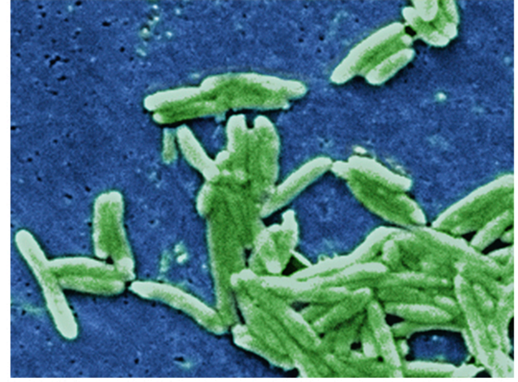


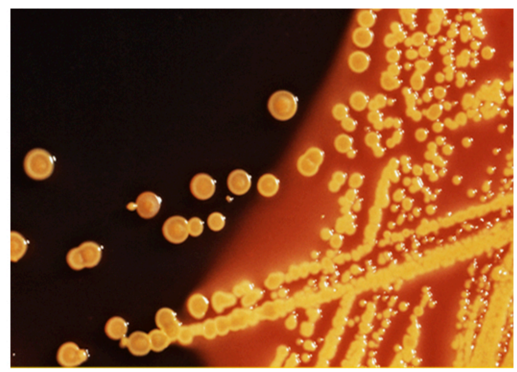
NARMS

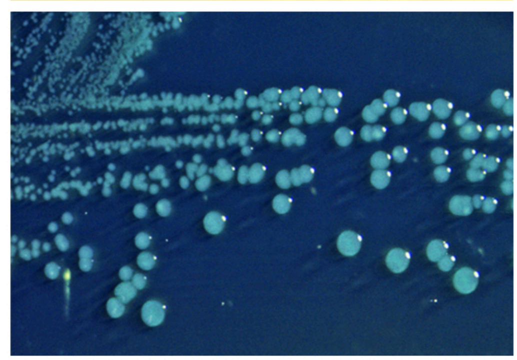
National Antimicrobial Resistance Monitoring System: Enteric Bacteria

NARMS

2013

Human Isolates Final 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

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List of Abbreviations and Acronyms

AAuCx	Resistance to at least ampicillin, amoxicillin-clavulanic acid, and ceftriaxone
ACSSuT	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline
ACSSuTAuCx	Resistance to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone
ACT/S	Resistance to at least ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole
ANT/S	Resistance to at least ampicillin, nalidixic acid and trimethoprim-sulfamethoxazole
ASSuT	Resistance to at least ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline
AT/S	Resistance to at least ampicillin and trimethoprim-sulfamethoxazole
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CLSI	Clinical and Laboratory Standards Institute
CxNal	Resistance to at least ceftriaxone and nalidixic acid
ECOFF	Epidemiological cut-off*
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 Inspection Service
WHO	World Health Organization

*For a description of epidemiological cut-offs 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) (http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/default.htm), 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) (http://www.ars.usda.gov/Business/docs.htm?docid=6750&page=1) and Food Safety and Inspection Service (USDA-FSIS) (http://www.fsis.usda.gov/OPPDE/rdad/FSISNotices/13-13.pdf?redirecthttp=true).

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

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

This annual report includes CDC's surveillance data for 2013 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.

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

What is New in the NARMS Report for 2013

New Baselines for Assessing Changes in Prevalence of Antimicrobial Resistance

To assess changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* isolates, NARMS models annual data using logistic regression. In previous reports, we compared the prevalence of resistance for the current year to the average prevalence during a historical baseline reference period of 2003–2007. In this report, we compared the prevalence of resistance among isolates tested in 2013 with the average prevalence from two reference periods: 2004–2008 and the previous five years, 2008–2012. 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 2008–2012 reference period allows comparison with more recent years. The results of these analyses can be found on pages 17–18.

Changes in Antimicrobial Susceptibility Testing for *Vibrio* Species other than *V. cholerae*

Since 2009, NARMS has tested *Vibrio* species other than *V. cholerae* to determine the minimum inhibitory concentrations for ampicillin, cephalothin, chloramphenicol, ciprofloxacin, kanamycin, nalidixic acid, streptomycin, tetracycline, and trimethoprim-sulfamethoxazole. In 2013, we added four antimicrobial agents to the panel: cefotaxime, ceftazidime, gentamicin, and imipenem. To accommodate these additions, cephalothin, kanamycin, and streptomycin were removed. Further details regarding testing can be found on page 29, and susceptibility results can be found in the *Vibrio* species other than *V. cholerae* section of this report.

Summary of NARMS 2013 Surveillance Data

Surveillance Population

In 2013, all 50 states and the District of Columbia participated in NARMS, representing the entire US population of approximately 316 million persons (Table 1). Surveillance was conducted in all states for *Salmonella* (typhoidal and nontyphoidal), *Shigella*, *Escherichia coli* O157, and *Vibrio* species other than *V. cholerae*. For *Campylobacter*, surveillance was conducted in the 10 states that comprise the Foodborne Diseases Active Surveillance Network (FoodNet), representing approximately 48 million persons (15% of the US population).

Clinically Important Antimicrobial Resistance Patterns

In the United States, fluoroquinolones (e.g., ciprofloxacin) and third-generation cephalosporins (e.g., ceftriaxone) are commonly used to treat severe *Salmonella* infections, including typhoid and paratyphoid fever as well as severe nontyphoidal infections. In *Enterobacteriaceae*, (e.g., *Salmonella* and *Shigella*) resistance to nalidixic acid, an elementary quinolone, usually correlates with decreased susceptibility to ciprofloxacin (Table 2) and possible fluoroquinolone treatment failure, although sometimes resistance or decreased susceptibility to ciprofloxacin occurs in the absence of nalidixic acid resistance. Macrolides (e.g., azithromycin), penicillins (e.g., ampicillin), and trimethoprim-sulfamethoxazole are also of clinical importance. A substantial proportion of *Enterobacteriaceae* isolates tested in 2013 demonstrated clinically important resistance.

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

- 3% (61/2178) of nontyphoidal *Salmonella* isolates were resistant to nalidixic acid. Enteritidis was the most common serotype among nalidixic acid-resistant nontyphoidal *Salmonella* isolates.
  - 36% (22/61) of nalidixic acid-resistant isolates were ser. Enteritidis
  - 6% (22/382) of ser. Enteritidis isolates were resistant to nalidixic acid
- 3% (55/2178) of nontyphoidal *Salmonella* isolates were resistant to ceftriaxone. The most common serotypes among the 55 ceftriaxone-resistant isolates were Newport, Dublin, Typhimurium, Heidelberg, and Infantis. Resistance to ceftriaxone occurred in
  - 5% (11/209) of ser. Newport isolates
  - 92% (11/12) of ser. Dublin isolates
  - 3% (11/325) of ser. Typhimurium isolates
  - 15% (9/60) of ser. Heidelberg isolates
  - 7% (5/76) of ser. Infantis isolates
- 67% (188/279) of *Salmonella* ser. Typhi isolates were resistant to nalidixic acid, and 9% (24/279) were resistant to ciprofloxacin.
- 81% (81/100) of *Salmonella* ser. Paratyphi A isolates were resistant to nalidixic acid, and 4% (4/100) were resistant to ciprofloxacin.
- No *Salmonella* ser. Typhi or *Salmonella* ser. Paratyphi A isolates were resistant to ceftriaxone.

For *Shigella*, fluoroquinolones and macrolides (e.g., azithromycin) are important agents in the treatment of severe infections. (Note: Azithromycin breakpoints were established by NARMS for resistance monitoring and should not be used to predict clinical efficacy. CLSI has not established breakpoints for *Shigella*.)

- 3% (12/344) of *Shigella* isolates were resistant to ciprofloxacin, including
  - 6% (4/64) of *Shigella flexneri* isolates
  - 3% (8/275) of *Shigella sonnei* isolates
- 5% (12/344) of *Shigella* isolates were resistant to nalidixic acid, including
  - 13% (8/64) of *Shigella flexneri* isolates
  - 3% (9/275) of *Shigella sonnei*
- 4% (13/344) of *Shigella* isolates were resistant to azithromycin, including
  - 16% (10/64) of *Shigella flexneri* isolates
  - 1% (3/275) of *Shigella sonnei* isolates

For *Campylobacte*r, fluoroquinolones and macrolides are important treatment options for severe infections. ECOFF values are used for interpreting antimicrobial susceptibility data. Since ECOFFs differ between *Campylobacter* species, the percentage resistant for *Campylobacter* overall is not reported.

- 22% (263/1182) of *Campylobacter jejuni* isolates and 34% (45/134) of *Campylobacter coli* isolates were resistant to ciprofloxacin
- 2% (26/1182) of *Campylobacter jejuni* isolates and 17% (24/142) of *Campylobacter coli* isolates were resistant to erythromycin
- 2% (26/1182) of *Campylobacter jejuni* isolates and 18% (25/142) of *Campylobacter coli* isolates were resistant to azithromycin

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 resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx); these agents represent seven CLSI classes.

- 3% (74/2178) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuT. The most common serotypes were Typhimurium, Newport, and Dublin. ACSSuT resistance occurred in
    - 12% (39/325) ser. Typhimurium isolates
    - 5% (10/209) ser. Newport isolates
    - 83% (10/12) ser. Dublin isolates

- 3% (74/2178) of nontyphoidal *Salmonella* isolates were resistant to at least ASSuT but not chloramphenicol. The most common serotype was I 4,[5],12:i:- (59 isolates) followed by Typhimurium. This resistance pattern occurred in
    - 47% (59/127) ser. I 4,[5],12:i:- isolates
    - 1% (4/325) ser. Typhimurium isolates

- 1% (31/2178) of nontyphoidal *Salmonella* isolates were resistant to at least ACSSuTAuCx. The most common serotypes were Newport, Dublin, and Typhimurium. This resistance pattern occurred in
    - 5% (10/209) ser. Newport isolates
    - 83% (10/12) ser. Dublin isolates
    - 2% (7/325) ser. Typhimurium isolates

- 10% (214/2178) of nontyphoidal *Salmonella* isolates were resistant to three or more CLSI classes. The most common serotypes with this resistance were I 4,[5],12:i:, Typhimurium, Heidelberg, Newport, Dublin, and Infantis. Resistance to three or more classes occurred in
    - 51% (65/127) ser. I 4,[5],12:i:- isolates
    - 17% (55/325) ser. Typhimurium isolates
    - 33% (20/60) ser. Heidelberg isolates
    - 6% (12/209) ser. Newport isolates
    - 92% (11/12) ser. Dublin isolates
    - 11% (8/76) ser. Infantis isolates

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

- 8% (23/279) of ser. Typhi isolates were resistant to at least ACT/S, and 10% (29/279) 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).

- 26% (88/344) of *Shigella* isolates were resistant to at least AT/S, and 54% (184/344) were resistant to three or more classes

Changes in Antimicrobial Resistance: 2013 vs. 2004–2008 and 2008–2012

To understand changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* over time, we used logistic regression to model annual data from 2004–2013. Since 2003, all 50 states have participated in *Salmonella* and *Shigella* surveillance, and all 10 FoodNet sites have participated in *Campylobacter* surveillance. We compared the prevalence of selected resistance patterns among isolates tested in 2013 with the average prevalence of resistance from two reference periods: 2004–2008 and 2008–2012. (These methods are detailed in the Data Analysis section.)

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

2013 vs. 2004–2008

The differences between the prevalence of resistance in 2013 and the average prevalence of resistance in 2004–2008 (Figure H1, A) were statistically significant for the following:

- Among *Salmonella* of particular serotypes
  - ACSSuT resistance in ser. Typhimurium was lower (12.0% vs. 22.3%; odds ratio [OR]=0.5, 95% confidence interval [CI] 0.3–0.7)
  - Nalidixic acid resistance in ser. Typhi was higher (67.4% vs. 53.1%; OR=1.9, 95% CI 1.4–2.5)
- Among *Shigella* spp.
  - Nalidixic acid resistance was higher (5.2% vs. 2.0%; OR=3.2, 95% CI 1.8–5.7).

The differences between the prevalence of resistance in 2013 and the average prevalence of resistance in 2004–2008 (Figure H1, A) were *not* statistically significant for the following selected pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Ceftriaxone resistance (2.5% vs. 3.2%; OR=0.9, 95% CI 0.6–1.1)
  - Nalidixic acid resistance (2.8% vs. 2.2%; OR=1.4, 95% CI 1.0–1.9)
  - Resistance to one or more classes (19.2% vs. 18.7%; OR=1.1, 95% CI 1.0–1.2)
  - Resistance to three or more classes (9.8% vs. 11.2%; OR=0.9, 95% CI 0.8–1.1)
- Among *Salmonella* of particular serotypes
  - Nalidixic acid resistance in ser. Enteritidis (5.8% vs. 6.3%; OR=1.0, 95% CI 0.6–1.5)
  - ACSSuTAuCx resistance in ser. Newport (4.8% vs. 11.7%; OR=0.5, 95% CI 0.3–1.1)
  - Ceftriaxone resistance in ser. Heidelberg (15.0% vs. 8.5%; OR=1.9, 95% CI 0.8–4.2)
- Among *Campylobacter jejuni* and *C. coli*
  - Ciprofloxacin resistance in *C. jejuni* (22.3% vs. 21.6%; OR=1.1, 95% CI 0.9–1.3)
  - Ciprofloxacin resistance in *C. coli* (34.5% vs. 27.2%; OR=1.4, 95% CI 0.9–2.2)

2013 vs. 2008–2012

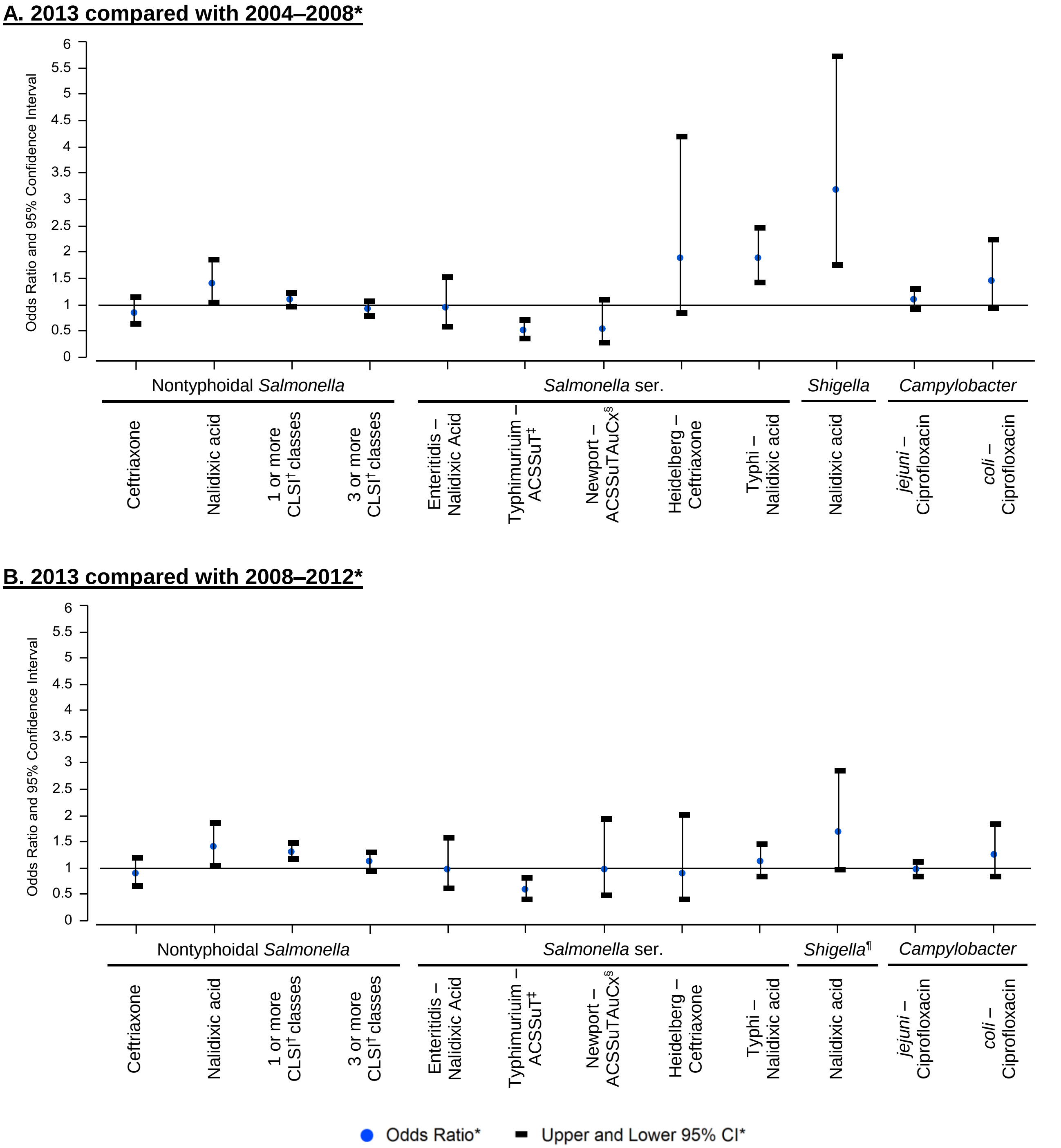
The differences between the prevalence of resistance in 2013 and the average prevalence of resistance in 2008–2012 (Figure H1, B) were statistically significant for the following:

- Among nontyphoidal *Salmonella*
  - Resistance to one or more classes was higher (19.2% vs. 15.7%; OR=1.3, 95% CI 1.2–1.5)
- Among *Salmonella* of particular serotypes
  - ACSSuT resistance in ser. Typhimurium was lower (12.0% vs. 19.7%;OR=0.6, 95% CI 0.4–0.8)

The differences between the prevalence of resistance in 2013 and the average prevalence of resistance in 2008–2012 (Figure H1, B) were *not* statistically significant for the following selected pathogen-resistance combinations:

- Among nontyphoidal *Salmonella*
  - Ceftriaxone resistance (2.5% vs. 2.9%; OR=0.9, 95% CI 0.7–1.2)
  - Nalidixic acid resistance (2.8% vs. 2.1%; OR=1.4, 95% CI 1.0–1.9)
  - Resistance to three or more classes (9.8% vs. 9.2%; OR=1.1, 95% CI 1.0–1.3)
- Among *Salmonella* of particular serotypes
  - Nalidixic acid resistance in ser. Enteritidis (5.8% vs. 6.2%; OR=1.0, 95% CI 0.6–1.6)
  - ACSSuTAuCx resistance in ser. Newport (4.8% vs. 6.7%; OR=1.0, 95% CI 0.5–2.0)
  - Ceftriaxone resistance in ser. Heidelberg (15.0% vs. 16.7%; OR=0.9, 95% CI 0.4–2.0)
  - Nalidixic acid resistance in ser. Typhi (67.4% vs. 65.5%; OR=1.1, 95% CI 0.9–1.5)
- Among *Campylobacter jejuni* and *C. coli*
  - Ciprofloxacin resistance in *C. jejuni* (22.3% vs. 23.4%; OR=1.0, 95% CI 0.8–1.1)
  - Ciprofloxacin resistance in *C. coli* (34.5% vs. 30.8%; OR=1.2, 95% CI 0.8–1.8)
- Among *Shigella* spp.
  - Nalidixic acid resistance (5.2% vs. 3.8% (OR=1.7, 95% CI 1.0–2.9)

Figure H1. Changes in prevalence of selected resistance patterns among *Salmonella, Shigella,* and *Campylobacter* isolates, 2013 compared with 2004–2008 and 2008–2012*



* The prevalence of resistance in 2013 was compared with the average prevalence from two reference periods, 2004–2008 and 2008–2012. Logistic regression models adjusted for site using a 9-level categorical variable (9 US census regions) for *Salmonella* and *Shigella* and 10-level categorical variable (10 FoodNet states) for *Campylobacter*. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. ORs that do not include 1.0 in the 95% CIs are reported as statistically significant.
† 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
¶ For 2013 vs. 2008–2012, the main effects model was adjusted for site using a two-level categorical variable (East, West)

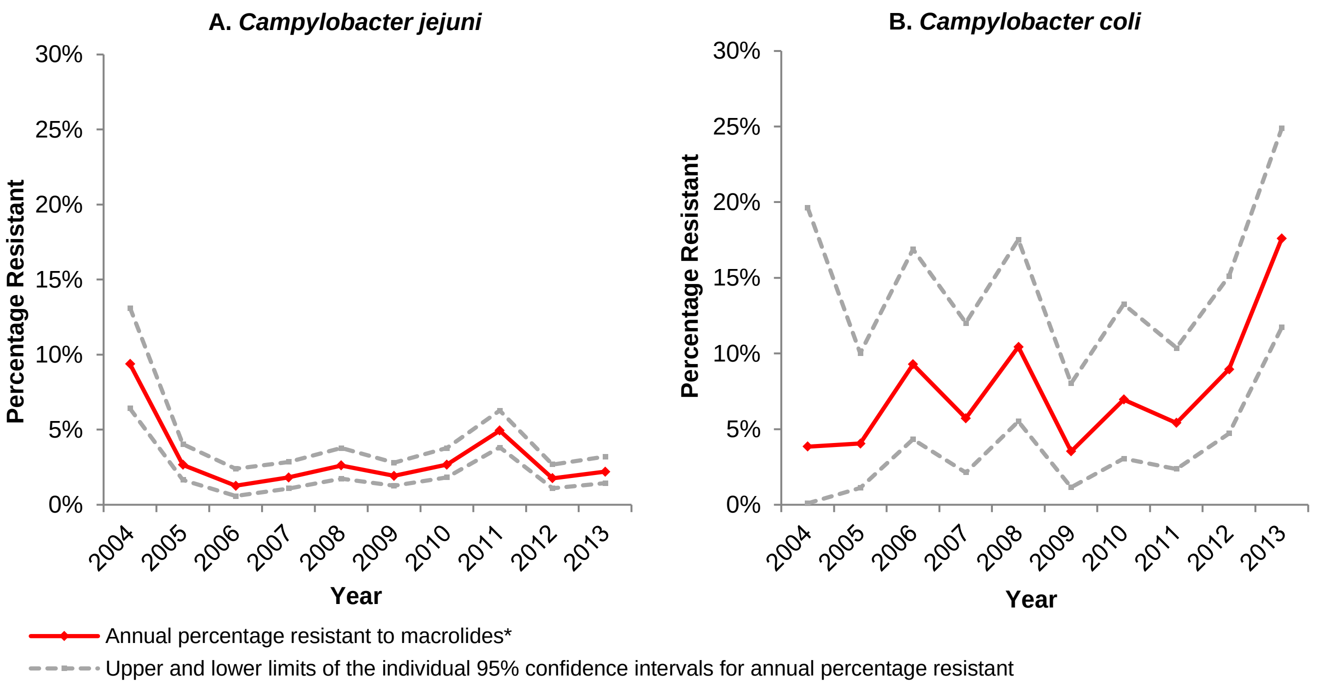
Increased Resistance to Macrolides in *Campylobacter*

Campylobacter is estimated to cause 1.3 million infections in the United States each year.[1] Symptoms include diarrhea (often bloody), abdominal pain, and fever.[2] Less common but more severe complications include extraintestinal infections, reactive arthritis, and Guillain-Barré syndrome.[2] The primary antimicrobial treatment options for *Campylobacter* infection are fluoroquinolones and macrolides.[2] Resistance to fluoroquinolones is common in the United States (24% in 2013) and elsewhere,[3,4] at times leaving macrolides as the only treatment option.[2] Historically, *Campylobacter* resistance to macrolides in the United States has been low (<5%), but increasing resistance to macrolides has been reported in many parts of the world.[4]

In 2013, the percentage of human *Campylobacter* isolates with macrolide resistance increased. The change was small (from 1.8% in 2012 to 2.2% in 2013) among *Campylobacter jejuni* (Figure H2, A), the most common species isolated from humans, but larger among *Campylobacter coli*, increasing from 9.0% in 2012 to 17.6% in 2013 (Figure H2, B).

Macrolide resistance in *Campylobacter* is usually mediated by a mutation in one or more copies of the chromosomal 23S rRNA gene (*Campylobacter* has three copies of 23S). However, a new horizontally transferable resistance determinant, *ermB*, was recently identified among macrolide resistant *Campylobacter coli*. The *ermB* gene encodes an rRNA methylase and can be plasmid-encoded, allowing for rapid dissemination.[5] Molecular studies are ongoing to identify the mechanism responsible for macrolide resistance among US *Campylobacter* isolates.

Figure H2. Percentage of *Campylobacter* isolates with resistance to macrolides*, 2004–2013



* Resistance to azithromycin or erythromycin

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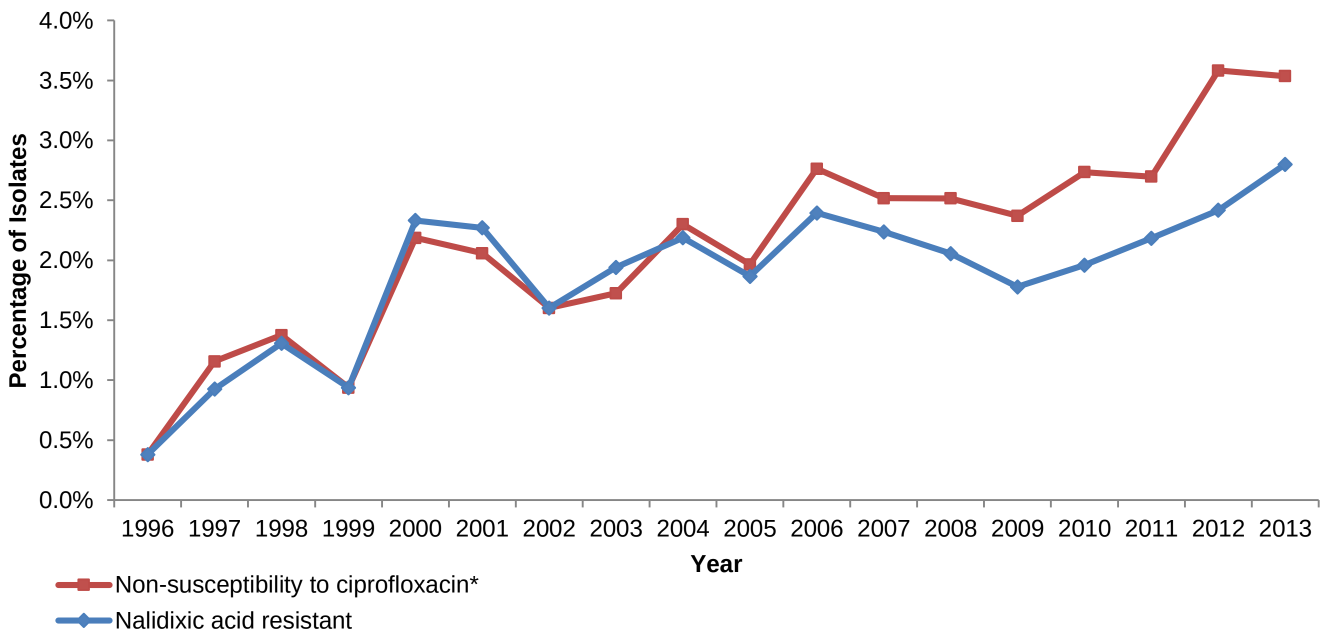
Increasing Non-Susceptibility to Quinolones among Nontyphoidal *Salmonella*

Fluoroquinolones (e.g., ciprofloxacin), a subset of the quinolone antimicrobial class, are important therapeutic options for severe nontyphoidal *Salmonella* (NTS) infections, especially in adults.[1] NARMS tests isolates of NTS for resistance to ciprofloxacin; a minimum inhibitory concentration (MIC) of 0.12–0.5 µg/mL is defined as intermediate, and MIC ≥1 µg/mL is defined as resistant. The quinolone nalidixic acid is also tested; MIC ≥32 µg/mL is defined as resistant, and there is no intermediate category. Although nalidixic acid is not used to treat invasive salmonellosis, monitoring susceptibility to this drug is important for surveillance purposes. Resistance to nalidixic acid is correlated with non-susceptibility to ciprofloxacin (intermediate or resistant) and may predict fluoroquinolone treatment failure.[2] In NTS and other *Enterobacteriaceae*, a single point mutation in the quinolone resistance-determining region (QRDR) of topoisomerase usually leads to nalidixic acid resistance and reduced susceptibility to ciprofloxacin.[3,4] Resistance to fluoroquinolones typically requires stepwise mutations in the QRDR that also result in nalidixic acid resistance. Non-susceptibility to ciprofloxacin in absence of nalidixic acid resistance may indicate extra-chromosomal (non-QRDR), plasmid-mediated quinolone resistance (PMQR) mechanisms.[4]

Non-susceptibility to quinolones has increased among NTS since 1996. Although both resistance to nalidixic acid and non-susceptibility to ciprofloxacin have been recently increasing, the trends diverged after 2005, with higher percentages of isolates with ciprofloxacin non-susceptibility than nalidixic acid resistance (Figure H3). From 2009 to 2013, the percentage of isolates resistant to nalidixic acid increased from 1.8% (39/2193) to 2.8% (61/2178), while the percentage with non-susceptibility to ciprofloxacin increased from 2.4% (52/2193) to 3.5% (77/2178). Among NTS isolates with non-susceptibility to ciprofloxacin, the proportion that lacked nalidixic acid resistance was only 9.3% (24/258) during 1996–2005, compared with 24.8% (127/513) during 2006–2013. Testing of NTS isolates collected during 2004–2006[5] and 2007[4] showed an increase in the proportion of isolates harboring PMQR mechanisms compared with 1996–2003.[6] NARMS is currently investigating the molecular mechanisms of resistance and possible sources of the more recent infections and undertaking analyses to describe correlations between nalidixic acid resistance and ciprofloxacin non-susceptibility in more detail at the serotype level.

Figure H3. Percentage of nontyphoidal *Salmonella* isolates with resistance to nalidixic acid compared with non-susceptibility to ciprofloxacin*, 1996–2013



* Ciprofloxacin intermediate or resistant phenotype (MIC ≥0.12 µg/mL)

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Continued Rise of ASSuT Resistance in *Salmonella* ser. I 4,[5],12:i:-

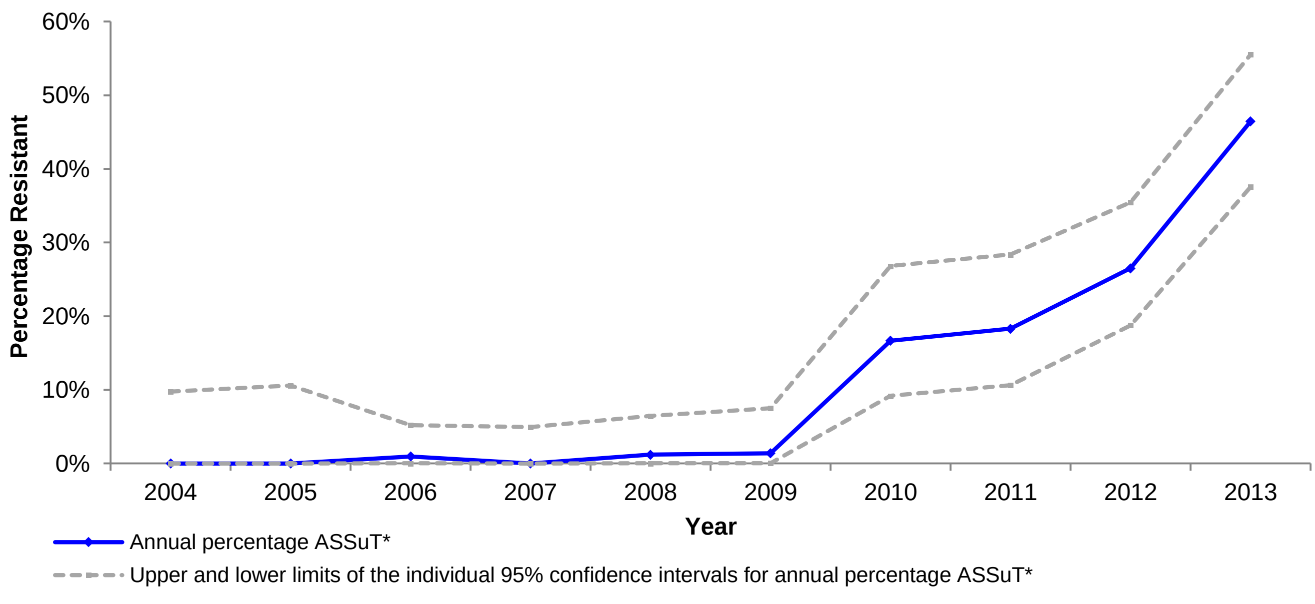
In 2013, the percentage of human *Salmonella* ser. I 4,[5],12:i:- isolates with resistance to ampicillin, streptomycin, sulfonamide, and tetracycline (ASSuT) but not chloramphenicol continued to increase. Resistance emerged in 2010 when the percentage of resistant isolates increased to nearly 17% from less than 1.5% for the previous 14 years.[1] This resistance increased to 18.3% (15/82) in 2011, 26.5% (31/117) in 2012, and 45.5% (59/127) in 2013 (Figure H4).

Serotype I 4,[5],12:i:- is a monophasic variant of serotype Typhimurium (I 4,[5],12:i:1,2). Resistance to ampicillin, streptomycin, sulfonamide, and tetracycline has also been observed among NARMS isolates of serotype Typhimurium; however, the majority of Typhimurium isolates resistant to these four agents have shown additional resistance to chloramphenicol. In 2013, 90.7% (39/43) of Typhimurium isolates resistant to at least ASSuT were also chloramphenicol resistant (ACSSuT), compared with only 1.7% (1/60) of ASSuT I 4,[5],12:i:- isolates. Among all nontyphoidal *Salmonella* isolates tested by NARMS in 2013, 74 (3.4%) were resistant to ASSuT but not chloramphenicol; 59 (79.7%) of these were serotype I 4,[5],12:i:-. The next most common serotype was Typhimurium with 4 (5.4%) isolates. (See the nontyphoidal *Salmonella* section for more detail).

In Europe, a notable increase of *Salmonella* ser. I 4,[5],12:i:- infections with resistance to ASSuT but not chloramphenicol has been observed since the early 2000s, predating the emergence in the United States. The European emergence was caused by a clonal group of I 4,[5],12:i:- ASSuT strains commonly belonging to definitive phage type DT193, with resistance conferred by $bla_{TEM\text{-}1}$, *strA/B*, *sul2,* and *tet*(B) genes on the chromosome.[2,3] Similar to ACSSuT in DT104, ASSuT in DT193 is due to a *Salmonella* Genomic Island (SGI) located in the chromosome; however, the SGI type and location differ between the two strains. Exposure to pigs or pork products has frequently been reported in persons infected with the DT193 "European clone," and the organism has been isolated from pigs.[2]

In the United States, ASSuT-resistant serotype I 4,[5],12:i- with pulsed-field gel electrophoresis (PFGE) pattern JPXX01.1314 (identical to DT193) and resistant determinates $bla_{TEM\text{-}1}$, *strA/B*, *sul2,* and *tet*(B) has caused multiple outbreaks. Frequently, these events have been linked with animal exposure or consumption of pork or beef, including meats purchased from live animal markets.[4] The increase of ASSuT-resistant serotype I 4,[5],12:i- in the United States is likely due to clonal expansion, given the frequency of the PFGE pattern and the resistance determinants likely being chromosomal, limiting horizontal transfer. These characteristics parallel the spread of DT193 in Europe.

Figure H4. Percentage of *Salmonella* ser. I 4,[5],12:i:- isolates with resistance to at least ASSuT* but not chloramphenicol, 2004–2013



* Ampicillin, streptomycin, sulphonamides, and tetracycline

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Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2013, NARMS conducted nationwide surveillance among the approximately 316 million persons living in the United States (2013 estimates published in the 2013 U.S. Census Bureau report). Public health laboratories systematically selected every 20th nontyphoidal *Salmonella, Shigella*, and *Escherichia coli* O157 isolate and every *Salmonella* ser. Typhi, *Salmonella* ser. Paratyphi A, and *Salmonella* ser. Paratyphi C isolate received at their laboratories and forwarded these isolates to CDC for antimicrobial susceptibility testing. With few exceptions, serotyping was performed at the public health laboratories and not further confirmed at CDC. *Salmonella* ser. Paratyphi B was included in the sampling for nontyphoidal *Salmonella* because laboratory methods are not always available to reliably distinguish between ser. Paratyphi B (which typically causes typhoidal illness) and ser. Paratyphi B var. L(+) tartrate+ (which does not typically cause typhoidal illness). Serotype Paratyphi B isolates for which the results of tartrate fermentation testing are reported as either “negative” or “missing” are retested and confirmed at CDC. Those identified as ser. Paratyphi B var. L(+) tartrate+ are included with other nontyphoidal *Salmonella* serotypes in this report. Because the number of ser. Paratyphi B (tartrate negative) and ser. Paratyphi C isolates is very small, this report includes susceptibility results only for ser. Paratyphi A.

Beginning in 2009, NARMS performed susceptibility testing on isolates of *Vibrio* species other than *V. cholerae* submitted by the NARMS participating public health laboratories. Participants were asked to forward every *Vibrio* isolate that they received to CDC. Isolates of *Vibrio* species other than *V. cholerae* are confirmed in CDC’s National Enteric Reference Laboratory and tested for antimicrobial susceptibility by NARMS, whereas isolates of *Vibrio cholerae* are only characterized in the Reference Laboratory and not tested by NARMS. Due to an increasing number of *Vibrio parahaemolyticus* submissions, NARMS began selecting every other *Vibrio parahaemolyticus* isolate for antimicrobial susceptibility testing during 2013. NARMS continued to test every isolate of the remaining *Vibrio* species other than *Vibrio cholerae*. For information on toxigenic *Vibrio cholerae*, refer to the Cholera and Other *Vibrio* Illness Surveillance System (COVIS) annual summaries.

Since 1997, NARMS has performed antimicrobial susceptibility testing on *Campylobacter* isolates submitted by the public health laboratories participating in CDC’s Foodborne Diseases Active Surveillance Network (FoodNet). The FoodNet sites, representing approximately 48 million persons (2013 estimates published in 2013 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 (Georgia, Maryland, New Mexico, Oregon, and Tennessee), every other isolate (California, Colorado, Connecticut, 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,19 to 101 per site in 2013), the number submitting isolates to the state public health laboratory ranged from one to 101 in 2013.

Table 1. Population size and number of isolates received and tested, 2013

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	4,833,722	(1.5)	66	(3.0)	6	(1.6)	15	(4.4)	0	(0)			0	(0)
Alaska	735,132	(0.2)	3	(0.1)	5	(1.3)	1	(0.3)	0	(0)			2	(0.3)
Arizona	6,626,624	(2.1)	54	(2.5)	13	(3.4)	0	(0)	4	(2.3)			2	(0.3)
Arkansas	2,959,373	(0.9)	30	(1.4)	0	(0)	10	(2.9)	1	(0.6)			0	(0)
California§	28,315,453	(9)	54	(2.5)	40	(10.5)	0	(0)	10	(5.6)	74	(5.4)	30	(4.9)
Colorado	5,268,367	(1.7)	33	(1.5)	5	(1.3)	6	(1.7)	3	(1.7)	28	(2.0)	10	(1.6)
Connecticut	3,596,080	(1.1)	25	(1.1)	7	(1.8)	3	(0.9)	1	(0.6)	158	(11.5)	25	(4.1)
Delaware	925,749	(0.3)	8	(0.4)	3	(0.8)	1	(0.3)	1	(0.6)			2	(0.3)
District of Columbia	646,449	(0.2)	9	(0.4)	1	(0.3)	2	(0.6)	0	(0)			0	(0)
Florida	19,552,860	(6.2)	76	(3.5)	12	(3.2)	6	(1.7)	0	(0)			124	(20.4)
Georgia	9,992,167	(3.2)	125	(5.7)	11	(2.9)	45	(13.1)	2	(1.1)	193	(14.1)	14	(2.3)
Hawaii	1,404,054	(0.4)	9	(0.4)	2	(0.5)	3	(0.9)	3	(1.7)			25	(4.1)
Houston, Texas¶	2,195,914	(0.7)	48	(2.2)	5	(1.3)	31	(9)	0	(0)			0	(0)
Idaho	1,612,136	(0.5)	8	(0.4)	2	(0.5)	1	(0.3)	2	(1.1)			0	(0)
Illinois	12,882,135	(4.1)	105	(4.8)	24	(6.3)	17	(4.9)	10	(5.6)			1	(0.2)
Indiana	6,570,902	(2.1)	39	(1.8)	4	(1.1)	2	(0.6)	6	(3.4)			4	(0.7)
Iowa	3,090,416	(1)	23	(1.1)	2	(0.5)	1	(0.3)	4	(2.3)			7	(1.2)
Kansas	2,893,957	(0.9)	15	(0.7)	1	(0.3)	2	(0.6)	2	(1.1)			0	(0)
Kentucky	4,395,295	(1.4)	20	(0.9)	2	(0.5)	0	(0)	2	(1.1)			1	(0.2)
Los Angeles**	10,017,068	(3.2)	56	(2.6)	18	(4.7)	2	(0.6)	1	(0.6)			0	(0)
Louisiana	4,625,470	(1.5)	49	(2.2)	0	(0)	12	(3.5)	0	(0)			21	(3.5)
Maine	1,328,302	(0.4)	4	(0.2)	0	(0)	1	(0.3)	3	(1.7)			7	(1.2)
Maryland	5,928,814	(1.9)	47	(2.2)	15	(3.9)	4	(1.2)	5	(2.8)	249	(18.1)	24	(4)
Massachusetts	6,692,824	(2.1)	77	(3.5)	20	(5.3)	11	(3.2)	3	(1.7)			47	(7.7)
Michigan	9,895,622	(3.1)	44	(2.0)	3	(0.8)	6	(1.7)	0	(0)			4	(0.7)
Minnesota	5,420,380	(1.7)	40	(1.8)	6	(1.6)	7	(2)	8	(4.5)	166	(12.1)	13	(2.1)
Mississippi	2,991,207	(0.9)	46	(2.1)	0	(0)	8	(2.3)	1	(0.6)			7	(1.2)
Missouri	6,044,171	(1.9)	61	(2.8)	1	(0.3)	7	(2)	14	(7.9)			2	(0.3)
Montana	1,015,165	(0.3)	9	(0.4)	0	(0)	4	(1.2)	6	(3.4)			2	(0.3)
Nebraska	1,868,516	(0.6)	11	(0.5)	0	(0)	8	(2.3)	4	(2.3)			2	(0.3)
Nevada	2,790,136	(0.9)	17	(0.8)	1	(0.3)	0	(0)	1	(0.6)			2	(0.3)
New Hampshire	1,323,459	(0.4)	9	(0.4)	3	(0.8)	0	(0)	0	(0)			3	(0.5)
New Jersey	8,899,339	(2.8)	49	(2.2)	25	(6.6)	7	(2)	6	(3.4)			22	(3.6)
New Mexico	2,085,287	(0.7)	21	(1.0)	1	(0.3)	2	(0.6)	0	(0)	90	(6.6)	1	(0.2)
New York††	11,245,290	(3.6)	71	(3.3)	13	(3.4)	4	(1.2)	5	(2.8)	196	(14.3)	35	(5.8)
New York City‡‡	8,405,837	(2.7)	62	(2.8)	39	(10.3)	15	(4.4)	4	(2.3)			12	(2)
North Carolina	9,848,060	(3.1)	91	(4.2)	9	(2.4)	5	(1.5)	1	(0.6)			4	(0.7)
North Dakota	723,393	(0.2)	6	(0.3)	0	(0)	2	(0.6)	1	(0.6)			1	(0.2)
Ohio	11,570,808	(3.7)	65	(3.0)	9	(2.4)	8	(2.3)	7	(4.0)			3	(0.5)
Oklahoma	3,850,568	(1.2)	33	(1.5)	1	(0.3)	2	(0.6)	6	(3.4)			0	(0)
Oregon	3,930,065	(1.2)	21	(1.0)	4	(1.1)	4	(1.2)	7	(4.0)	145	(10.6)	7	(1.2)
Pennsylvania	12,773,801	(4)	75	(3.4)	12	(3.2)	6	(1.7)	6	(3.4)			2	(0.3)
Rhode Island	1,051,511	(0.3)	8	(0.4)	1	(0.3)	8	(2.3)	0	(0)			10	(1.6)
South Carolina	4,774,839	(1.5)	54	(2.5)	0	(0)	4	(1.2)	1	(0.6)			7	(1.2)
South Dakota	844,877	(0.3)	9	(0.4)	0	(0)	2	(0.6)	1	(0.6)			0	(0)
Tennessee	6,495,978	(2.1)	44	(2.0)	3	(0.8)	27	(7.8)	4	(2.3)	73	(5.3)	3	(0.5)
Texas§§	24,252,279	(7.7)	153	(7.0)	11	(2.9)	10	(2.9)	4	(2.3)			32	(5.3)
Utah	2,900,872	(0.9)	16	(0.7)	2	(0.5)	1	(0.3)	2	(1.1)			1	(0.2)
Vermont	626,630	(0.2)	4	(0.2)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Virginia	8,260,405	(2.6)	52	(2.4)	14	(3.7)	4	(1.2)	1	(0.6)			21	(3.5)
Washington	6,971,406	(2.2)	34	(1.6)	20	(5.3)	7	(2)	11	(6.2)			62	(10.2)
West Virginia	1,854,304	(0.6)	35	(1.6)	0	(0)	5	(1.5)	5	(2.8)			0	(0)
Wisconsin	5,742,713	(1.8)	50	(2.3)	4	(1.1)	2	(0.6)	5	(2.8)			3	(0.5)
Wyoming	582,658	(0.2)	5	(0.2)	0	(0)	2	(0.6)	2	(1.1)			0	(0)
Total	**316,128,839**	**(100)**	**2,178**	**(100)**	**380**	**(100)**	**344**	**(100)**	**177**	**(100)**	**1,372**	**(100)**	**607**	**(100)**

* Published in 2013 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,19 to 101 per site in 2013), the number submitting isolates to the state public health laboratory ranged from one to all.

§ Excluding Los Angeles County

¶ Houston City

** Los Angeles County

†† Excluding New York City

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

§§ Excluding Houston City

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 MICs for each of 15 antimicrobial agents: ampicillin, amoxicillin-clavulanic acid, azithromycin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole (Table 2). Interpretive criteria defined by CLSI were used when available. Before 2004, sulfamethoxazole was used instead of sulfisoxazole to represent the sulfonamides. In 2011, azithromycin replaced amikacin on the panel of drugs tested for *Salmonella*, *Shigella*, and *E. coli* O157, so only historical susceptibility data are provided for amikacin.

In January 2010, CLSI published revised interpretive criteria for ceftriaxone and *Enterobacteriaceae;* the revised resistance breakpoint for ceftriaxone is MIC ≥4 µg/mL. Since the 2009 report, NARMS has applied the revised CLSI breakpoint for ceftriaxone resistance to data from all years. In January 2012, CLSI published revised ciprofloxacin breakpoints for invasive *Salmonella* infections. For those infections, ciprofloxacin susceptibility is defined as ≤0.06 µg/mL; the intermediate category is defined as 0.12 to 0.5 µg/mL; and resistance is defined as ≥1 µg/mL. In 2013, CLSI decided to apply these ciprofloxacin breakpoints to all subspecies and serotypes of *Salmonella*. In January 2014, CLSI added azithromycin MIC interpretive criteria for *Salmonella* ser. Typhi. Azithromycin susceptibility is defined as ≤16 µg/mL and resistance is defined as ≥32 µg/mL. These breakpoints match the NARMS-established breakpoints used for *Enterobacteriaceae* since azithromycin testing began in 2011. In this report, NARMS continued to apply these breakpoints to MIC data for all *Salmonella*, *Shigella*, and *E. coli* O157 (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, 1996–2013

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

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

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

‡ CLSI breakpoints are not established for streptomycin; resistance breakpoint used in NARMS is ≥64 μg/mL

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

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

** CLSI breakpoints for azithromycin are only established for *Salmonella* ser. Typhi. The azithromycin breakpoints used elsewhere in this report for nontyphi *Salmonella*, *Shigella*, 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

β-lactam Panel Testing

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 using broth microdilution on a Sensititre® β-lactam panel (Trek Diagnostics, part of Thermo Fisher Scientific, Cleveland, OH) according to manufacturer's instructions. The panel contained additional broad-spectrum β-lactam drugs: aztreonam, cefepime, cefotaxime, ceftazidime, imipenem, and piperacillin-tazobactam (Table 2). Briefly, a suspension of each isolate was made in water to a McFarland standard equivalency of 0.5, 10uL of this suspension was then used to inoculate a 10mL tube of cation-adjusted Mueller-Hinton broth, 50uL of this inoculated broth was dosed into each well of the 96-well 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, *K. pneumoniae* ATCC 700603, *P. aeruginosa* ATCC 27853, and *S. aureus* ATCC 29213.

Cephalosporin Retesting of Isolates from 1996–1998

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

Serotype Confirmation/Categorization

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

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

Testing of *Campylobacter*

Changes in Identification/Speciation and Antimicrobial Susceptibility Testing Over Time

From 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 by other PCR assays (Linton *et al.* 1996) or were characterized by the CDC National *Campylobacter* Reference Laboratory. From 1997 to 2002, methodology similar to that used from 2005 to 2009 was used.

From 2005 to 2010, isolates were confirmed as *Campylobacter* by determination of typical morphology and motility using dark-field microscopy and a positive oxidase test reaction. Identification of *C. jejuni* was performed using the hippurate hydrolysis test. Hippurate-positive isolates were identified as *C. jejuni.* Hippurate-negative isolates were further characterized with PCR assays with specific targets for *C*. *jejuni (mapA* or *hipO* gene*)*, *C*. *coli*-specific *ceuE* gene (Linton *et al.* 1997, Gonzales *et al.* 1997, Pruckler *et al*. 2006), or other species-specific primers. In 2010, all *C. jejuni* and suspected *C. coli* isolates were also confirmed through a multiplex PCR (Vandamme *et al.* 1997). In 2010 and 2011, the *ceuE* PCR was not used, and all *C. jejuni* and suspected *C. coli* isolates were confirmed through a multiplex PCR (Vandamme *et al.* 1997). From 2012 to present, 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.

The 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 used for erythromycin, ciprofloxacin, and tetracycline beginning with the 2004 NARMS annual report. NARMS breakpoints were used for agents for which CLSI breakpoints were not available. Beginning in 2004, NARMS breakpoints were established based on the MIC distributions of NARMS isolates and the presence of known resistance genes or mutations. In pre-2004 annual reports, NARMS breakpoints used had been based on those available for other organisms. Establishment of breakpoints based on MIC distributions resulted in higher MIC breakpoints for azithromycin and erythromycin resistance compared with those reported in pre-2004 annual reports. Beginning in 2005, broth microdilution using the Sensititre® system (Trek Diagnostics, part of Thermo Fisher Scientific, Cleveland, OH) was performed according to manufacturer's instructions to determine the MICs for nine antimicrobial agents: azithromycin, ciprofloxacin, clindamycin, erythromycin, florfenicol, gentamicin, nalidixic acid, telithromycin, and tetracycline (Table 3). CLSI recommendations for quality control were followed. 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. In 2012, the criteria for interpretation of results were changed from the previously used breakpoints to European Committee on Antimicrobial Susceptibility Testing (EUCAST) epidemiological cut-off values (ECOFFs). Repeat testing of isolates was based on criteria in Appendix B.

Table 3. Antimicrobial agents used for susceptibility testing of *Campylobacter* isolates, 1997–2013

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

* Etest dilution range used from 1997–2004

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

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

NARMS participating public health laboratories were asked to forward every *Vibrio* isolate that they received to CDC. Isolates of *Vibrio* species other than *V*. *cholerae* are confirmed in CDC's National Enteric Reference Laboratory and tested for antimicrobial susceptibility by NARMS, whereas isolates of *Vibrio cholerae* are only characterized in the Reference Laboratory and not tested by NARMS. Due to an increasing number of *Vibrio parahaemolyticus* submissions, NARMS began selecting every other *Vibrio parahaemolyticus* isolate for antimicrobial susceptibility testing during 2013. NARMS continued to test every isolate of the remaining *Vibrio* species other than *Vibrio cholerae*.

Minimum inhibitory concentrations were determined by Etest® (AB bioMerieux, Solna, Sweden) according to manufacturer's instructions for ten antimicrobial agents: ampicillin, cefotaxime, ceftazidime, chloramphenicol, ciprofloxacin, gentamicin, imipenem, nalidixic acid, tetracycline, and trimethoprim-sulfamethoxazole (Table 4). In 2013, cefotaxime, ceftazidime, gentamicin, and imipenem were added to the panel of drugs tested, while cephalothin, kanamycin, and streptomycin were removed. CLSI breakpoints specific for *Vibrio* species other than *V. cholerae* were available for ampicillin, cefotaxime, ceftazidime, ciprofloxacin, gentamicin, imipenem, tetracycline, and trimethoprim-sulfamethoxazole. The percentage of isolates susceptible, intermediate, and resistant to those agents in 2013 is shown in this report (Table 58). MIC distributions are shown for all agents tested in 2013. 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.

Table 4. Antimicrobial agents used for susceptibility testing of *Vibrio* species other than *V. cholerae* isolates, 2009–2013

CLSI Class	Antimicrobial Agent	Years Tested	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
				Susceptible	Intermediate*	Resistant
Aminoglycosides	Gentamicin	2013	0.064–1024	≤4	8	≥16
	Kanamycin	2009–2012	0.015–256	No CLSI or NARMS breakpoints		
	Streptomycin	2009–2012	0.064–1024	No CLSI or NARMS breakpoints		
Cephems	Cefotaxime	2013	0.016–256	≤1	2	≥4
	Ceftazidime	2013	0.016–256	≤4	8	≥16
	Cephalothin	2009–2012	0.015–256	No CLSI or NARMS breakpoints		
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	all	0.002–32	≤2/38	N/A	≥4/76
Penems	Imipenem	2013	0.002–32	≤4	8	≥16
Penicillins	Ampicillin	all	0.015–256	≤8	16	≥32
Phenicols	Chloramphenicol	all	0.015–256	No CLSI or NARMS breakpoints		
Quinolones	Ciprofloxacin	all	0.002–32	≤1	2	≥4
	Nalidixic acid	all	0.015–256	No CLSI or NARMS breakpoints		
Tetracyclines	Tetracycline	all	0.015–256	≤4	8	≥16

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

Data Analysis

For all pathogens, isolates were categorized as resistant, intermediate (if applicable), or susceptible. For *Campylobacter*, epidemiological cutoff values established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) were used to interpret MICs. This approach assigns bacteria to one of two groups: wild type or non-wild type. For simplicity, the EUCAST wild type and non-wild type are referred to in this report as susceptible and resistant, respectively.

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

In the analysis of antimicrobial class resistance among *Salmonella, Shigella,* and *E. coli* O157, nine CLSI classes (Table 2) were represented by the following agents: amoxicillin-clavulanic acid, ampicillin, azithromycin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole/sulfisoxazole, tetracycline, and trimethoprim-sulfamethoxazole. Isolates that were not resistant to any of these agents were considered to have no resistance detected. In the analysis of antimicrobial class resistance among *Campylobacter*, seven CLSI classes were represented by azithromycin, ciprofloxacin, chloramphenicol/florfenicol, clindamycin, erythromycin, gentamicin, nalidixic acid, telithromycin, and tetracycline (Table 3). *Campylobacter* 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 2004–2013 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 2013 with the average prevalence from two reference periods, 2004–2008 and the previous five years, 2008–2012. 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 2008–2012 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, 2014). Comparisons were made for the following:

- Nontyphoidal *Salmonella*: resistance to nalidixic acid, ceftriaxone, one or more CLSI classes, three or more CLSI classes
- *Salmonella* of particular serotypes
  - *Salmonella* ser. Enteritidis: resistance to nalidixic acid
  - *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: resistance to nalidixic acid
- *Shigella*: resistance to nalidixic acid
- *Campylobacter jejuni, C. coli*: resistance to ciprofloxacin

In the logistic regression analysis for main effects, year was modelled as a 10-level categorical variable. To account for site-to-site variation in the prevalence of antimicrobial resistance, we included adjustments for site. The final regression models for *Salmonella* and *Shigella* adjusted for the submitting site using the nine division categories described by the U.S. Census Bureau: East North Central, East South Central, Middle Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central. For *Campylobacter*, the final regression models adjusted for the submitting site using the 10 FoodNet states. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. The adequacy of model fit was assessed in several ways (Fleiss et al., 2004; Kleinbaum et al., 2008). The significance of the main effect of year was assessed using the likelihood ratio test. The likelihood ratio test was also used to test for significance of interaction between site and year, although the power of the test to detect a single site-specific interaction was low. When the main effect of year was significant, we report ORs with 95% CIs (for 2013 compared with 2004-2008 and 2008–2012) 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

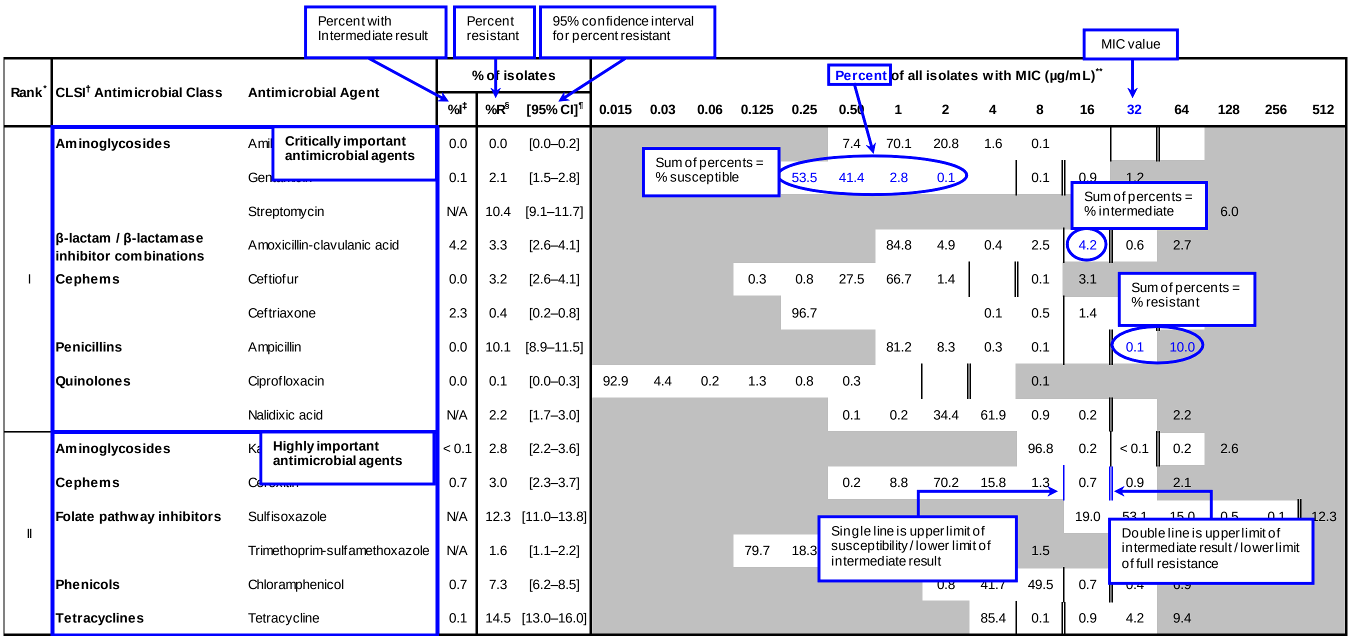
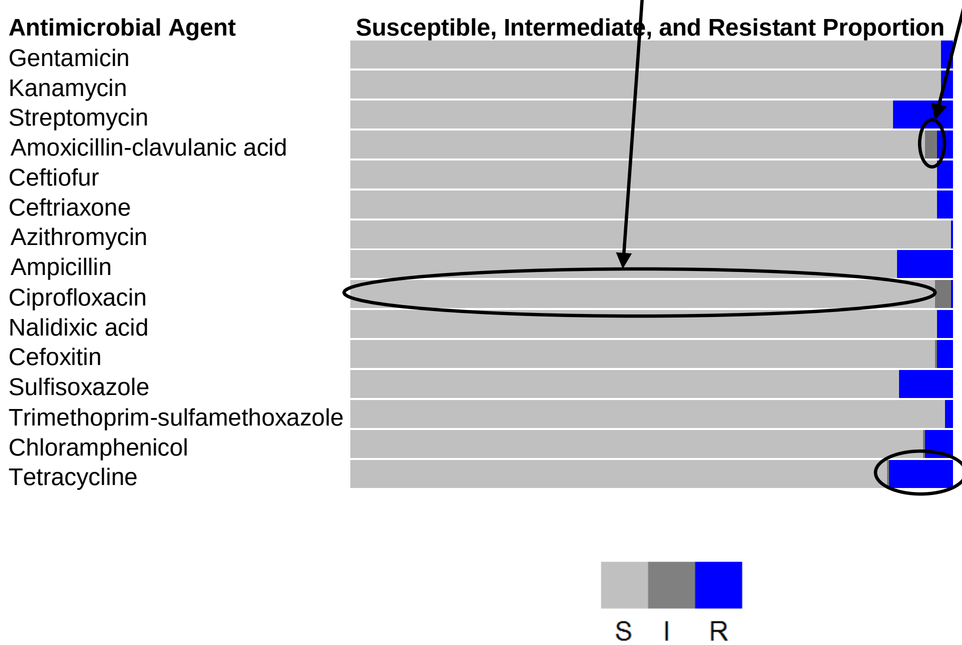


Figure 2. Proportional chart, a categorical graph of a squashtogram

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 of the most common serotypes* tested with the number of resistant isolates by class and agent, 2013

	Isolates		Number of Isolates: Number of CLSI† Antimicrobial Classes to which Isolates are Resistant						Number of Resistant Isolates by CLSI† Antimicrobial Class and Agent‡: Aminoglycosides			β-lactam/β-lactamase inhibitor combinations	Cephems			Folate pathway inhibitors		Macrolides	Penicillins	Phenicols	Quinolones		Tetracyclines
Serotype*	**N**	**(%)**	**0**	**1**	**2–3**	**4–5**	**6–7**	**8**	**GEN**	**KAN**	**STR**	**AMC**	**FOX**	**TIO**	**AXO**	**FIS**	**COT**	**AZI**	**AMP**	**CHL**	**CIP**	**NAL**	**TET**
Enteritidis	382	(17.5)	334	31	11	5	1	0	0	0	10	0	0	1	1	6	2	0	22	1	0	22	17
Typhimurium	325	(14.9)	226	25	26	40	8	0	4	1	67	11	11	11	11	68	4	0	54	44	0	5	69
Newport	209	(9.6)	192	5	2	0	10	0	1	1	12	11	11	11	11	10	1	0	13	10	0	0	13
Javiana	140	(6.4)	126	12	2	0	0	0	0	0	6	1	0	0	0	0	0	0	1	0	0	4	4
I 4,[5],12:i:-	127	(5.8)	50	8	7	60	2	0	6	1	68	2	2	2	2	68	3	2	63	3	1	1	70
Infantis	76	(3.5)	62	5	5	1	3	0	3	3	3	3	3	5	5	7	3	0	7	3	0	4	10
Heidelberg	60	(2.8)	28	1	26	4	1	0	13	16	24	8	9	9	9	9	1	0	20	4	0	0	20
Muenchen	59	(2.7)	58	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1
Saintpaul	56	(2.6)	44	6	6	0	0	0	3	0	5	0	0	0	0	4	1	0	4	0	0	2	7
Montevideo	53	(2.4)	51	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Braenderup	44	(2.0)	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi	36	(1.7)	35	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Oranienburg	34	(1.6)	30	2	2	0	0	0	1	0	1	0	1	0	0	1	0	0	2	0	0	1	0
Thompson	33	(1.5)	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agona	28	(1.3)	23	2	1	1	0	1	1	2	2	1	1	1	1	3	2	0	2	2	0	2	4
Paratyphi B var. L(+) tartrate+	28	(1.3)	22	4	0	2	0	0	0	0	2	0	0	0	0	2	0	0	2	3	1	3	2
Anatum	20	(0.9)	19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Bareilly	19	(0.9)	16	1	2	0	0	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0	2
Poona	17	(0.8)	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Berta	16	(0.7)	13	2	1	0	0	0	0	0	1	1	1	1	1	0	0	0	1	0	0	0	1
Litchfield	15	(0.7)	13	0	2	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	0	2
Schwarzengrund	15	(0.7)	12	2	1	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1
Rubislaw	14	(0.6)	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mbandaka	13	(0.6)	9	3	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	2
Dublin	12	(0.6)	1	0	0	0	10	1	2	8	10	11	10	11	11	11	1	0	11	11	0	1	11
Hadar	11	(0.5)	2	0	9	0	0	0	0	0	9	0	0	0	0	0	0	0	1	0	0	0	9
Panama	11	(0.5)	10	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Uganda	11	(0.5)	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Hartford	10	(0.5)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sandiego	10	(0.5)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**1884**	**(86.5)**	**1514**	**115**	**105**	**113**	**35**	**2**	**34**	**32**	**228**	**49**	**49**	**52**	**52**	**196**	**22**	**2**	**203**	**81**	**4**	**49**	**245**
All other serotypes	239	(11.0)	203	12	12	8	4	0	6	1	15	3	2	2	2	23	8	1	16	4	5	9	25
Partially serotyped	13	(0.6)	11	0	1	1	0	0	1	2	2	0	1	0	0	1	0	1	1	0	1	1	1
Rough/Nonmotile isolates	6	(0.3)	4	1	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	0	0	1	0
Unknown serotype	36	(1.7)	28	2	3	3	0	0	2	0	5	1	1	1	1	4	0	0	6	0	1	1	4
Total	**2178**	**(100)**	**1760**	**130**	**121**	**126**	**39**	**2**	**43**	**35**	**251**	**53**	**53**	**55**	**55**	**225**	**31**	**5**	**227**	**85**	**11**	**61**	**275**

* Only serotypes with at least 10 isolates are listed individually
† CLSI: Clinical and Laboratory Standards Institute
‡ Antimicrobial agent abbreviations: GEN, gentamicin; KAN, kanamycin; 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, 2013

			At least ACSSuT*		At least ACT/S†		At least ACSSuTAuCx‡		Nalidixic Acid		Ceftriaxone		At least CxN§	
		N	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes														
1	Enteritidis	382	1	(1.4)	0	(0)	0	(0)	22	(36.1)	1	(1.8)	1	(20.0)
2	Typhimurium	325	39	(52.7)	0	(0)	7	(22.6)	5	(8.2)	11	(20.0)	0	(0)
3	Newport	209	10	(13.5)	1	(10.0)	10	(32.3)	0	(0)	11	(20.0)	0	(0)
4	Javiana	140	0	(0)	0	(0)	0	(0)	4	(6.6)	0	(0)	0	(0)
5	I 4,[5],12:i:-	127	1	(1.4)	1	(10.0)	0	(0)	1	(1.6)	2	(3.6)	0	(0)
6	Infantis	76	1	(1.4)	1	(10.0)	1	(3.2)	4	(6.6)	5	(9.1)	2	(40.0)
7	Heidelberg	60	4	(5.4)	1	(10.0)	1	(3.2)	0	(0)	9	(16.4)	0	(0)
8	Muenchen	59	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
9	Saintpaul	56	0	(0)	0	(0)	0	(0)	2	(3.3)	0	(0)	0	(0)
10	Montevideo	53	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
11	Braenderup	44	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
12	Mississippi	36	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
13	Oranienburg	34	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
14	Thompson	33	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
15	Agona	28	2	(2.7)	2	(20.0)	1	(3.2)	2	(3.3)	1	(1.8)	1	(20.0)
	Paratyphi B var. L(+) tartrate+	28	2	(2.7)	0	(0)	0	(0)	3	(4.9)	0	(0)	0	(0)
17	Anatum	20	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
18	Bareilly	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
19	Poona	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
20	Berta	16	0	(0)	0	(0)	0	(0)	0	(0)	1	(1.8)	0	(0)
Additional serotypes¶														
	Mbandaka	13	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Dublin	12	10	(13.5)	1	(10.0)	10	(32.3)	1	(1.6)	11	(20.0)	1	(20.0)
	Uganda	11	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Senftenberg	7	1	(1.4)	1	(10.0)	1	(3.2)	0	(0)	1	(1.8)	0	(0)
	Kentucky	6	0	(0)	0	(0)	0	(0)	3	(4.9)	1	(1.8)	0	(0)
	Muenster	6	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Bredeney	4	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Choleraesuis	2	2	(2.7)	2	(20.0)	0	(0)	2	(3.3)	0	(0)	0	(0)
	Indiana	2	1	(1.4)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	London	2	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
Subtotal		**1827**	**74**	**(100)**	**10**	**(100)**	**31**	**(100)**	**58**	**(95.1)**	**54**	**(98.2)**	**5**	**(100)**
	All other serotypes	296	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Partially serotyped	13	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Rough/Nonmotile isolates	6	0	(0)	0	(0)	0	(0)	1	(1.6)	0	(0)	0	(0)
	Unknown serotype	36	0	(0)	0	(0)	0	(0)	1	(1.6)	1	(1.8)	0	(0)
Total		**2178**	**74**	**(100)**	**10**	**(100)**	**31**	**(100)**	**61**	**(100)**	**55**	**(100)**	**5**	**(100)**

* ACSSuT: resistance to ampicillin, chloramphenicol, streptomycin, sulfisoxazole, tetracycline
† ACT/S: resistance to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
‡ ACSSuTAuCx: resistance to ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone
§ CxN: resistance to ceftriaxone and nalidixic acid
¶ 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, 2013

			≥ 3 CLSI classes*		≥ 4 CLSI classes*		≥ 5 CLSI classes*		≥ 6 CLSI classes*		≥ 7 CLSI classes*		≥ 8 CLSI classes*		≥ 9 CLSI classes*	
		N	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes																
1	Enteritidis	382	6	(2.8)	6	(3.6)	1	(1.1)	1	(2.4)	1	(2.9)	0	(0)	0	-
2	Typhimurium	325	55	(25.7)	48	(28.7)	40	(46.0)	8	(19.5)	7	(20.0)	0	(0)	0	-
3	Newport	209	12	(5.6)	10	(6.0)	10	(11.5)	10	(24.4)	10	(28.6)	0	(0)	0	-
4	Javiana	140	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
5	I 4,[5],12:i:-	127	65	(30.4)	62	(37.1)	3	(3.4)	2	(4.9)	1	(2.9)	0	(0)	0	-
6	Infantis	76	8	(3.7)	4	(2.4)	4	(4.6)	3	(7.3)	2	(5.7)	0	(0)	0	-
7	Heidelberg	60	20	(9.3)	5	(3.0)	4	(4.6)	1	(2.4)	1	(2.9)	0	(0)	0	-
8	Muenchen	59	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
9	Saintpaul	56	4	(1.9)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
10	Montevideo	53	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
11	Braenderup	44	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
12	Mississippi	36	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
13	Oranienburg	34	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
14	Thompson	33	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
15	Agona	28	2	(0.9)	2	(1.2)	2	(2.3)	1	(2.4)	1	(2.9)	1	(50.0)	0	-
	Paratyphi B var. L(+) tartrate+	28	2	(0.9)	2	(1.2)	2	(2.3)	0	(0)	0	(0)	0	(0)	0	-
17	Anatum	20	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
18	Bareilly	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
19	Poona	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
20	Berta	16	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Additional serotypes†																
	Litchfield	15	2	(0.9)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Dublin	12	11	(5.1)	11	(6.6)	11	(12.6)	11	(26.8)	11	(31.4)	1	(50.0)	0	-
	Hadar	11	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Senftenberg	7	1	(0.5)	1	(0.6)	1	(1.1)	1	(2.4)	1	(2.9)	0	(0)	0	-
	Kentucky	6	4	(1.9)	3	(1.8)	2	(2.3)	0	(0)	0	(0)	0	(0)	0	-
	Brandenburg	5	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Derby	5	2	(0.9)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Bredeney	4	1	(0.5)	1	(0.6)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	-
	Lomalinda	4	1	(0.5)	1	(0.6)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Choleraesuis	2	2	(0.9)	2	(1.2)	2	(2.3)	2	(4.9)	0	(0)	0	(0)	0	-
	Indiana	2	1	(0.5)	1	(0.6)	1	(1.1)	1	(2.4)	0	(0)	0	(0)	0	-
	London	2	1	(0.5)	1	(0.6)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	-
	IIIb 48:i:z	1	1	(0.5)	1	(0.6)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Reading	1	1	(0.5)	1	(0.6)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
Subtotal		**1839**	**206**	**(96.3)**	**162**	**(97)**	**85**	**(97.7)**	**41**	**(100)**	**35**	**(100)**	**2**	**(100)**	0	**-**
	All other serotypes	284	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Partially serotyped	13	2	(0.9)	1	(0.6)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	-
	Rough/Nonmotile isolates	6	1	(0.5)	1	(0.6)	0	(0)	0	(0)	0	(0)	0	(0)	0	-
	Unknown serotype	36	5	(2.3)	3	(1.8)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	-
Total		**2178**	**214**	**(100)**	**167**	**(100)**	**87**	**(100)**	**41**	**(100)**	**35**	**(100)**	**2**	**(100)**	0	**-**

* CLSI: Clinical and Laboratory Standards Institute

† Additional serotypes that displayed resistance to at least three CLSI classes

Table 8. Minimum inhibitory concentrations (MICs) and resistance of nontyphoidal *Salmonella* isolates to antimicrobial agents, 2013 (N=2178)

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	2.0	[1.4 - 2.7]					11.6	77.5	8.3	0.6	0.1	<0.1	0.6	1.4				
		Kanamycin	0.1	1.6	[1.1 - 2.2]										98.0	0.2	0.1	0.2	1.4		
		Streptomycin	N/A	11.5	[10.2 - 12.9]												88.5	3.0	8.5		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.6	2.4	[1.8 - 3.2]							84.2	3.9	1.7	5.2	2.6	0.1	2.3			
	Cephems	Ceftiofur	0.1	2.5	[1.9 - 3.3]				0.1	0.2	13.3	81.7	2.1	0.1	0.1	2.4					
		Ceftriaxone	<0.1	2.5	[1.9 - 3.3]					97.2	0.1	<0.1	<0.1		0.2	1.1	1.0	0.2	<0.1		
	Macrolide	Azithromycin	N/A	0.2	[0.1 - 0.5]					<0.1	<0.1	0.1	2.8	82.8	13.3	0.6	0.2				
	Penicillins	Ampicillin	0.0	10.4	[9.2 - 11.8]							81.1	7.2	0.9	0.4		0.1	10.3			
	Quinolones	Ciprofloxacin	3.0	0.5	[0.3 - 0.9]	83.0	13.1	0.4	1.0	1.1	0.9	0.1	0.1		0.3						
		Nalidixic acid	N/A	2.8	[2.1 - 3.6]						<0.1	0.1	30.3	64.6	1.2	0.9	0.5	2.3			
II	Cephems	Cefoxitin	0.4	2.4	[1.8 - 3.2]						0.1	5.9	72.0	17.9	1.3	0.4	0.7	1.7			
	Folate pathway inhibitors	Sulfisoxazole	N/A	10.3	[9.1 - 11.7]											10.8	56.2	21.7	0.6	0.4	10.3
		Trimethoprim-sulfamethoxazole	N/A	1.4	[1.0 - 2.0]				95.7	2.4	0.3	<0.1	0.1	0.2	1.2						
	Phenicols	Chloramphenicol	0.9	3.9	[3.1 - 4.8]								0.5	37.3	57.3	0.9	<0.1	3.9			
	Tetracyclines	Tetracycline	1.0	12.6	[11.3 - 14.1]									86.4	1.0	0.2	2.1	10.4			

* 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.

Figure 3. Antimicrobial resistance pattern for nontyphoidal *Salmonella*, 2013

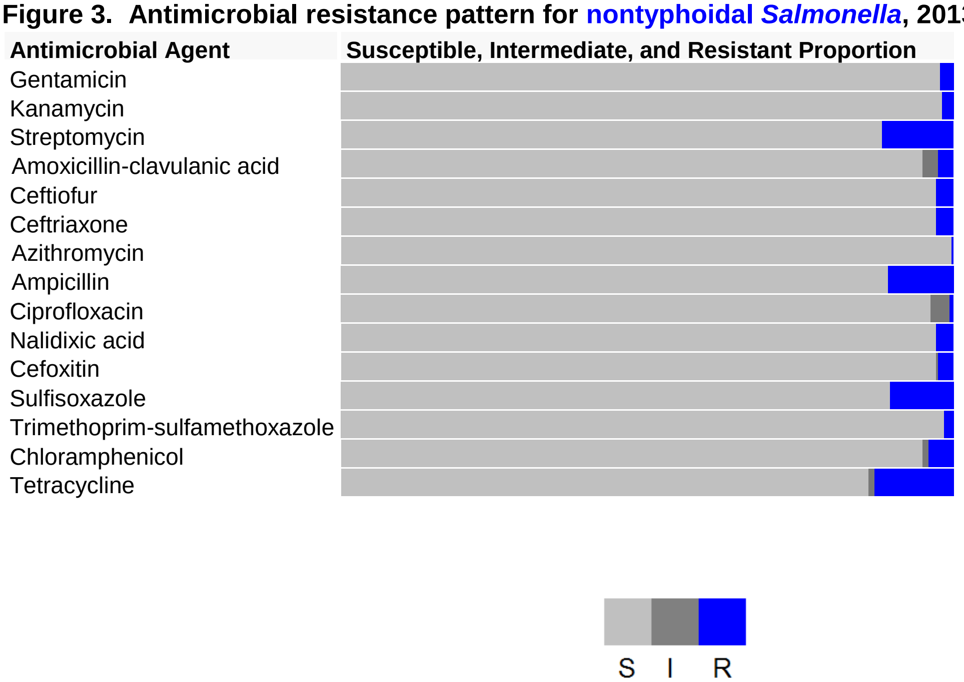


Table 9. Percentage and number of nontyphoidal *Salmonella* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 1782	2005 2036	2006 2171	2007 2145	2008 2384	2009 2193	2010 2449	2011 2335	2012 2233	2013 2178
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	< 0.1% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	1.3% 24	2.2% 44	2.0% 44	2.1% 45	1.5% 35	1.3% 28	1.0% 24	1.7% 40	1.2% 26	2.0% 43
		Kanamycin (MIC ≥ 64)	2.8% 50	3.4% 70	2.9% 63	2.8% 61	2.1% 50	2.5% 54	2.2% 54	1.7% 39	1.1% 24	1.6% 35
		Streptomycin (MIC ≥ 64)	12.0% 213	11.1% 225	10.7% 233	10.3% 222	10.0% 238	8.9% 196	8.6% 210	9.8% 229	8.4% 187	11.5% 251
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	3.7% 66	3.2% 65	3.7% 81	3.3% 70	3.1% 73	3.4% 75	2.9% 70	2.6% 60	2.9% 65	2.4% 53
	Cephems	Ceftiofur (MIC ≥ 8)	3.4% 60	2.9% 59	3.6% 79	3.3% 70	3.1% 73	3.4% 75	2.8% 69	2.5% 58	2.9% 64	2.5% 55
		Ceftriaxone (MIC ≥ 4)	3.3% 59	2.9% 59	3.7% 80	3.3% 70	3.1% 73	3.4% 75	2.9% 70	2.5% 58	2.9% 64	2.5% 55
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.2% 5	< 0.1% 1	0.2% 5
	Penicillins	Ampicillin (MIC ≥ 32)	12.1% 216	11.3% 231	10.9% 237	10.1% 217	9.7% 232	9.8% 216	9.1% 223	9.1% 213	8.8% 196	10.4% 227
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.3% 5	0.1% 2	0.1% 3	0.1% 2	0.2% 5	0.3% 7	0.2% 6	0.2% 4	0.3% 7	0.5% 11
		Nalidixic Acid (MIC ≥ 32)	2.2% 39	1.9% 38	2.4% 52	2.2% 48	2.1% 49	1.8% 39	2.0% 48	2.2% 51	2.4% 54	2.8% 61
II	Cephems	Cefoxitin (MIC ≥ 32)	3.4% 61	3.0% 62	3.5% 77	2.9% 63	3.0% 72	3.2% 71	2.6% 63	2.6% 60	2.7% 61	2.4% 53
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	13.3% 237	12.6% 256	12.1% 263	12.3% 264	10.1% 240	9.9% 217	9.0% 221	8.6% 201	8.4% 188	10.3% 225
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.7% 31	1.7% 34	1.7% 36	1.5% 33	1.6% 37	1.7% 38	1.6% 38	1.2% 28	1.3% 29	1.4% 31
	Phenicols	Chloramphenicol (MIC ≥ 32)	7.6% 136	7.8% 159	6.4% 139	7.3% 156	6.1% 146	5.7% 125	5.0% 122	4.4% 103	3.9% 87	3.9% 85
	Tetracyclines	Tetracycline (MIC ≥ 16)	13.6% 242	13.9% 282	13.5% 293	14.5% 310	11.5% 275	11.9% 261	11.0% 270	10.5% 245	11.1% 247	12.6% 275

* 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 10. Resistance patterns of nontyphoidal *Salmonella* isolates, 2004–2013

Year Total Isolates	2004 1782	2005 2036	2006 2171	2007 2145	2008 2384	2009 2193	2010 2449	2011 2335	2012 2233	2013 2178
Resistance Pattern										
No resistance detected	79.9% 1424	80.9% 1648	80.5% 1748	81.1% 1739	83.9% 2000	83.2% 1824	84.6% 2073	84.8% 1981	84.7% 1892	80.8% 1760
Resistance ≥ 1 CLSI* class	20.1% 358	19.1% 388	19.5% 423	18.9% 406	16.1% 384	16.8% 369	15.4% 376	15.2% 354	15.3% 341	19.2% 418
Resistance ≥ 2 CLSI* classes	15.0% 267	14.8% 301	14.7% 320	14.2% 305	12.5% 298	13.0% 284	11.3% 276	11.1% 259	11.8% 264	13.2% 288
Resistance ≥ 3 CLSI* classes	11.4% 204	11.9% 243	11.8% 256	11.1% 239	9.6% 228	9.6% 211	9.2% 225	9.1% 213	8.6% 193	9.8% 214
Resistance ≥ 4 CLSI classes	9.3% 165	9.1% 185	8.2% 177	8.2% 176	7.4% 177	7.3% 159	6.8% 166	6.5% 152	6.1% 137	7.7% 167
Resistance ≥ 5 CLSI* classes	8.0% 142	7.2% 146	6.3% 137	6.9% 149	6.6% 157	6.2% 137	5.2% 128	4.6% 108	3.9% 88	4.0% 87
At least ACSSuT†	7.2% 129	6.9% 141	5.6% 121	6.3% 136	5.8% 138	5.1% 112	4.4% 107	3.9% 91	3.4% 77	3.4% 74
At least ASSuT‡ and not resistant to chloramphenicol	1.1% 19	0.8% 16	1.0% 22	0.8% 17	0.7% 17	0.6% 14	1.7% 42	1.8% 42	2.0% 44	3.4% 74
At least ACT/S§	0.6% 10	0.9% 18	0.7% 15	0.7% 16	0.5% 11	0.7% 15	0.4% 11	0.4% 9	0.3% 7	0.5% 10
At least ACSSuTAuCx¶	2.4% 42	2.0% 41	2.0% 43	2.1% 46	1.8% 44	1.4% 30	1.3% 33	1.5% 36	1.5% 34	1.4% 31
At least AAuCx**	3.3% 59	2.9% 59	3.6% 78	3.0% 65	2.9% 69	3.3% 73	2.5% 62	2.5% 58	2.8% 62	2.3% 51
At least ceftriaxone and nalidixic acid resistant	0.1% 2	< 0.1% 1	0.2% 4	0.2% 5	< 0.1% 1	0.2% 4	0.1% 2	0.1% 2	0.3% 6	0.2% 5
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.1% 2	0.0% 0	0.1% 3
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	< 0.1% 1	0.0% 0	0.0% 0

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

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

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]**	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	β-lactam / β-lactamase inhibitor combinations	Piperacillin-tazobactam	2011 (58)	15.5	10.3	[3.9 - 21.2]							1.7	5.2	15.5	39.7	12.1	5.2	10.3	3.4	6.9	
			2012 (64)	9.4	6.3	[1.7 - 15.2]								3.1	12.5	56.3	12.5	7.8	1.6	3.1	3.1	
			2013 (55)	10.9	1.8	[0.0 - 9.7]								5.5	25.5	40.0	16.4	3.6	7.3	1.8		
	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					
		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		
		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			
	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			
	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										

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

† CLSI: Clinical and Laboratory Standards Institute

‡ Percentage of isolates with intermediate susceptibility

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

¶ Percentage of isolates that were resistant

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

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

A. *Salmonella* ser. Enteritidis

Table 12. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Enteritidis isolates to antimicrobial agents, 2013 (N=382)

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]					38.0	59.4	2.4		0.3							
		Kanamycin	0.0	0.0	[0.0 - 1.0]										100.0						
		Streptomycin	N/A	2.6	[1.3 - 4.8]												97.4	1.0	1.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.8	0.0	[0.0 - 1.0]							89.0	2.9	1.3	6.0	0.8					
	Cephems	Ceftiofur	0.0	0.3	[0.0 - 1.4]						1.8	94.8	3.1			0.3					
		Ceftriaxone	0.0	0.3	[0.0 - 1.4]					99.7									0.3		
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.0]							0.3	2.1	90.8	6.3	0.5					
	Penicillins	Ampicillin	0.0	5.8	[3.6 - 8.6]							75.4	16.8	1.6	0.5			5.8			
	Quinolones	Ciprofloxacin	5.8	0.0	[0.0 - 1.0]	47.6	46.6		2.6	2.9	0.3										
		Nalidixic acid	N/A	5.8	[3.6 - 8.6]								11.3	80.6	2.1	0.3	0.3	5.5			
II	Cephems	Cefoxitin	0.3	0.0	[0.0 - 1.0]							1.8	84.6	11.8	1.6	0.3					
	Folate pathway inhibitors	Sulfisoxazole	N/A	1.6	[0.6 - 3.4]											6.8	73.8	17.0	0.8		1.6
		Trimethoprim-sulfamethoxazole	N/A	0.5	[0.1 - 1.9]				98.2	0.8	0.5			0.3	0.3						
	Phenicols	Chloramphenicol	0.8	0.3	[0.0 - 1.4]								1.0	41.9	56.0	0.8		0.3			
	Tetracyclines	Tetracycline	0.5	4.5	[2.6 - 7.0]									95.0	0.5		1.0	3.4			

* 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.

Figure 4. Antimicrobial resistance pattern for *Salmonella ser.* Enteritidis, 2013

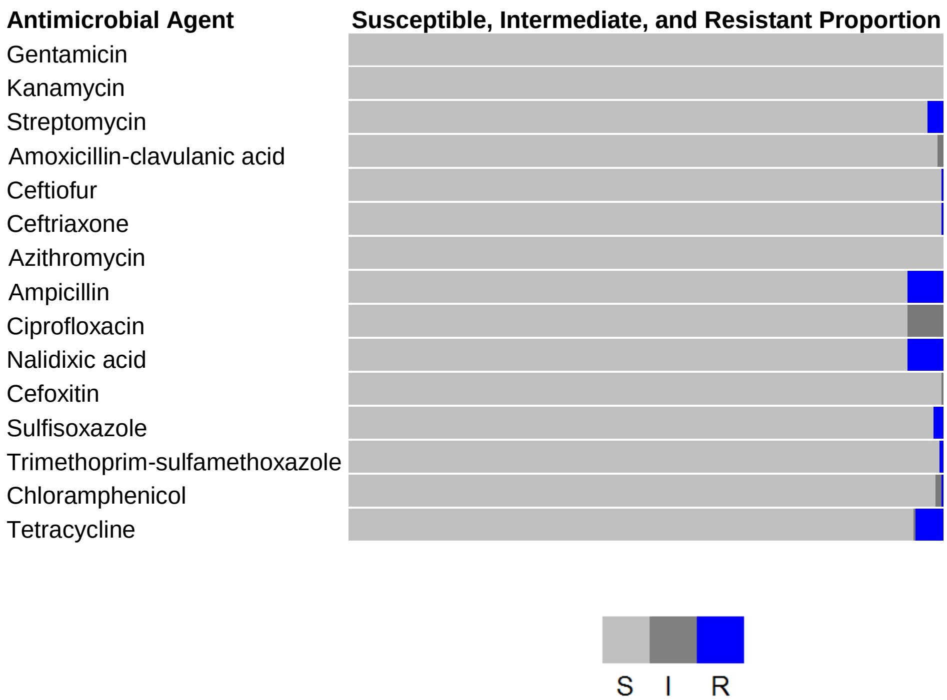


Table 13. Percentage and number of *Salmonella ser.* Enteritidis isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 271	2005 384	2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.4% 1	0.8% 3	0.2% 1	0.0% 0	0.2% 1	0.0% 0	0.2% 1	0.5% 2	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.7% 2	0.3% 1	0.2% 1	0.5% 2	0.0% 0	0.2% 1	0.2% 1	0.3% 1	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	2.2% 6	1.0% 4	1.2% 5	0.5% 2	0.7% 3	1.2% 5	0.6% 3	1.8% 7	1.9% 7	2.6% 10
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.8% 3	0.5% 2	0.5% 2	0.0% 0	0.0% 0	0.4% 2	0.3% 1	0.5% 2	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	4.1% 11	2.6% 10	4.1% 17	2.1% 8	4.1% 18	3.9% 16	2.3% 12	5.1% 20	4.1% 15	5.8% 22
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	6.6% 18	4.7% 18	7.0% 29	5.7% 22	7.2% 32	3.7% 15	5.3% 27	7.2% 28	7.7% 28	5.8% 22
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	1.0% 4	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	1.8% 5	1.6% 6	1.5% 6	1.6% 6	1.4% 6	1.7% 7	1.9% 10	2.0% 8	2.7% 10	1.6% 6
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.5% 2	0.5% 2	1.0% 4	0.9% 4	0.7% 3	1.0% 5	0.5% 2	1.1% 4	0.5% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.4% 1	0.5% 2	0.0% 0	0.5% 2	0.5% 2	0.0% 0	0.6% 3	0.0% 0	0.5% 2	0.3% 1
	Tetracyclines	Tetracycline (MIC ≥ 16)	3.3% 9	2.3% 9	1.7% 7	3.9% 15	1.8% 8	1.2% 5	2.1% 11	1.8% 7	3.6% 13	4.5% 17

* 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 14. Resistance patterns of *Salmonella* ser. Enteritidis isolates, 2004–2013

Year Total Isolates	2004 271	2005 384	2006 412	2007 385	2008 442	2009 410	2010 513	2011 391	2012 364	2013 382
Resistance Pattern										
No resistance detected	86.7% 235	91.4% 351	88.8% 366	90.4% 348	87.3% 386	92.0% 377	92.0% 472	88.0% 344	88.2% 321	87.4% 334
Resistance ≥ 1 CLSI* class	13.3% 36	8.6% 33	11.2% 46	9.6% 37	12.7% 56	8.0% 33	8.0% 41	12.0% 47	11.8% 43	12.6% 48
Resistance ≥ 2 CLSI* classes	3.0% 8	3.4% 13	2.9% 12	3.4% 13	2.3% 10	2.4% 10	2.9% 15	2.6% 10	4.9% 18	4.5% 17
Resistance ≥ 3 CLSI* classes	1.1% 3	1.3% 5	1.7% 7	1.0% 4	0.7% 3	1.0% 4	2.1% 11	2.3% 9	2.7% 10	1.6% 6
Resistance ≥ 4 CLSI classes	0.7% 2	1.0% 4	0.7% 3	0.3% 1	0.2% 1	0.5% 2	0.4% 2	1.3% 5	1.6% 6	1.6% 6
Resistance ≥ 5 CLSI* classes	0.7% 2	0.5% 2	0.2% 1	0.3% 1	0.0% 0	0.2% 1	0.0% 0	0.5% 2	0.5% 2	0.3% 1
At least ACSSuT†	0.4% 1	0.5% 2	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1
At least ASSuT‡ and not resistant to chloramphenicol	0.4% 1	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.2% 1	0.4% 2	1.3% 5	1.1% 4	0.8% 3
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	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least AAuCx**	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

B. *Salmonella* ser. Typhimurium

Table 15. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhimurium isolates to antimicrobial agents, 2013 (N=325)

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	[0.3 - 3.1]					4.0	83.7	10.5	0.6			0.3	0.9				
		Kanamycin	0.0	0.3	[0.0 - 1.7]										99.1	0.6			0.3		
		Streptomycin	N/A	20.6	[16.3 - 25.4]												79.4	6.5	14.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	10.8	3.4	[1.7 - 6.0]							77.5	4.0	1.5	2.8	10.8		3.4			
	Cephems	Ceftiofur	0.0	3.4	[1.7 - 6.0]				0.6	0.6	8.0	86.5	0.9		0.3	3.1					
		Ceftriaxone	0.0	3.4	[1.7 - 6.0]					96.6					1.2	1.5	0.6				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.1]					0.3	0.3		1.8	92.3	5.2						
	Penicillins	Ampicillin	0.0	16.6	[12.7 - 21.1]							76.0	6.5	0.9				16.6			
	Quinolones	Ciprofloxacin	2.5	0.0	[0.0 - 1.1]	93.8	3.1	0.6	0.9	0.6	0.9										
		Nalidixic acid	N/A	1.5	[0.5 - 3.6]						0.3	0.6	29.5	67.1	0.3	0.6		1.5			
II	Cephems	Cefoxitin	0.0	3.4	[1.7 - 6.0]							5.2	82.2	7.7	1.5		1.8	1.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	20.9	[16.6 - 25.8]											8.0	62.2	8.0		0.9	20.9
		Trimethoprim-sulfamethoxazole	N/A	1.2	[0.3 - 3.1]				92.9	5.5			0.3	0.3	0.9						
	Phenicols	Chloramphenicol	0.0	13.5	[10.0 - 17.7]								1.2	31.7	53.5		0.3	13.2			
	Tetracyclines	Tetracycline	1.2	21.2	[16.9 - 26.1]									77.5	1.2	0.9	8.6	11.7			

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

Figure 5. Antimicrobial resistance pattern for *Salmonella* ser. Typhimurium, 2013

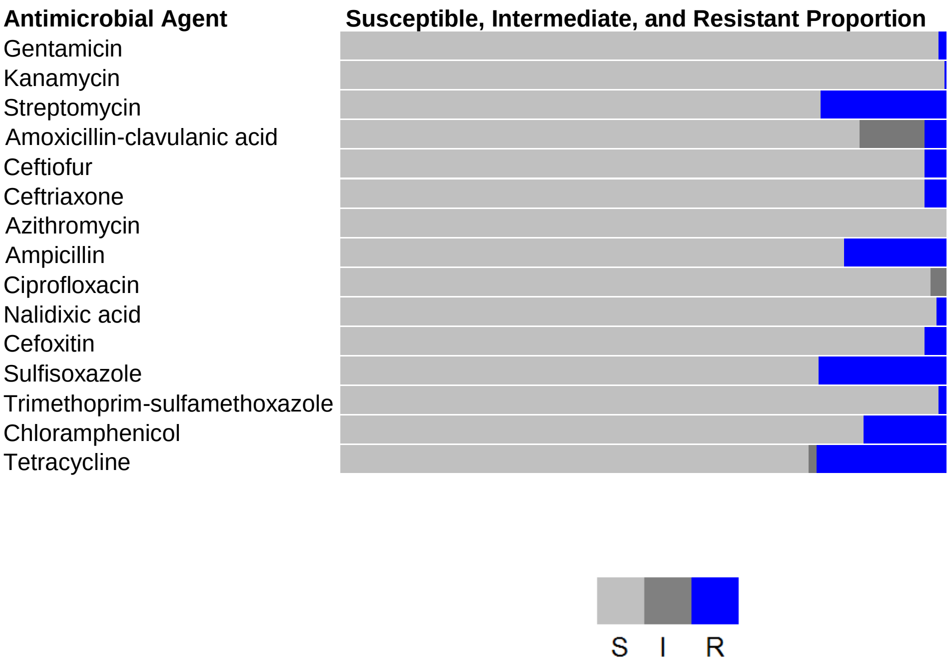


Table 16. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 382	2005 438	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	2.1% 8	1.8% 8	2.7% 11	2.5% 10	1.5% 6	1.9% 7	0.8% 3	1.9% 6	3.0% 9	1.2% 4
		Kanamycin (MIC ≥ 64)	5.8% 22	5.7% 25	5.1% 21	5.9% 24	2.5% 10	4.9% 18	7.2% 26	4.0% 13	2.0% 6	0.3% 1
		Streptomycin (MIC ≥ 64)	31.9% 122	28.1% 123	29.4% 120	32.3% 131	28.5% 113	25.9% 96	25.6% 92	25.7% 83	24.0% 71	20.6% 67
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.7% 18	3.2% 14	4.4% 18	6.7% 27	3.5% 14	6.2% 23	4.2% 15	7.1% 23	5.7% 17	3.4% 11
	Cephems	Ceftiofur (MIC ≥ 8)	4.5% 17	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.7% 17	3.4% 11
		Ceftriaxone (MIC ≥ 4)	4.5% 17	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.7% 17	3.4% 11
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	32.2% 123	29.0% 127	28.2% 115	31.6% 128	26.3% 104	28.1% 104	26.2% 94	26.0% 84	23.6% 70	16.6% 54
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.2% 1	0.2% 1	0.0% 0	0.0% 0	0.8% 3	0.0% 0	0.0% 0	0.3% 1	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.5% 2	0.9% 4	0.7% 3	1.5% 6	1.0% 4	2.2% 8	1.4% 5	0.3% 1	1.7% 5	1.5% 5
II	Cephems	Cefoxitin (MIC ≥ 32)	4.7% 18	2.5% 11	3.9% 16	5.7% 23	3.5% 14	5.4% 20	3.3% 12	6.8% 22	5.4% 16	3.4% 11
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	36.1% 138	32.0% 140	33.3% 136	37.3% 151	30.3% 120	30.0% 111	28.7% 103	27.2% 88	27.0% 80	20.9% 68
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.6% 10	2.7% 12	2.2% 9	2.5% 10	1.8% 7	3.0% 11	1.9% 7	1.9% 6	1.7% 5	1.2% 4
	Phenicols	Chloramphenicol (MIC ≥ 32)	24.3% 93	24.4% 107	22.1% 90	25.4% 103	23.5% 93	20.5% 76	20.3% 73	19.8% 64	18.2% 54	13.5% 44
	Tetracyclines	Tetracycline (MIC ≥ 16)	30.4% 116	30.4% 133	31.6% 129	36.8% 149	27.8% 110	28.9% 107	29.0% 104	27.2% 88	27.0% 80	21.2% 69

* 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 17. Resistance patterns of *Salmonella* ser. Typhimurium isolates, 2004–2013

Year Total Isolates	2004 382	2005 438	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 296	2013 325
Resistance Pattern										
No resistance detected	60.5% 231	65.1% 285	62.5% 255	57.5% 233	67.9% 269	63.5% 235	66.9% 240	69.0% 223	68.6% 203	69.5% 226
Resistance ≥ 1 CLSI* class	39.5% 151	34.9% 153	37.5% 153	42.5% 172	32.1% 127	36.5% 135	33.1% 119	31.0% 100	31.4% 93	30.5% 99
Resistance ≥ 2 CLSI* classes	37.2% 142	33.3% 146	34.1% 139	39.3% 159	31.3% 124	33.2% 123	30.4% 109	28.8% 93	29.4% 87	22.8% 74
Resistance ≥ 3 CLSI* classes	31.7% 121	30.1% 132	30.4% 124	34.3% 139	27.8% 110	28.1% 104	27.3% 98	26.3% 85	24.7% 73	16.9% 55
Resistance ≥ 4 CLSI classes	27.7% 106	27.4% 120	27.0% 110	29.9% 121	24.7% 98	24.1% 89	24.2% 87	22.0% 71	20.9% 62	14.8% 48
Resistance ≥ 5 CLSI* classes	24.3% 93	22.8% 100	20.8% 85	24.9% 101	24.0% 95	22.2% 82	20.9% 75	21.1% 68	18.6% 55	12.3% 40
At least ACSSuT†	23.6% 90	22.4% 98	19.6% 80	22.7% 92	23.2% 92	19.5% 72	18.7% 67	19.8% 64	17.2% 51	12.0% 39
At least ASSuT‡ and not resistant to chloramphenicol	2.4% 9	2.3% 10	3.2% 13	3.7% 15	0.3% 1	1.6% 6	3.6% 13	1.2% 4	1.7% 5	1.2% 4
At least ACT/S§	1.6% 6	2.1% 9	0.7% 3	2.0% 8	0.5% 2	2.2% 8	1.1% 4	0.6% 2	0.7% 2	0.0% 0
At least ACSSuTAuCx¶	2.6% 10	1.8% 8	2.9% 12	3.7% 15	2.3% 9	1.6% 6	1.7% 6	5.3% 17	4.1% 12	2.2% 7
At least AAuCx**	4.5% 17	2.5% 11	4.2% 17	6.2% 25	3.5% 14	6.2% 23	3.6% 13	6.8% 22	5.7% 17	3.4% 11
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.5% 2	0.3% 1	0.0% 0	0.7% 2	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

C. *Salmonella* ser. Newport

Table 18. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Newport isolates to antimicrobial agents, 2013 (N=209)

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	0.5	[0.0 - 2.6]					4.3	86.1	8.6	0.5				0.5				
		Kanamycin	0.0	0.5	[0.0 - 2.6]										99.0	0.5			0.5		
		Streptomycin	N/A	5.7	[3.0 - 9.8]												94.3	1.0	4.8		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	5.3	[2.7 - 9.2]							88.5	3.3	1.9	1.0		0.5	4.8			
	Cephems	Ceftiofur	0.0	5.3	[2.7 - 9.2]						6.2	88.0	0.5			5.3					
		Ceftriaxone	0.0	5.3	[2.7 - 9.2]					94.7						1.9	3.3				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.7]								2.9	92.8	3.8	0.5					
	Penicillins	Ampicillin	0.0	6.2	[3.4 - 10.4]							90.0	3.8				0.5	5.7			
	Quinolones	Ciprofloxacin	1.9	0.0	[0.0 - 1.7]	98.1			0.5		1.4										
		Nalidixic acid	N/A	0.0	[0.0 - 1.7]								29.7	67.0	0.5	2.9					
II	Cephems	Cefoxitin	0.5	5.3	[2.7 - 9.2]							5.3	83.3	4.3	1.4	0.5	1.0	4.3			
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.8	[2.3 - 8.6]											3.8	38.8	52.2	0.5		4.8
		Trimethoprim-sulfamethoxazole	N/A	0.5	[0.0 - 2.6]				97.1	2.4					0.5						
	Phenicols	Chloramphenicol	0.0	4.8	[2.3 - 8.6]								0.5	70.8	23.9			4.8			
	Tetracyclines	Tetracycline	1.0	6.2	[3.4 - 10.4]									92.8	1.0		1.0	5.3			

* 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 6. Antimicrobial resistance pattern for *Salmonella* ser. Newport, 2013

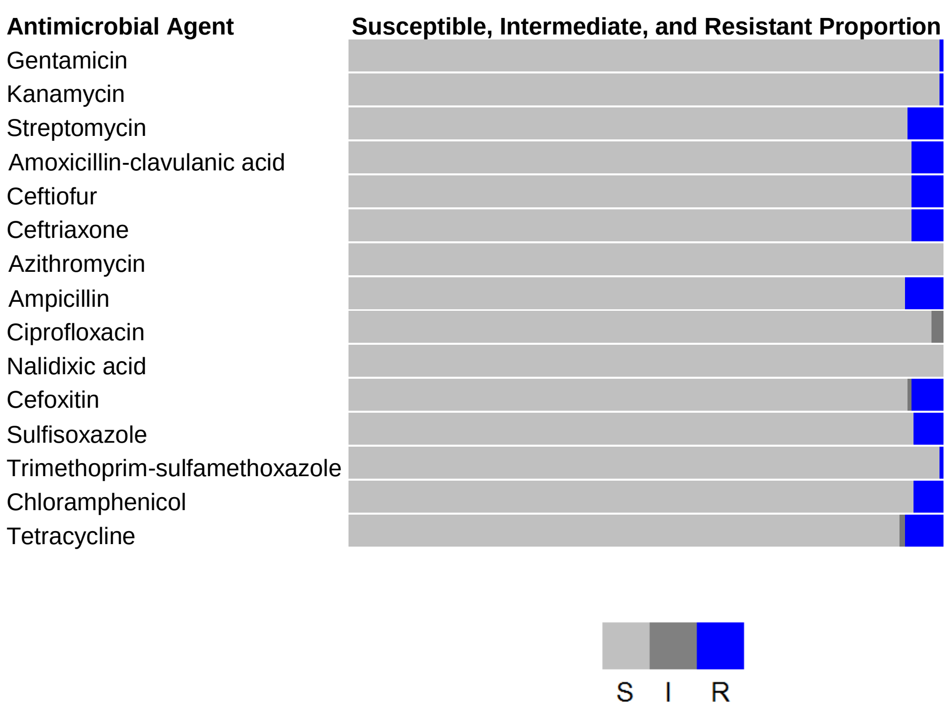


Table 19. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 192	2005 207	2006 219	2007 222	2008 258	2009 239	2010 306	2011 285	2012 258	2013 209
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.5% 1	1.0% 2	0.9% 2	0.9% 2	0.4% 1	0.4% 1	0.3% 1	0.7% 2	0.0% 0	0.5% 1
		Kanamycin (MIC ≥ 64)	2.6% 5	1.9% 4	2.7% 6	0.9% 2	3.5% 9	1.7% 4	0.7% 2	0.4% 1	0.0% 0	0.5% 1
		Streptomycin (MIC ≥ 64)	16.1% 31	14.0% 29	14.2% 31	10.4% 23	13.6% 35	8.4% 20	8.5% 26	4.2% 12	3.9% 10	5.7% 12
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	15.6% 30	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.5% 18	7.8% 24	3.9% 11	6.2% 16	5.3% 11
	Cephems	Ceftiofur (MIC ≥ 8)	15.6% 30	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.9% 11	6.2% 16	5.3% 11
		Ceftriaxone (MIC ≥ 4)	15.1% 29	12.6% 26	13.2% 29	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.9% 11	6.2% 16	5.3% 11
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	16.1% 31	14.0% 29	15.5% 34	9.9% 22	14.3% 37	8.4% 20	7.8% 24	3.9% 11	7.0% 18	6.2% 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
		Nalidixic Acid (MIC ≥ 32)	0.5% 1	0.0% 0	0.9% 2	0.0% 0	0.4% 1	0.0% 0	0.3% 1	0.4% 1	0.0% 0	0.0% 0
II	Cephems	Cefoxitin (MIC ≥ 32)	15.6% 30	12.6% 26	13.2% 29	8.1% 18	12.4% 32	6.7% 16	7.5% 23	3.9% 11	6.2% 16	5.3% 11
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	17.2% 33	15.5% 32	15.5% 34	10.4% 23	13.2% 34	8.8% 21	7.8% 24	4.6% 13	3.9% 10	4.8% 10
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.1% 4	1.9% 4	3.7% 8	1.8% 4	3.1% 8	1.3% 3	1.3% 4	0.0% 0	0.4% 1	0.5% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	15.6% 30	13.5% 28	12.8% 28	9.5% 21	12.0% 31	7.5% 18	7.5% 23	3.5% 10	3.9% 10	4.8% 10
	Tetracyclines	Tetracycline (MIC ≥ 16)	17.2% 33	14.5% 30	14.6% 32	9.9% 22	14.0% 36	8.8% 21	8.5% 26	4.6% 13	4.3% 11	6.2% 13

* 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 20. Resistance patterns of *Salmonella* ser. Newport isolates, 2004–2013

Year Total Isolates	2004 192	2005 207	2006 219	2007 222	2008 258	2009 239	2010 306	2011 285	2012 258	2013 209
Resistance Pattern										
No resistance detected	81.8% 157	84.1% 174	82.2% 180	89.2% 198	85.3% 220	89.1% 213	90.5% 277	94.4% 269	93.0% 240	91.9% 192
Resistance ≥ 1 CLSI* class	18.2% 35	15.9% 33	17.8% 39	10.8% 24	14.7% 38	10.9% 26	9.5% 29	5.6% 16	7.0% 18	8.1% 17
Resistance ≥ 2 CLSI* classes	17.7% 34	15.0% 31	16.9% 37	10.8% 24	13.6% 35	9.2% 22	8.2% 25	4.6% 13	6.6% 17	5.7% 12
Resistance ≥ 3 CLSI* classes	16.7% 32	14.5% 30	15.5% 34	10.8% 24	13.6% 35	8.4% 20	7.8% 24	3.9% 11	6.2% 16	5.7% 12
Resistance ≥ 4 CLSI classes	16.1% 31	14.0% 29	13.7% 30	9.5% 21	13.6% 35	7.5% 18	7.8% 24	3.9% 11	3.9% 10	4.8% 10
Resistance ≥ 5 CLSI* classes	15.1% 29	12.6% 26	13.2% 29	8.6% 19	12.8% 33	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10
At least ACSSuT†	15.1% 29	12.6% 26	12.3% 27	8.6% 19	11.6% 30	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.5% 1	1.4% 3	0.5% 1	1.6% 4	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0
At least ACT/S§	1.0% 2	1.9% 4	2.7% 6	0.5% 1	2.7% 7	1.3% 3	1.3% 4	0.0% 0	0.4% 1	0.5% 1
At least ACSSuTAuCx¶	15.1% 29	12.6% 26	11.0% 24	8.1% 18	11.6% 30	7.1% 17	7.5% 23	3.5% 10	3.9% 10	4.8% 10
At least AAuCx**	15.1% 29	12.6% 26	12.3% 27	8.1% 18	12.4% 32	7.1% 17	7.5% 23	3.9% 11	6.2% 16	5.3% 11
At least ceftriaxone and nalidixic acid resistant	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

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, 2013 (N=127)

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	0.8	4.7	[1.7 - 10.0]					3.9	78.0	11.8	0.8		0.8	1.6	3.1				
		Kanamycin	0.0	0.8	[0.0 - 4.3]										98.4	0.8			0.8		
		Streptomycin	N/A	53.5	[44.5 - 62.4]												46.5	2.4	51.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.8	1.6	[0.2 - 5.6]							45.7	4.7	3.9	43.3	0.8		1.6			
	Cephems	Ceftiofur	0.0	1.6	[0.2 - 5.6]						8.7	84.3	5.5			1.6					
		Ceftriaxone	0.0	1.6	[0.2 - 5.6]					97.6	0.8					0.8	0.8				
	Macrolide	Azithromycin	N/A	1.6	[0.2 - 5.6]								4.7	88.2	2.4	3.1	1.6				
	Penicillins	Ampicillin	0.0	49.6	[40.6 - 58.6]							45.7	2.4	2.4				49.6			
	Quinolones	Ciprofloxacin	1.6	0.8	[0.0 - 4.3]	81.1	15.0	1.6		0.8	0.8		0.8								
		Nalidixic acid	N/A	0.8	[0.0 - 4.3]								18.1	76.4	2.4	2.4	0.8				
II	Cephems	Cefoxitin	0.8	1.6	[0.2 - 5.6]							5.5	75.6	14.2	2.4	0.8		1.6			
	Folate pathway inhibitors	Sulfisoxazole	N/A	53.5	[44.5 - 62.4]											2.4	30.7	12.6		0.8	53.5
		Trimethoprim-sulfamethoxazole	N/A	2.4	[0.5 - 6.7]				95.3	2.4					2.4						
	Phenicols	Chloramphenicol	3.1	2.4	[0.5 - 6.7]								0.8	29.9	63.8	3.1		2.4			
	Tetracyclines	Tetracycline	0.0	55.1	[46.0 - 64.0]									44.9				55.1			

* 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:-, 2013

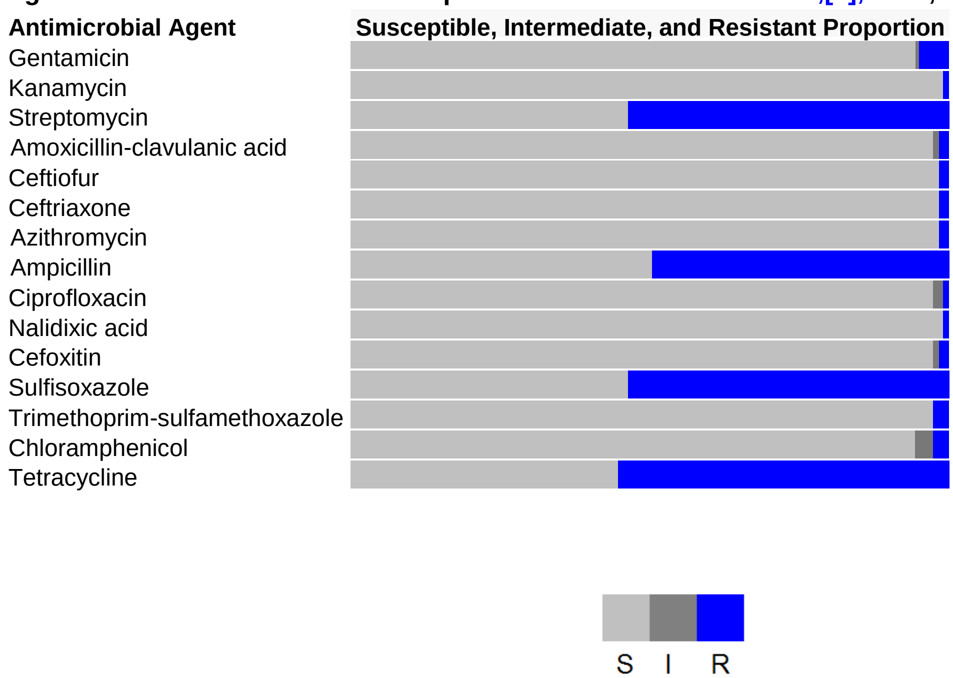


Table 22. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2004–2013

Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Total Isolates		36	33	105	73	84	72	78	82	117	127
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	5.6% 2	0.0% 0	4.8% 5	1.4% 1	3.6% 3	2.8% 2	1.3% 1	2.4% 2	2.6% 3	4.7% 6
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	1.4% 1	1.2% 1	0.0% 0	1.3% 1	0.0% 0	0.0% 0	0.8% 1
		Streptomycin (MIC ≥ 64)	5.6% 2	3.0% 1	3.8% 4	8.2% 6	10.7% 9	12.5% 9	19.2% 15	24.4% 20	29.1% 34	53.5% 68
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	4.2% 3	3.8% 3	3.7% 3	1.7% 2	1.6% 2
	Cephems	Ceftiofur (MIC ≥ 8)	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2
		Ceftriaxone (MIC ≥ 4)	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 2
	Penicillins	Ampicillin (MIC ≥ 32)	5.6% 2	6.1% 2	6.7% 7	5.5% 4	9.5% 8	11.1% 8	21.8% 17	25.6% 21	29.1% 34	49.6% 63
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1	0.0% 0	0.0% 0	0.8% 1
		Nalidixic Acid (MIC ≥ 32)	2.8% 1	0.0% 0	1.0% 1	1.4% 1	1.2% 1	0.0% 0	2.6% 2	0.0% 0	0.0% 0	0.8% 1
II	Cephems	Cefoxitin (MIC ≥ 32)	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	4.9% 4	0.9% 1	1.6% 2
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	11.1% 4	0.0% 0	8.6% 9	4.1% 3	13.1% 11	13.9% 10	19.2% 15	23.2% 19	29.1% 34	53.5% 68
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.8% 1	0.0% 0	0.0% 0	1.4% 1	4.8% 4	1.4% 1	1.3% 1	1.2% 1	0.0% 0	2.4% 3
	Phenicols	Chloramphenicol (MIC ≥ 32)	2.8% 1	0.0% 0	1.9% 2	1.4% 1	6.0% 5	8.3% 6	1.3% 1	1.2% 1	0.0% 0	2.4% 3
	Tetracyclines	Tetracycline (MIC ≥ 16)	11.1% 4	3.0% 1	8.6% 9	9.6% 7	16.7% 14	16.7% 12	28.2% 22	25.6% 21	33.3% 39	55.1% 70

* 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 23. Resistance patterns of *Salmonella* ser. I 4,[5],12:i:- isolates, 2004–2013

Resistance Pattern	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Isolates	36	33	105	73	84	72	78	82	117	127
No resistance detected	80.6% 29	87.9% 29	85.7% 90	82.2% 60	76.2% 64	76.4% 55	66.7% 52	65.9% 54	62.4% 73	39.4% 50
Resistance ≥ 1 CLSI* class	19.4% 7	12.1% 4	14.3% 15	17.8% 13	23.8% 20	23.6% 17	33.3% 26	34.1% 28	37.6% 44	60.6% 77
Resistance ≥ 2 CLSI* classes	13.9% 5	3.0% 1	11.4% 12	6.8% 5	17.9% 15	16.7% 12	21.8% 17	28.0% 23	31.6% 37	54.3% 69
Resistance ≥ 3 CLSI* classes	8.3% 3	3.0% 1	9.5% 10	5.5% 4	10.7% 9	12.5% 9	21.8% 17	26.8% 22	28.2% 33	51.2% 65
Resistance ≥ 4 CLSI classes	2.8% 1	0.0% 0	3.8% 4	2.7% 2	7.1% 6	9.7% 7	19.2% 15	19.5% 16	26.5% 31	48.8% 62
Resistance ≥ 5 CLSI* classes	2.8% 1	0.0% 0	2.9% 3	1.4% 1	4.8% 4	6.9% 5	3.8% 3	0.0% 0	0.9% 1	2.4% 3
At least ACSSuT†	2.8% 1	0.0% 0	1.9% 2	1.4% 1	3.6% 3	6.9% 5	1.3% 1	0.0% 0	0.0% 0	0.8% 1
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.0% 0	1.0% 1	0.0% 0	1.2% 1	1.4% 1	16.7% 13	18.3% 15	26.5% 31	46.5% 59
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	0.8% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.4% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least AAuCx**	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.9% 1	1.6% 2
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.8% 1
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

E. *Salmonella* ser. Infantis

Table 24. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Infantis isolates to antimicrobial agents, 2013 (N=76)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	3.9	[0.8 - 11.1]					17.1	69.7	6.6		2.6		2.6	1.3				
		Kanamycin	0.0	3.9	[0.8 - 11.1]										96.1				3.9		
		Streptomycin	N/A	3.9	[0.8 - 11.1]												96.1		3.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.3	3.9	[0.8 - 11.1]							88.2	5.3		1.3	1.3	1.3	2.6			
	Cephems	Ceftiofur	0.0	6.6	[2.2 - 14.7]						2.6	86.8	3.9			6.6					
		Ceftriaxone	0.0	6.6	[2.2 - 14.7]					93.4						1.3	2.6	2.6			
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 4.7]									78.9	21.1						
	Penicillins	Ampicillin	0.0	9.2	[3.8 - 18.1]							90.8						9.2			
	Quinolones	Ciprofloxacin	3.9	0.0	[0.0 - 4.7]	85.5	9.2	1.3	2.6	1.3											
		Nalidixic acid	N/A	5.3	[1.4 - 12.9]								55.3	39.5			1.3	3.9			
II	Cephems	Cefoxitin	0.0	3.9	[0.8 - 11.1]								9.2	86.8				3.9			
	Folate pathway inhibitors	Sulfisoxazole	N/A	9.2	[3.8 - 18.1]											9.2	50.0	31.6			9.2
		Trimethoprim-sulfamethoxazole	N/A	3.9	[0.8 - 11.1]				94.7	1.3					3.9						
	Phenicols	Chloramphenicol	0.0	3.9	[0.8 - 11.1]									14.5	81.6			3.9			
	Tetracyclines	Tetracycline	0.0	13.2	[6.5 - 22.9]									86.8				13.2			

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

Figure 8. Antimicrobial resistance pattern for *Salmonella* ser. Infantis, 2013

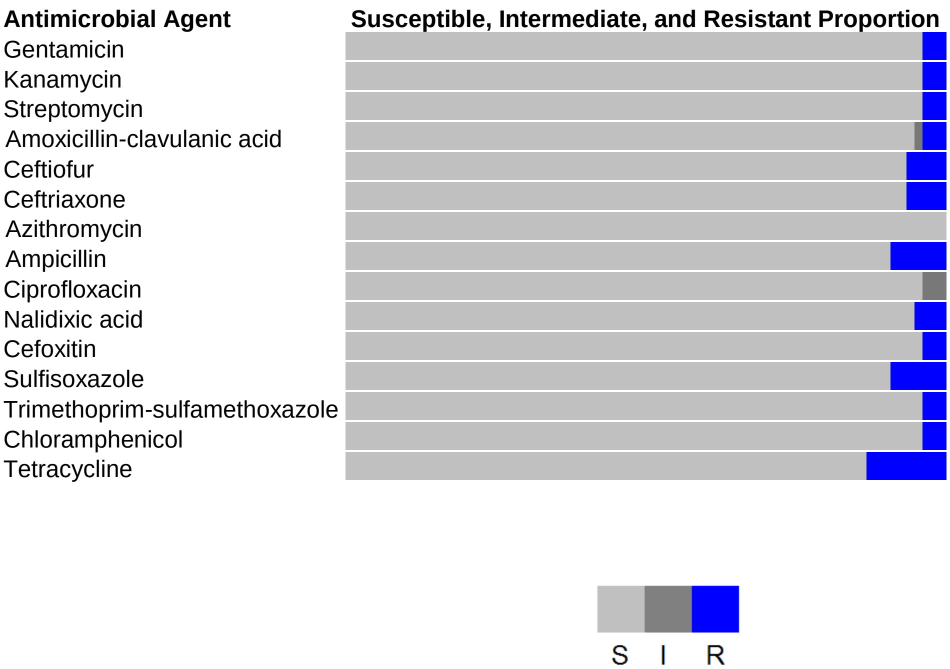


Table 25. Percentage and number of *Salmonella* ser. Infantis isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 29	2005 30	2006 22	2007 26	2008 51	2009 44	2010 53	2011 63	2012 90	2013 76
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	4.5% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.6% 1	0.0% 0	3.9% 3
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	6.8% 3	0.0% 0	0.0% 0	2.2% 2	3.9% 3
		Streptomycin (MIC ≥ 64)	0.0% 0	3.3% 1	4.5% 1	3.8% 1	2.0% 1	6.8% 3	1.9% 1	4.8% 3	0.0% 0	3.9% 3
	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	9.1% 4	3.8% 2	1.6% 1	1.1% 1	3.9% 3
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	3.8% 1	0.0% 0	11.4% 5	3.8% 2	1.6% 1	2.2% 2	6.6% 5
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	3.8% 1	0.0% 0	11.4% 5	3.8% 2	1.6% 1	2.2% 2	6.6% 5
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	3.8% 1	2.0% 1	13.6% 6	5.7% 3	1.6% 1	2.2% 2	9.2% 7
	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
		Nalidixic Acid (MIC ≥ 32)	3.4% 1	3.3% 1	0.0% 0	0.0% 0	2.0% 1	2.3% 1	0.0% 0	1.6% 1	4.4% 4	5.3% 4
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	11.4% 5	3.8% 2	1.6% 1	1.1% 1	3.9% 3
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	3.4% 1	6.7% 2	9.1% 2	3.8% 1	3.9% 2	6.8% 3	7.5% 4	4.8% 3	3.3% 3	9.2% 7
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	3.4% 1	0.0% 0	0.0% 0	0.0% 0	2.0% 1	2.3% 1	1.9% 1	1.6% 1	4.4% 4	3.9% 3
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	3.8% 2	1.6% 1	1.1% 1	3.9% 3
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	3.3% 1	4.5% 1	7.7% 2	3.9% 2	11.4% 5	3.8% 2	4.8% 3	4.4% 4	13.2% 10

* 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 26. Resistance patterns of *Salmonella* ser. Infantis isolates, 2004–2013

Year Total Isolates	2004 29	2005 30	2006 22	2007 26	2008 51	2009 44	2010 53	2011 63	2012 90	2013 76
Resistance Pattern										
No resistance detected	93.1% 27	90.0% 27	90.9% 20	92.3% 24	96.1% 49	84.1% 37	88.7% 47	93.7% 59	92.2% 83	81.6% 62
Resistance ≥ 1 CLSI* class	6.9% 2	10.0% 3	9.1% 2	7.7% 2	3.9% 2	15.9% 7	11.3% 6	6.3% 4	7.8% 7	18.4% 14
Resistance ≥ 2 CLSI* classes	0.0% 0	3.3% 1	9.1% 2	7.7% 2	3.9% 2	15.9% 7	7.5% 4	6.3% 4	4.4% 4	11.8% 9
Resistance ≥ 3 CLSI* classes	0.0% 0	3.3% 1	4.5% 1	7.7% 2	3.9% 2	15.9% 7	3.8% 2	6.3% 4	4.4% 4	10.5% 8
Resistance ≥ 4 CLSI classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.0% 1	9.1% 4	1.9% 1	3.2% 2	2.2% 2	5.3% 4
Resistance ≥ 5 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	1.9% 1	0.0% 0	2.2% 2	5.3% 4
At least ACSSuT†	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.0% 1	4.5% 2	1.9% 1	0.0% 0	0.0% 0	1.3% 1
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.3% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	4.5% 2	1.9% 1	0.0% 0	0.0% 0	1.3% 1
At least AAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	9.1% 4	3.8% 2	1.6% 1	1.1% 1	3.9% 3
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.1% 1	2.6% 2
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

F. *Salmonella* ser. Heidelberg

Table 27. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Heidelberg isolates to antimicrobial agents, 2013 (N=60)

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	21.7	[12.1 - 34.2]					1.7	66.7	10.0				5.0	16.7				
		Kanamycin	3.3	26.7	[16.1 - 39.7]										70.0		3.3	5.0	21.7		
		Streptomycin	N/A	40.0	[27.6 - 53.5]												60.0	11.7	28.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	8.3	13.3	[5.9 - 24.6]							65.0		1.7	11.7	8.3		13.3			
	Cephems	Ceftiofur	0.0	15.0	[7.1 - 26.6]						5.0	78.3	1.7			15.0					
		Ceftriaxone	0.0	15.0	[7.1 - 26.6]					85.0					1.7	8.3	5.0				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 6.0]									83.3	16.7						
	Penicillins	Ampicillin	0.0	33.3	[21.7 - 46.7]							65.0	1.7					33.3			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 6.0]	96.7	3.3														
		Nalidixic acid	N/A	0.0	[0.0 - 6.0]								20.0	80.0							
II	Cephems	Cefoxitin	0.0	15.0	[7.1 - 26.6]							18.3	58.3	8.3			5.0	10.0			
	Folate pathway inhibitors	Sulfisoxazole	N/A	15.0	[7.1 - 26.6]											16.7	65.0	3.3			15.0
		Trimethoprim-sulfamethoxazole	N/A	1.7	[0.0 - 8.9]				96.7	1.7					1.7						
	Phenicols	Chloramphenicol	1.7	6.7	[1.8 - 16.2]									23.3	68.3	1.7		6.7			
	Tetracyclines	Tetracycline	0.0	33.3	[21.7 - 46.7]									66.7			1.7	31.7			

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

Figure 9. Antimicrobial resistance pattern for *Salmonella* ser. Heidelberg, 2013

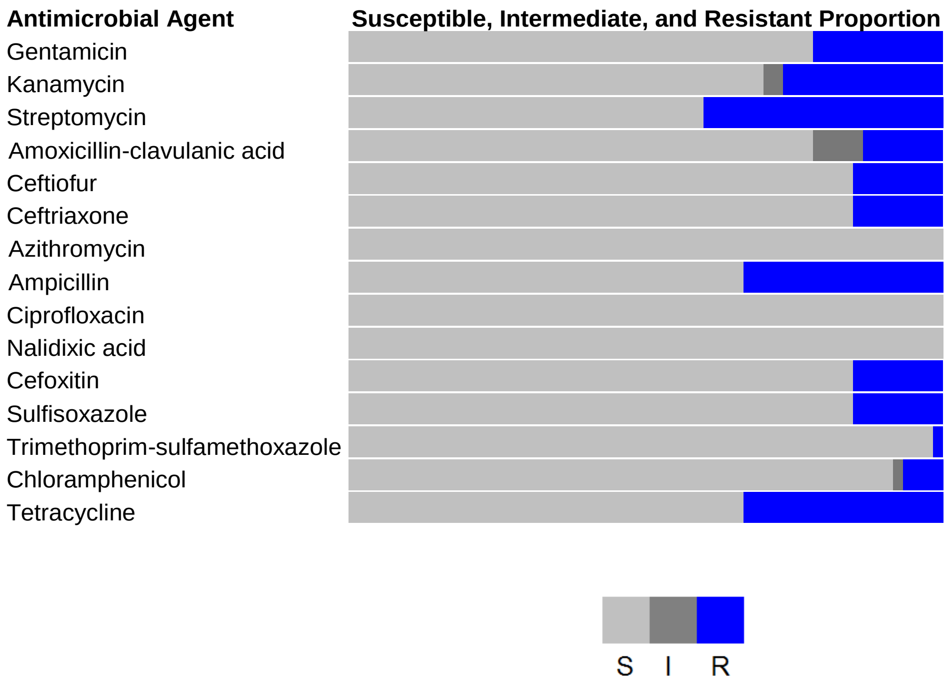


Table 28. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 92	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	4.3% 4	6.4% 8	4.9% 5	16.3% 16	14.7% 11	2.3% 2	8.1% 5	20.0% 14	7.3% 3	21.7% 13
		Kanamycin (MIC ≥ 64)	8.7% 8	12.8% 16	8.8% 9	11.2% 11	26.7% 20	20.9% 18	21.0% 13	21.4% 15	9.8% 4	26.7% 16
		Streptomycin (MIC ≥ 64)	15.2% 14	13.6% 17	11.8% 12	12.2% 12	30.7% 23	23.3% 20	25.8% 16	37.1% 26	17.1% 7	40.0% 24
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	9.8% 9	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	10.0% 7	22.0% 9	13.3% 8
	Cephems	Ceftiofur (MIC ≥ 8)	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	15.0% 9
		Ceftriaxone (MIC ≥ 4)	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	15.0% 9
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	25.0% 23	20.0% 25	18.6% 19	18.4% 18	28.0% 21	27.9% 24	38.7% 24	30.0% 21	26.8% 11	33.3% 20
	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
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	0.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
II	Cephems	Cefoxitin (MIC ≥ 32)	7.6% 7	8.8% 11	8.8% 9	7.1% 7	8.0% 6	19.8% 17	24.2% 15	8.6% 6	22.0% 9	15.0% 9
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	7.6% 7	8.0% 10	4.9% 5	18.4% 18	12.0% 9	7.0% 6	11.3% 7	7.1% 5	2.4% 1	15.0% 9
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.8% 1	0.0% 0	0.0% 0	2.7% 2	3.5% 3	0.0% 0	1.4% 1	0.0% 0	1.7% 1
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.1% 1	0.8% 1	0.0% 0	3.1% 3	1.3% 1	4.7% 4	1.6% 1	4.3% 3	0.0% 0	6.7% 4
	Tetracyclines	Tetracycline (MIC ≥ 16)	19.6% 18	18.4% 23	13.7% 14	22.4% 22	36.0% 27	27.9% 24	22.6% 14	34.3% 24	14.6% 6	33.3% 20

* 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 29. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2004–2013

Year Total Isolates	2004 92	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70	2012 41	2013 60
Resistance Pattern										
No resistance detected	56.5% 52	62.4% 78	67.6% 69	58.2% 57	57.3% 43	60.5% 52	53.2% 33	55.7% 39	61.0% 25	46.7% 28
Resistance ≥ 1 CLSI* class	43.5% 40	37.6% 47	32.4% 33	41.8% 41	42.7% 32	39.5% 34	46.8% 29	44.3% 31	39.0% 16	53.3% 32
Resistance ≥ 2 CLSI* classes	22.8% 21	24.8% 31	23.5% 24	28.6% 28	40.0% 30	34.9% 30	41.9% 26	44.3% 31	39.0% 16	51.7% 31
Resistance ≥ 3 CLSI* classes	13.0% 12	15.2% 19	12.7% 13	17.3% 17	28.0% 21	25.6% 22	33.9% 21	30.0% 21	26.8% 11	33.3% 20
Resistance ≥ 4 CLSI classes	4.3% 4	4.8% 6	2.0% 2	5.1% 5	13.3% 10	17.4% 15	11.3% 7	4.3% 3	2.4% 1	8.3% 5
Resistance ≥ 5 CLSI* classes	3.3% 3	1.6% 2	2.0% 2	4.1% 4	6.7% 5	15.1% 13	9.7% 6	4.3% 3	0.0% 0	6.7% 4
At least ACSSuT†	1.1% 1	0.0% 0	0.0% 0	3.1% 3	1.3% 1	3.5% 3	1.6% 1	1.4% 1	0.0% 0	6.7% 4
At least ASSuT‡ and not resistant to chloramphenicol	3.3% 3	0.8% 1	0.0% 0	0.0% 0	6.7% 5	2.3% 2	6.5% 4	0.0% 0	0.0% 0	0.0% 0
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	3.5% 3	0.0% 0	1.4% 1	0.0% 0	1.7% 1
At least ACSSuTAuCx¶	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.2% 1	0.0% 0	1.4% 1	0.0% 0	1.7% 1
At least AAuCx**	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9	13.3% 8
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

2. Typhoidal *Salmonella*

A. *Salmonella* ser. Typhi

Table 30. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhi isolates to antimicrobial agents, 2013 (N=279)

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 - 1.3]					87.8	12.2										
		Kanamycin	0.0	0.0	[0.0 - 1.3]										100.0						
		Streptomycin	N/A	7.9	[5.0 - 11.7]												92.1		7.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.7	0.0	[0.0 - 1.3]							89.2		2.2	7.9	0.7					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 1.3]				0.4	5.0	74.6	20.1									
		Ceftriaxone	0.0	0.0	[0.0 - 1.3]					99.6	0.4										
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.3]							1.8	26.9	68.5	2.5	0.4					
	Penicillins	Ampicillin	0.0	10.4	[7.1 - 14.6]							89.2		0.4				10.4			
	Quinolones	Ciprofloxacin	60.9	8.6	[5.6 - 12.5]	29.7		0.7	9.7	35.5	15.8	0.4	0.4	0.4	7.5						
		Nalidixic acid	N/A	67.4	[61.5 - 72.9]						0.4	2.9	25.8	0.7	2.2	0.7		67.4			
II	Cephems	Cefoxitin	0.7	0.0	[0.0 - 1.3]						3.2	29.4	14.0	45.5	7.2	0.7					
	Folate pathway inhibitors	Sulfisoxazole	N/A	11.1	[7.7 - 15.4]											60.6	23.7	3.9	0.4	0.4	11.1
		Trimethoprim-sulfamethoxazole	N/A	10.8	[7.4 - 15.0]				88.9	0.4					10.8						
	Phenicols	Chloramphenicol	0.0	9.3	[6.2 - 13.4]								2.9	75.6	12.2			9.3			
	Tetracyclines	Tetracycline	0.4	2.2	[0.8 - 4.6]									97.5	0.4			2.2			

* 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 10. Antimicrobial resistance pattern for *Salmonella* ser. Typhi, 2013

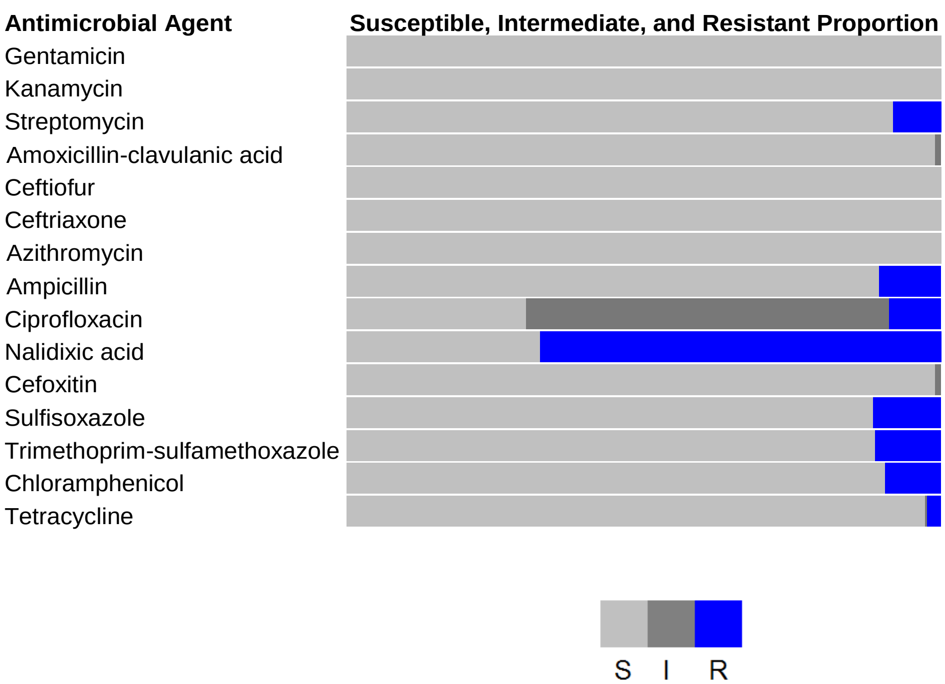


Table 31. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 304	2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 279
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	11.8% 36	13.2% 42	18.9% 61	15.8% 63	11.5% 47	10.7% 39	10.1% 45	10.7% 41	9.2% 30	7.9% 22
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	11.8% 36	13.2% 42	20.4% 66	17.0% 68	13.0% 53	12.7% 46	12.3% 55	11.2% 43	10.1% 33	10.4% 29
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.3% 1	0.9% 3	2.0% 8	0.7% 3	3.9% 14	4.3% 19	7.3% 28	6.7% 22	8.6% 24
		Nalidixic Acid (MIC ≥ 32)	41.8% 127	48.4% 154	54.5% 176	62.0% 248	59.0% 240	59.8% 217	69.3% 309	70.8% 271	68.5% 224	67.4% 188
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	11.8% 36	14.2% 45	20.7% 67	17.5% 70	13.0% 53	13.8% 50	12.3% 55	12.0% 46	10.4% 34	11.1% 31
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	13.2% 40	14.5% 46	20.7% 67	16.3% 65	12.5% 51	12.7% 46	11.9% 53	11.7% 45	10.1% 33	10.8% 30
	Phenicols	Chloramphenicol (MIC ≥ 32)	13.2% 40	13.2% 42	19.5% 63	15.8% 63	12.8% 52	11.8% 43	11.7% 52	10.7% 41	10.1% 33	9.3% 26
	Tetracyclines	Tetracycline (MIC ≥ 16)	8.9% 27	10.1% 32	8.4% 27	6.3% 25	4.4% 18	6.1% 22	3.6% 16	4.4% 17	1.5% 5	2.2% 6

* 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 32. Resistance patterns of *Salmonella* ser. Typhi isolates, 2004–2013

Year Total Isolates	2004 304	2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383	2012 327	2013 279
Resistance Pattern										
No resistance detected	56.6% 172	48.1% 153	40.2% 130	35.5% 142	38.3% 156	37.5% 136	29.4% 131	27.9% 107	30.6% 100	29.4% 82
Resistance ≥ 1 CLSI* class	43.4% 132	51.9% 165	59.8% 193	64.5% 258	61.7% 251	62.5% 227	70.6% 315	72.1% 276	69.4% 227	70.6% 197
Resistance ≥ 2 CLSI* classes	13.2% 40	14.5% 46	21.7% 70	18.0% 72	14.3% 58	14.6% 53	13.7% 61	12.5% 48	11.0% 36	11.5% 32
Resistance ≥ 3 CLSI* classes	12.8% 39	13.8% 44	20.7% 67	17.5% 70	13.3% 54	13.2% 48	13.7% 61	12.3% 47	10.4% 34	10.4% 29
Resistance ≥ 4 CLSI classes	12.5% 38	12.9% 41	19.2% 62	17.0% 68	12.8% 52	12.7% 46	11.7% 52	11.2% 43	9.5% 31	9.0% 25
Resistance ≥ 5 CLSI* classes	11.8% 36	11.9% 38	16.7% 54	14.8% 59	10.8% 44	10.2% 37	9.6% 43	9.9% 38	8.9% 29	7.2% 20
At least ACSSuT†	7.9% 24	9.1% 29	5.9% 19	3.8% 15	2.5% 10	2.8% 10	1.6% 7	2.3% 9	0.9% 3	0.4% 1
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	0.0% 0	0.6% 2	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.4% 1
At least ACT/S§	11.8% 36	12.9% 41	18.6% 60	15.2% 61	12.0% 49	11.0% 40	10.5% 47	10.4% 40	9.2% 30	8.2% 23
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 and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

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, 2013

Serotype*	2013	
	n	(%)
Paratyphi A	100	(99.0)
Paratyphi B	1	(1.0)
Paratyphi C	0	(0)
Total	**101**	**(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, 2013 (N=100)

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 - 3.6]					93.0	6.0	1.0									
		Kanamycin	0.0	0.0	[0.0 - 3.6]										99.0	1.0					
		Streptomycin	N/A	1.0	[0.0 - 5.4]												99.0	1.0			
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 3.6]							30.0	67.0	3.0							
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 3.6]					1.0	2.0	91.0	6.0								
		Ceftriaxone	0.0	0.0	[0.0 - 3.6]					100.0											
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 3.6]								2.0	19.0	72.0	7.0					
	Penicillins	Ampicillin	0.0	0.0	[0.0 - 3.6]							5.0	88.0	7.0							
	Quinolones	Ciprofloxacin	78.0	4.0	[1.1 - 9.9]	9.0	9.0		3.0	1.0	74.0	4.0									
		Nalidixic acid	N/A	81.0	[71.9 - 88.2]								2.0	17.0				81.0			
II	Cephems	Cefoxitin	1.0	0.0	[0.0 - 3.6]								6.0	69.0	24.0	1.0					
	Folate pathway inhibitors	Sulfisoxazole	N/A	0.0	[0.0 - 3.6]											13.0	84.0	3.0			
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 3.6]				97.0	3.0											
	Phenicols	Chloramphenicol	6.0	0.0	[0.0 - 3.6]									6.0	88.0	6.0					
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 3.6]									100.0							

* 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 11. Antimicrobial resistance pattern for *Salmonella* ser. Paratyphi A, 2013

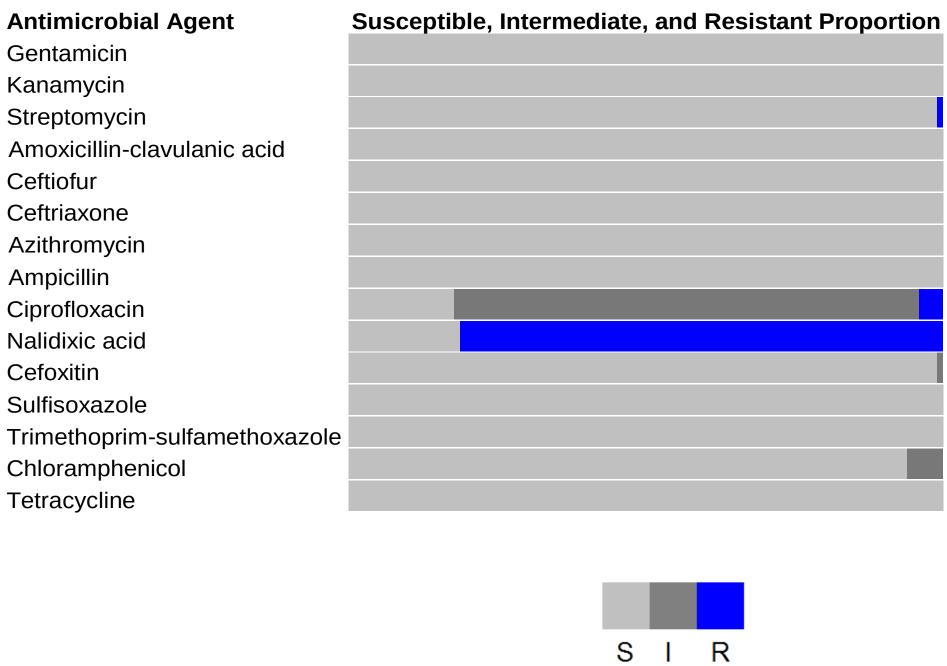


Table 35. Percentage and number of *Salmonella* ser. Paratyphi A isolates resistant to antimicrobial agents, 2004–2013

Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
		Total Isolates	**8**	**12**	**10**	**16**	**116**	**99**	**145**	**152**	**111**	**100**
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	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	0.7% 1	0.0% 0	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	0.0% 0	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3	0.0% 0	0.0% 0	1.0% 1
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 1	0.0% 0	2.8% 4	2.0% 3	2.7% 3	4.0% 4
		Nalidixic Acid (MIC ≥ 32)	100.0% 8	91.7% 11	80.0% 8	93.8% 15	88.8% 103	86.9% 86	92.4% 134	96.7% 147	94.6% 105	81.0% 81
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)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.1% 3	0.0% 0	0.0% 0	0.0% 0
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 1	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0

* 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 36. Resistance patterns of *Salmonella* ser. Paratyphi A isolates, 2004–2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Isolates	**8**	**12**	**10**	**16**	**116**	**99**	**145**	**152**	**111**	**100**
Resistance Pattern										
No resistance detected	0.0% 0	8.3% 1	20.0% 2	6.3% 1	10.3% 12	12.1% 12	5.5% 8	3.3% 5	5.4% 6	19.0% 19
Resistance ≥ 1 CLSI* class	100.0% 8	91.7% 11	80.0% 8	93.8% 15	89.7% 104	87.9% 87	94.5% 137	96.7% 147	94.6% 105	81.0% 81
Resistance ≥ 2 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	2.8% 4	0.0% 0	0.9% 1	1.0% 1
Resistance ≥ 3 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.9% 1	0.0% 0
Resistance ≥ 4 CLSI classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0	0.0% 0
Resistance ≥ 5 CLSI* classes	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	0.0% 0	0.0% 0	0.0% 0
At least ACSSuT†	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	0.0% 0	0.0% 0	0.0% 0
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	0.7% 1	0.0% 0	0.0% 0	0.0% 0
At least ACT/S§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	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 and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

3. *Shigella*

Table 37. Frequency of *Shigella* species, 2013

Species	2013	
	n	(%)
Shigella sonnei	275	(79.9)
Shigella flexneri	64	(18.6)
Shigella dysenteriae	4	(1.2)
Shigella boydii	1	(0.3)
Total	**344**	**(100)**

Table 38. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2013 (N=344)

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	0.3	[0.0 - 1.6]					0.6	8.4	85.5	4.7	0.6			0.3				
		Kanamycin	0.0	0.0	[0.0 - 1.1]										100.0						
		Streptomycin	N/A	91.6	[88.1 - 94.3]												8.4	36.6	54.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	15.1	2.9	[1.4 - 5.3]							1.7	3.5	53.8	23.0	15.1	1.2	1.7			
	Cephems	Ceftiofur	0.0	1.2	[0.3 - 3.0]				6.4	64.0	21.8	6.7				1.2					
		Ceftriaxone	0.0	1.2	[0.3 - 3.0]					96.5	2.3					0.3		0.3	0.6		
	Macrolide	Azithromycin	N/A	3.8	[2.0 - 6.4]					0.6	2.6	4.1	9.3	62.5	16.6	0.6	3.8				
	Penicillins	Ampicillin	0.3	36.0	[31.0 - 41.4]							5.2	42.2	15.7	0.6	0.3	1.2	34.9			
	Quinolones	Ciprofloxacin	0.0	3.5	[1.8 - 6.0]	93.9	0.3		1.2	1.2				2.0	1.5						
		Nalidixic acid	N/A	5.2	[3.1 - 8.1]						2.6	71.2	17.7	2.9	0.3		0.3	4.9			
II	Cephems	Cefoxitin	1.2	1.7	[0.6 - 3.8]						0.6	1.5	63.4	29.7	2.0	1.2	1.7				
	Folate pathway inhibitors	Sulfisoxazole	N/A	48.0	[42.6 - 53.4]											48.5	2.9	0.3		0.3	48.0
		Trimethoprim-sulfamethoxazole	N/A	49.7	[44.3 - 55.1]				6.4	2.3	11.3	17.7	12.5	1.7	48.0						
	Phenicols	Chloramphenicol	0.6	11.6	[8.4 - 15.5]								9.0	71.5	7.3	0.6	3.8	7.8			
	Tetracyclines	Tetracycline	0.6	43.6	[38.3 - 49.0]									55.8	0.6		5.5	38.1			

* 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 12. Antimicrobial resistance pattern for *Shigella*, 2013

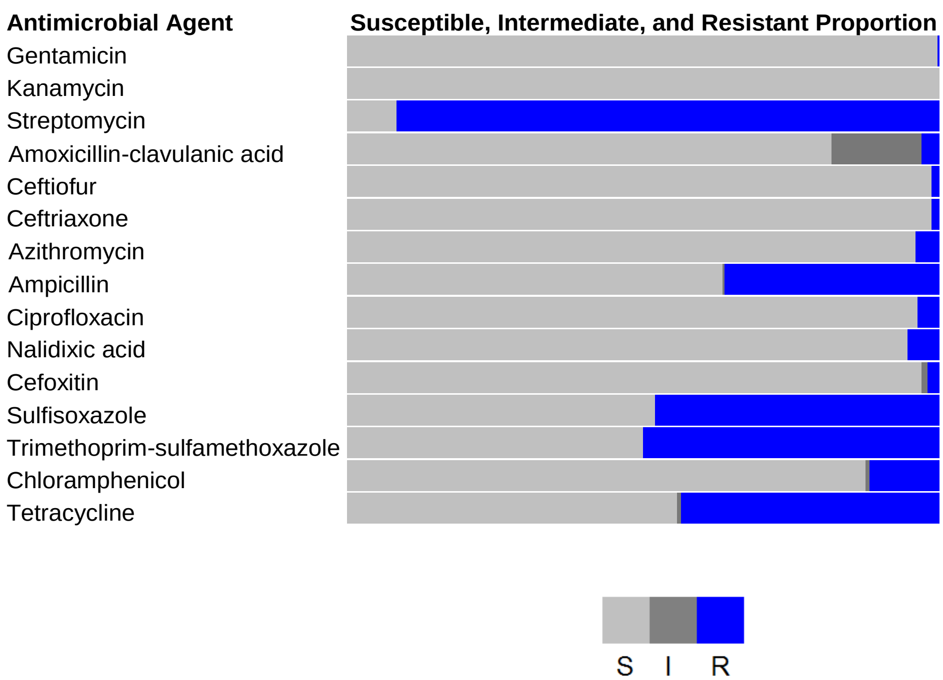


Table 39. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 316	2005 396	2006 402	2007 480	2008 551	2009 475	2010 411	2011 293	2012 353	2013 344
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	1.0% 4	0.2% 1	0.8% 4	0.4% 2	0.6% 3	0.5% 2	0.7% 2	0.0% 0	0.3% 1
		Kanamycin (MIC ≥ 64)	0.0% 0	0.8% 3	0.0% 0	0.2% 1	0.5% 3	0.4% 2	0.0% 0	0.0% 0	0.3% 1	0.0% 0
		Streptomycin (MIC ≥ 64)	59.8% 189	68.7% 272	60.7% 244	73.3% 352	80.6% 444	89.1% 423	91.0% 374	87.7% 257	83.0% 293	91.6% 315
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.6% 5	1.0% 4	1.5% 6	0.4% 2	3.3% 18	2.1% 10	0.0% 0	2.0% 6	1.7% 6	2.9% 10
	Cephems	Ceftiofur (MIC ≥ 8)	0.3% 1	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1	1.7% 5	1.1% 4	1.2% 4
		Ceftriaxone (MIC ≥ 4)	0.3% 1	0.5% 2	0.2% 1	0.0% 0	0.0% 0	0.6% 3	0.2% 1	1.7% 5	1.1% 4	1.2% 4
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	3.4% 10	4.0% 14	3.8% 13
	Penicillins	Ampicillin (MIC ≥ 32)	77.5% 245	70.7% 280	62.4% 251	63.8% 306	62.4% 344	46.3% 220	40.9% 168	33.8% 99	25.5% 90	36.0% 124
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.2% 1	0.2% 1	0.7% 4	0.6% 3	1.7% 7	2.4% 7	2.0% 7	3.5% 12
		Nalidixic Acid (MIC ≥ 32)	1.6% 5	1.5% 6	3.5% 14	1.7% 8	1.6% 9	2.1% 10	4.4% 18	6.1% 18	4.5% 16	5.2% 18
II	Cephems	Cefoxitin (MIC ≥ 32)	0.3% 1	0.5% 2	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.0% 3	0.6% 2	1.7% 6
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	52.5% 166	57.6% 228	40.3% 162	25.8% 124	28.5% 157	30.5% 145	29.9% 123	44.7% 131	34.8% 123	48.0% 165
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	46.8% 148	53.3% 211	46.0% 185	25.8% 124	31.2% 172	40.4% 192	47.7% 196	66.9% 196	43.3% 153	49.7% 171
	Phenicols	Chloramphenicol (MIC ≥ 32)	15.2% 48	10.9% 43	10.9% 44	8.3% 40	6.9% 38	9.3% 44	10.0% 41	12.3% 36	11.3% 40	11.6% 40
	Tetracyclines	Tetracycline (MIC ≥ 16)	49.4% 156	38.4% 152	34.6% 139	25.6% 123	24.3% 134	29.5% 140	31.4% 129	40.6% 119	37.1% 131	43.6% 150

* 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, 2004–2013

Year Total Isolates	2004 316	2005 396	2006 402	2007 480	2008 551	2009 475	2010 411	2011 293	2012 353	2013 344
Resistance Pattern										
No resistance detected	4.7% 15	4.5% 18	6.5% 26	7.1% 34	4.5% 25	4.0% 19	3.6% 15	4.4% 13	7.4% 26	4.1% 14
Resistance ≥ 1 CLSI* class	95.3% 301	95.5% 378	93.5% 376	92.9% 446	95.5% 526	96.0% 456	96.4% 396	95.6% 280	92.6% 327	95.9% 330
Resistance ≥ 2 CLSI* classes	64.2% 203	72.0% 285	64.7% 260	65.4% 314	68.2% 376	68.0% 323	69.8% 287	74.4% 218	53.8% 190	61.0% 210
Resistance ≥ 3 CLSI* classes	59.5% 188	58.6% 232	43.8% 176	27.7% 133	35.2% 194	36.4% 173	39.7% 163	51.2% 150	37.4% 132	53.5% 184
Resistance ≥ 4 CLSI classes	32.9% 104	19.4% 77	15.4% 62	11.7% 56	10.3% 57	13.3% 63	14.1% 58	22.2% 65	19.3% 68	23.8% 82
Resistance ≥ 5 CLSI* classes	7.0% 22	4.8% 19	5.2% 21	4.6% 22	2.7% 15	6.5% 31	4.6% 19	9.9% 29	7.6% 27	9.9% 34
At least ACSSuT†	6.0% 19	4.0% 16	5.0% 20	3.8% 18	2.2% 12	5.9% 28	4.4% 18	6.1% 18	5.7% 20	7.3% 25
At least ACT/S‡	6.6% 21	6.3% 25	6.0% 24	4.0% 19	2.9% 16	6.7% 32	4.9% 20	7.8% 23	7.4% 26	8.1% 28
At least AT/S§	34.5% 109	35.6% 141	26.6% 107	12.9% 62	16.0% 88	17.5% 83	17.8% 73	25.9% 76	15.6% 55	25.6% 88
At least ANT/S¶	0.6% 2	0.5% 2	0.5% 2	0.8% 4	0.0% 0	0.2% 1	1.2% 5	2.4% 7	0.8% 3	1.2% 4
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.3% 1	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.0% 0	0.2% 1	1.4% 4	0.8% 3	0.3% 1
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.3% 1	0.3% 1	0.3% 1
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

Table 41. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2013 (N=275)

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 - 1.3]						4.7	89.1	5.5	0.7							
		Kanamycin	0.0	0.0	[0.0 - 1.3]										100.0						
		Streptomycin	N/A	97.8	[95.3 - 99.2]												2.2	44.0	53.8		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	6.5	3.6	[1.8 - 6.6]							0.4		64.7	24.7	6.5	1.5	2.2			
	Cephems	Ceftiofur	0.0	0.7	[0.1 - 2.6]				1.5	67.6	23.3	6.9				0.7					
		Ceftriaxone	0.0	0.7	[0.1 - 2.6]					96.4	2.9					0.4			0.4		
	Macrolide	Azithromycin	N/A	1.1	[0.2 - 3.2]							0.4	3.3	74.2	20.4	0.7	1.1				
	Penicillins	Ampicillin	0.4	28.0	[22.8 - 33.7]							0.7	50.9	19.3	0.7	0.4	1.1	26.9			
	Quinolones	Ciprofloxacin	0.0	2.9	[1.3 - 5.7]	96.0	0.4		0.4	0.4				1.8	1.1						
		Nalidixic acid	N/A	3.3	[1.5 - 6.1]						2.9	76.0	14.9	2.9				3.3			
II	**Cephems**	Cefoxitin	1.5	2.2	[0.8 - 4.7]						0.4	0.7	73.5	21.8		1.5	2.2				
	Folate pathway inhibitors	Sulfisoxazole	N/A	45.1	[39.1 - 51.2]											51.3	2.9	0.4		0.4	45.1
		Trimethoprim-sulfamethoxazole	N/A	47.6	[41.6 - 53.7]				0.7	1.1	12.7	22.2	15.6	2.2	45.5						
	Phenicols	Chloramphenicol	0.7	0.7	[0.1 - 2.6]								3.3	87.3	8.0	0.7		0.7			
	Tetracyclines	Tetracycline	0.4	34.9	[29.3 - 40.9]									64.7	0.4		4.4	30.5			

* 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 13. Antimicrobial resistance pattern for *Shigella sonnei*, 2013

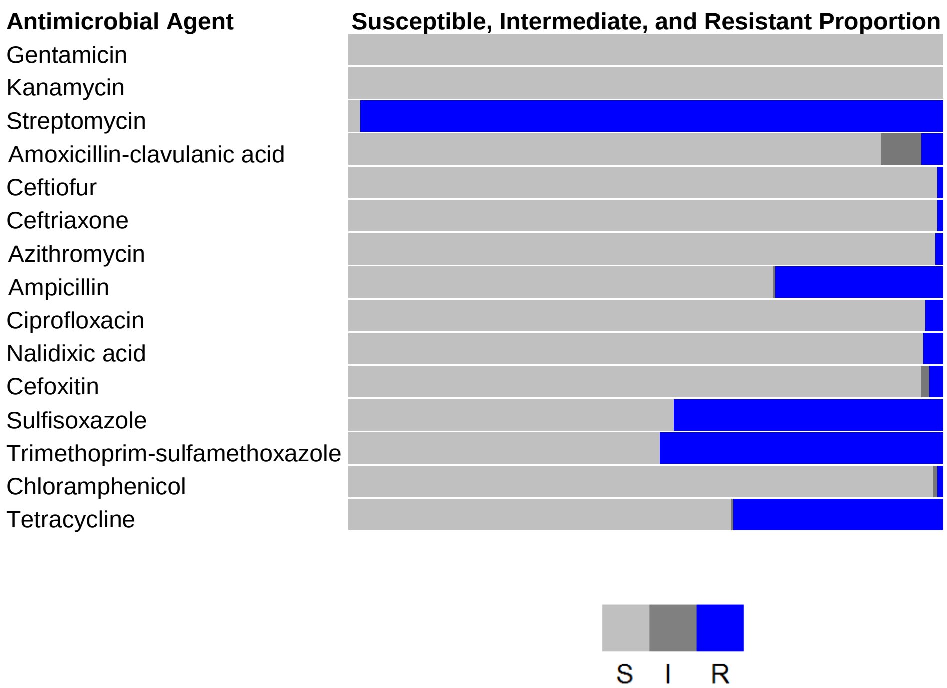


Table 42. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 241	2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 225	2012 287	2013 275
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	1.2% 4	0.0% 0	1.0% 4	0.4% 2	0.7% 3	0.0% 0	0.9% 2	0.0% 0	0.0% 0
		Kanamycin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.6% 3	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.0% 0
		Streptomycin (MIC ≥ 64)	56.8% 137	70.3% 239	61.7% 198	76.8% 318	82.4% 407	91.5% 375	96.1% 324	95.6% 215	89.2% 256	97.8% 269
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.7% 4	1.2% 4	1.9% 6	0.5% 2	3.2% 16	2.0% 8	0.0% 0	2.7% 6	1.7% 5	3.6% 10
	Cephems	Ceftiofur (MIC ≥ 8)	0.4% 1	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1	1.8% 4	1.0% 3	0.7% 2
		Ceftriaxone (MIC ≥ 4)	0.4% 1	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.5% 2	0.3% 1	1.8% 4	1.0% 3	0.7% 2
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.9% 2	2.1% 6	1.1% 3
	Penicillins	Ampicillin (MIC ≥ 32)	79.3% 191	70.6% 240	62.6% 201	64.0% 265	61.3% 303	43.2% 177	36.8% 124	27.6% 62	18.1% 52	28.0% 77
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.5% 5	1.3% 3	2.1% 6	2.9% 8
		Nalidixic Acid (MIC ≥ 32)	1.7% 4	1.2% 4	2.8% 9	1.2% 5	1.6% 8	1.7% 7	3.3% 11	3.6% 8	4.2% 12	3.3% 9
II	Cephems	Cefoxitin (MIC ≥ 32)	0.4% 1	0.6% 2	0.0% 0	0.0% 0	0.0% 0	0.7% 3	0.0% 0	1.3% 3	0.7% 2	2.2% 6
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	49.0% 118	57.9% 197	33.3% 107	20.0% 83	24.5% 121	23.9% 98	25.2% 85	39.6% 89	30.0% 86	45.1% 124
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	46.9% 113	55.0% 187	42.7% 137	22.0% 91	29.1% 144	36.1% 148	46.9% 158	68.9% 155	41.8% 120	47.6% 131
	Phenicols	Chloramphenicol (MIC ≥ 32)	2.5% 6	2.4% 8	0.9% 3	1.2% 5	0.8% 4	1.2% 5	1.5% 5	2.7% 6	3.1% 9	0.7% 2
	Tetracyclines	Tetracycline (MIC ≥ 16)	36.1% 87	29.4% 100	22.7% 73	16.2% 67	16.8% 83	20.7% 85	21.4% 72	29.8% 67	27.5% 79	34.9% 96

* 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, 2004–2013

Year Total Isolates	2004 241	2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 225	2012 287	2013 275
Resistance Pattern										
No resistance detected	5.4% 13	4.4% 15	6.2% 20	6.8% 28	4.7% 23	3.7% 15	1.5% 5	0.9% 2	5.9% 17	0.7% 2
Resistance ≥ 1 CLSI* class	94.6% 228	95.6% 325	93.8% 301	93.2% 386	95.3% 471	96.3% 395	98.5% 332	99.1% 223	94.1% 270	99.3% 273
Resistance ≥ 2 CLSI* classes	56.4% 136	70.6% 240	59.8% 192	63.0% 261	65.4% 323	65.4% 268	68.0% 229	73.8% 166	49.1% 141	56.4% 155
Resistance ≥ 3 CLSI* classes	51.0% 123	55.3% 188	35.8% 115	21.3% 88	29.4% 145	29.8% 122	32.6% 110	44.9% 101	31.0% 89	48.0% 132
Resistance ≥ 4 CLSI classes	25.7% 62	12.4% 42	8.1% 26	5.1% 21	5.3% 26	5.9% 24	6.5% 22	13.3% 30	11.5% 33	14.5% 40
Resistance ≥ 5 CLSI* classes	0.8% 2	0.9% 3	0.0% 0	1.2% 5	0.4% 2	0.5% 2	0.6% 2	3.6% 8	2.8% 8	1.8% 5
At least ACSSuT†	0.0% 0	0.3% 1	0.0% 0	0.5% 2	0.2% 1	0.0% 0	0.6% 2	0.4% 1	1.0% 3	0.4% 1
At least ACT/S‡	1.7% 4	2.4% 8	0.9% 3	0.5% 2	0.8% 4	1.0% 4	0.9% 3	2.2% 5	2.8% 8	0.7% 2
At least AT/S§	35.3% 85	35.6% 121	22.7% 73	9.4% 39	14.2% 70	12.2% 50	14.2% 48	22.2% 50	10.8% 31	19.3% 53
At least ANT/S¶	0.8% 2	0.3% 1	0.0% 0	0.7% 3	0.0% 0	0.0% 0	0.0% 0	1.3% 3	1.0% 3	0.0% 0
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	1.3% 3	0.7% 2	0.0% 0
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.3% 1	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

Table 44. Minimum inhibitory concentrations and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2013 (N=64)

Rank*	CLSI[†] Antimicrobial Class	Antimicrobial Agent	%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
			Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
I	**Aminoglycosides**	Gentamicin	0.0	1.6	[0.0 - 8.4]					3.1	21.9	71.9	1.6				1.6				
		Kanamycin	0.0	0.0	[0.0 - 5.6]										100.0						
		Streptomycin	N/A	67.2	[54.3 - 78.4]												32.8	7.8	59.4		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	53.1	0.0	[0.0 - 5.6]							6.3	17.2	9.4	14.1	53.1					
	Cephems	Ceftiofur	0.0	3.1	[0.4 - 10.8]				25.0	51.6	14.1	6.3				3.1					
		Ceftriaxone	0.0	3.1	[0.4 - 10.8]					96.9								1.6	1.6		
	Macrolide	Azithromycin	N/A	15.6	[7.7 - 26.9]					3.1	14.1	20.3	31.3	15.6			15.6				
	Penicillins	Ampicillin	0.0	70.3	[57.6 - 81.1]							21.9	7.8				1.6	68.8			
	Quinolones	Ciprofloxacin	0.0	6.3	[1.7 - 15.2]	85.9			3.1	4.7				3.1	3.1						
		Nalidixic acid	N/A	12.5	[5.5 - 23.2]						1.6	51.6	31.3	1.6	1.6			12.5			
II	**Cephems**	Cefoxitin	0.0	0.0	[0.0 - 5.6]						1.6	1.6	21.9	64.1	10.9						
	Folate pathway inhibitors	Sulfisoxazole	N/A	59.4	[46.4 - 71.5]											37.5	3.1				59.4
		Trimethoprim-sulfamethoxazole	N/A	57.8	[44.8 - 70.1]				28.1	7.8	6.3				57.8						
	Phenicols	Chloramphenicol	0.0	59.4	[46.4 - 71.5]								31.3	6.3	3.1		20.3	39.1			
	Tetracyclines	Tetracycline	0.0	81.3	[69.5 - 89.9]									18.8			9.4	71.9			

* 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 14. Antimicrobial resistance pattern for *Shigella flexneri*, 2013

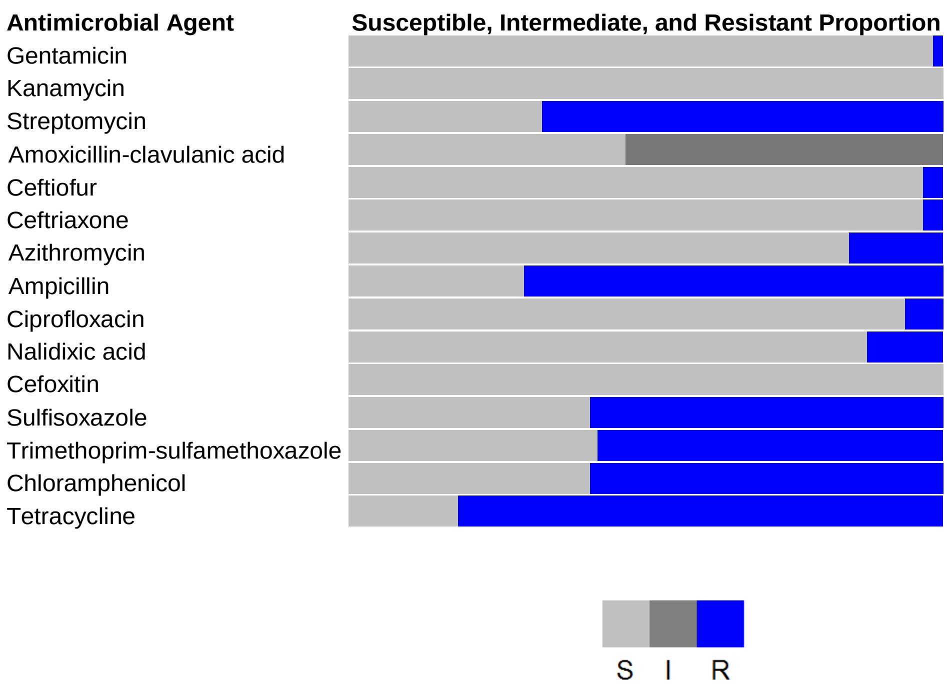


Table 45. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 62	2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	3.3% 2	0.0% 0	0.0% 0	1.6% 1
		Kanamycin (MIC ≥ 64)	0.0% 0	3.8% 2	0.0% 0	0.0% 0	0.0% 0	1.8% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	71.0% 44	57.7% 30	58.1% 43	52.5% 32	63.3% 31	73.7% 42	68.9% 42	58.6% 34	55.9% 33	67.2% 43
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.6% 1	0.0% 0	0.0% 0	0.0% 0	4.1% 2	3.5% 2	0.0% 0	0.0% 0	1.7% 1	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0	1.7% 1	1.7% 1	3.1% 2
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	1.8% 1	0.0% 0	1.7% 1	1.7% 1	3.1% 2
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	12.1% 7	13.6% 8	15.6% 10
	Penicillins	Ampicillin (MIC ≥ 32)	80.6% 50	75.0% 39	63.5% 47	63.9% 39	75.5% 37	70.2% 40	67.2% 41	60.3% 35	61.0% 36	70.3% 45
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	1.4% 1	1.6% 1	2.0% 1	3.5% 2	3.3% 2	6.9% 4	1.7% 1	6.3% 4
		Nalidixic Acid (MIC ≥ 32)	1.6% 1	3.8% 2	5.4% 4	4.9% 3	2.0% 1	3.5% 2	11.5% 7	12.1% 7	5.1% 3	12.5% 8
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)	66.1% 41	55.8% 29	68.9% 51	62.3% 38	63.3% 31	73.7% 42	55.7% 34	60.3% 35	55.9% 33	59.4% 38
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	46.8% 29	44.2% 23	59.5% 44	49.2% 30	49.0% 24	68.4% 39	55.7% 34	58.6% 34	50.8% 30	57.8% 37
	Phenicols	Chloramphenicol (MIC ≥ 32)	61.3% 38	65.4% 34	54.1% 40	55.7% 34	65.3% 32	66.7% 38	55.7% 34	50.0% 29	52.5% 31	59.4% 38
	Tetracyclines	Tetracycline (MIC ≥ 16)	95.2% 59	94.2% 49	83.8% 62	83.6% 51	87.8% 43	87.7% 50	86.9% 53	79.3% 46	84.7% 50	81.3% 52

* 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, 2004–2013

Year Total Isolates	2004 62	2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58	2012 59	2013 64
Resistance Pattern										
No resistance detected	0.0% 0	5.8% 3	5.4% 4	9.8% 6	4.1% 2	5.3% 3	9.8% 6	17.2% 10	11.9% 7	15.6% 10
Resistance ≥ 1 CLSI* class	100.0% 62	94.2% 49	94.6% 70	90.2% 55	95.9% 47	94.7% 54	90.2% 55	82.8% 48	88.1% 52	84.4% 54
Resistance ≥ 2 CLSI* classes	93.5% 58	80.8% 42	85.1% 63	80.3% 49	93.9% 46	86.0% 49	83.6% 51	77.6% 45	76.3% 45	81.3% 52
Resistance ≥ 3 CLSI* classes	90.3% 56	78.8% 41	75.7% 56	68.9% 42	85.7% 42	82.5% 47	80.3% 49	72.4% 42	67.8% 40	76.6% 49
Resistance ≥ 4 CLSI classes	64.5% 40	65.4% 34	47.3% 35	55.7% 34	57.1% 28	63.2% 36	57.4% 35	56.9% 33	57.6% 34	62.5% 40
Resistance ≥ 5 CLSI* classes	29.0% 18	30.8% 16	28.4% 21	27.9% 17	26.5% 13	49.1% 28	27.9% 17	32.8% 19	32.2% 19	45.3% 29
At least ACSSuT†	27.4% 17	28.8% 15	27.0% 20	26.2% 16	22.4% 11	47.4% 27	26.2% 16	27.6% 16	28.8% 17	37.5% 24
At least ACT/S‡	24.2% 15	32.7% 17	28.4% 21	26.2% 16	24.5% 12	47.4% 27	27.9% 17	29.3% 17	30.5% 18	40.6% 26
At least AT/S§	35.5% 22	38.5% 20	43.2% 32	36.1% 22	32.7% 16	52.6% 30	41.0% 25	41.4% 24	37.3% 22	51.6% 33
At least ANT/S¶	0.0% 0	1.9% 1	2.7% 2	1.6% 1	0.0% 0	1.8% 1	8.2% 5	5.2% 3	0.0% 0	6.2% 4
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	1.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.7% 1	1.7% 1	1.6% 1
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	1.6% 1
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0	0.0% 0

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

4. *Escherichia coli* O157

Table 47. Minimum inhibitory concentrations (MICs) and resistance of *Escherichia coli* O157 isolates to antimicrobial agents, 2013 (N=177)

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	0.6	0.6	[0.0 - 3.1]					5.6	79.1	11.3	2.8		0.6	0.6					
		Kanamycin	0.0	0.0	[0.0 - 2.1]										100.0						
		Streptomycin	N/A	6.8	[3.5 - 11.5]												93.2	1.1	5.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.6	1.1	[0.1 - 4.0]							2.3	5.1	85.9	5.1	0.6	0.6	0.6			
	Cephems	Ceftiofur	0.0	0.6	[0.0 - 3.1]				1.1	7.9	80.2	9.6	0.6			0.6					
		Ceftriaxone	0.0	0.6	[0.0 - 3.1]					99.4							0.6				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 2.1]							5.1	62.7	30.5	0.6	1.1					
	Penicillins	Ampicillin	0.0	4.5	[2.0 - 8.7]							4.5	63.8	26.6	0.6		1.1	3.4			
	Quinolones	Ciprofloxacin	0.0	0.6	[0.0 - 3.1]	94.9	1.7			2.3		0.6		0.6							
		Nalidixic acid	N/A	2.8	[0.9 - 6.5]							1.7	80.2	14.1	0.6	0.6		2.8			
II	Cephems	Cefoxitin	2.3	1.1	[0.1 - 4.0]							0.6	6.2	68.9	20.9	2.3		1.1			
	Folate pathway inhibitors	Sulfisoxazole	N/A	5.6	[2.7 - 10.1]											80.2	9.6	3.4		1.1	5.6
		Trimethoprim-sulfamethoxazole	N/A	1.7	[0.3 - 4.9]				94.4	2.3		1.7			1.7						
	Phenicols	Chloramphenicol	0.6	2.8	[0.9 - 6.5]								1.1	14.1	81.4	0.6		2.8			
	Tetracyclines	Tetracycline	1.7	8.5	[4.8 - 13.6]									89.8	1.7		1.1	7.3			

* 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 15. Antimicrobial resistance pattern for *Escherichia coli* O157, 2013

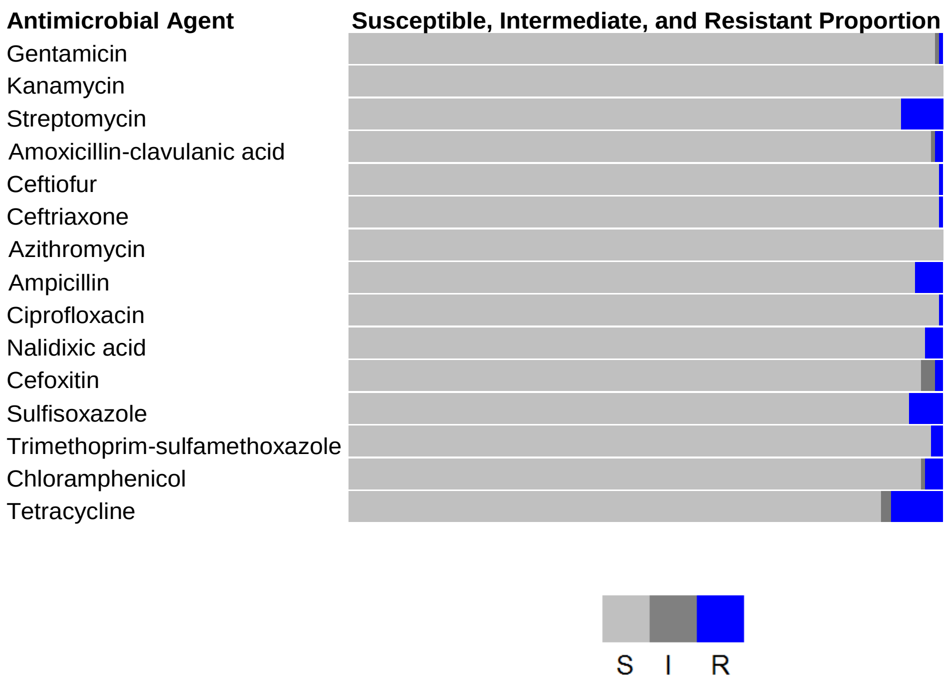


Table 48. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2004–2013

Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Year			**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Total Isolates			**169**	**194**	**233**	**189**	**161**	**187**	**170**	**162**	**166**	**177**
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.6% 1	0.5% 1	0.0% 0	0.0% 0	1.2% 2	0.5% 1	0.6% 1	0.6% 1	0.6% 1	0.6% 1
		Kanamycin (MIC ≥ 64)	0.0% 0	0.5% 1	0.4% 1	0.0% 0	0.0% 0	0.5% 1	1.2% 2	1.9% 3	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	1.8% 3	2.1% 4	2.6% 6	2.1% 4	1.9% 3	4.8% 9	2.4% 4	4.3% 7	2.4% 4	6.8% 12
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.5% 1	0.0% 0	0.0% 0	0.6% 1	1.1% 2
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.6% 1
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	1.3% 3	0.0% 0	0.6% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.6% 1
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.6% 1	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	1.2% 2	4.1% 8	2.6% 6	2.1% 4	3.7% 6	4.3% 8	1.8% 3	3.7% 6	1.8% 3	4.5% 8
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	0.0% 0	0.4% 1	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.6% 1	0.0% 0	0.6% 1
		Nalidixic Acid (MIC ≥ 32)	1.8% 3	1.5% 3	2.1% 5	2.1% 4	1.2% 2	2.1% 4	1.2% 2	1.2% 2	2.4% 4	2.8% 5
II	Cephems	Cefoxitin (MIC ≥ 32)	0.6% 1	0.0% 0	1.3% 3	0.0% 0	1.2% 2	0.5% 1	0.0% 0	0.0% 0	0.6% 1	1.1% 2
	Folate pathway inhibitors	Sulfisoxazole (MIC ≥ 512)	1.8% 3	6.7% 13	3.0% 7	2.6% 5	3.1% 5	6.4% 12	4.7% 8	4.9% 8	3.6% 6	5.6% 10
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	0.5% 1	0.4% 1	1.1% 2	1.2% 2	4.3% 8	1.2% 2	2.5% 4	1.2% 2	1.7% 3
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.6% 1	1.0% 2	1.3% 3	0.5% 1	0.6% 1	1.1% 2	0.6% 1	1.2% 2	1.8% 3	2.8% 5
	Tetracyclines	Tetracycline (MIC ≥ 16)	1.8% 3	8.8% 17	4.7% 11	4.2% 8	1.9% 3	7.5% 14	4.7% 8	4.9% 8	5.4% 9	8.5% 15

* 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, 2004–2013

Year Total Isolates	2004 169	2005 194	2006 233	2007 189	2008 161	2009 187	2010 170	2011 162	2012 166	2013 177
Resistance Pattern										
No resistance detected	94.7% 160	87.6% 170	91.8% 214	92.6% 175	91.9% 148	89.8% 168	93.5% 159	92.6% 150	92.2% 153	84.7% 150
Resistance ≥ 1 CLSI* class	5.3% 9	12.4% 24	8.2% 19	7.4% 14	8.1% 13	10.2% 19	6.5% 11	7.4% 12	7.8% 13	15.3% 27
Resistance ≥ 2 CLSI* classes	2.4% 4	6.7% 13	4.7% 11	2.6% 5	3.1% 5	7.5% 14	4.7% 8	4.9% 8	4.2% 7	7.9% 14
Resistance ≥ 3 CLSI* classes	1.2% 2	5.2% 10	3.4% 8	2.1% 4	2.5% 4	5.9% 11	4.1% 7	4.3% 7	3.0% 5	6.2% 11
Resistance ≥ 4 CLSI classes	0.6% 1	1.0% 2	2.1% 5	1.1% 2	1.2% 2	4.3% 8	1.8% 3	2.5% 4	1.8% 3	2.3% 4
Resistance ≥ 5 CLSI* classes	0.0% 0	0.0% 0	0.9% 2	0.5% 1	0.0% 0	0.5% 1	0.0% 0	0.6% 1	1.2% 2	1.1% 2
At least ACSSuT†	0.0% 0	0.0% 0	0.9% 2	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 1	1.2% 2	1.1% 2
At least ACT/S‡	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.6% 1	0.0% 0	0.0% 0	1.2% 2	0.6% 1	1.1% 2
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

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

5. *Campylobacter*

Table 50. Frequency of *Campylobacter* species, 2013

Species	2013	
	n	(%)
Campylobacter jejuni	1182	(86.2)
Campylobacter coli	142	(10.3)
Other	48	(3.5)
Total	**1372**	**(100)**

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2013 (N=1182)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	N/A	1.6	[1.0 - 2.5]					0.1	45.8	51.9	0.6		0.1		0.1	1.4			
	Ketolide	Telithromycin	N/A	2.0	[1.3 - 3.0]					3.6	22.4	41.7	27.8	2.4	0.3	1.8					
	Macrolides	Azithromycin	N/A	2.2	[1.4 - 3.2]		12.5	45.4	34.3	5.6								0.1	2.1		
		Erythromycin	N/A	2.2	[1.4 - 3.2]				0.4	21.2	42.6	29.9	3.4	0.3			0.2	0.1	1.9		
	Quinolones	Ciprofloxacin	N/A	22.3	[19.9 - 24.7]		0.3	19.7	47.0	9.5	1.2	0.1		0.1	8.5	8.1	3.0	1.8	0.6		
		Nalidixic acid	N/A	22.2	[19.8 - 24.6]									63.1	13.9	0.8		0.3	21.9		
II	Lincosamides	Clindamycin	N/A	3.2	[2.3 - 4.4]		0.1	5.7	54.0	29.9	7.2	1.0	0.3	0.1	0.9	0.5	0.4				
	Phenicols	Florfenicol	N/A	1.2	[0.6 - 2.0]						1.4	76.1	19.5	1.9	1.0	0.2					
	Tetracyclines	Tetracycline	N/A	49.1	[46.2 - 52.0]			1.4	23.9	20.1	4.1	1.4	0.7	0.1		0.3	0.7	5.3	42.0		

* 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*, 2013

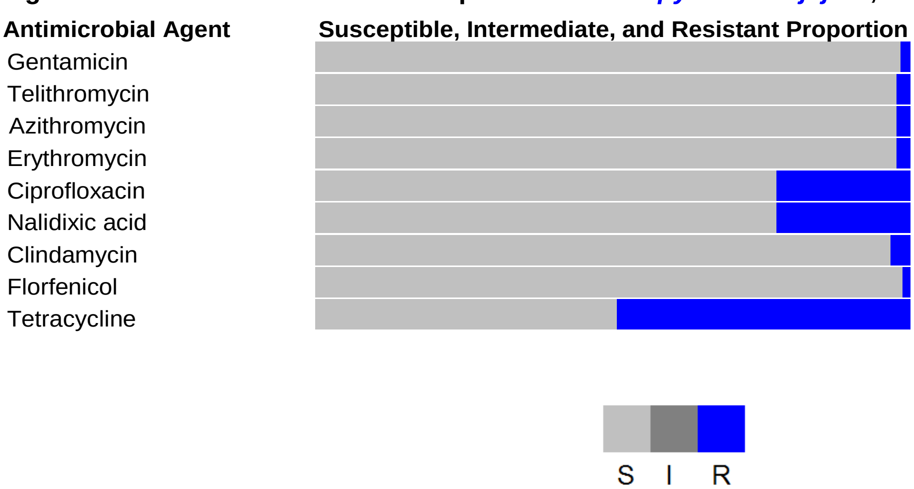


Table 52. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 320	2005 788	2006 709	2007 992	2008 1033	2009 1350	2010 1159	2011 1275	2012 1191	2013 1182
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	2.2% 7	0.1% 1	0.0% 0	0.8% 8	1.1% 11	0.6% 8	0.6% 7	1.0% 13	1.0% 12	1.6% 19
	Ketolides	Telithromycin (MIC ≥ 8)	Not Tested	0.8% 6	1.0% 7	1.3% 13	2.2% 23	1.9% 25	2.4% 28	2.6% 33	1.4% 17	2.0% 24
	Macrolides	Azithromycin (MIC ≥ 0.5)	9.4% 30	2.7% 21	1.3% 9	1.8% 18	2.6% 27	1.9% 26	2.7% 31	4.9% 63	1.8% 21	2.2% 26
		Erythromycin (MIC ≥ 8)	0.9% 3	1.5% 12	0.8% 6	1.6% 16	2.2% 23	1.5% 20	1.2% 14	1.8% 23	1.5% 18	2.2% 26
	Quinolones	Ciprofloxacin (MIC ≥ 1)	18.1% 58	21.6% 170	19.6% 139	26.0% 258	22.6% 233	23.1% 312	22.0% 255	24.1% 307	25.3% 301	22.3% 263
		Nalidixic Acid (MIC ≥ 32)	19.1% 61	22.5% 177	19.5% 138	26.5% 263	22.8% 236	23.1% 312	22.1% 256	24.1% 307	25.5% 304	22.2% 262
II	Lincosamides	Clindamycin (MIC ≥ 1)	5.6% 18	3.2% 25	2.4% 17	3.5% 35	3.8% 39	2.9% 39	14.1% 163	21.5% 274	10.8% 129	3.2% 38
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.6% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol (MIC ≥ 8)	Not Tested	0.4% 3	0.0% 0	0.0% 0	0.6% 6	0.6% 8	1.5% 17	2.1% 27	1.4% 17	1.2% 14
	Tetracyclines	Tetracycline (MIC ≥ 2)	47.5% 152	43.7% 344	48.7% 345	45.7% 453	45.3% 468	44.1% 595	44.2% 512	48.3% 616	47.8% 569	49.1% 580

* 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, 2004–2013

Year Total Isolates	2004 320	2005 788	2006 709	2007 992	2008 1033	2009 1350	2010 1159	2011 1275	2012 1191	2013 1182
Resistance Pattern										
No resistance detected	41.9% 134	46.3% 365	42.5% 301	44.3% 439	45.2% 467	45.9% 620	39.5% 458	33.0% 421	38.6% 460	44.6% 527
Resistance ≥ 1 CLSI* class	58.1% 186	53.7% 423	57.5% 408	55.7% 553	54.8% 566	54.1% 730	60.5% 701	67.0% 854	61.4% 731	55.4% 655
Resistance ≥ 2 CLSI* classes	19.7% 63	16.2% 128	13.1% 93	18.9% 187	15.8% 163	15.1% 204	19.0% 220	23.5% 300	20.0% 238	17.3% 204
Resistance ≥ 3 CLSI* classes	5.3% 17	2.4% 19	1.3% 9	2.0% 20	3.5% 36	2.7% 37	4.2% 49	7.5% 96	4.8% 57	3.1% 37
Resistance ≥ 4 CLSI classes	1.9% 6	1.0% 8	0.7% 5	1.3% 13	1.9% 20	1.6% 21	1.9% 22	3.6% 46	1.8% 21	2.2% 26
Resistance ≥ 5 CLSI* classes	0.3% 1	0.0% 0	0.3% 2	1.1% 11	1.5% 16	1.0% 13	1.0% 12	1.9% 24	0.9% 11	1.8% 21
At least quinolone and macrolide resistant	2.2% 7	1.4% 11	0.7% 5	1.4% 14	1.5% 15	1.2% 16	1.3% 15	3.0% 38	1.3% 16	1.9% 22

* CLSI: Clinical and Laboratory Standards Institute

Table 54. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2013 (N=142)

Rank*	CLSI[†] Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I[‡]	%R[§]	[95% CI][¶]	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	N/A	2.1	[0.4 - 6.0]						14.8	72.5	10.6					2.1			
	Ketolide	Telithromycin	N/A	21.8	[15.3 - 29.5]				0.7	10.6	19.7	5.6	25.4	16.2	7.7	14.1					
	Macrolides	Azithromycin	N/A	16.9	[11.1 - 24.1]		0.7	12.0	38.7	29.6	2.1								16.9		
		Erythromycin	N/A	17.6	[11.7 - 24.9]					5.6	21.1	24.6	16.9	13.4	0.7	0.7		0.7	16.2		
	Quinolones	Ciprofloxacin	N/A	34.5	[26.7 - 42.9]			4.2	26.1	28.2	7.0			0.7	7.0	13.4	10.6	2.1	0.7		
		Nalidixic acid	N/A	35.2	[27.4 - 43.7]									19.0	38.7	7.0	0.7	3.5	31.0		
II	**Lincosamides**	Clindamycin	N/A	21.1	[14.7 - 28.8]				4.9	30.3	28.2	15.5	3.5	1.4	4.9	9.2	2.1				
	Phenicols	Florfenicol	N/A	0.7	[0.0 - 3.9]						1.4	35.9	49.3	12.7	0.7						
	Tetracyclines	Tetracycline	N/A	51.4	[42.9 - 59.9]				4.2	21.8	16.9	5.6				0.7			50.7		

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

Figure 17. Antimicrobial resistance pattern for *Campylobacter coli*, 2013

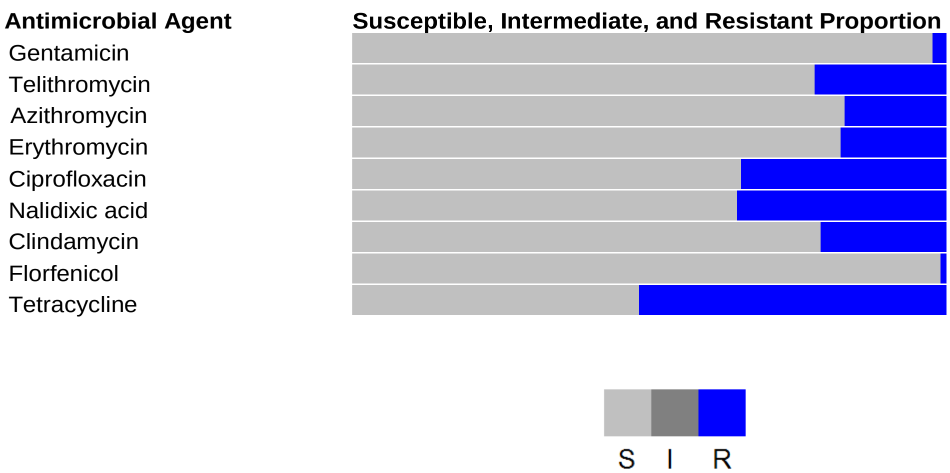


Table 55. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2004–2013

Year Total Isolates			2004 26	2005 99	2006 97	2007 105	2008 115	2009 142	2010 115	2011 148	2012 134	2013 142
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	3.8% 1	3.0% 3	1.0% 1	0.0% 0	1.7% 2	3.5% 5	12.2% 14	12.2% 18	6.0% 8	2.1% 3
	Ketolides	Telithromycin (MIC ≥ 8)	Not Tested	8.1% 8	9.3% 9	9.5% 10	10.4% 12	7.0% 10	13.9% 16	10.8% 16	11.2% 15	21.8% 31
	Macrolides	Azithromycin (MIC ≥ 1)	3.8% 1	4.0% 4	9.3% 9	5.7% 6	10.4% 12	3.5% 5	7.0% 8	5.4% 8	9.0% 12	16.9% 24
		Erythromycin (MIC ≥ 16)	3.8% 1	4.0% 4	8.2% 8	5.7% 6	10.4% 12	3.5% 5	5.2% 6	2.7% 4	9.0% 12	17.6% 25
	Quinolones	Ciprofloxacin (MIC ≥ 1)	30.8% 8	25.3% 25	21.6% 21	28.6% 30	29.6% 34	23.9% 34	30.4% 35	36.5% 54	33.6% 45	34.5% 49
		Nalidixic Acid (MIC ≥ 32)	34.6% 9	27.3% 27	23.7% 23	30.5% 32	29.6% 34	24.6% 35	30.4% 35	35.8% 53	33.6% 45	35.2% 50
II	Lincosamides	Clindamycin (MIC ≥ 2)	11.5% 3	8.1% 8	14.4% 14	9.5% 10	14.8% 17	7.7% 11	17.4% 20	16.9% 25	16.4% 22	21.1% 30
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol (MIC ≥ 8)	Not Tested	1.0% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.7% 1	1.5% 2	0.7% 1
	Tetracyclines	Tetracycline (MIC ≥ 4)	38.5% 10	31.3% 31	39.2% 38	42.9% 45	39.1% 45	45.1% 64	50.4% 58	50.7% 75	45.5% 61	51.4% 73

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

Table 56. Resistance patterns of *Campylobacter coli* isolates, 2004–2013

Year Total Isolates	2004 26	2005 99	2006 97	2007 105	2008 115	2009 142	2010 115	2011 148	2012 134	2013 142
Resistance Pattern										
No resistance detected	34.6% 9	49.5% 49	43.3% 42	38.1% 40	43.5% 50	43.7% 62	33.9% 39	31.1% 46	42.5% 57	31.7% 45
Resistance ≥ 1 CLSI* class	65.4% 17	50.5% 50	56.7% 55	61.9% 65	56.5% 65	56.3% 80	66.1% 76	68.9% 102	57.5% 77	68.3% 97
Resistance ≥ 2 CLSI* classes	26.9% 7	19.2% 19	20.6% 20	21.0% 22	28.7% 33	21.1% 30	38.3% 44	43.2% 64	32.8% 44	35.9% 51
Resistance ≥ 3 CLSI* classes	0.0% 0	7.1% 7	10.3% 10	8.6% 9	8.7% 10	7.0% 10	13.9% 16	14.9% 22	12.7% 17	21.1% 30
Resistance ≥ 4 CLSI classes	0.0% 0	4.0% 4	6.2% 6	5.7% 6	7.0% 8	4.2% 6	7.0% 8	4.7% 7	9.0% 12	14.1% 20
Resistance ≥ 5 CLSI* classes	0.0% 0	2.0% 2	2.1% 2	1.0% 1	3.5% 4	2.8% 4	3.5% 4	1.4% 2	6.0% 8	8.5% 12
At least quinolone and macrolide resistant	0.0% 0	2.0% 2	4.1% 4	1.9% 2	4.3% 5	2.8% 4	3.5% 4	3.4% 5	8.2% 11	9.2% 13

* CLSI: Clinical and Laboratory Standards Institute

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

Table 57. Frequency* of *Vibrio* species other than *V. cholerae*, 2009–2013

Species*	2009 n	2009 (%)	2010 n	2010 (%)	2011 n	2011 (%)	2012 n	2012 (%)	2013* n	2013* (%)
Vibrio parahaemolyticus	149	(53.0)	179	(54.4)	201	(50.5)	370	(61.4)	317	(52.2)
Vibrio alginolyticus	46	(16.4)	49	(14.9)	103	(25.9)	117	(19.4)	122	(20.1)
Vibrio vulnificus	50	(17.8)	61	(18.5)	63	(15.8)	65	(10.8)	87	(14.3)
Vibrio fluvialis	21	(7.5)	24	(7.3)	18	(4.5)	28	(4.6)	40	(6.6)
Vibrio mimicus	11	(3.9)	9	(2.7)	9	(2.3)	11	(1.8)	27	(4.4)
Vibrio harveyi	0	(0)	2	(0.6)	4	(1.0)	3	(0.5)	5	(0.8)
Other	4	(1.4)	5	(1.5)	0	(0)	9	(1.5)	9	(1.5)

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

Table 58. Minimum inhibitory concentrations (MICs) and resistance of isolates of *Vibrio* species other than *V. cholerae* to antimicrobial agents, 2013 (N=607)

Rank*	CLSI† Antimicrobial Class / Antimicrobial Agent	Species (# of isolates)	%I‡	%R§	[95% CI]¶	0.002	0.004	0.007	0.015	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	512	1024	2048
	Aminoglycosides																									
	Gentamicin	**All** (607)	0.2	0.0	[0.0 - 0.6]								0.5	2.1	27.2	67.2	2.8	0.2								
		parahaemolyticus (317)	0.0	0.0	[0.0 - 1.2]									0.9	18.0	80.1	0.9									
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]								1.6	0.8	42.6	54.1	0.8									
		vulnificus (87)	1.1	0.0	[0.0 - 4.2]									1.1	2.3	81.6	13.8	1.1								
	Cephems																									
	Cefotaxime	**All** (607)	0.7	0.3	[0.0 - 1.2]					5.4	8.4	43.7	36.7	2.8	2.0	0.7		0.2	0.2							
		parahaemolyticus (317)	0.0	0.0	[0.0 - 1.2]					0.6	6.0	38.8	52.7	0.9	0.9											
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]					0.8	0.8	63.1	33.6	1.6												
		vulnificus (87)	0.0	0.0	[0.0 - 4.2]					2.3	24.1	67.8	4.6	1.1												
	Ceftazidime	**All** (607)	0.2	0.0	[0.0 - 0.6]							0.7	12.9	37.9	46.1	2.0	0.3	0.2								
		parahaemolyticus (317)	0.0	0.0	[0.0 - 1.2]							0.6	10.4	22.7	63.1	2.5	0.6									
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]							0.8	34.4	48.4	16.4											
		vulnificus (87)	0.0	0.0	[0.0 - 4.2]									62.1	35.6	2.3										
	Penems																									
	Imipenem	**All** (607)	0.0	0.0	[0.0 - 0.6]							43.3	43.0	1.8	0.7	8.7	2.5									
I		***parahaemolyticus*** (317)	0.0	0.0	[0.0 - 1.2]							60.6	38.8			0.6										
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]							49.2	49.2			1.6										
		vulnificus (87)	0.0	0.0	[0.0 - 4.2]							4.6	79.3	12.6		3.4										
	Penicillins																									
	Ampicillin	**All** (607)	12.0	46.0	[41.9 - 50.0]								0.2	0.2	5.3	8.9	10.0	17.5	12.0	16.5	5.4	2.3	0.8	20.9		
		parahaemolyticus (317)	19.9	40.7	[35.2 - 46.3]								0.3	0.3		0.9	11.4	26.5	19.9	27.1	6.9	2.2	0.6	3.8		
		alginolyticus (122)	1.6	95.9	[90.7 - 98.7]										0.8			1.6	1.6	4.1	4.9	3.3	0.8	82.8		
		vulnificus (87)	0.0	2.3	[0.3 - 8.1]										35.6	57.5	3.4	1.1		1.1				1.1		
	Quinolones																									
	Ciprofloxacin	**All** (607)	0.7	0.0	[0.0 - 0.6]		0.7	2.8	4.8	2.8	13.5	43.2	30.0	1.6		0.7										
		parahaemolyticus (317)	0.9	0.0	[0.0 - 1.2]				0.6	0.3	0.9	62.5	34.4	0.3		0.9										
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]					4.1	6.6	36.1	51.6	1.6												
		vulnificus (87)	1.1	0.0	[0.0 - 4.2]			1.1	1.1	8.0	79.3	5.7	1.1	2.3		1.1										
	Nalidixic acid††	**All** (607)	N/A	N/A	N/A							0.2	0.5	3.8	23.1	60.0	11.7	0.7						0.2		
		parahaemolyticus (317)	N/A	N/A	N/A							0.3		0.9	15.8	70.3	12.6									
		alginolyticus (122)	N/A	N/A	N/A									3.3	23.8	54.9	15.6	2.5								
		vulnificus (87)	N/A	N/A	N/A									4.6	33.3	55.2	6.9									
	Folate pathway inhibitors																									
	Trimethoprim-sulfamethoxazole	**All** (607)	N/A	0.0	[0.0 - 0.6]		0.2		0.3		5.1	54.0	39.4	0.8	0.2											
		parahaemolyticus (317)	N/A	0.0	[0.0 - 1.2]						0.3	29.7	69.4	0.6												
		alginolyticus (122)	N/A	0.0	[0.0 - 3.0]		0.8		1.6		8.2	79.5	9.0	0.8												
		vulnificus (87)	N/A	0.0	[0.0 - 4.2]						17.2	80.5	1.1		1.1											
	Phenicols																									
	Chloramphenicol††	**All** (607)	N/A	N/A	N/A								0.3	5.6	82.4	11.4		0.2		0.2						
II		***parahaemolyticus*** (317)	N/A	N/A	N/A									0.6	83.3	16.1										
		alginolyticus (122)	N/A	N/A	N/A								1.6	6.6	86.1	4.9		0.8								
		vulnificus (87)	N/A	N/A	N/A									20.7	78.2	1.1										
	Tetracyclines																									
	Tetracycline	**All** (607)	0.0	0.0	[0.0 - 0.6]								0.5	6.6	68.0	23.7	1.2									
		parahaemolyticus (317)	0.0	0.0	[0.0 - 1.2]								0.3	0.9	71.9	26.8										
		alginolyticus (122)	0.0	0.0	[0.0 - 3.0]									5.7	77.0	17.2										
		vulnificus (87)	0.0	0.0	[0.0 - 4.2]								1.1	26.4	70.1	2.3										

Percentage of isolates: %I, %R, [95% CI]. Percentage of all isolates with MIC (µg/mL)**: 0.002–2048.

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table A1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility; N/A if no MIC range of intermediate susceptibility exists or no CLSI breakpoints have been established
§ Percentage of isolates that were resistant; N/A indicates that no CLSI breakpoints have been established
¶ The 95% confidence intervals (CI) for percent resistant (%R) were calculated using the Paulson-Camp-Pratt approximation to the Clopper-Pearson exact method; N/A indicates that no CLSI breakpoints have been established
** The unshaded areas indicate the dilution range of the Etest® strips used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Etest® strip. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.
†† CLSI MIC interpretive criteria have not been established

Table 59. Percentage and number of isolates of *Vibrio* species other than *V. cholerae* resistant to ampicillin, 2009–2013

Species	2009	2010	2011	2012	2013
Vibrio parahaemolyticus	9.4% 14	8.4% 15	40.3% 81	14.1% 52	40.7% 129
Vibrio alginolyticus	82.6% 38	89.8% 44	95.1% 98	98.3% 115	95.9% 117
Vibrio vulnificus	2.0% 1	0% 0	4.8% 3	1.5% 1	2.3% 2
Vibrio fluvialis	33.3% 7	12.5% 3	44.4% 8	21.4% 6	50.0% 20
Vibrio mimicus	9.1% 1	0% 0	0% 0	9.1% 1	7.4% 2
Vibrio harveyi	N/A* 0	50.0% 1	100% 4	100% 3	80.0% 4
Other	25.0% 1	0% 0	N/A* 0	22.2% 2	55.6% 5
Total	22.1% 62	19.1% 63	48.7% 194	29.9% 180	46.0% 279

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

Antimicrobial Resistance: 1996–2013

The following figures display resistance to selected agents and combinations of agents from 1996–2013 for nontyphoidal *Salmonella*, 1999–2013 for *Salmonella* ser. Typhi, 1997–2013 for *Campylobacter*, and 1999–2013 for *Shigella*.

Figure 18. Percentage of nontyphoidal *Salmonella* isolates resistant to nalidixic acid, by year, 1996–2013

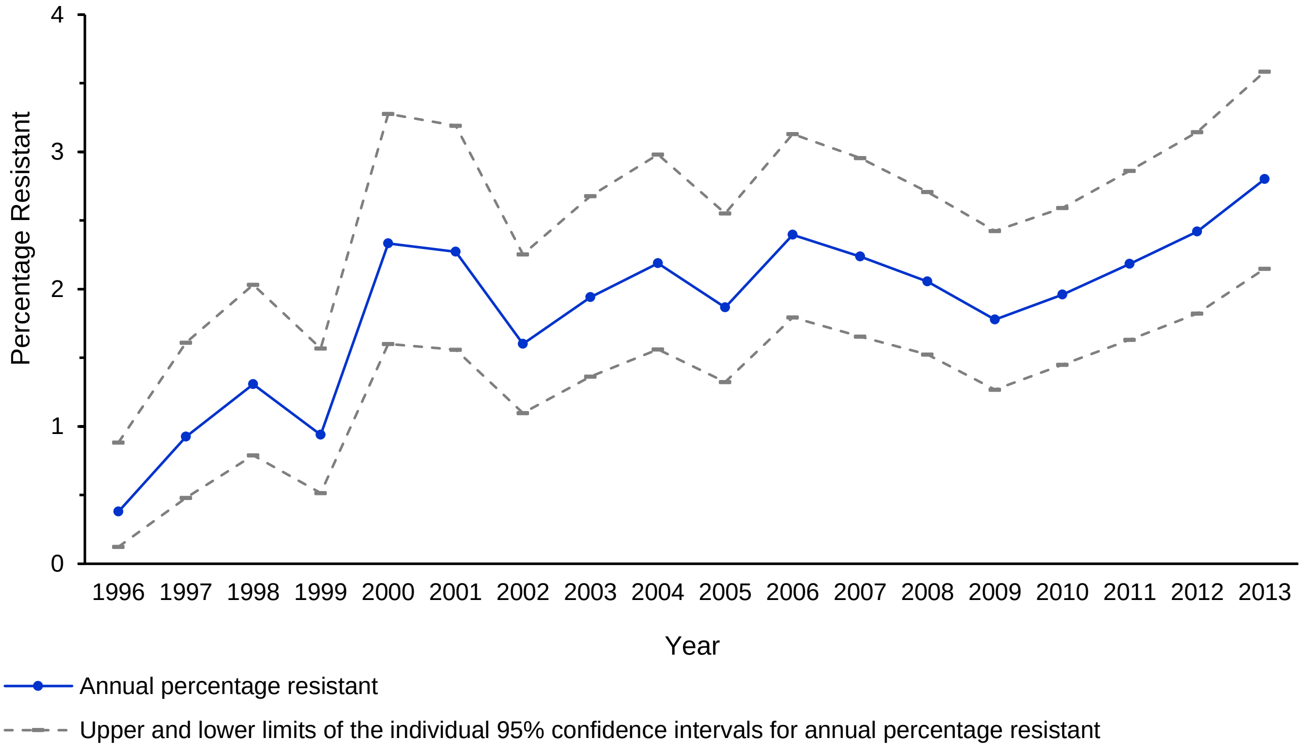


Figure 19. Percentage of nontyphoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2013

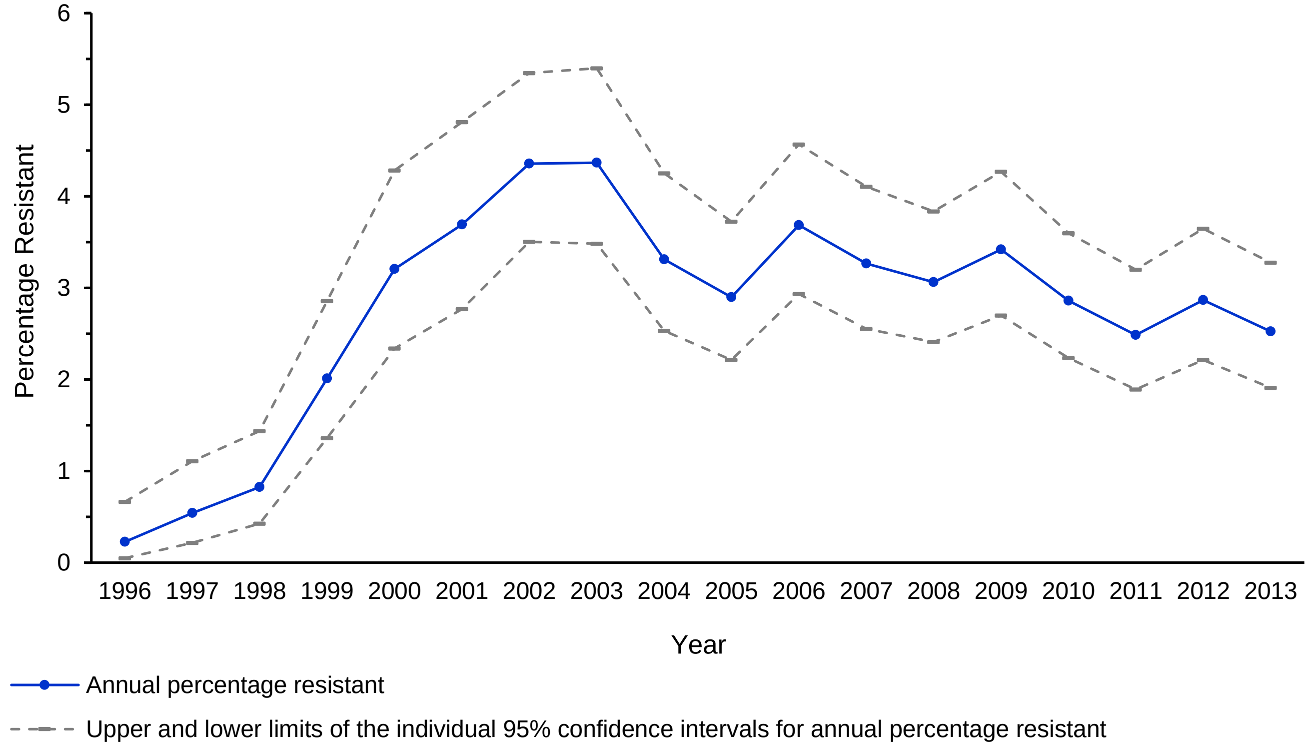


Figure 20. Percentage of *Salmonella* ser. Enteritidis isolates resistant to nalidixic acid, by year, 1996–2013

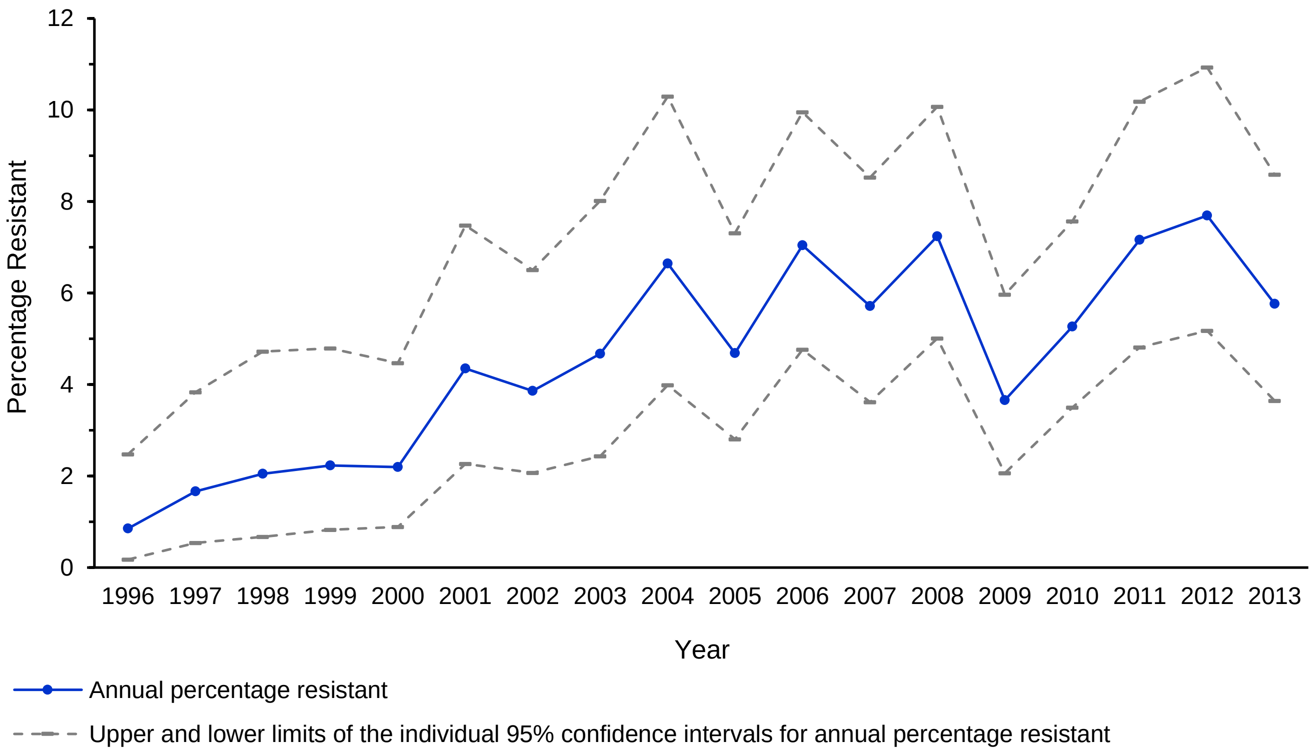


Figure 21. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2013

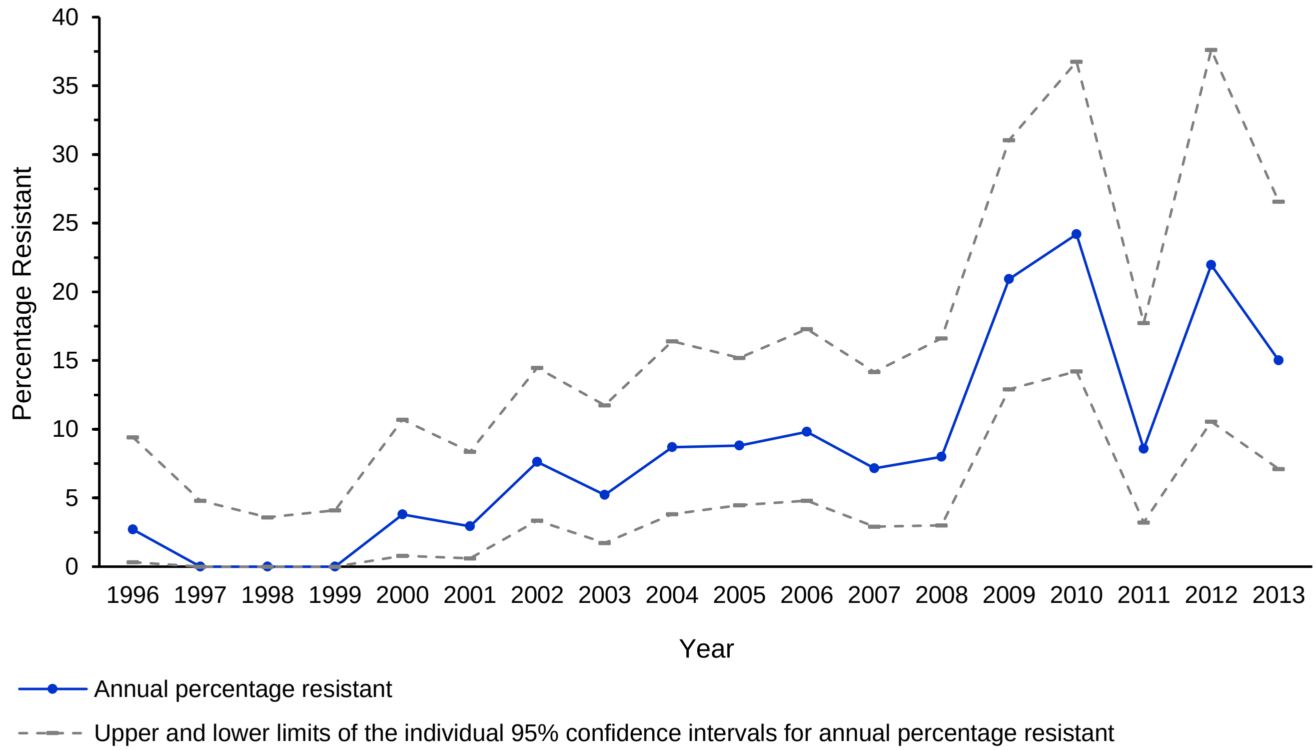


Figure 22. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2013

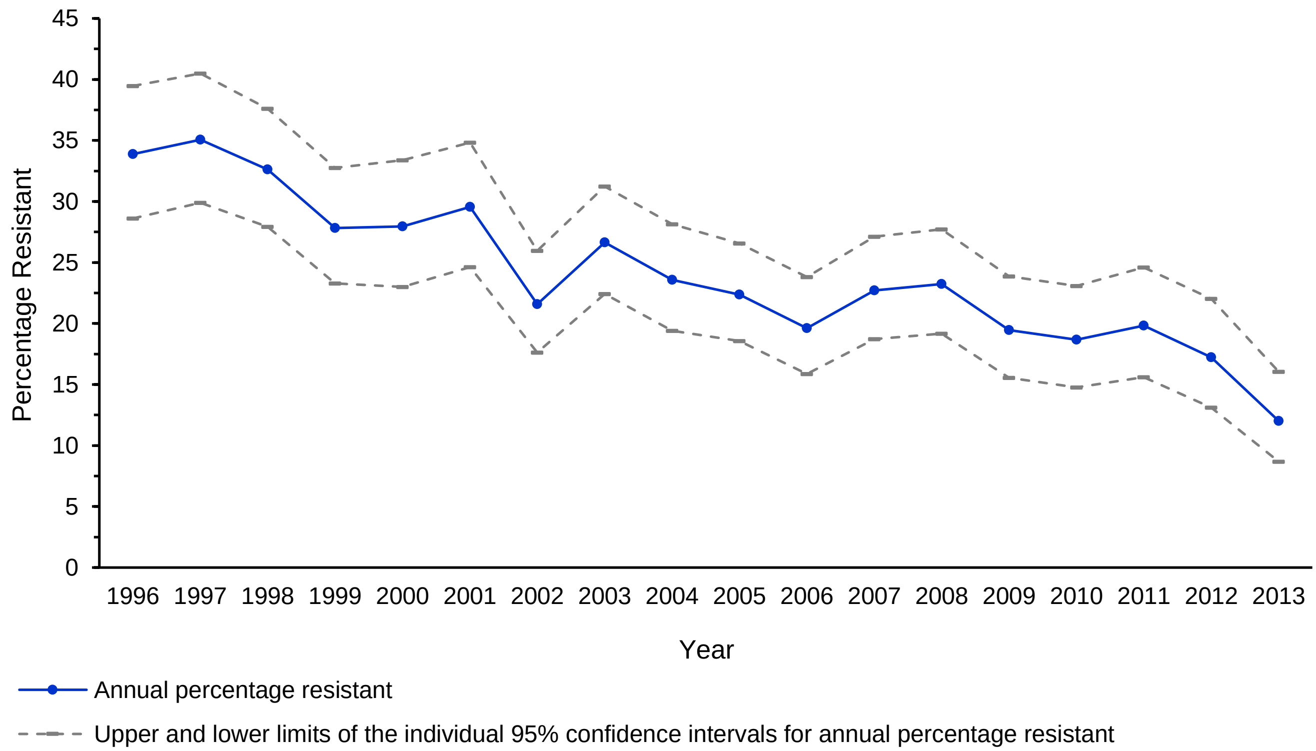


Figure 23. Percentage of *Salmonella* ser. Newport isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx), by year, 1996–2013

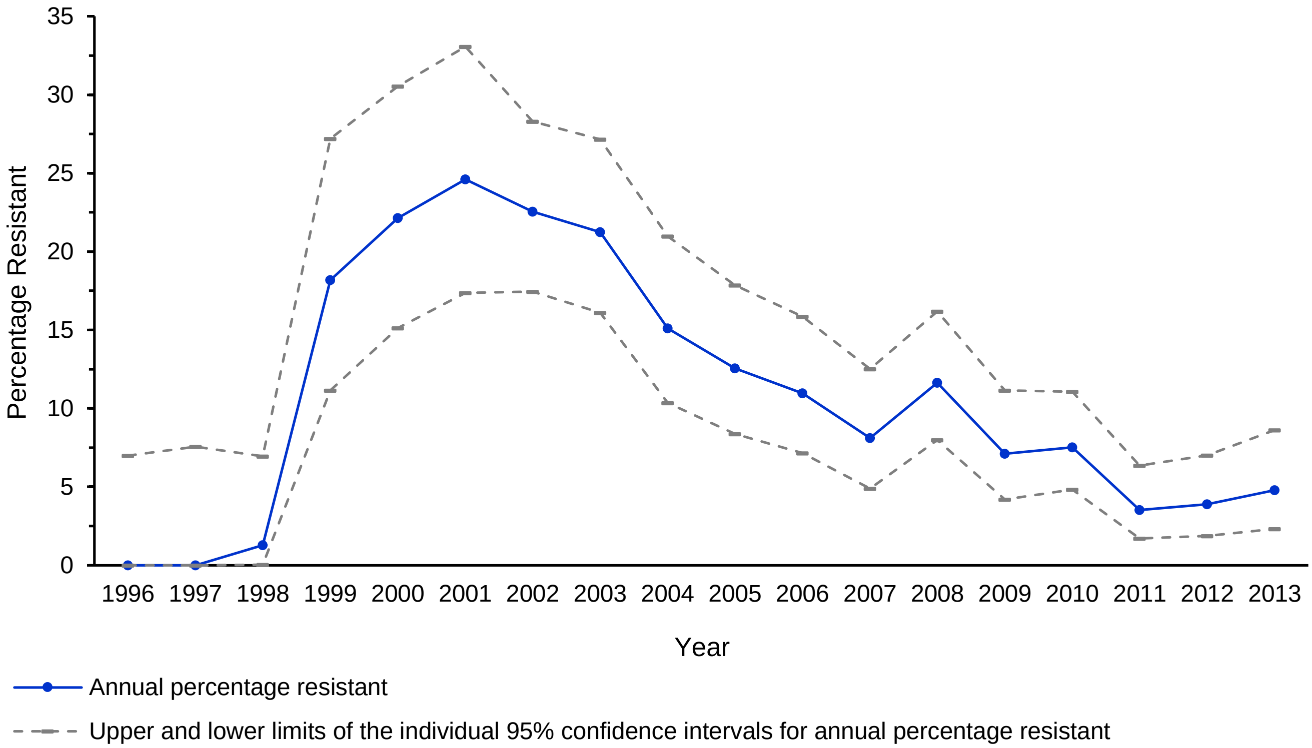


Figure 24. Percentage of nontyphoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2013

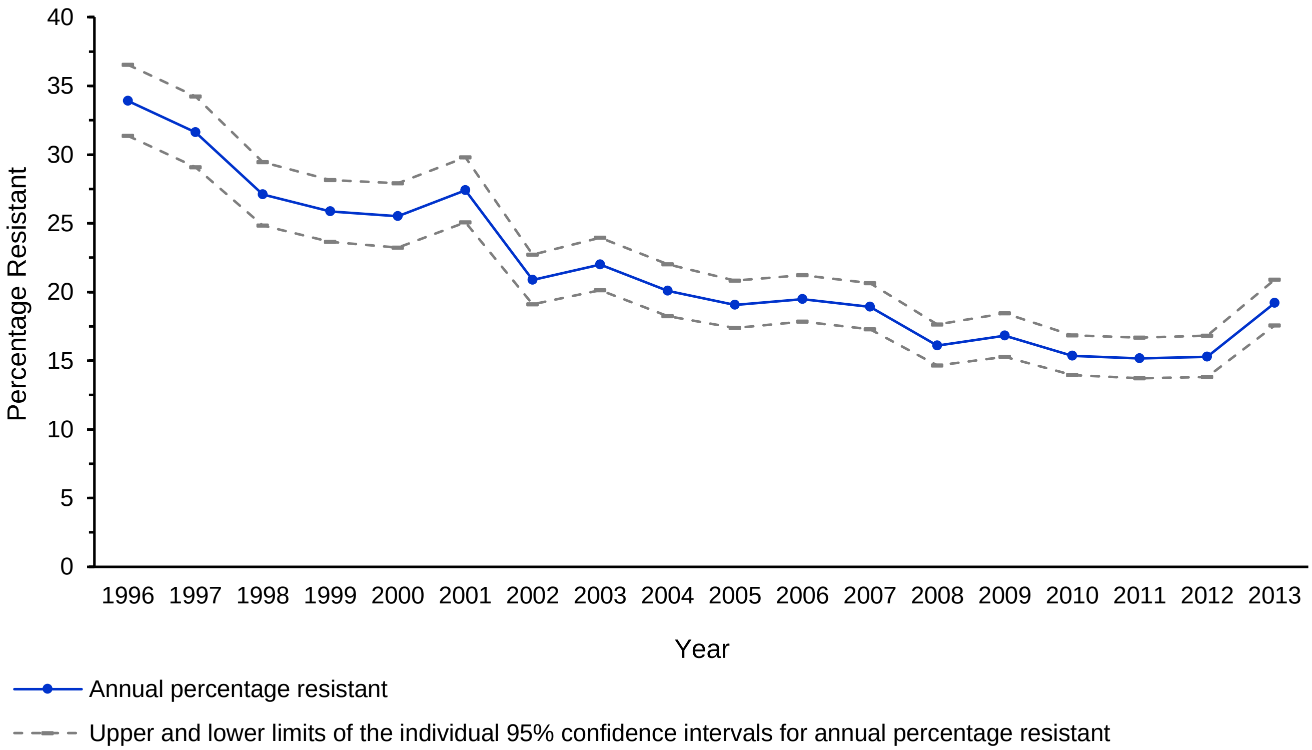


Figure 25. Percentage of nontyphoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2013

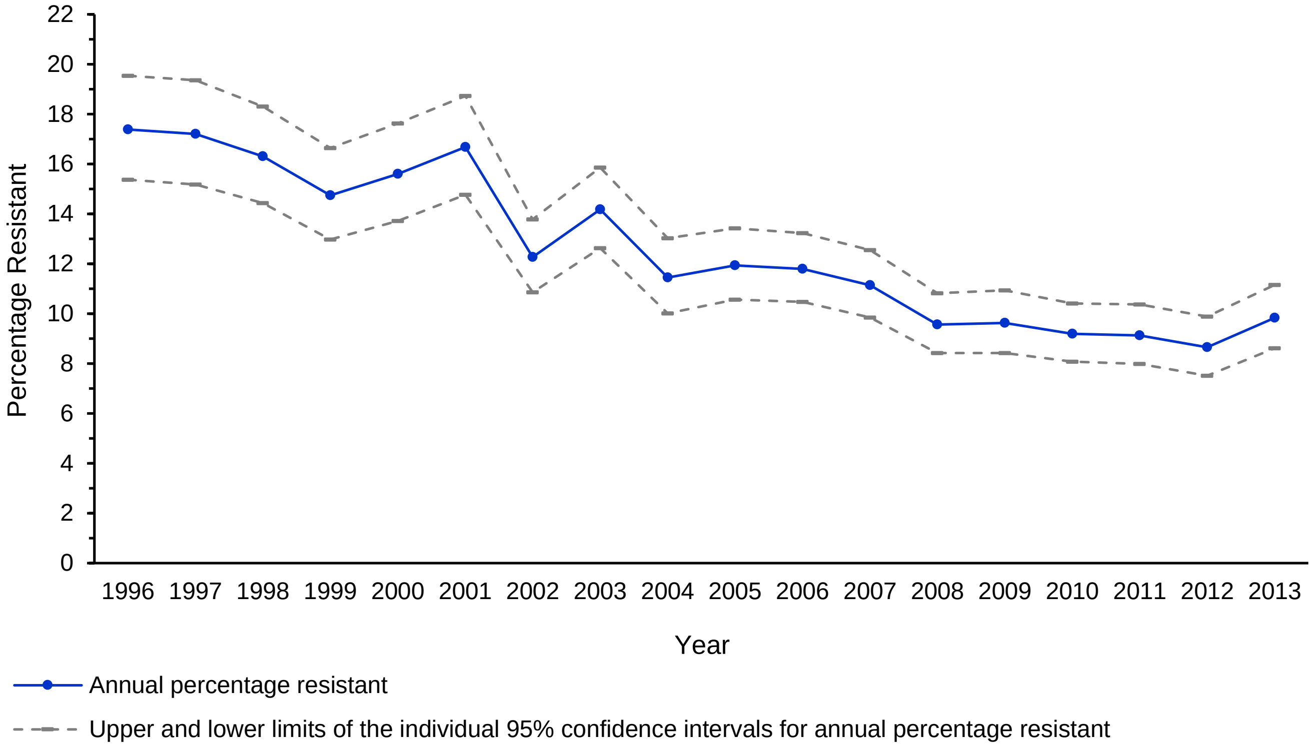


Figure 26. Percentage of *Salmonella* ser. Typhi isolates resistant to nalidixic acid, by year, 1999–2013

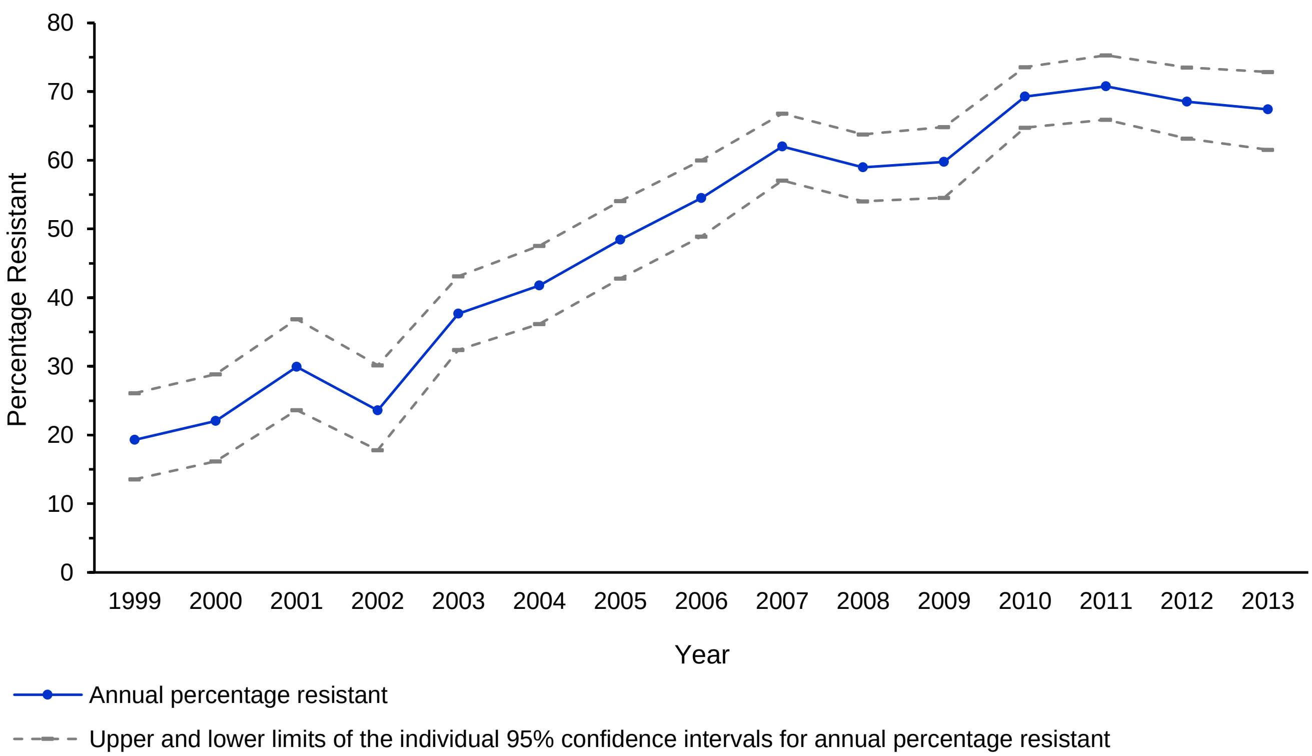


Figure 27. Percentage of *Campylobacter jejuni* isolates resistant to ciprofloxacin, by year, 1997–2013

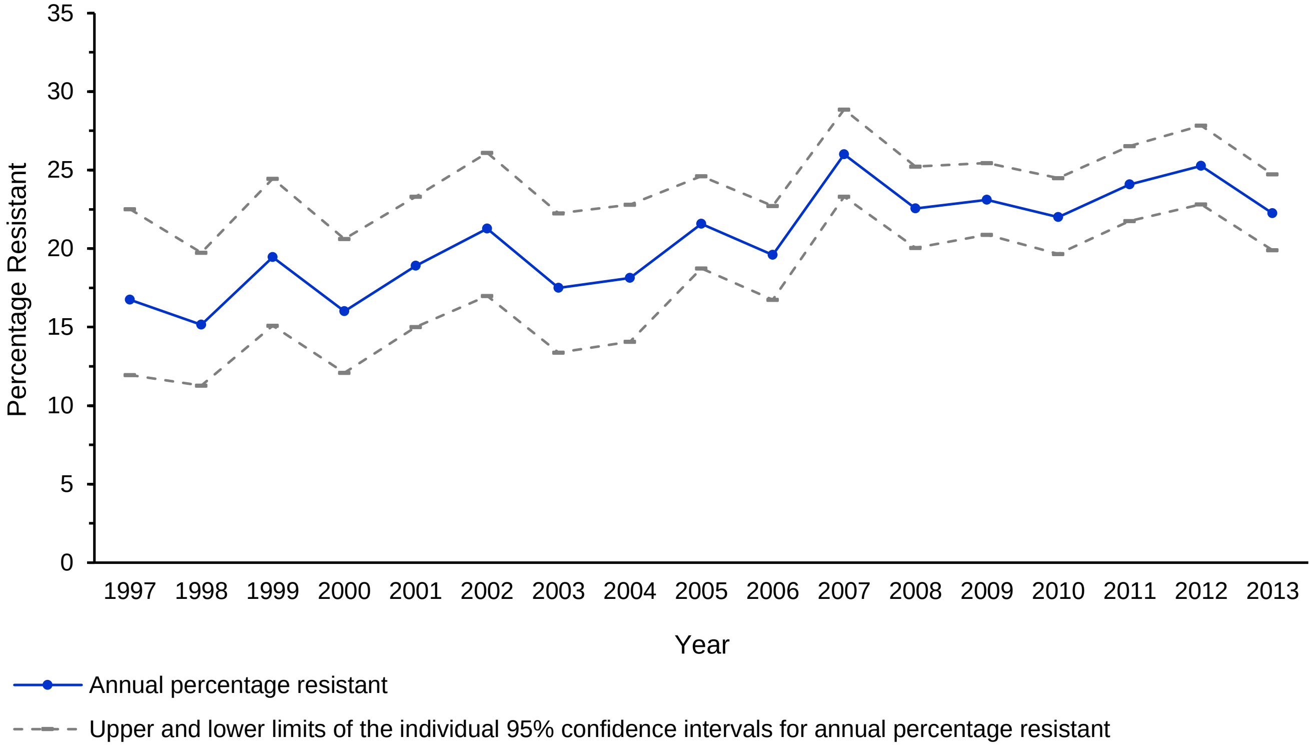


Figure 28. Percentage of *Campylobacter coli* isolates resistant to ciprofloxacin, by year, 1997–2013

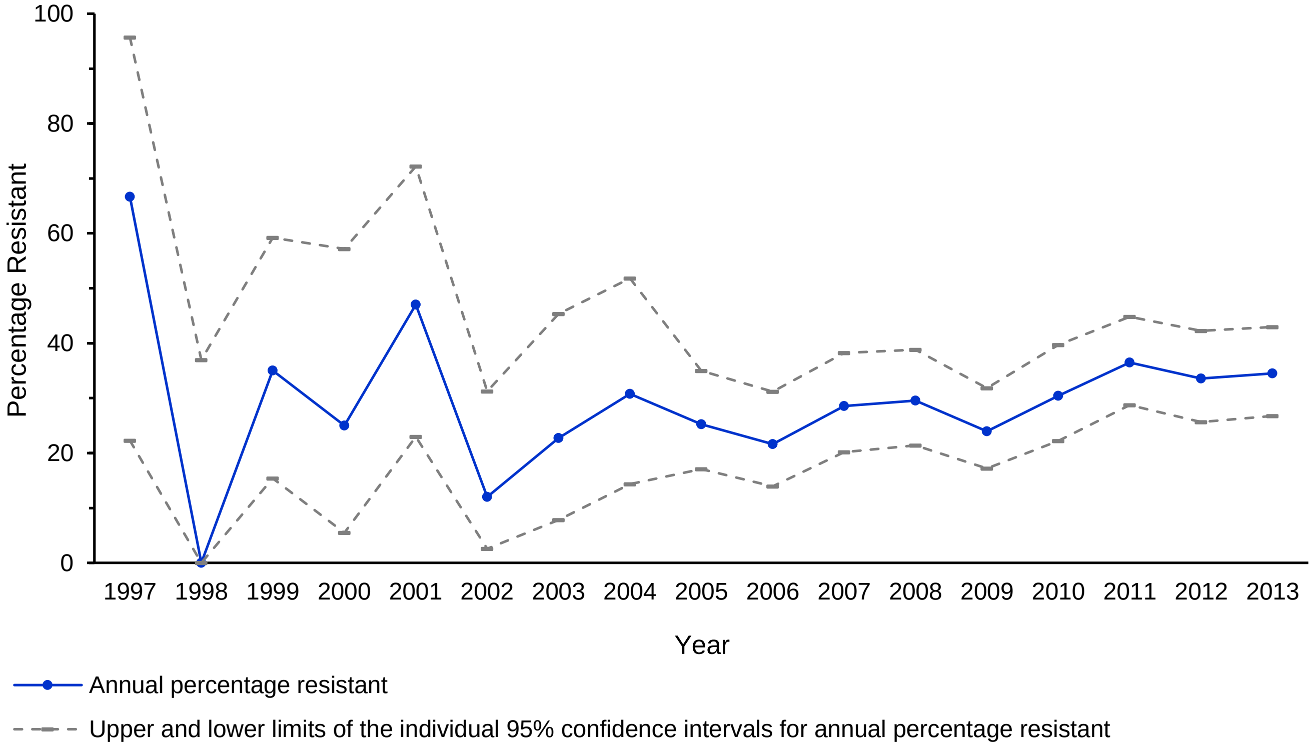
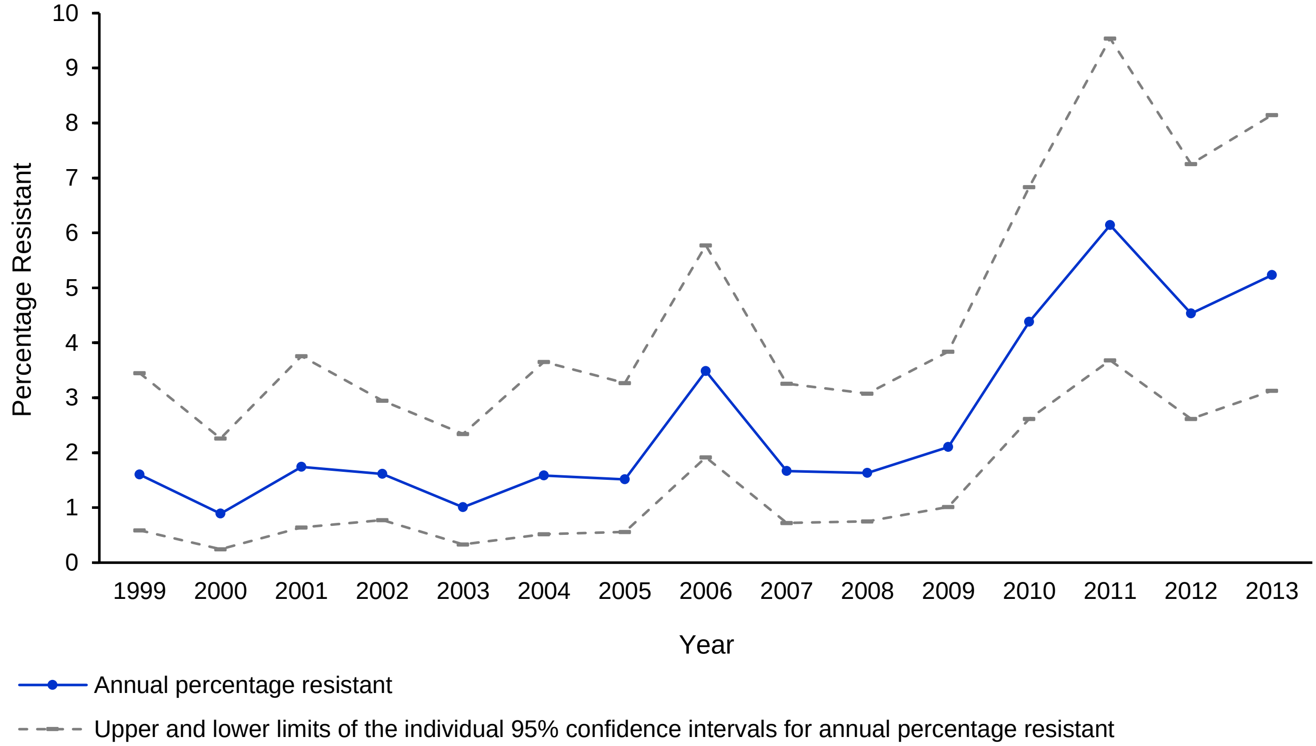


Figure 29. Percentage of *Shigella* isolates resistant to nalidixic acid, by year, 1999–2013



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Appendix A. WHO Categorization of Antimicrobial Agents

In 2011 the World Health Organization (WHO) convened a panel of experts to update a list of antimicrobial agents ranked according to their relative importance to human medicine (WHO, 2011). The participants categorized antimicrobial agents as either Critically Important, Highly Important, or Important based upon two criteria: (1) used as sole therapy or one of the few alternatives to treat serious human disease and (2) used to treat disease caused by either organisms that may be transmitted via non–human sources or diseases caused by organisms that may acquire resistance genes from non–human sources 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)