	0.4% 1
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	6.5% 15
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	4.7% 11
	Cephems	Ceftiofur (MIC ≥ 8)	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	4.7% 11
		Ceftriaxone (MIC ≥ 4)	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	4.7% 11
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	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	5.6% 13
	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)	0.5% 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	2.2% 5
		Nalidixic acid (MIC ≥ 32)	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	0.4% 1
II	Cephems	Cefoxitin (MIC ≥ 32)	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	4.7% 11
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	5.6% 13
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	0.4% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	4.7% 11
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	9.9% 23

* 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, 2006–2015

Year / Total Isolates	2006 218	2007 222	2008 258	2009 239	2010 306	2011 286	2012 258	2013 209	2014 235	2015 232
Resistance Pattern										
No resistance detected	82.6% 180	89.2% 198	85.3% 220	89.5% 214	90.2% 276	94.1% 269	91.9% 237	90.9% 190	93.2% 219	87.9% 204
Resistance ≥ 1 CLSI* class†	17.4% 38	10.8% 24	14.7% 38	10.5% 25	9.8% 30	5.9% 17	8.1% 21	9.1% 19	6.8% 16	12.1% 28
Resistance ≥ 2 CLSI* classes†	16.5% 36	10.8% 24	13.6% 35	9.2% 22	8.2% 25	4.9% 14	6.6% 17	5.7% 12	4.7% 11	5.6% 13
Resistance ≥ 3 CLSI* classes†	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	5.6% 13
Resistance ≥ 4 CLSI* classes†	13.8% 30	9.5% 21	13.6% 35	7.5% 18	7.8% 24	3.8% 11	5.8% 15	4.8% 10	4.3% 10	5.6% 13
Resistance ≥ 5 CLSI* classes†	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	5.2% 12
At least ACSSuT‡	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	4.7% 11
At least ASSuT§ and not resistant to chloramphenicol	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	0.9% 2
At least ACT/S¶	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	0.0% 0
At least ACSSuTAuCx**	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	4.7% 11
At least AAuCx††	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	4.7% 11
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin‡‡	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	0.4% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=149).

Data table at https://www.cdc.gov/narms/files/table21.xlsx

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	1.3	4.7	[1.9 - 9.4]					34.9	56.4	2.7			1.3	2.7	2.0				
		Streptomycin	N/A	67.8	[59.6 - 75.2]										24.8	7.4	2.0	0.7	65.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	4.0	4.7	[1.9 - 9.4]							29.5	4.7	6.0	51.0	4.0		4.7			
	Cephems	Ceftiofur	0.7	6.0	[2.8 - 11.2]						18.1	73.2	2.0	0.7	1.3	4.7					
		Ceftriaxone	0.0	6.0	[2.8 - 11.2]					93.3	0.7				2.7	2.7		0.7			
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 2.4]								32.2	64.4	3.4						
	Penicillins	Ampicillin	0.0	65.8	[57.6 - 73.3]							28.9	4.7	0.7				65.8			
	Quinolones	Ciprofloxacin	5.4	0.0	[0.0 - 2.4]	92.6	2.0		0.7	1.3	3.4										
		Nalidixic acid	N/A	3.4	[1.1 - 7.7]								10.7	80.5	2.7	2.7	2.0	1.3			
II	**Cephems**	Cefoxitin	0.0	4.7	[1.9 - 9.4]								79.2	14.1	2.0		1.3	3.4			
	Folate pathway inhibitors	Sulfisoxazole	N/A	67.8	[59.6 - 75.2]											2.0	22.8	7.4			67.8
		Trimethoprim-sulfamethoxazole	N/A	4.0	[1.5 - 8.6]				94.6	1.3					4.0						
	Phenicols	Chloramphenicol	0.7	4.7	[1.9 - 9.4]									28.9	65.8	0.7		4.7			
	Tetracyclines	Tetracycline	0.7	67.1	[58.9 - 74.6]									32.2	0.7			67.1			

* 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 7. Antimicrobial resistance pattern for *Salmonella* ser. I 4,[5],12:i:-, 2015.

Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

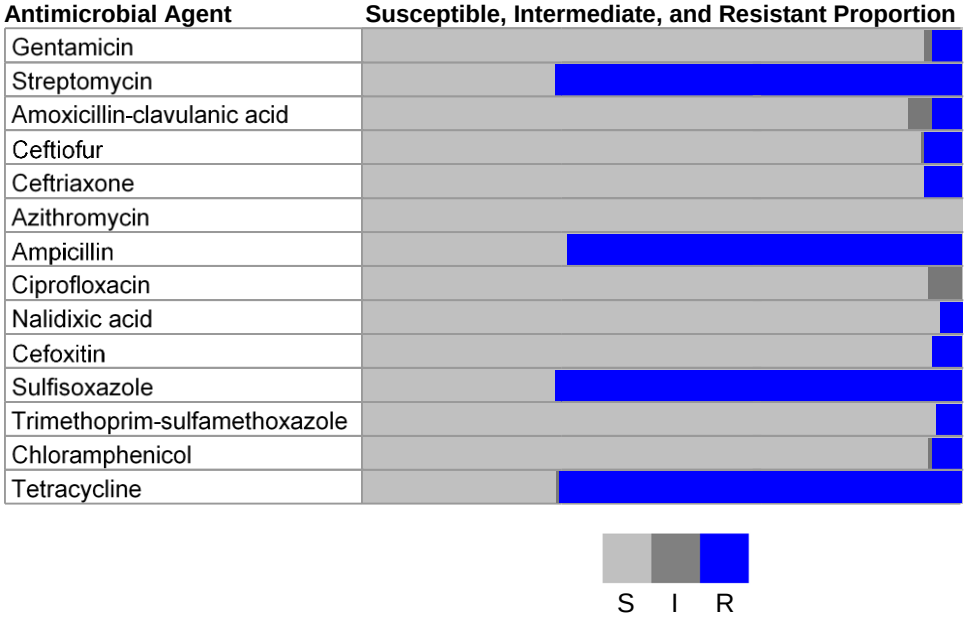


Table 22. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table22.xlsx

Year / Total Isolates			2006 105	2007 73	2008 84	2009 72	2010 78	2011 82	2012 117	2013 127	2014 110	2015 149
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	4.7% 7
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	67.8% 101
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	4.7% 7
	Cephems	Ceftiofur (MIC ≥ 8)	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	6.0% 9
		Ceftriaxone (MIC ≥ 4)	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	6.0% 9
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 2	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	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	65.8% 98
	Quinolones	Ciprofloxacin (MIC ≥ 1)	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	0.0% 0
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	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	5.4% 8
		Nalidixic acid (MIC ≥ 32)	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	3.4% 5
II	Cephems	Cefoxitin (MIC ≥ 32)	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	4.7% 7
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	67.8% 101
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	4.0% 6
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	4.7% 7
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	67.1% 100

* 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, 2006–2015

Year / Total Isolates	2006 105	2007 73	2008 84	2009 72	2010 78	2011 82	2012 117	2013 127	2014 110	2015 149
Resistance Pattern										
No resistance detected	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	27.5% 41
Resistance ≥ 1 CLSI* class†	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	72.5% 108
Resistance ≥ 2 CLSI* classes†	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	69.8% 104
Resistance ≥ 3 CLSI* classes†	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	67.8% 101
Resistance ≥ 4 CLSI* classes†	3.8% 4	2.7% 2	7.1% 6	9.7% 7	19.2% 15	19.5% 16	26.5% 31	49.6% 63	47.3% 52	63.1% 94
Resistance ≥ 5 CLSI* classes†	2.9% 3	1.4% 1	4.8% 4	6.9% 5	3.8% 3	0.0% 0	0.9% 1	3.1% 4	7.3% 8	8.1% 12
At least ACSSuT‡	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	4.0% 6
At least ASSuT§ and not resistant to chloramphenicol	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	59.1% 88
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	0.8% 1	0.9% 1	3.4% 5
At least ACSSuTAuCx**	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	2.7% 4
At least AAuCx††	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	4.7% 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	0.0% 0	0.0% 0	0.0% 0	0.9% 1	2.0% 3
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.8% 1	0.0% 0	0.0% 0
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=72). Data table at https://www.cdc.gov/narms/files/table24.xlsx

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	1.4	6.9	[2.3 - 15.5]					52.8	38.9				1.4	5.6	1.4				
		Streptomycin	N/A	16.7	[8.9 - 27.3]									11.1	58.3	13.9	6.9	2.8	6.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.4	6.9	[2.3 - 15.5]							79.2	5.6	4.2	2.8	1.4	2.8	4.2			
	Cephems	Ceftiofur	2.8	5.6	[1.5 - 13.6]						1.4	87.5	2.8	2.8		5.6					
		Ceftriaxone	1.4	6.9	[2.3 - 15.5]					91.7			1.4		1.4	4.2	1.4				
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 5.0]								5.6	88.9	4.2	1.4					
	Penicillins	Ampicillin	0.0	16.7	[8.9 - 27.3]							77.8	5.6				2.8	13.9			
	Quinolones	Ciprofloxacin	1.4	0.0	[0.0 - 5.0]	93.1	5.6				1.4										
		Nalidixic acid	N/A	0.0	[0.0 - 5.0]								47.2	48.6	1.4	2.8					
II	**Cephems**	Cefoxitin	0.0	5.6	[1.5 - 13.6]									87.5	6.9			5.6			
	Folate pathway inhibitors	Sulfisoxazole	N/A	9.7	[4.0 - 19.0]											9.7	55.6	22.2	1.4	1.4	9.7
		Trimethoprim-sulfamethoxazole	N/A	4.2	[0.8 - 11.7]				90.3	4.2		1.4			4.2						
	Phenicols	Chloramphenicol	2.8	4.2	[0.8 - 11.7]									13.9	79.2	2.8		4.2			
	Tetracyclines	Tetracycline	2.8	16.7	[8.9 - 27.3]									80.6	2.8	1.4	1.4	13.9			

* 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 8. Antimicrobial resistance pattern for *Salmonella* ser. Infantis, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

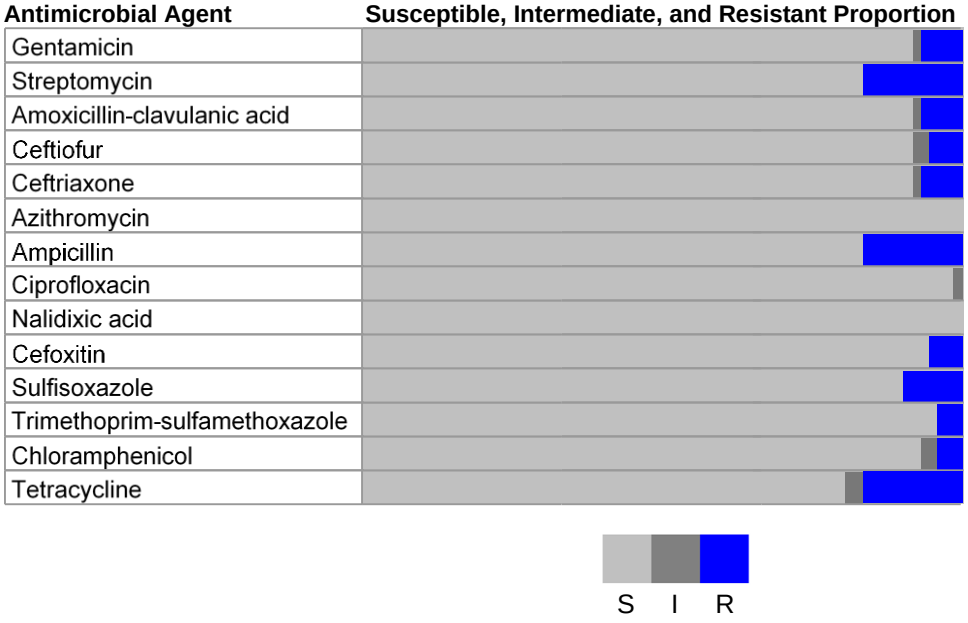


Table 25. Percentage and number of *Salmonella* ser. Infantis isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table25.xlsx

Year Total Isolates			2006 22	2007 26	2008 51	2009 44	2010 53	2011 63	2012 90	2013 76	2014 73	2015 72
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	6.9% 5
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	16.7% 12
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	6.9% 5
	Cephems	Ceftiofur (MIC ≥ 8)	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	5.6% 4
		Ceftriaxone (MIC ≥ 4)	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	6.9% 5
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	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	16.7% 12
	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	0.0% 0	2.0% 1	2.3% 1	0.0% 0	1.6% 1	4.4% 4	3.9% 3	4.1% 3	1.4% 1
		Nalidixic acid (MIC ≥ 32)	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	0.0% 0
II	Cephems	Cefoxitin (MIC ≥ 32)	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	5.6% 4
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	9.7% 7
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	4.2% 3
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	4.2% 3
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	16.7% 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 26. Resistance patterns of *Salmonella* ser. Infantis isolates, 2006–2015

Year Total Isolates	2006 22	2007 26	2008 51	2009 44	2010 53	2011 63	2012 90	2013 76	2014 73	2015 72
Resistance Pattern										
No resistance detected	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	72.2% 52
Resistance ≥ 1 CLSI* class†	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	27.8% 20
Resistance ≥ 2 CLSI* classes†	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	20.8% 15
Resistance ≥ 3 CLSI* classes†	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	15.3% 11
Resistance ≥ 4 CLSI* classes†	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	6.9% 5
Resistance ≥ 5 CLSI* classes†	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	4.2% 3
At least ACSSuT‡	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	2.8% 2
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	1.3% 1	1.4% 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	1.3% 1	2.7% 2	0.0% 0
At least ACSSuTAuCx**	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	2.8% 2
At least AAuCx††	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	6.9% 5
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	1.1% 1	2.6% 2	2.7% 2	0.0% 0
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=68). Data table at https://www.cdc.gov/narms/files/table27.xlsx

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	1.5	11.8	[5.2 - 21.9]					16.2	61.8	7.4		1.5	1.5	2.9	8.8				
		Streptomycin	N/A	26.5	[16.5 - 38.6]									1.5	35.3	36.8	7.4	7.4	11.8		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	2.9	[0.3 - 10.2]							85.3	4.4		7.4		1.5	1.5			
	Cephems	Ceftiofur	0.0	4.4	[0.9 - 12.4]				1.5		25.0	69.1			1.5	2.9					
		Ceftriaxone	0.0	4.4	[0.9 - 12.4]					95.6					2.9	1.5					
	Macrolides	Azithromycin	N/A	1.5	[0.0 - 7.9]								7.4	86.8	2.9	1.5	1.5				
	Penicillins	Ampicillin	0.0	10.3	[4.2 - 20.1]							83.8	5.9					10.3			
	Quinolones	Ciprofloxacin	1.5	0.0	[0.0 - 5.3]	97.1	1.5			1.5											
		Nalidixic acid	N/A	0.0	[0.0 - 5.3]								4.4	91.2	2.9	1.5					
II	**Cephems**	Cefoxitin	0.0	2.9	[0.3 - 10.2]							2.9	86.8	4.4	2.9		1.5	1.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	11.8	[5.2 - 21.9]											23.5	55.9	7.4		1.5	11.8
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 5.3]				97.1	2.9											
	Phenicols	Chloramphenicol	0.0	1.5	[0.0 - 7.9]								1.5	22.1	75.0			1.5			
	Tetracyclines	Tetracycline	0.0	11.8	[5.2 - 21.9]									88.2			1.5	10.3			

* 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 9. Antimicrobial resistance pattern for *Salmonella* ser. Heidelberg, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

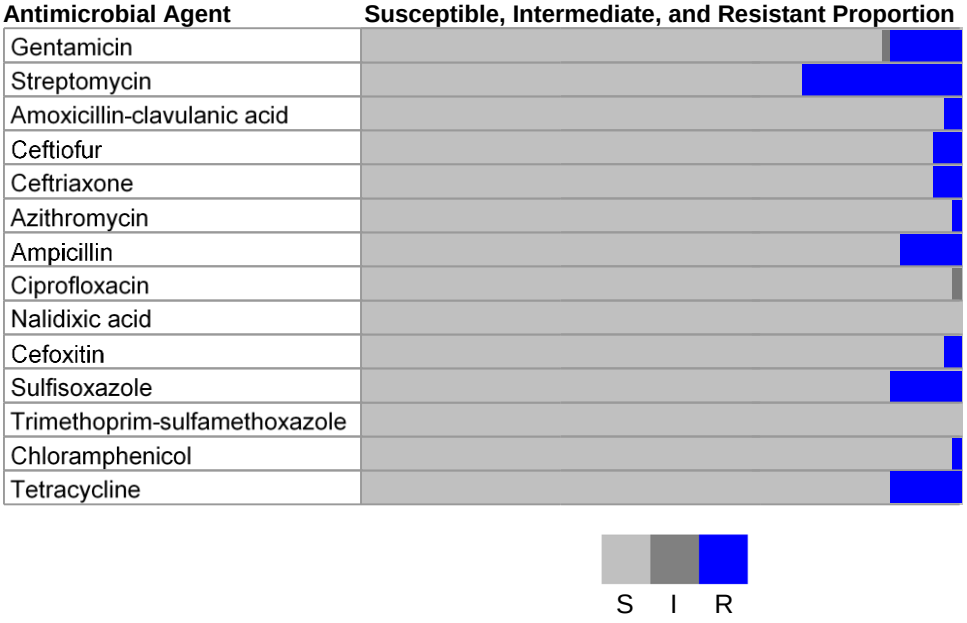


Table 28. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table28.xlsx

Year Total Isolates			2006 103	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60	2014 71	2015 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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	11.8% 8
		Kanamycin (MIC ≥ 64)	8.7% 9	11.2% 11	26.7% 20	20.9% 18	21.0% 13	21.4% 15	9.8% 4	26.7% 16	Not Tested	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	11.7% 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	26.5% 18
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	9.7% 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	2.9% 2
	Cephems	Ceftiofur (MIC ≥ 8)	9.7% 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	4.4% 3
		Ceftriaxone (MIC ≥ 4)	9.7% 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	4.4% 3
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.5% 1
	Penicillins	Ampicillin (MIC ≥ 32)	18.4% 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	10.3% 7
	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.4% 1	0.0% 0	4.2% 3	1.5% 1
		Nalidixic acid (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	4.2% 3	0.0% 0
II	Cephems	Cefoxitin (MIC ≥ 32)	8.7% 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	2.9% 2
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	11.8% 8
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	0.0% 0
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	1.5% 1
	Tetracyclines	Tetracycline (MIC ≥ 16)	13.6% 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	11.8% 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
‡ Includes isolates with MICs categorized as intermediate or resistant

Table 29. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2006–2015

Year Total Isolates	2006 103	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60	2014 71	2015 68
Resistance Pattern										
No resistance detected	68.0% 70	58.2% 57	57.3% 43	60.5% 52	53.2% 33	55.7% 39	58.5% 24	46.7% 28	62.0% 44	67.6% 46
Resistance ≥ 1 CLSI* class†	32.0% 33	41.8% 41	42.7% 32	39.5% 34	46.8% 29	44.3% 31	41.5% 17	53.3% 32	38.0% 27	32.4% 22
Resistance ≥ 2 CLSI* classes†	21.4% 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	22.1% 15
Resistance ≥ 3 CLSI* classes†	12.6% 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	10.3% 7
Resistance ≥ 4 CLSI* classes†	1.9% 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	4.4% 3
Resistance ≥ 5 CLSI* classes†	1.9% 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	1.5% 1
At least ACSSuT‡	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	1.5% 1
At least ASSuT§ and not resistant to chloramphenicol	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	2.9% 2
At least ACT/S¶	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	0.0% 0
At least ACSSuTAuCx**	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	0.0% 0
At least AAuCx††	9.7% 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	2.9% 2
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	1.4% 1	1.5% 1
At least azithromycin resistant and decreased susceptibility to ciprofloxacin‡‡	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015 (N=336). Data table at https://www.cdc.gov/narms/files/table30.xlsx

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]					75.3	23.2	1.5									
		Streptomycin	N/A	15.5	[11.8 - 19.8]								0.3	1.2	33.6	49.4	4.5	0.9	10.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.2	0.0	[0.0 - 1.1]							89.0	0.6	1.2	8.0	1.2					
	Cephems	Ceftiofur (N=335)††	0.0	0.0	[0.0 - 1.1]				0.6	3.3	83.0	13.1									
		Ceftriaxone	0.0	0.0	[0.0 - 1.1]					99.7	0.3										
	Macrolides	Azithromycin	N/A	0.3	[0.0 - 1.6]							3.6	56.3	38.7	0.9	0.3	0.3				
	Penicillins	Ampicillin	0.0	10.4	[7.4 - 14.2]							88.1	1.5					10.4			
	Quinolones	Ciprofloxacin	57.4	8.3	[5.6 - 11.8]	33.6		0.6	18.8	26.2	12.5	0.9	0.3	0.3	6.8						
		Nalidixic acid	N/A	63.4	[58.0 - 68.6]							2.4	30.4	1.5	2.4			63.4			
II	Cephems	Cefoxitin	0.6	0.0	[0.0 - 1.1]						0.6	26.5	20.8	30.1	21.4	0.6					
	Folate pathway inhibitors	Sulfisoxazole	N/A	11.6	[8.4 - 15.5]											54.5	24.4	8.0	1.5		11.6
		Trimethoprim-sulfamethoxazole	N/A	11.9	[8.6 - 15.9]				87.8			0.3			11.9						
	Phenicols	Chloramphenicol	0.0	9.5	[6.6 - 13.2]								2.4	73.2	14.9			9.5			
	Tetracyclines	Tetracycline	1.2	2.7	[1.2 - 5.0]									96.1	1.2		0.3	2.4			

* 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.
†† 1 of 336 isolates was not tested against ceftiofur due to a plate configuration change, but had a susceptible ceftriaxone MIC (≤0.25 µg/mL). The percentages shown are based on a total of 335 isolates tested for ceftiofur.

Figure 10. Antimicrobial resistance pattern for *Salmonella* ser. Typhi, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

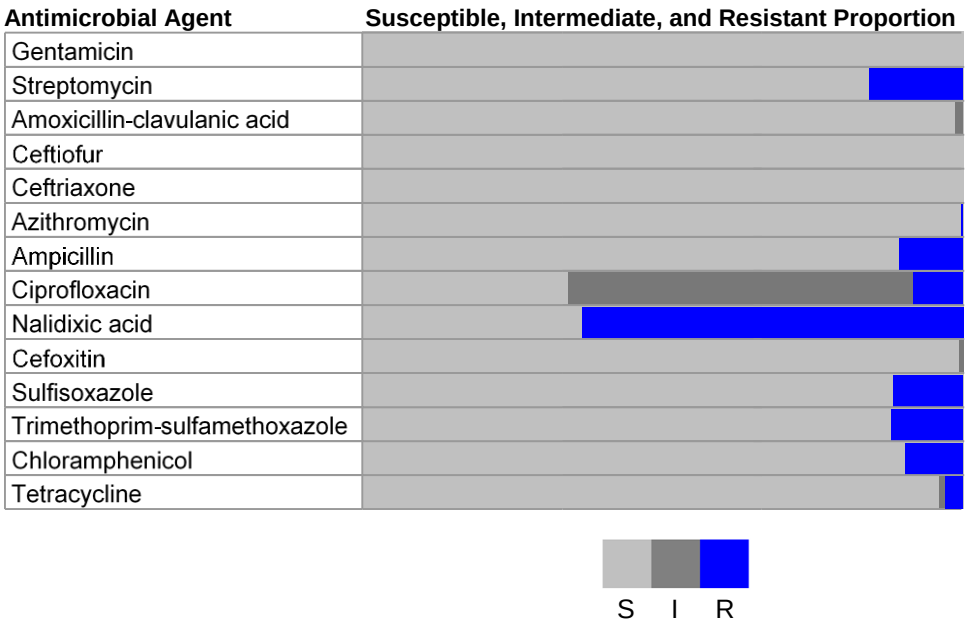


Table 31. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table31.xlsx

Year Total Isolates			2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 278	2014 335	2015 336
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	Not Tested	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	0.2% 1	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	15.5% 52
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1
	Penicillins	Ampicillin (MIC ≥ 32)	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	10.4% 35
	Quinolones	Ciprofloxacin (MIC ≥ 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	8.3% 28
		Decreased susceptibility to ciprofloxacin§ (MIC ≥ 0.12)	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	65.8% 221
		Nalidixic acid (MIC ≥ 32)	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	63.4% 213
II	Cephems	Cefoxitin (MIC ≥ 32)	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	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	11.6% 39
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	11.9% 40
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	9.5% 32
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	2.7% 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
‡ In 2015, the number tested for ceftiofur was 335; the one isolate not tested for ceftiofur was susceptible to ceftriaxone (MIC ≤0.25 µg/mL)
§ Includes isolates with MICs categorized as intermediate or resistant

Table 32. Resistance patterns of *Salmonella* ser. Typhi isolates, 2006–2015

Year Total Isolates	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 278	2014 335	2015 336
Resistance Pattern										
No resistance detected	39.6% 128	34.5% 138	36.9% 150	37.2% 135	28.7% 128	26.6% 102	30.6% 100	27.3% 76	22.4% 75	28.3% 95
Resistance ≥ 1 CLSI* class†	60.4% 195	65.5% 262	63.1% 257	62.8% 228	71.3% 318	73.4% 281	69.4% 227	72.7% 202	77.6% 260	71.7% 241
Resistance ≥ 2 CLSI* classes†	21.7% 70	18.3% 73	14.3% 58	14.6% 53	13.7% 61	12.5% 48	11.0% 36	11.5% 32	17.0% 57	13.7% 46
Resistance ≥ 3 CLSI* classes†	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	11.6% 39
Resistance ≥ 4 CLSI* classes†	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	10.7% 36
Resistance ≥ 5 CLSI* classes†	17.3% 56	15.0% 60	11.1% 45	10.2% 37	9.9% 44	9.9% 38	8.9% 29	7.2% 20	10.7% 36	8.3% 28
At least ACSSuT‡	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	0.6% 2
At least ASSuT§ and not resistant to chloramphenicol	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	0.6% 2
At least ACT/S¶	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	8.9% 30
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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015. Data table at https://www.cdc.gov/narms/files/table33.xlsx

Serotype*	n	(%)
Paratyphi A	88	(96.7)
Paratyphi B	3	(3.3)
Paratyphi C	0	(0)
Total	**91**	**(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, 2015 (N=88).
Data table at https://www.cdc.gov/narms/files/table34.xlsx

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 - 4.1]					84.1	12.5	3.4									
		Streptomycin	N/A	9.1	[4.0 - 17.1]									3.4	52.3	35.2	6.8	1.1	1.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 4.1]							20.5	70.5	6.8	2.3						
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 4.1]				1.1		3.4	94.3	1.1								
		Ceftriaxone	0.0	0.0	[0.0 - 4.1]					100											
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 4.1]								1.1	35.2	63.6						
	Penicillins	Ampicillin	0.0	1.1	[0.0 - 6.2]							6.8	88.6	3.4				1.1			
	Quinolones	Ciprofloxacin	88.6	0.0	[0.0 - 4.1]	9.1	2.3		1.1		87.5										
		Nalidixic acid	N/A	88.6	[80.1 - 94.4]									11.4				88.6			
II	Cephems	Cefoxitin	2.3	1.1	[0.0 - 6.2]							1.1	4.5	58.0	33.0	2.3	1.1				
	Folate pathway inhibitors	Sulfisoxazole	N/A	2.3	[0.3 - 8.0]											30.7	56.8	5.7	2.3	2.3	2.3
		Trimethoprim-sulfamethoxazole	N/A	1.1	[0.0 - 6.2]				96.6	2.3					1.1						
	Phenicols	Chloramphenicol	5.7	0.0	[0.0 - 4.1]								2.3	1.1	90.9	5.7					
	Tetracyclines	Tetracycline	4.5	1.1	[0.0 - 6.2]									94.3	4.5		1.1				

* 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 11. Antimicrobial resistance pattern for *Salmonella* ser. Paratyphi A, 2015.
Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

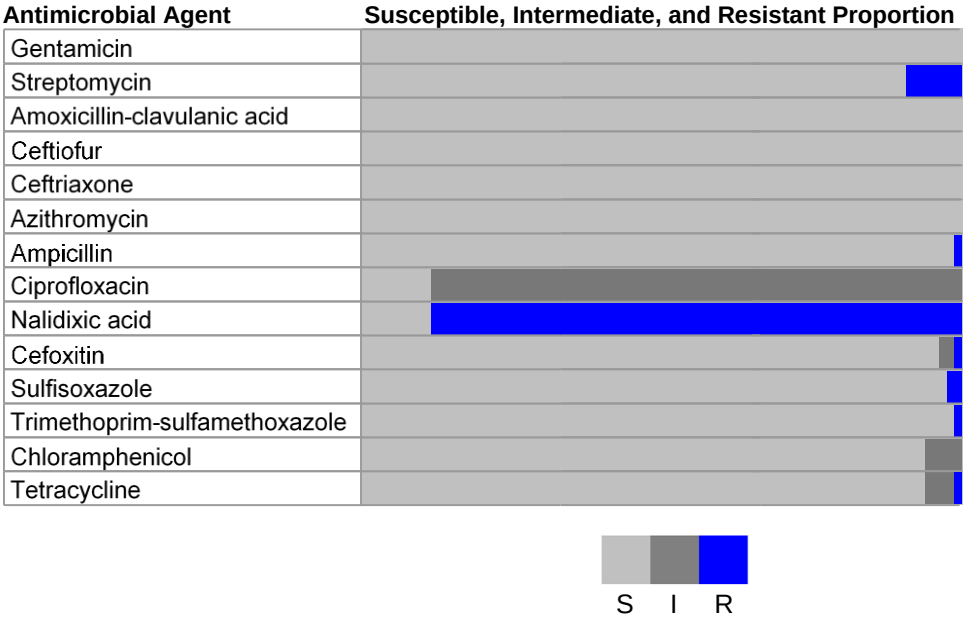


Table 35. Percentage and number of *Salmonella* ser. Paratyphi A isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table35.xlsx

Year / Total Isolates			2006 10	2007 16	2008 116	2009 100	2010 145	2011 152	2012 110	2013 101	2014 108	2015 88
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	0.0% 0
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	9.1% 8
	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0	0.9% 1	1.1% 1
	Quinolones	Ciprofloxacin (MIC ≥ 1)	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	0.0% 0
		Decreased susceptibility to ciprofloxacin‡ (MIC ≥ 0.12)	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	88.6% 78
		Nalidixic acid (MIC ≥ 32)	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	88.6% 78
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	0.9% 1	1.1% 1
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	2.3% 2
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	1.1% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	1.1% 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, 2006–2015. Data table at https://www.cdc.gov/narms/files/table36.xlsx

Year / Total Isolates	2006 10	2007 16	2008 116	2009 100	2010 145	2011 152	2012 110	2013 101	2014 108	2015 88
Resistance Pattern										
No resistance detected	20.0% 2	6.3% 1	10.3% 12	11.0% 11	5.5% 8	2.6% 4	4.5% 5	18.8% 19	19.4% 21	11.4% 10
Resistance ≥ 1 CLSI* class†	80.0% 8	93.8% 15	89.7% 104	89.0% 89	94.5% 137	97.4% 148	95.5% 105	81.2% 82	80.6% 87	88.6% 78
Resistance ≥ 2 CLSI* classes†	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	11.4% 10
Resistance ≥ 3 CLSI* classes†	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	2.3% 2
Resistance ≥ 4 CLSI* classes†	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	1.1% 1
Resistance ≥ 5 CLSI* classes†	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	0.0% 0
At least ACSSuT‡	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	0.0% 0
At least ASSuT§ and not resistant to chloramphenicol	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	0.0% 0
At least ACT/S¶	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	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	0.0% 0	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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were categorized as resistant to the quinolone class
‡ 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, 2015

Species	n	(%)
Shigella sonnei	489	(85.9)
Shigella flexneri	79	(13.9)
Shigella boydii	1	(0.2)
Total	**569**	**(100)**

Table 38. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2015 (N=569)

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	0.2	[0.0 - 1.0]					0.9	6.2	88.4	3.5	0.9			0.2				
		Streptomycin	N/A	96.1	[94.2 - 97.6]								0.2	0.4	2.6	0.7	2.5	48.7	45.0		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	10.4	4.0	[2.6 - 6.0]							1.2	2.3	48.2	33.9	10.4	3.7	0.4			
	Cephems	Ceftiofur	0.0	0.5	[0.1 - 1.5]				3.5	70.5	16.0	9.3	0.2		0.4	0.2					
		Ceftriaxone	0.0	0.5	[0.1 - 1.5]					97.4	1.9	0.2			0.4			0.2			
	Macrolides	Azithromycin††	N/A	9.8	[7.5 - 12.6]					0.2	1.1	3.5	7.6	75.7	1.9	0.7	9.3				
	Penicillins	Ampicillin	0.5	42.5	[38.4 - 46.7]							3.2	32.5	20.7	0.5	0.5	0.9	41.7			
	Quinolones	Ciprofloxacin	0.0	2.5	[1.4 - 4.1]	89.1	0.7	0.4	3.7	2.6	1.1			2.1	0.4						
		Nalidixic acid	N/A	7.7	[5.7 - 10.2]						1.9	64.3	20.4	4.4	1.2		0.7	7.0			
II	**Cephems**	Cefoxitin	1.2	2.6	[1.5 - 4.3]							0.2	59.4	35.0	1.6	1.2	2.5	0.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	30.1	[26.3 - 34.0]											61.3	6.0	0.9	0.7	1.1	30.1
		Trimethoprim-sulfamethoxazole	N/A	38.3	[34.3 - 42.4]				4.0	2.3	15.6	26.7	13.0	5.4	32.9						
	Phenicols	Chloramphenicol	0.9	8.1	[6.0 - 10.6]								5.1	75.0	10.9	0.9	2.3	5.8			
	Tetracyclines	Tetracycline	1.1	34.1	[30.2 - 38.2]									64.9	1.1	0.7	4.0	29.3			

* 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.
†† 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*, 2015.
Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

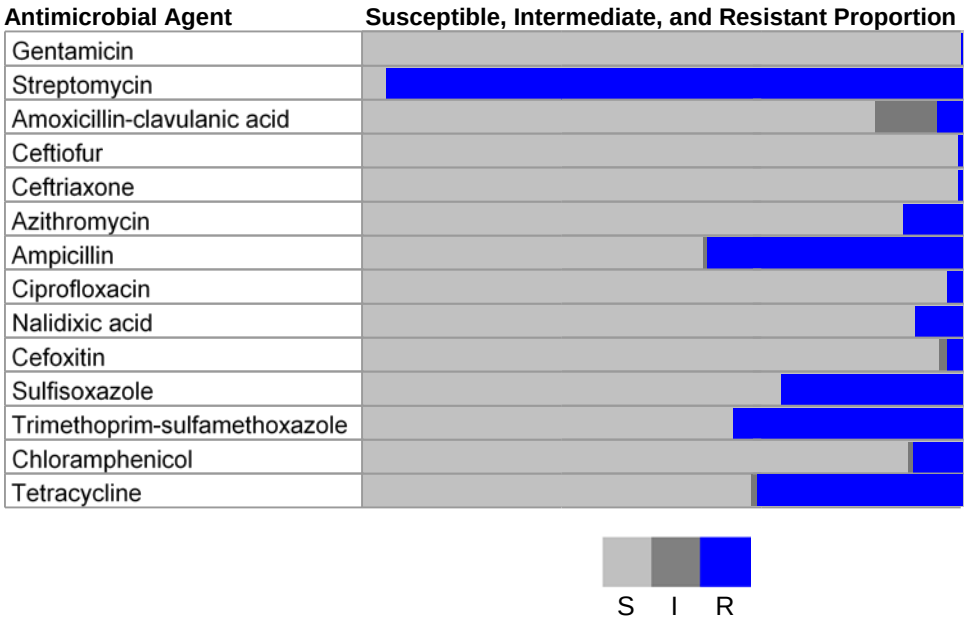


Table 39. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table39.xlsx

Year Total Isolates			2006 402	2007 480	2008 551	2009 473	2010 411	2011 293	2012 353	2013 343	2014 531	2015 569
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	0.2% 1
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	60.7% 244	73.3% 352	80.6% 444	89.2% 422	91.0% 374	87.7% 257	83.0% 293	91.5% 314	95.9% 509	96.1% 547
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	4.0% 23
	Cephems	Ceftiofur (MIC ≥ 8)	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	0.5% 3
		Ceftriaxone (MIC ≥ 4)	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	0.5% 3
	Macrolides	Azithromycin (MIC ≥ 32; *S. flexneri*: MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	3.4% 10	4.5% 16	3.8% 13	4.7% 25	9.8% 56
	Penicillins	Ampicillin (MIC ≥ 32)	62.4% 251	63.8% 306	62.4% 344	46.3% 219	40.9% 168	33.8% 99	25.5% 90	36.2% 124	33.9% 180	42.5% 242
	Quinolones	Ciprofloxacin (MIC ≥ 4)	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	2.5% 14
		Decreased susceptibility to ciprofloxacin (MIC ≥ 0.12)	2.7% 11	1.9% 9	1.5% 8	1.5% 7	4.1% 17	6.5% 19	5.1% 18	5.5% 19	7.7% 41	9.8% 56
		Nalidixic acid (MIC ≥ 32)	3.5% 14	1.7% 8	1.6% 9	2.1% 10	4.4% 18	6.1% 18	4.5% 16	5.0% 17	6.2% 33	7.7% 44
II	Cephems	Cefoxitin (MIC ≥ 32)	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	2.6% 15
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	40.3% 162	25.8% 124	28.5% 157	30.4% 144	29.9% 123	44.7% 131	34.8% 123	47.8% 164	30.1% 160	30.1% 171
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	46.0% 185	25.8% 124	31.2% 172	40.4% 191	47.7% 196	66.9% 196	43.3% 153	49.6% 170	40.9% 217	38.3% 218
	Phenicols	Chloramphenicol (MIC ≥ 32)	10.9% 44	8.3% 40	6.9% 38	9.1% 43	10.0% 41	12.3% 36	11.3% 40	11.7% 40	8.5% 45	8.1% 46
	Tetracyclines	Tetracycline (MIC ≥ 16)	34.6% 139	25.6% 123	24.3% 134	29.4% 139	31.4% 129	40.6% 119	37.1% 131	43.4% 149	27.3% 145	34.1% 194

* 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, 2006–2015

Year Total Isolates	2006 402	2007 480	2008 551	2009 473	2010 411	2011 293	2012 353	2013 343	2014 531	2015 569
Resistance Pattern										
No resistance detected	6.5% 26	6.9% 33	4.5% 25	3.8% 18	3.6% 15	4.1% 12	7.4% 26	4.1% 14	1.9% 10	1.1% 6
Resistance ≥ 1 CLSI* class†	93.5% 376	93.1% 447	95.5% 526	96.2% 455	96.4% 396	95.9% 281	92.6% 327	95.9% 329	98.1% 521	98.9% 563
Resistance ≥ 2 CLSI* classes†	64.7% 260	65.6% 315	68.2% 376	68.1% 322	69.8% 287	74.4% 218	54.4% 192	60.9% 209	59.3% 315	62.9% 358
Resistance ≥ 3 CLSI* classes†	43.8% 176	27.7% 133	35.2% 194	36.4% 172	39.7% 163	51.2% 150	37.7% 133	53.4% 183	42.4% 225	41.1% 234
Resistance ≥ 4 CLSI* classes†	15.7% 63	11.7% 56	10.3% 57	12.9% 61	14.1% 58	23.2% 68	20.1% 71	23.9% 82	24.1% 128	27.6% 157
Resistance ≥ 5 CLSI* classes†	5.2% 21	4.6% 22	3.1% 17	6.6% 31	4.9% 20	10.2% 30	7.6% 27	9.9% 34	8.3% 44	13.4% 76
At least ACSSuT‡	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	5.1% 29
At least ACT/S§	6.0% 24	4.0% 19	2.9% 16	6.6% 31	4.9% 20	7.8% 23	7.4% 26	8.2% 28	4.7% 25	4.6% 26
At least AT/S¶	26.6% 107	12.9% 62	16.0% 88	17.3% 82	17.8% 73	25.9% 76	15.6% 55	25.7% 88	15.3% 81	19.3% 110
At least AT/S¶ and decreased susceptibilty to ciprofloxacin**	0.5% 2	0.8% 4	0.4% 2	0.4% 2	1.5% 6	2.4% 7	1.4% 5	1.5% 5	1.3% 7	2.3% 13
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 resistant and decreased susceptibility to ciprofloxacin**	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.6% 2	0.6% 2	0.4% 2	0.4% 2
At least azithromycin resistant and decreased susceptibility to ciprofloxacin**	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.3% 1	0.3% 1	0.3% 1	0.9% 5	1.4% 8
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were included in the quinolone resistance category for surveillance purposes to capture emerging quinolone resistance mechanisms. This NARMS-established categorization does not follow CLSI ciprofloxacin interpretive criteria for clinical resistance and is not intended to predict clinical efficacy.
‡ ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
** Includes isolates with a ciprofloxacin MIC ≥0.12 µg/mL
†† ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

Table 41. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2015 (N=489). Data table at https://www.cdc.gov/narms/files/table41.xlsx

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]					0.4	5.1	89.4	4.1	1.0							
		Streptomycin	N/A	98.4	[96.8 - 99.3]										1.4	0.2	1.8	53.8	42.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	4.9	4.5	[2.8 - 6.7]							0.2	0.2	54.0	36.2	4.9	4.1	0.4			
	Cephems	Ceftiofur	0.0	0.6	[0.1 - 1.8]					75.3	14.7	9.2	0.2		0.4	0.2					
		Ceftriaxone	0.0	0.6	[0.1 - 1.8]					96.9	2.2	0.2			0.4			0.2			
	Macrolides	Azithromycin	N/A	6.1	[4.2 - 8.6]								5.3	86.7	1.6	0.2	6.1				
	Penicillins	Ampicillin	0.4	38.7	[34.3 - 43.1]							0.2	36.4	24.1	0.2	0.4	1.0	37.6			
	Quinolones	Ciprofloxacin	0.0	2.5	[1.3 - 4.2]	89.6	0.8	0.4	3.7	2.7	0.4			2.0	0.4						
		Nalidixic acid	N/A	7.2	[5.0 - 9.8]						2.0	68.9	16.6	4.3	1.0		0.8	6.3			
II	**Cephems**	Cefoxitin	1.4	3.1	[1.7 - 5.0]								66.5	28.4	0.6	1.4	2.9	0.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	24.1	[20.4 - 28.2]											66.7	6.1	1.0	0.8	1.2	24.1
		Trimethoprim-sulfamethoxazole	N/A	33.9	[29.8 - 38.3]				0.6	1.4	17.8	31.1	15.1	6.1	27.8						
	Phenicols	Chloramphenicol	0.8	2.0	[1.0 - 3.7]								1.4	84.0	11.7	0.8	0.2	1.8			
	Tetracyclines	Tetracycline	1.0	25.6	[21.8 - 29.7]									73.4	1.0	0.8	4.5	20.2			

* 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 13. Antimicrobial resistance pattern for *Shigella sonnei*, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

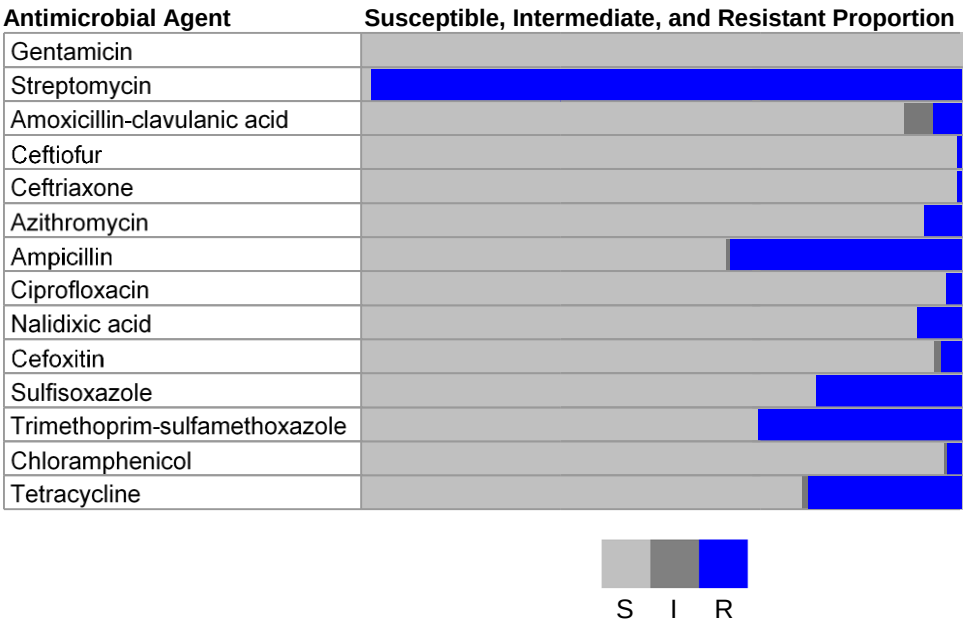


Table 42. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2006–2015

Year			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates			321	414	494	410	337	226	287	275	458	489
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	0.0% 0
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	98.4% 481
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	4.5% 22
	Cephems	Ceftiofur (MIC ≥ 8)	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	0.6% 3
		Ceftriaxone (MIC ≥ 4)	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	0.6% 3
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.9% 2	2.1% 6	1.1% 3	2.0% 9	6.1% 30
	Penicillins	Ampicillin (MIC ≥ 32)	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	38.7% 189
	Quinolones	Ciprofloxacin (MIC ≥ 4)	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	2.5% 12
		Decreased susceptibility to ciprofloxacin (MIC ≥ 0.12)	2.2% 7	1.2% 5	1.0% 5	0.7% 3	3.0% 10	3.1% 7	4.9% 14	3.6% 10	6.1% 28	9.2% 45
		Nalidixic acid (MIC ≥ 32)	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	7.2% 35
II	Cephems	Cefoxitin (MIC ≥ 32)	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	3.1% 15
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	24.1% 118
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	33.9% 166
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	2.0% 10
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	25.6% 125

* 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, 2006–2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates	321	414	494	410	337	226	287	275	458	489
Resistance Pattern										
No resistance detected	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	0.4% 2
Resistance ≥ 1 CLSI* class†	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	99.6% 487
Resistance ≥ 2 CLSI* classes†	59.8% 192	63.3% 262	65.4% 323	65.4% 268	68.0% 229	73.5% 166	49.8% 143	56.4% 155	55.7% 255	59.1% 289
Resistance ≥ 3 CLSI* classes†	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	34.8% 170
Resistance ≥ 4 CLSI* classes†	8.4% 27	5.1% 21	5.3% 26	5.6% 23	6.5% 22	14.2% 32	11.8% 34	14.9% 41	17.0% 78	21.1% 103
Resistance ≥ 5 CLSI* classes†	0.0% 0	1.2% 5	0.4% 2	0.5% 2	0.9% 3	3.5% 8	2.8% 8	1.8% 5	2.6% 12	8.0% 39
At least ACSSuT‡	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	1.6% 8
At least ACT/S§	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	0.8% 4
At least AT/S¶	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	14.7% 72
At least AT/S¶ and decreased susceptibilty to ciprofloxacin**	0.0% 0	0.7% 3	0.0% 0	0.0% 0	0.3% 1	0.4% 1	1.4% 4	0.0% 0	0.4% 2	1.6% 8
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 resistant and decreased susceptibility to ciprofloxacin**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.0% 0	0.2% 1	0.4% 2
At least azithromycin resistant and decreased susceptibility to ciprofloxacin**	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.3% 1	0.0% 0	0.2% 1	0.8% 4
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were included in the quinolone resistance category for surveillance purposes to capture emerging quinolone resistance mechanisms. This NARMS-established categorization does not follow CLSI ciprofloxacin interpretive criteria for clinical resistance and is not intended to predict clinical efficacy.
‡ ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
** Includes isolates with a ciprofloxacin MIC ≥0.12 µg/mL
†† ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, ceftriaxone

Table 44. Minimum inhibitory concentrations and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2015 (N=79). Data table in https://www.cdc.gov/narms/files/table44.xlsx

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**													
			%‡	%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	1.3	[0.0 - 6.8]					3.8	12.7	82.3					1.3				
		Streptomycin	N/A	82.3	[72.1 - 90.0]								1.3	2.5	10.1	3.8	6.3	17.7	58.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	44.3	1.3	[0.0 - 6.8]							7.6	15.2	11.4	20.3	44.3	1.3				
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 4.6]				24.1	41.8	24.1	10.1									
		Ceftriaxone	0.0	0.0	[0.0 - 4.6]					100											
	Macrolides	Azithromycin	N/A	32.9	[22.7 - 44.4]					1.3	7.6	25.3	20.3	8.9	3.8	3.8	29.1				
	Penicillins	Ampicillin	1.3	67.1	[55.6 - 77.3]							21.5	7.6		2.5	1.3		67.1			
	Quinolones	Ciprofloxacin	0.0	2.5	[0.3 - 8.8]	86.1			3.8	2.5	5.1			2.5							
		Nalidixic acid	N/A	11.4	[5.3 - 20.5]						1.3	35.4	44.3	5.1	2.5			11.4			
II	Cephems	Cefoxitin	0.0	0.0	[0.0 - 4.6]							1.3	16.5	74.7	7.6						
	Folate pathway inhibitors	Sulfisoxazole	N/A	65.8	[54.3 - 76.1]											29.1	5.1				65.8
		Trimethoprim-sulfamethoxazole	N/A	64.6	[53.0 - 75.0]				25.3	7.6	2.5			1.3	63.3						
	Phenicols	Chloramphenicol	1.3	45.6	[34.3 - 57.2]								26.6	20.3	6.3	1.3	15.2	30.4			
	Tetracyclines	Tetracycline	1.3	86.1	[76.4 - 92.8]									12.7	1.3		1.3	84.8			

* 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 14. Antimicrobial resistance pattern for *Shigella flexneri*, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

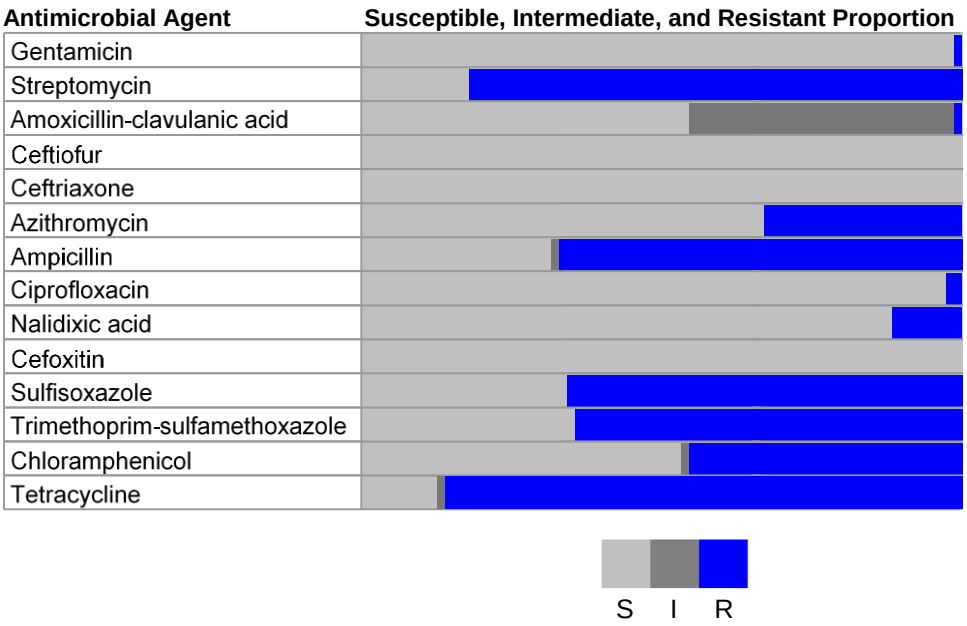


Table 45. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2006–2015

Year Total Isolates			2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64	2014 68	2015 79
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	1.3% 1
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	82.3% 65
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	1.3% 1
	Cephems	Ceftiofur (MIC ≥ 8)	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	0.0% 0
		Ceftriaxone (MIC ≥ 4)	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	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	12.1% 7	16.9% 10	15.6% 10	22.1% 15	32.9% 26
	Penicillins	Ampicillin (MIC ≥ 32)	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	67.1% 53
	Quinolones	Ciprofloxacin (MIC ≥ 4)	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	2.5% 2
		Decreased susceptibility to ciprofloxacin (MIC ≥ 0.12)	5.4% 4	6.6% 4	2.0% 1	3.5% 2	11.5% 7	15.5% 9	5.1% 3	14.1% 9	17.6% 12	13.9% 11
		Nalidixic acid (MIC ≥ 32)	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	11.4% 9
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)	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	65.8% 52
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	64.6% 51
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	45.6% 36
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	86.1% 68

* 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, 2006–2015

Year Total Isolates	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64	2014 68	2015 79
Resistance Pattern										
No resistance detected	5.4% 4	8.2% 5	4.1% 2	5.3% 3	9.8% 6	15.5% 9	11.9% 7	15.6% 10	8.8% 6	5.1% 4
Resistance ≥ 1 CLSI* class†	94.6% 70	91.8% 56	95.9% 47	94.7% 54	90.2% 55	84.5% 49	88.1% 52	84.4% 54	91.2% 62	94.9% 75
Resistance ≥ 2 CLSI* classes†	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	86.1% 68
Resistance ≥ 3 CLSI* classes†	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	79.7% 63
Resistance ≥ 4 CLSI* classes†	47.3% 35	55.7% 34	57.1% 28	63.2% 36	57.4% 35	58.6% 34	59.3% 35	62.5% 40	72.1% 49	68.4% 54
Resistance ≥ 5 CLSI* classes†	28.4% 21	27.9% 17	26.5% 13	49.1% 28	27.9% 17	34.5% 20	32.2% 19	45.3% 29	45.6% 31	46.8% 37
At least ACSSuT‡	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	26.6% 21
At least ACT/S§	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	27.8% 22
At least AT/S¶	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	48.1% 38
At least AT/S¶ and decreased susceptibilty to ciprofloxacin**	2.7% 2	1.6% 1	0.0% 0	1.8% 1	8.2% 5	8.6% 5	0.0% 0	7.8% 5	5.9% 4	6.3% 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 resistant and decreased susceptibility to ciprofloxacin**	1.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.7% 1	1.7% 1	3.1% 2	1.5% 1	0.0% 0
At least azithromycin resistant and decreased susceptibility to ciprofloxacin**	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 1	4.4% 3	5.1% 4
At least azithromycin and ceftriaxone resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0	1.5% 1	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were included in the quinolone resistance category for surveillance purposes to capture emerging quinolone resistance mechanisms. This NARMS-established categorization does not follow CLSI ciprofloxacin interpretive criteria for clinical resistance and is not intended to predict clinical efficacy.
‡ ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline
§ ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
¶ AT/S: resistance to ampicillin, trimethoprim-sulfamethoxazole
** Includes isolates with a ciprofloxacin MIC ≥0.12 µg/mL
†† 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, 2015 (N=181). Data table at https://www.cdc.gov/narms/files/table47.xlsx

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	1.1	[0.1 - 3.9]					21.5	65.2	11.6		0.6			1.1				
		Streptomycin	N/A	12.2	[7.8 - 17.8]								6.6	65.2	14.4	1.7	3.9	2.8	5.5		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.1	1.7	[0.3 - 4.8]							0.6	0.6	91.2	5.0	1.1	0.6	1.1			
	Cephems	Ceftiofur	0.0	1.7	[0.3 - 4.8]					2.8	90.6	3.9	1.1			1.7					
		Ceftriaxone	0.0	1.7	[0.3 - 4.8]					97.2	1.1						1.1		0.6		
	Macrolides	Azithromycin	N/A	0.0	[0.0 - 2.0]							12.2	76.2	11.0		0.6					
	Penicillins	Ampicillin	1.1	6.6	[3.5 - 11.3]							0.6	50.8	39.8	1.1	1.1	1.1	5.5			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 2.0]	94.5		0.6	1.1	3.3	0.6										
		Nalidixic acid	N/A	5.0	[2.3 - 9.2]							1.1	66.9	26.0	1.1			5.0			
II	**Cephems**	Cefoxitin	1.7	1.1	[0.1 - 3.9]								1.1	33.1	63.0	1.7		1.1			
	Folate pathway inhibitors	Sulfisoxazole	N/A	7.7	[4.3 - 12.6]											82.9	6.6	2.2	0.6		7.7
		Trimethoprim-sulfamethoxazole	N/A	0.6	[0.0 - 3.0]				92.3	6.6	0.6				0.6						
	Phenicols	Chloramphenicol	0.0	3.9	[1.6 - 7.8]								0.6	8.8	86.7		1.1	2.8			
	Tetracyclines	Tetracycline	1.7	9.9	[6.0 - 15.3]									88.4	1.7			9.9			

* 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 15. Antimicrobial resistance pattern for *Escherichia coli* O157, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

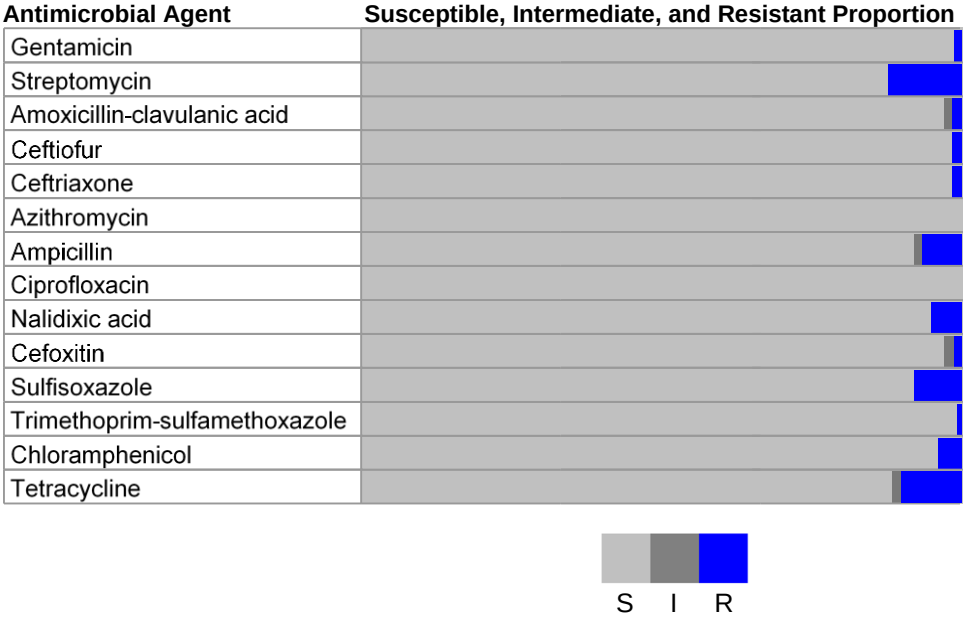


Table 48. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2006–2015. Data table at https://www.cdc.gov/narms/files/table48.xlsx

Year			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates			233	189	161	187	170	162	166	177	155	181
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	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	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	1.1% 2
		Kanamycin (MIC ≥ 64)	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	Not Tested
		Streptomycin (MIC ≥ 32; pre-2014: MIC ≥ 64)	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	12.2% 22
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	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	1.7% 3
	Cephems	Ceftiofur (MIC ≥ 8)	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	1.7% 3
		Ceftriaxone (MIC ≥ 4)	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	1.7% 3
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	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	6.6% 12
	Quinolones	Ciprofloxacin (MIC ≥ 4)	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	0.0% 0
		Decreased susceptibility to ciprofloxacin (MIC ≥ 0.12)	2.6% 6	2.1% 4	1.2% 2	2.1% 4	1.2% 2	1.2% 2	2.4% 4	3.4% 6	5.8% 9	5.0% 9
		Nalidixic acid (MIC ≥ 32)	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	5.0% 9
II	Cephems	Cefoxitin (MIC ≥ 32)	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	1.1% 2
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	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	7.7% 14
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	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	0.6% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	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	3.9% 7
	Tetracyclines	Tetracycline (MIC ≥ 16)	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	9.9% 18

* 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, 2006–2015. Data table at https://www.cdc.gov/narms/files/table49.xlsx

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates	233	189	161	187	170	162	166	177	155	181
Resistance Pattern										
No resistance detected	91.4% 213	92.6% 175	91.9% 148	89.8% 168	93.5% 159	92.6% 150	92.2% 153	84.2% 149	87.1% 135	77.3% 140
Resistance ≥ 1 CLSI* class†	8.6% 20	7.4% 14	8.1% 13	10.2% 19	6.5% 11	7.4% 12	7.8% 13	15.8% 28	12.9% 20	22.7% 41
Resistance ≥ 2 CLSI* classes†	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	12.2% 22
Resistance ≥ 3 CLSI* classes†	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	8.3% 15
Resistance ≥ 4 CLSI* classes†	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	3.3% 6
Resistance ≥ 5 CLSI* classes†	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	1.1% 2
At least ACSSuT‡	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	1.1% 2
At least ACT/S§	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	0.6% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 1
At least ceftriaxone resistant and decreased susceptibility to ciprofloxacin**	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute
† Isolates with decreased susceptibility to ciprofloxacin (DSC; MIC ≥0.12 µg/mL) were included in the quinolone resistance category for surveillance purposes to capture emerging quinolone resistance mechanisms. This NARMS-established categorization does not follow CLSI ciprofloxacin interpretive criteria for clinical resistance and is not intended to predict clinical efficacy.
‡ 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
** Includes isolates with a ciprofloxacin MIC ≥0.12 µg/mL

5. *Campylobacter*

Table 50. Frequency* of *Campylobacter* species, 2015

Species	n	(%)
Campylobacter jejuni	1000	(85.9)
Campylobacter coli	118	(10.1)
Other	46	(4.0)
Total	**1164**	**(100)**

* Frequencies reflect the number of isolates tested, not the number of isolates received. See Methods for testing sampling methods.

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2015 (N=1000). Data table at https://www.cdc.gov/narms/files/table51.xlsx

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
I	**Aminoglycosides**	Gentamicin	N/A	1.8	[1.1 - 2.8]				0.1	2.1	54.7	40.9	0.4					1.8	
	Ketolide	Telithromycin	N/A	3.0	[2.0 - 4.3]				0.3	2.4	15.8	51.5	24.6	2.4	0.7	2.3			
	Macrolides	Azithromycin	N/A	2.7	[1.8 - 3.9]	0.1	9.1	44.4	38.0	5.7									2.7
		Erythromycin	N/A	2.7	[1.8 - 3.9]			0.1	0.5	15.6	51.8	25.5	3.8						2.7
	Quinolones	Ciprofloxacin	N/A	25.3	[22.6 - 28.1]	0.1	0.5	18.5	47.4	6.9	1.3	0.1		0.4	11.0	7.7	3.6	2.2	0.3
		Nalidixic acid	N/A	25.2	[22.5 - 28.0]									55.9	16.8	2.1	0.2	0.3	24.7
II	**Lincosamides**	Clindamycin	N/A	3.1	[2.1 - 4.4]			6.7	50.5	32.3	7.4	0.4		0.5	0.6	0.9	0.7		
	Phenicols	Florfenicol	N/A	1.5	[0.8 - 2.5]				0.2	0.1	1.8	75.4	17.3	3.7	1.3	0.2			
	Tetracyclines	Tetracycline	N/A	47.7	[44.6 - 50.8]			0.4	17.5	28.8	4.0	1.6	0.9		0.1		0.6	6.1	40.0

* 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*, 2015. Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

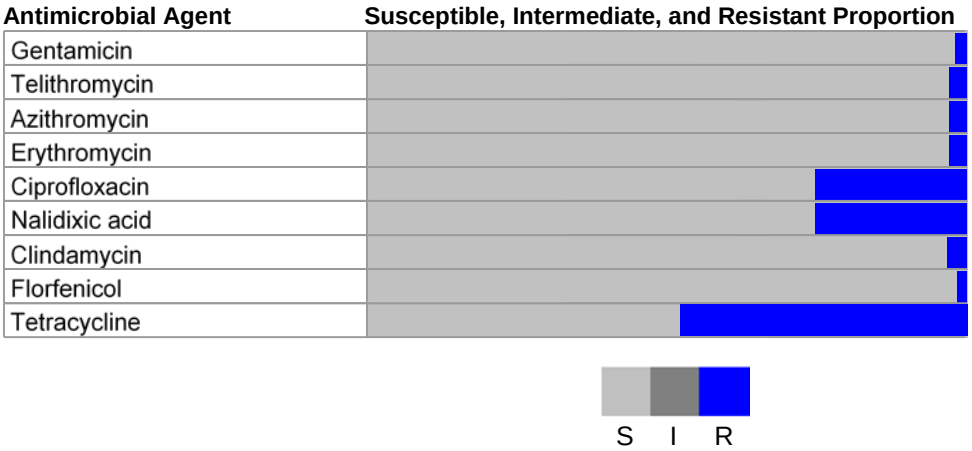


Table 52. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2006–2015

Year			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates			709	991	1033	1350	1159	1282	1190	1183	1251	1000
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	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	1.8% 18
	Ketolides	Telithromycin (MIC ≥ 8)	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	3.0% 30
	Macrolides	Azithromycin (MIC ≥ 0.5)	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	2.7% 27
		Erythromycin (MIC ≥ 8)	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	2.7% 27
	Quinolones	Ciprofloxacin (MIC ≥ 1)	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	25.3% 253
		Nalidixic acid (MIC ≥ 32)	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	25.2% 252
II	Lincosamides	Clindamycin (MIC ≥ 1)	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	3.1% 31
	Phenicols	Florfenicol (MIC ≥ 8)	0.0% 0	0.0% 0	0.6% 6	0.6% 8	1.5% 17	2.0% 26	1.4% 17	1.2% 14	1.0% 12	1.5% 15
	Tetracyclines	Tetracycline (MIC ≥ 2)	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	47.7% 477

* 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, 2006–2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates	709	991	1033	1350	1159	1282	1190	1183	1251	1000
Resistance Pattern										
No resistance detected	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	45.7% 457
Resistance ≥ 1 CLSI* class	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	54.3% 543
Resistance ≥ 2 CLSI* classes	13.1% 93	18.8% 186	15.8% 163	15.1% 204	19.0% 220	23.5% 301	20.0% 238	17.2% 204	20.9% 262	20.8% 208
Resistance ≥ 3 CLSI* classes	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	4.4% 44
Resistance ≥ 4 CLSI* classes	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	2.2% 22
Resistance ≥ 5 CLSI* classes	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	1.9% 19
At least macrolide and quinolone resistant	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	2.1% 21

* CLSI: Clinical and Laboratory Standards Institute

Table 54. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2015 (N=118)

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
I	**Aminoglycosides**	Gentamicin	N/A	3.4	[0.9 - 8.5]				0.8		15.3	78.0	2.5					3.4	
	Ketolide	Telithromycin	N/A	22.0	[14.9 - 30.6]					14.4	17.8	10.2	11.0	24.6	9.3	12.7			
	Macrolides	Azithromycin	N/A	12.7	[7.3 - 20.1]			3.4	49.2	31.4	3.4								12.7
		Erythromycin	N/A	12.7	[7.3 - 20.1]					1.7	30.5	25.4	16.1	11.9	1.7				12.7
	Quinolones	Ciprofloxacin	N/A	39.8	[30.9 - 49.3]			5.1	35.6	12.7	6.8			0.8	5.9	19.5	11.9	1.7	
		Nalidixic acid	N/A	40.7	[31.7 - 50.1]									18.6	33.9	6.8	0.8	1.7	38.1
II	**Lincosamides**	Clindamycin	N/A	17.8	[11.4 - 25.9]				4.2	33.9	32.2	11.9	3.4	0.8	2.5	7.6	3.4		
	Phenicols	Florfenicol	N/A	2.5	[0.5 - 7.2]						2.5	48.3	41.5	5.1	0.8	0.8	0.8		
	Tetracyclines	Tetracycline	N/A	45.8	[36.6 - 55.2]				0.8	28.0	16.1	5.9	3.4			0.8			44.9

* 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. ECOFFs were used when available.

Figure 17. Antimicrobial resistance pattern for *Campylobacter coli*, 2015.
Data table at https://www.cdc.gov/narms/files/Figs.-3-17.xlsx

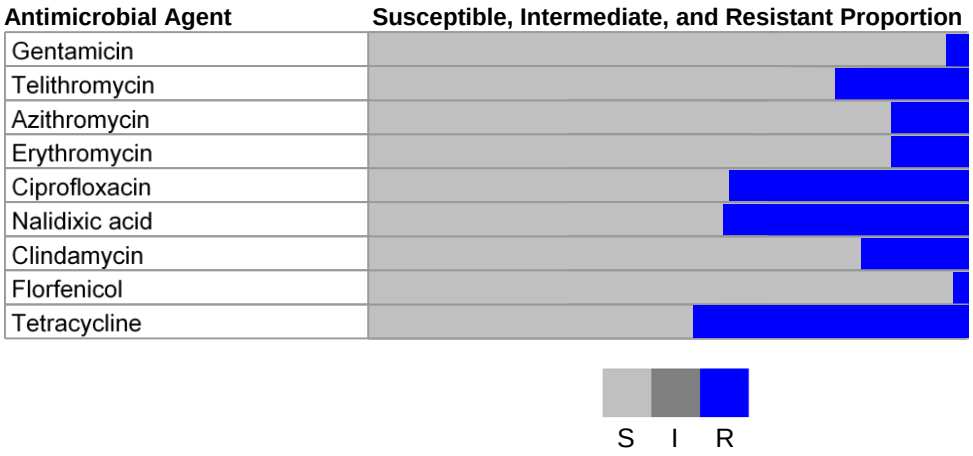


Table 55. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2006–2015

Year			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates			96	104	115	141	115	149	134	142	146	118
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint in µg/mL)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	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	3.4% 4
	Ketolides	Telithromycin (MIC ≥ 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	22.0% 26
	Macrolides	Azithromycin (MIC ≥ 1)	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	12.7% 15
		Erythromycin (MIC ≥ 16)	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	12.7% 15
	Quinolones	Ciprofloxacin (MIC ≥ 1)	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	39.8% 47
		Nalidixic acid (MIC ≥ 32)	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	40.7% 48
II	Lincosamides	Clindamycin (MIC ≥ 2)	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	17.8% 21
	Phenicols	Florfenicol (MIC ≥ 8)	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	2.5% 3
	Tetracyclines	Tetracycline (MIC ≥ 4)	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	45.8% 54

* 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, 2006–2015

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Isolates	96	104	115	141	115	149	134	142	146	118
Resistance Pattern										
No resistance detected	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	36.4% 43
Resistance ≥ 1 CLSI* class	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	63.6% 75
Resistance ≥ 2 CLSI* classes	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	39.0% 46
Resistance ≥ 3 CLSI* classes	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	19.5% 23
Resistance ≥ 4 CLSI* classes	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	11.0% 13
Resistance ≥ 5 CLSI* classes	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	8.5% 10
At least macrolide and quinolone resistant	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	8.5% 10

* CLSI: Clinical and Laboratory Standards Institute

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

Table 57. Frequency of *Vibrio* species other than *V. cholerae*, 2009–2015.

Data table at https://www.cdc.gov/narms/files/table57.xlsx

Species	2009		2010		2011		2012		2013*		2014*		2015	
	n	(%)	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)	361	(56.4)
Vibrio alginolyticus	46	(16.4)	49	(14.9)	103	(25.9)	117	(19.4)	122	(20.2)	127	(25.8)	122	(19.1)
Vibrio vulnificus	50	(17.8)	61	(18.5)	63	(15.8)	65	(10.8)	87	(14.4)	80	(16.3)	94	(14.7)
Vibrio fluvialis	21	(7.5)	24	(7.3)	18	(4.5)	28	(4.6)	40	(6.6)	45	(9.1)	40	(6.3)
Vibrio mimicus	11	(3.9)	9	(2.7)	9	(2.3)	11	(1.8)	27	(4.5)	22	(4.5)	19	(3.0)
Vibrio harveyi	0	(0)	2	(0.6)	4	(1.0)	3	(0.5)	5	(0.8)	6	(1.2)	3	(0.5)
Other	4	(1.4)	5	(1.5)	0	(0)	9	(1.5)	9	(1.5)	12	(2.4)	1	(0.2)
Total	**281**	**(100)**	**329**	**(100)**	**398**	**(100)**	**603**	**(100)**	**605**	**(100)**	**492**	**(100)**	**640**	**(100)**

* Frequencies reflect the number of isolates tested, not the number of isolates received. 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, 2015 (N=640). Data table at https://www.cdc.gov/narms/files/table58.xlsx

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 - 0.6]					3.1	13.0	64.1	19.5	0.3							
		Streptomycin††	N/A	N/A	N/A								0.8	5.3	26.4	62.7	4.4	0.5			
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.4	2.0	[1.1 - 3.4]							27.8	35.0	26.9	6.9	1.4	1.4	0.6			
	Cephems	Ceftiofur†† (N=580)‡‡	N/A	N/A	N/A				15.7	5.5	18.4	57.8	2.2	0.3							
		Ceftriaxone††	N/A	N/A	N/A					98.8	0.6	0.5	0.2								
	Macrolides	Azithromycin††	N/A	N/A	N/A				18.1	53.0§§	25.5	3.1		0.3							
	Penicillins	Ampicillin	5.8	57.2	[53.3 - 61.1]							15.0	3.0	3.9	15.2	5.8	12.8	44.4			
	Quinolones	Ciprofloxacin	0.2	0.0	[0.0 - 0.6]	20.8	5.6	15.8	49.5	8.0	0.2		0.2								
		Nalidixic acid††	N/A	N/A	N/A						63.1	34.8	1.4	0.5		0.2					
II	**Cephems**	Cefoxitin	11.3	2.0	[1.1 - 3.4]						0.2	0.2	0.9	8.9	76.6	11.3	1.7	0.3			
	Folate pathway inhibitors	Sulfisoxazole††	N/A	N/A	N/A											12.3	10.2	9.5	13.9	21.7	32.3
		Trimethoprim-sulfamethoxazole	N/A	0.3	[0.0 - 1.1]				90.3	9.4					0.3						
	Phenicols	Chloramphenicol††	N/A	N/A	N/A								97.2	2.5	0.3						
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 0.6]									100							

* 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 if 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 for resistance have been established
** 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.
†† CLSI MIC interpretive criteria have not been established
‡‡ 60 of 640 isolates were not tested against ceftiofur due to a plate configuration change. The percentages shown are based on a total of 580 isolates tested for ceftiofur.
§§ 39 of the 339 isolates represented by this proportion were tested on a panel in which the lowest tested concentration for azithromycin was 0.25 µg/mL instead of 0.125 µg/mL. Thus, for these isolates, the MIC may be 0.25 µg/mL (as depicted) or ≤0.125 µg/mL.

Table 59. Minimum inhibitory concentrations (MICs) and resistance of *Vibrio parahaemolyticus* isolates to antimicrobial agents, 2015 (N=361). Data table at https://www.cdc.gov/narms/files/table59.xlsx

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 - 1.0]					0.3	2.8	71.2	25.8								
		Streptomycin††	N/A	N/A	N/A									0.3	12.7	83.9	2.8	0.3			
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 1.0]							28.3	50.1	21.3	0.3						
	Cephems	Ceftiofur†† (N=307)‡‡	N/A	N/A	N/A				0.7	0.3	15.3	81.4	2.0	0.3							
		Ceftriaxone††	N/A	N/A	N/A					100											
	Macrolides	Azithromycin††	N/A	N/A	N/A				6.4	67.6§§	24.9	0.8		0.3							
	Penicillins	Ampicillin	9.4	63.4	[58.2 - 68.4]							1.4	1.1	2.5	22.2	9.4	19.9	43.5			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 1.0]	2.5	1.9	17.5	73.7	4.4											
		Nalidixic acid††	N/A	N/A	N/A						56.2	43.2		0.6							
II	**Cephems**	Cefoxitin	3.0	0.3	[0.0 - 1.5]						0.3		0.8	6.6	88.9	3.0	0.3				
	Folate pathway inhibitors	Sulfisoxazole††	N/A	N/A	N/A											1.7	2.8	6.6	15.8	25.2	47.9
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 1.0]				84.2	15.8											
	Phenicols	Chloramphenicol††	N/A	N/A	N/A								98.6	1.1	0.3						
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 1.0]									100							

* 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 if 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 for resistance have been established
** 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.
†† CLSI MIC interpretive criteria have not been established
‡‡ 54 of 361 isolates were not tested against ceftiofur due to a plate configuration change. The percentages shown are based on a total of 307 isolates tested for ceftiofur.
§§ 34 of the 244 isolates represented by this proportion were tested on a panel in which the lowest tested concentration for azithromycin was 0.25 µg/mL instead of 0.125 µg/mL. Thus, for these isolates, the MIC may be 0.25 µg/mL (as depicted) or ≤0.125 µg/mL.

Table 60. Minimum inhibitory concentrations (MICs) and resistance of *Vibrio alginolyticus* isolates to antimicrobial agents, 2015 (N=122). Data table at https://www.cdc.gov/narms/files/table60.xlsx

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 - 3.0]						24.6	66.4	8.2	0.8							
		Streptomycin††	N/A	N/A	N/A									5.7	74.6	17.2	2.5				
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 3.0]							1.6	18.0	67.2	13.1						
	Cephems	Ceftiofur†† (N=120)‡‡	N/A	N/A	N/A					2.5	35.8	59.2	2.5								
		Ceftriaxone††	N/A	N/A	N/A					99.2		0.8									
	Macrolides	Azithromycin††	N/A	N/A	N/A				4.1	52.5§§	40.2	3.3									
	Penicillins	Ampicillin	0.8	97.5	[93.0 - 99.5]							0.8			0.8	0.8	3.3	94.3			
	Quinolones	Ciprofloxacin	0.8	0.0	[0.0 - 3.0]	4.9	4.1	22.1	40.2	27.0	0.8		0.8								
		Nalidixic acid††	N/A	N/A	N/A						52.5	41.0	4.9	0.8		0.8					
II	Cephems	Cefoxitin	22.1	0.8	[0.0 - 4.5]								0.8	6.6	69.7	22.1	0.8				
	Folate pathway inhibitors	Sulfisoxazole††	N/A	N/A	N/A											23.0	17.2	11.5	13.9	24.6	9.8
		Trimethoprim-sulfamethoxazole	N/A	1.6	[0.2 - 5.8]				95.9	2.5					1.6						
	Phenicols	Chloramphenicol††	N/A	N/A	N/A								97.5	2.5							
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 3.0]									100							

* 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 if 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 for resistance have been established
** 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.
†† CLSI MIC interpretive criteria have not been established
‡‡ 2 of 122 isolates were not tested against ceftiofur due to a plate configuration change. The percentages shown are based on a total of 120 isolates tested for ceftiofur.
§§ 3 of the 64 isolates represented by this proportion were tested on a panel in which the lowest tested concentration for azithromycin was 0.25 µg/mL instead of 0.125 µg/mL. Thus, for these isolates, the MIC may be 0.25 µg/mL (as depicted) or ≤0.125 µg/mL.

Table 61. Minimum inhibitory concentrations (MICs) and resistance of *Vibrio vulnificus* isolates to antimicrobial agents, 2015 (N=94). Data table at https://www.cdc.gov/narms/files/table61.xlsx

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 - 3.8]					5.3	12.8	61.7	20.2								
		Streptomycin††	N/A	N/A	N/A										12.8	70.2	14.9	2.1			
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 3.8]							78.7	18.1	2.1	1.1						
	Cephems	Ceftiofur†† (N=93)‡‡	N/A	N/A	N/A				74.2	19.4	4.3	1.1	1.1								
		Ceftriaxone††	N/A	N/A	N/A					100											
	Macrolides	Azithromycin††	N/A	N/A	N/A				78.7	18.1§§	2.1	1.1									
	Penicillins	Ampicillin	0.0	1.1	[0.0 - 5.8]							94.7	2.1	2.1				1.1			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 3.8]	77.7	21.3			1.1											
		Nalidixic acid††	N/A	N/A	N/A						86.2	13.8									
II	Cephems	Cefoxitin	31.9	0.0	[0.0 - 3.8]									5.3	62.8	31.9					
	Folate pathway inhibitors	Sulfisoxazole††	N/A	N/A	N/A											40.4	25.5	14.9	8.5	6.4	4.3
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 3.8]				100												
	Phenicols	Chloramphenicol††	N/A	N/A	N/A								92.6	7.4							
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 3.8]									100							

* 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 if 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 for resistance have been established
** 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.
†† CLSI MIC interpretive criteria have not been established
‡‡ 1 of 94 isolates were not tested against ceftiofur due to a plate configuration change. The percentages shown are based on a total of 93 isolates tested for ceftiofur.
§§ 1 of the 17 isolates represented by this proportion were tested on a panel in which the lowest tested concentration for azithromycin was 0.25 µg/mL instead of 0.125 µg/mL. Thus, for these isolates, the MIC may be 0.25 µg/mL (as depicted) or ≤0.125 µg/mL.

Table 62. Percentage and number of isolates of *Vibrio* species other than *V. cholerae* resistant to ampicillin, 2009–2015

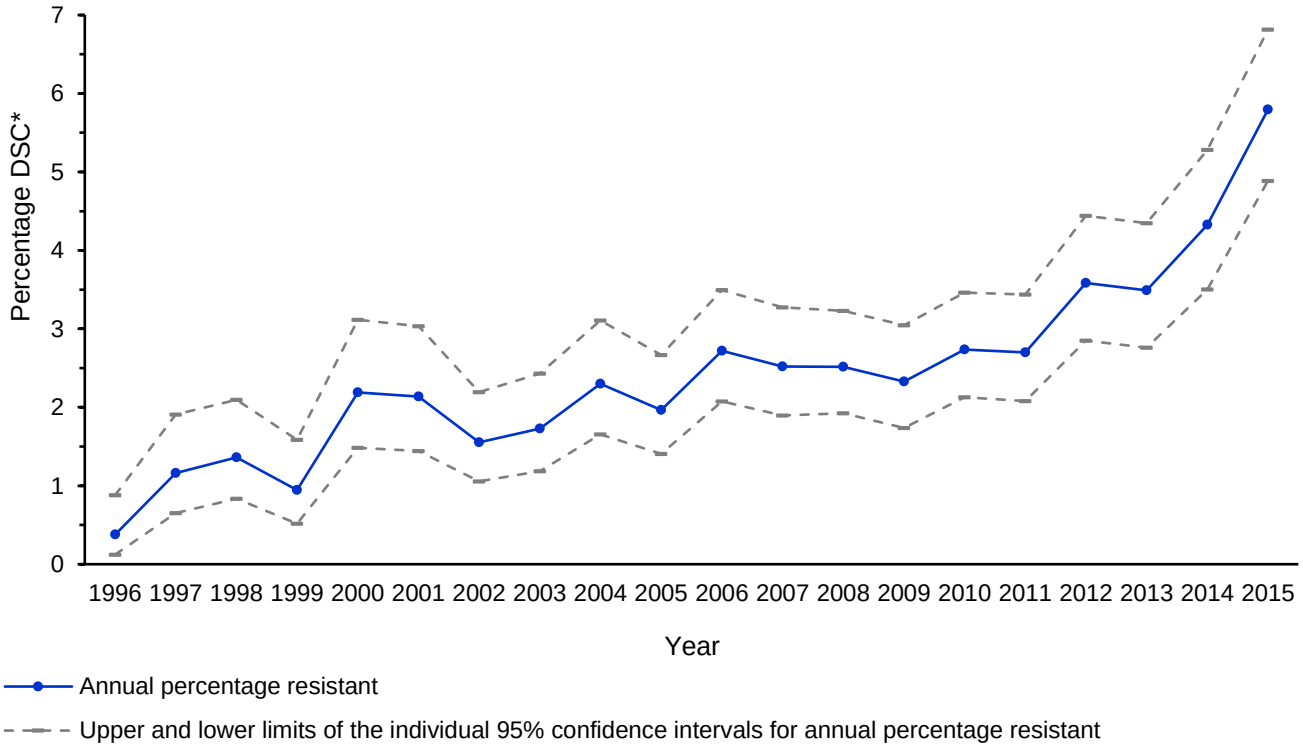
Species	2009	2010	2011	2012	2013	2014	2015
Vibrio parahaemolyticus	9.4% 14	8.4% 15	40.3% 81	14.1% 52	41.0% 129	37.0% 74	63.4% 229
Vibrio alginolyticus	82.6% 38	89.8% 44	95.1% 98	98.3% 115	95.9% 117	97.6% 124	97.5% 119
Vibrio vulnificus	2.0% 1	0% 0	4.8% 3	1.5% 1	2.3% 2	2.5% 2	1.1% 1
Vibrio fluvialis	33.3% 7	12.5% 3	44.4% 8	21.4% 6	50.0% 20	55.6% 25	32.5% 13
Vibrio mimicus	9.1% 1	0% 0	0% 0	9.1% 1	7.4% 2	0.0% 0	0.0% 0
Vibrio harveyi	N/A* 0	50.0% 1	100% 4	100% 3	80.0% 4	100% 6	100% 3
Other	25.0% 1	0% 0	N/A* 0	22.2% 2	55.6% 5	33.3% 4	100% 1
Total	22.1% 62	19.1% 63	48.7% 194	29.9% 180	46.1% 279	47.8% 235	57.2% 366

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

Antimicrobial Resistance: 1996–2015

The following figures display resistance to selected agents and combinations of agents from 1996–2015 for nontyphoidal *Salmonella*, 1999–2015 for *Salmonella* ser. Typhi and *Shigella*, and 1997–2015 for *Campylobacter*.

Figure 18. Percentage of nontyphoidal *Salmonella* isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1996–2015



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

Data table for graph at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 19. Percentage of nontyphoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2015

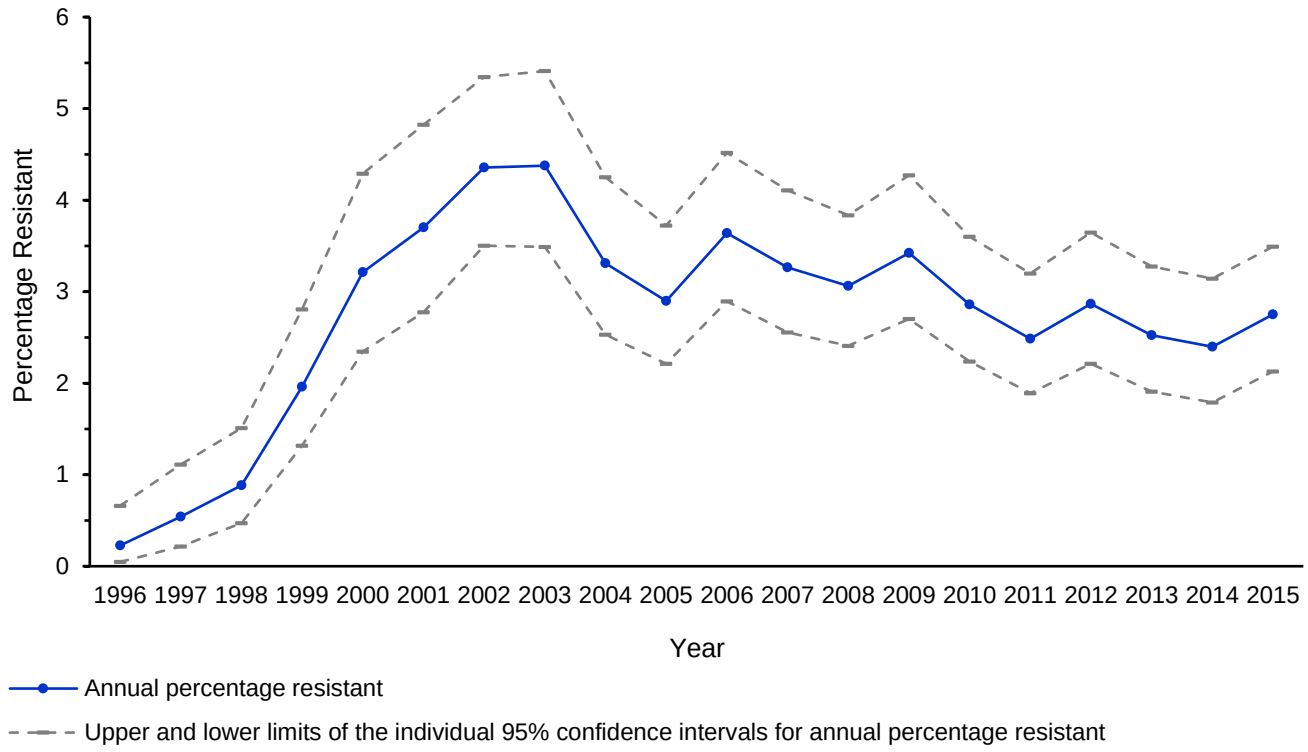
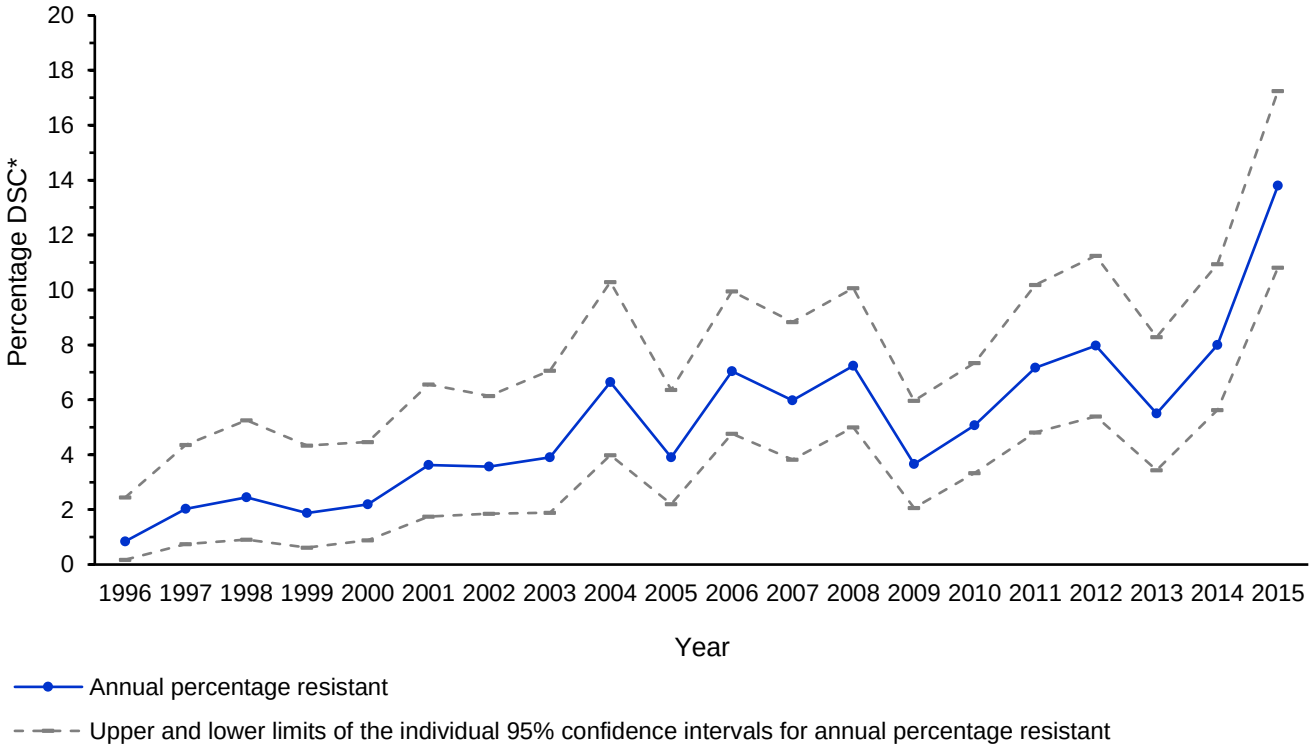


Figure 20. Percentage of *Salmonella* ser. Enteritidis isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1996–2015



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

Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 21. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2015

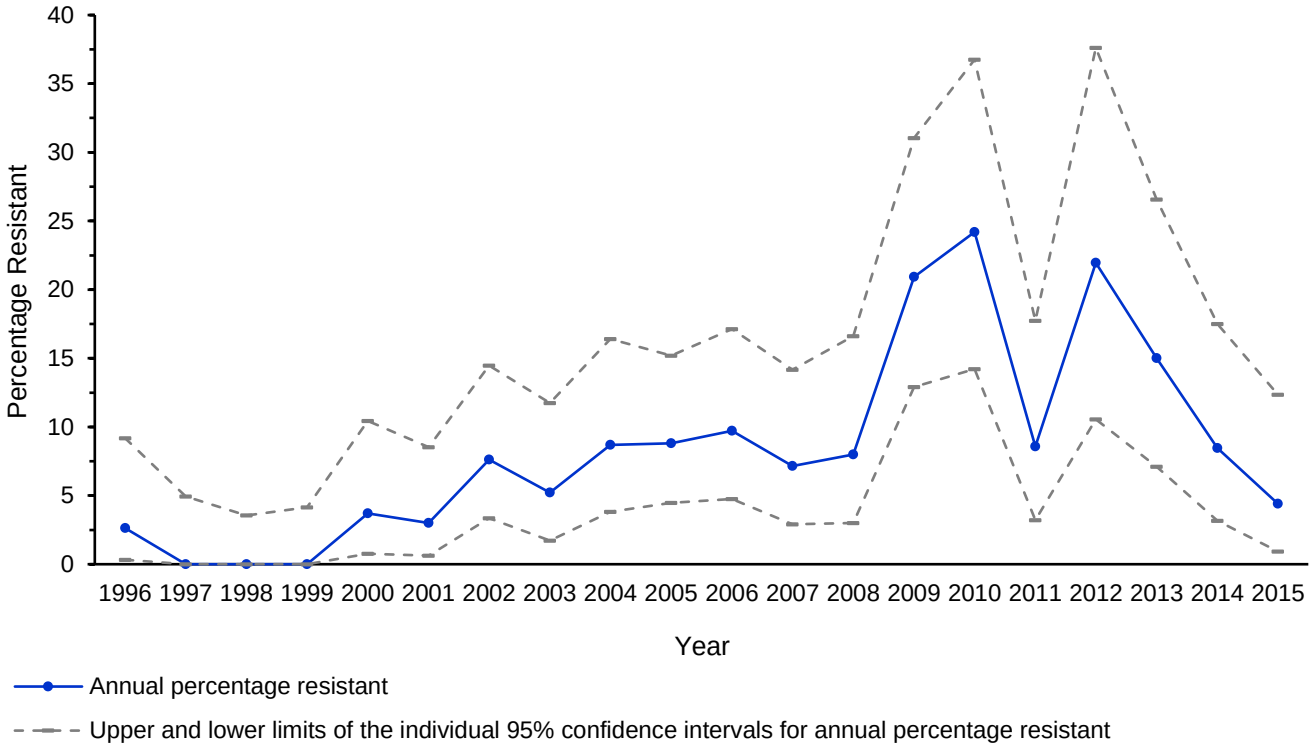
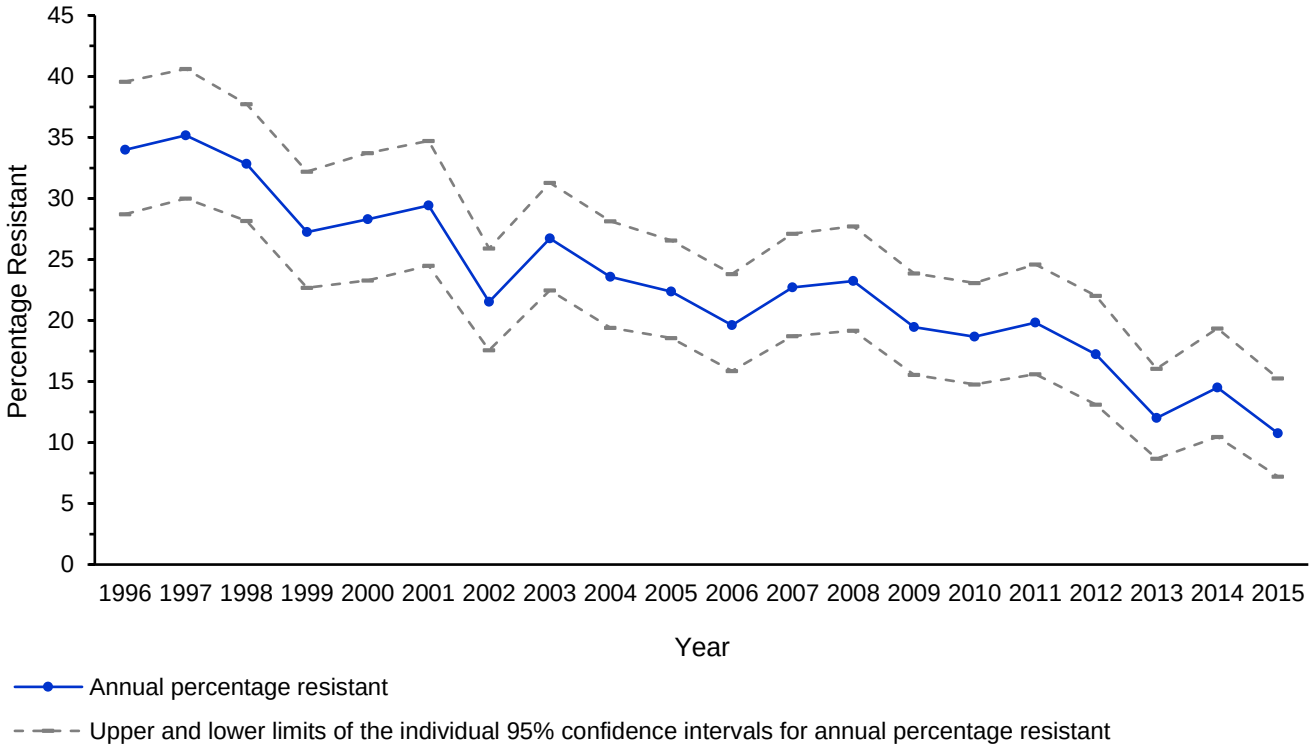


Figure 22. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2015



Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

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, 1996–2015

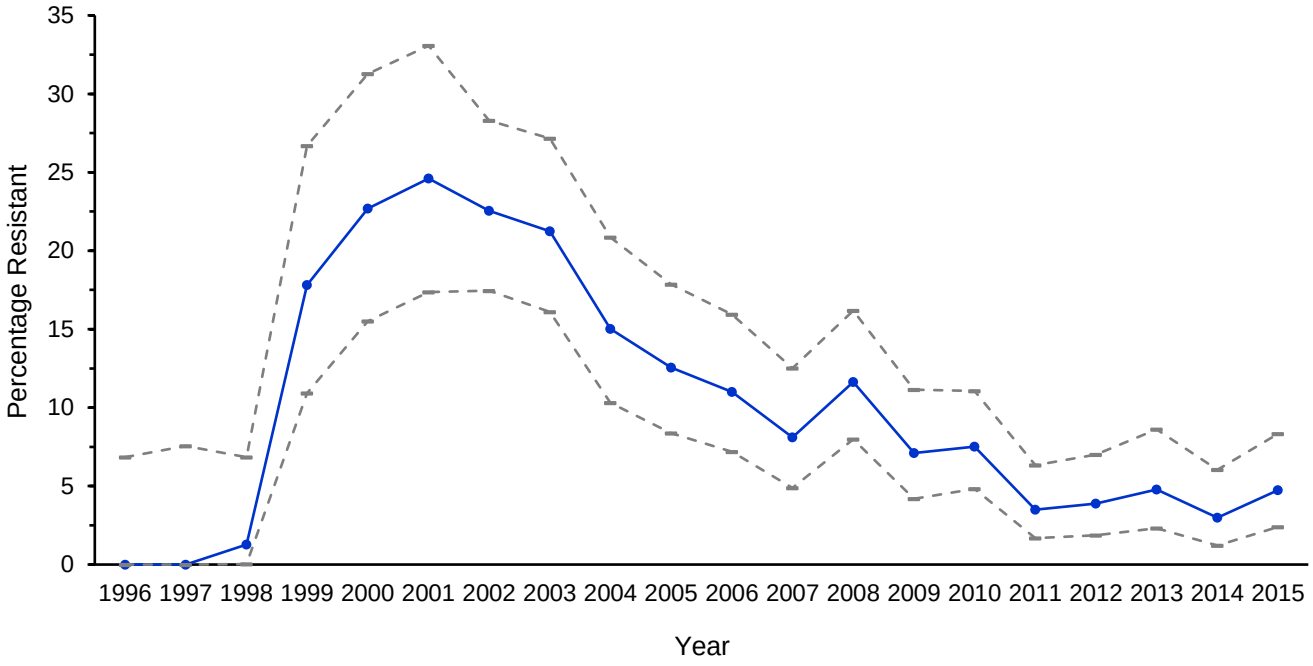
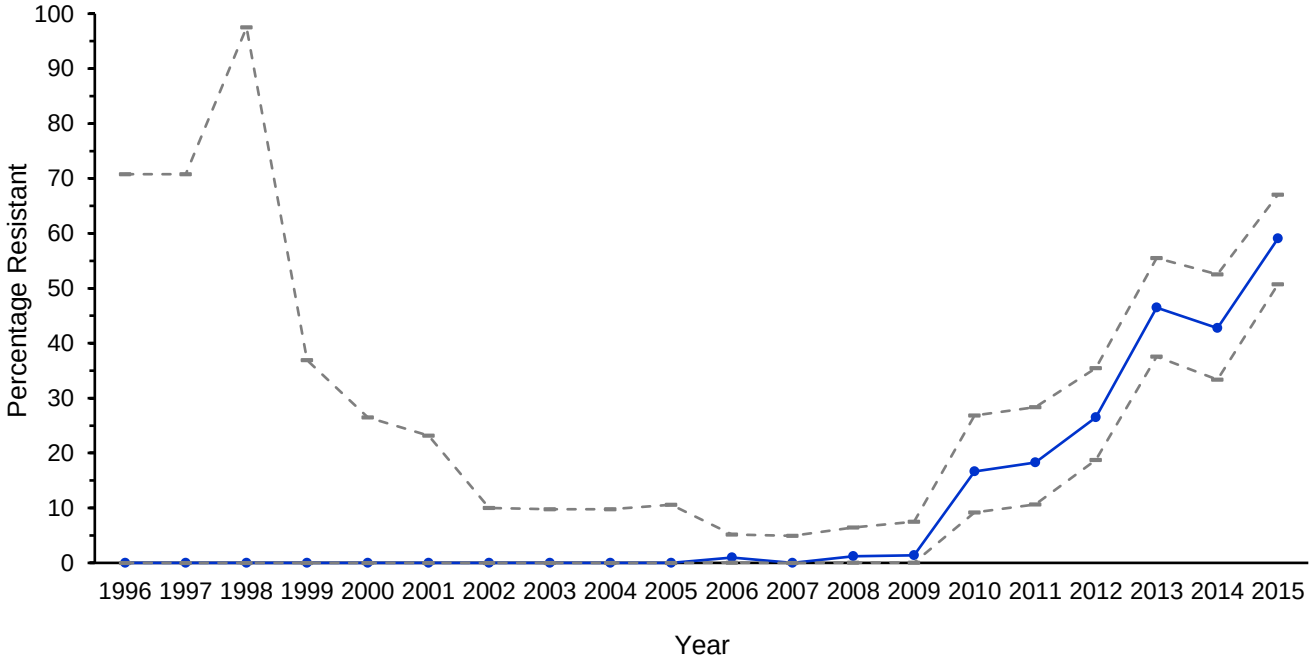


Figure 24. Percentage of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to at least ampicillin, streptomycin, sulfonamide, and tetracycline (ASSuT), but not chloramphenicol, by year, 1996–2015



Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 25. Percentage of nontyphoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2015

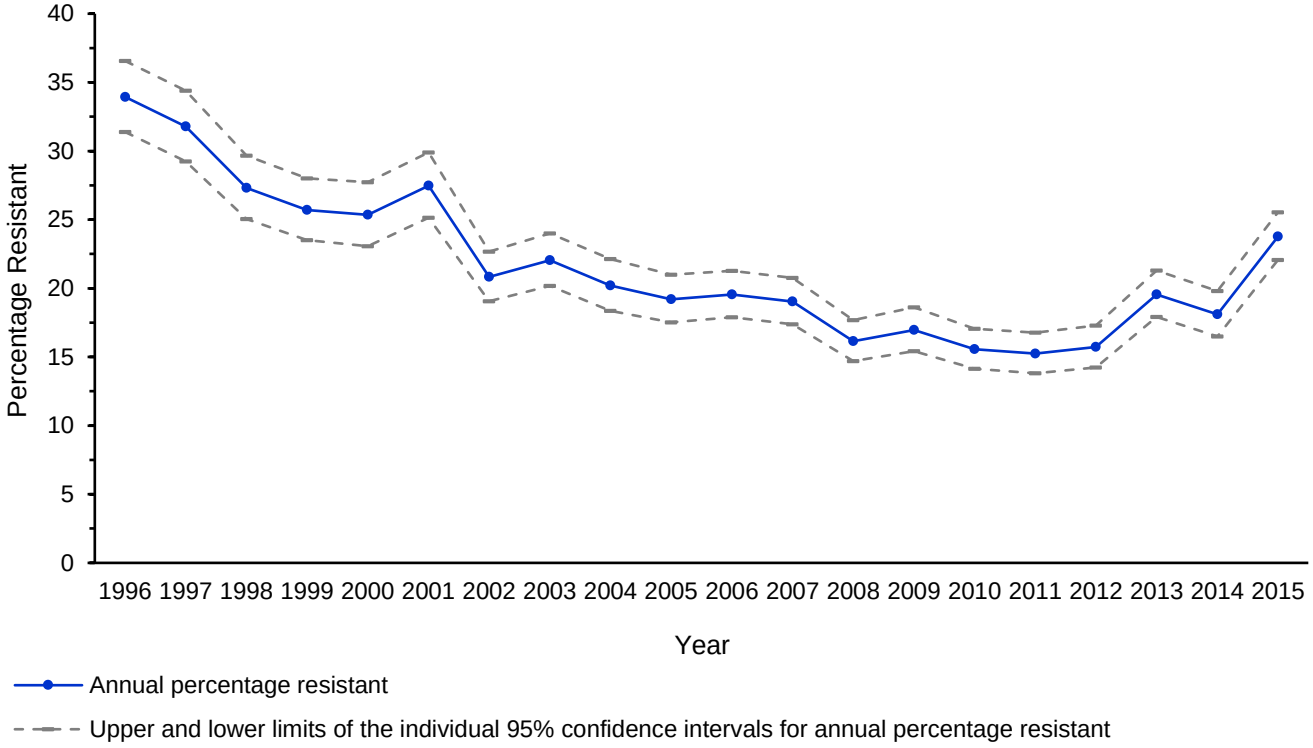
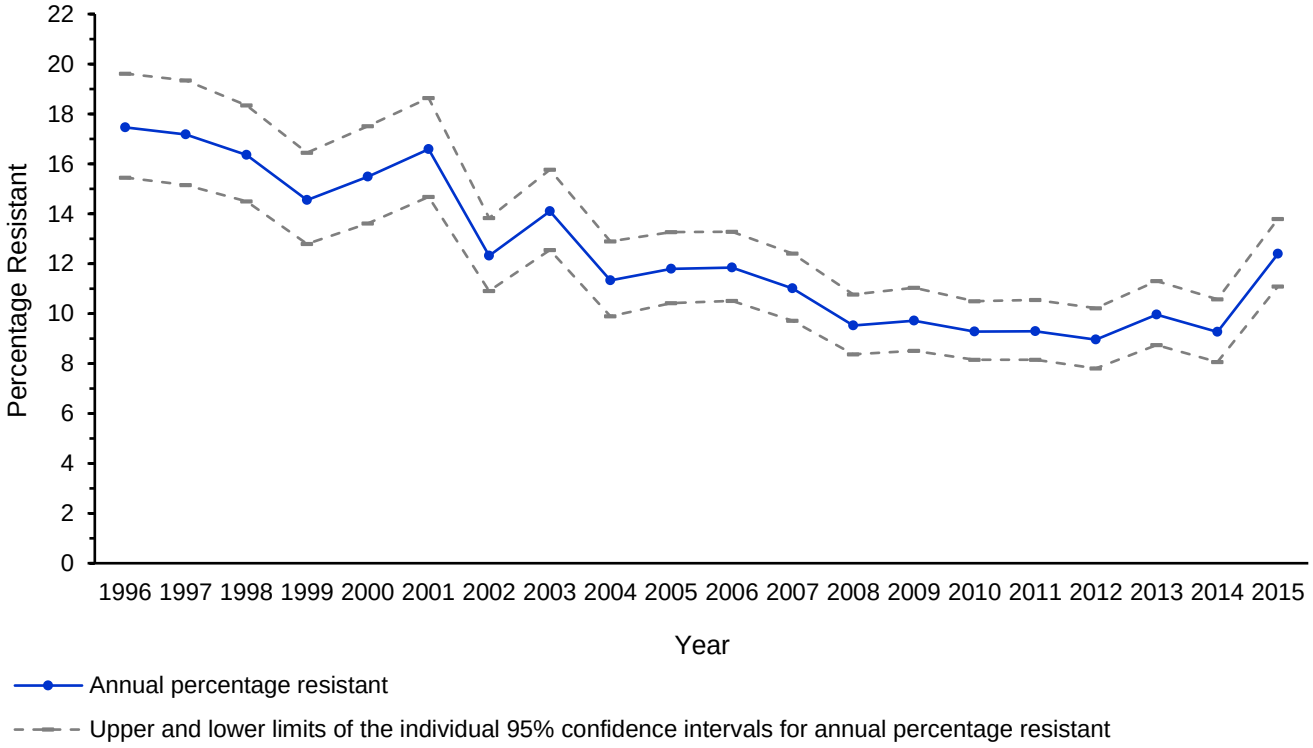
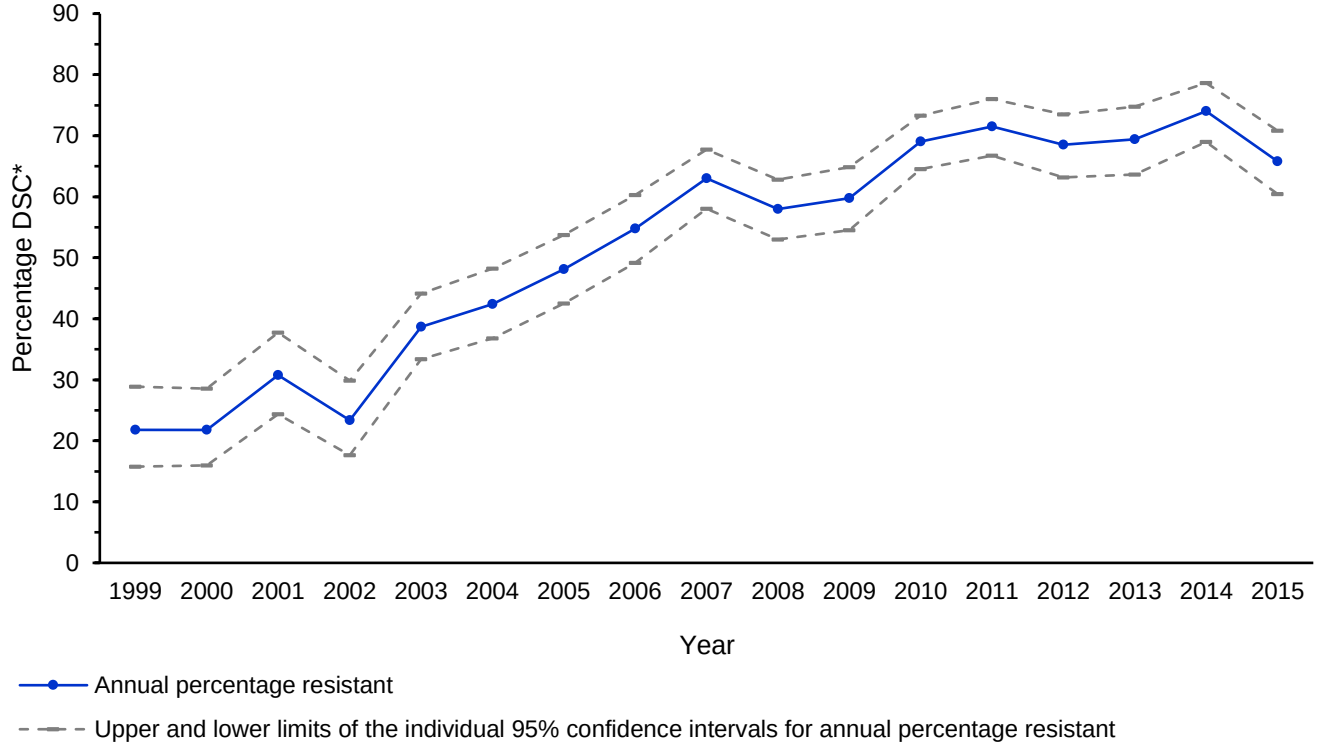


Figure 26. Percentage of nontyphoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2015



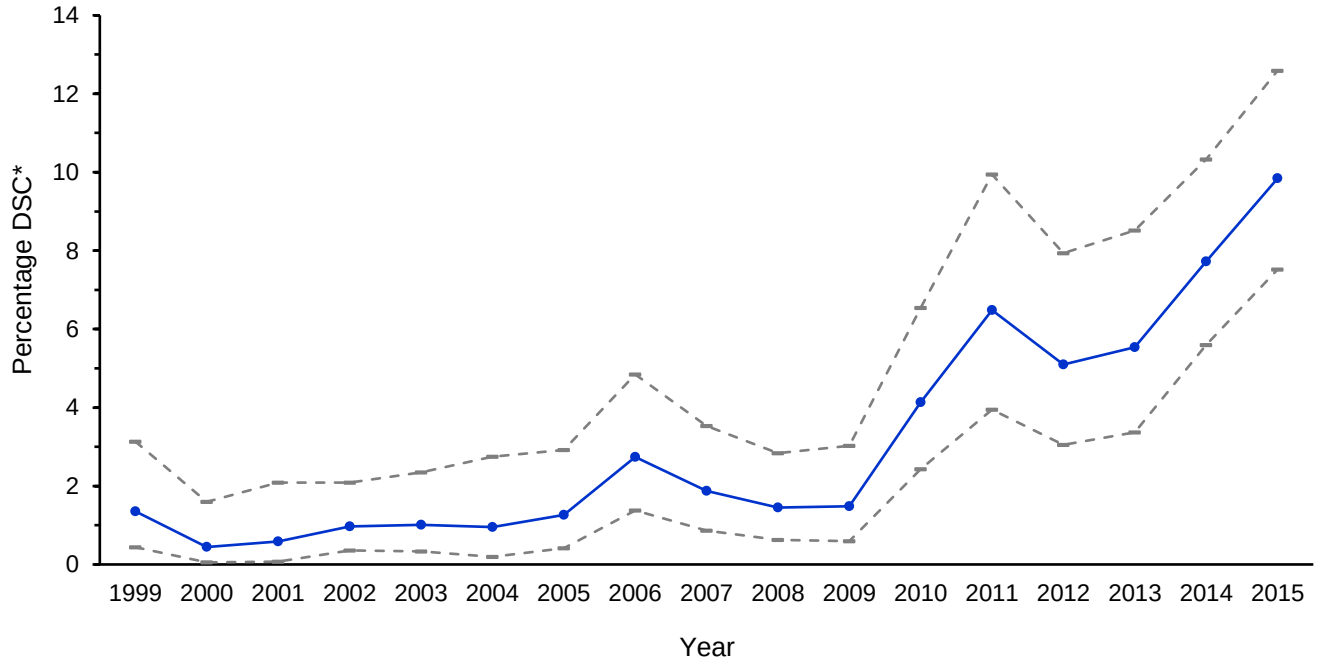
Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 27. Percentage of *Salmonella* ser. Typhi isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1999–2015



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

Figure 28. Percentage of *Shigella* isolates with decreased susceptibility to ciprofloxacin (DSC)*, 1999–2015



* Includes isolates with a ciprofloxacin MIC ≥0.12 µg/mL

Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 29. Percentage of *Campylobacter jejuni* isolates resistant to ciprofloxacin, by year, 1997–2015

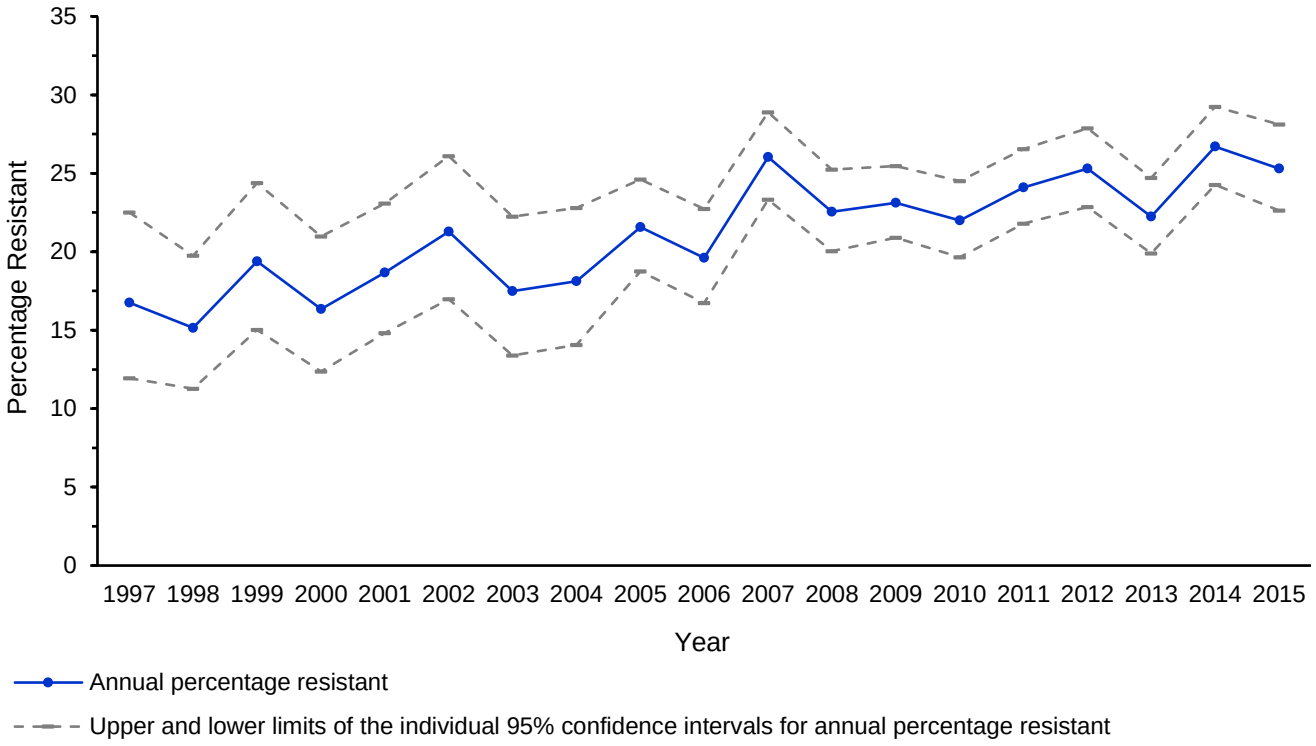
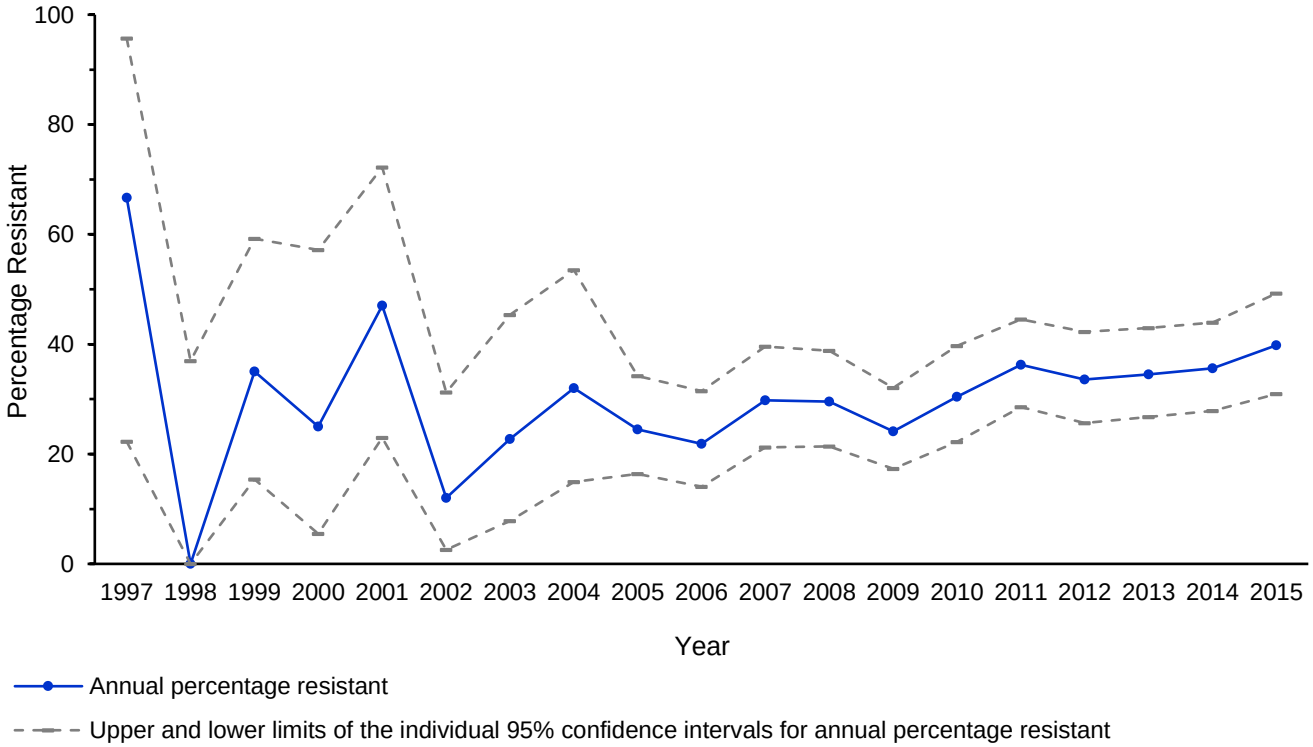
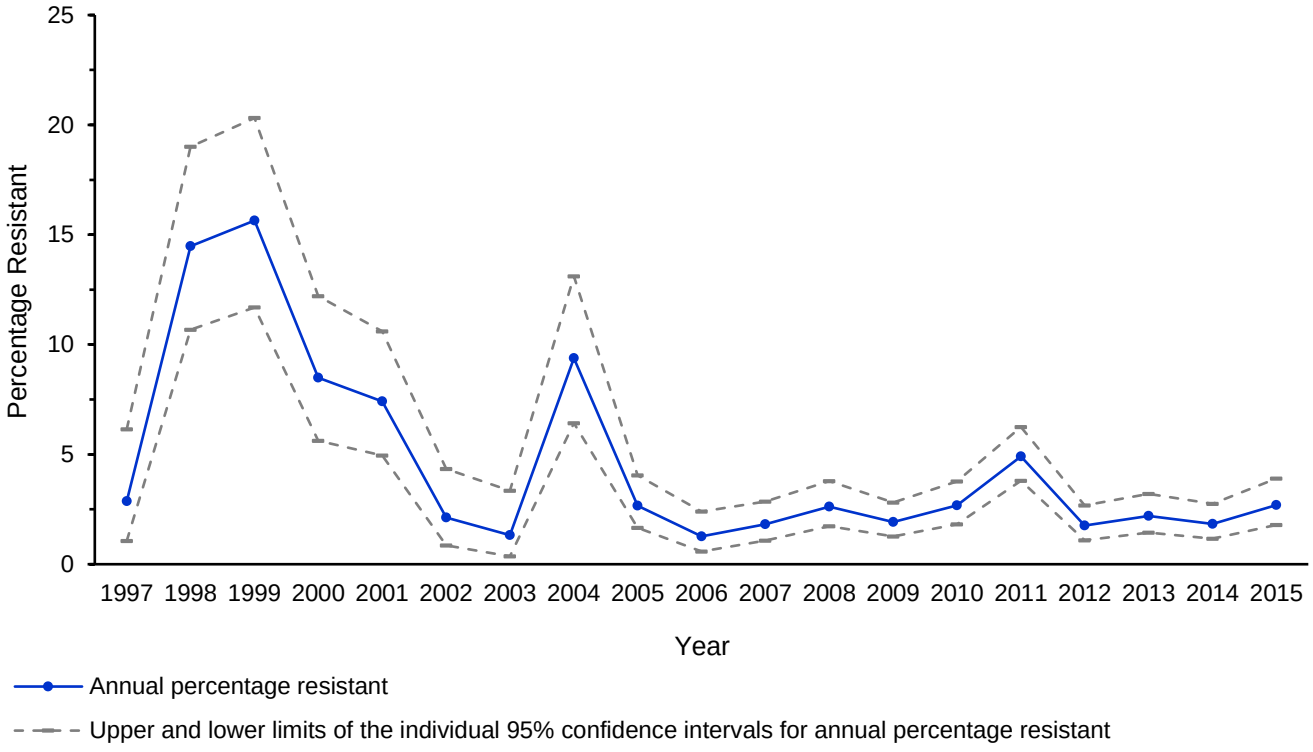


Figure 30. Percentage of *Campylobacter coli* isolates resistant to ciprofloxacin, by year, 1997–2015



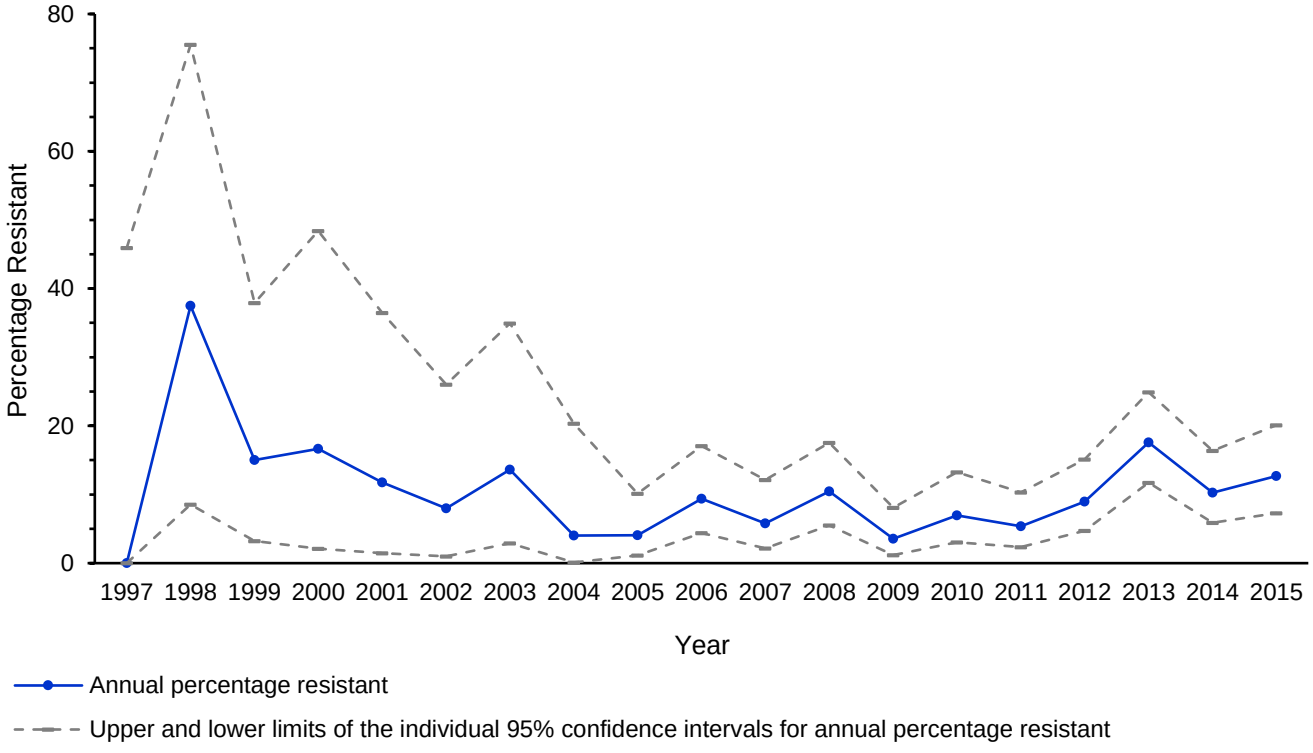
Data tables for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

Figure 31. Percentage of *Campylobacter jejuni* isolates with resistance to macrolides*, 1997–2015



* Resistance to azithromycin or erythromycin

Figure 32. Percentage of *Campylobacter coli* isolates with resistance to macrolides*, 1997–2015



* Resistance to azithromycin or erythromycin

Data table for both graphs at https://www.cdc.gov/narms/files/Figs.-18-32.xlsx

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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, 2017). The participants categorize antimicrobial agents as either Critically Important, Highly Important, or Important based upon two criteria: (C1) the antimicrobial class is the sole, or one of limited available therapies, to treat serious bacterial infections in people; (C2) the antimicrobial class is used to treat infections in people caused by either: (1) bacteria that may be transmitted to humans from non-human sources, or (2) bacteria 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 all 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)