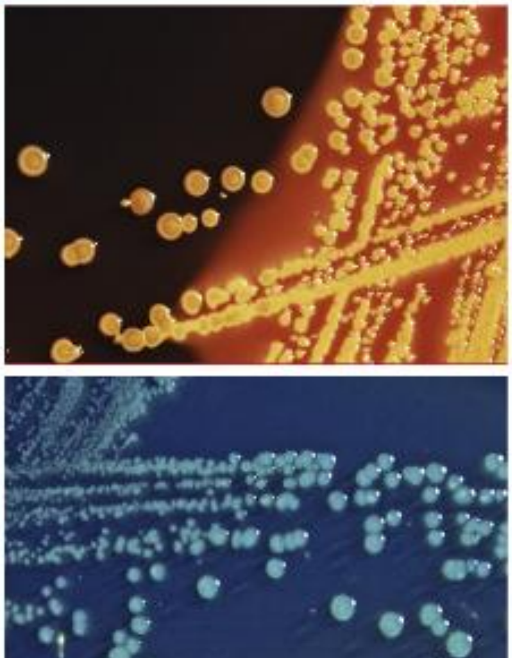
NARMS

National Antimicrobial Resistance Monitoring System: Enteric Bacteria

2012

Human Isolates Final Report



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

CDC

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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
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	United States Department of Agriculture
WHO	World Health Organization

NARMS Working Group

Centers for Disease Control and Prevention

National Center for Emerging and Zoonotic Infectious Diseases

Division of Foodborne, Waterborne and Environmental Diseases

Enteric Diseases Epidemiology Branch

Enteric Diseases Laboratory Branch

Christy Bennett
Amelia Bicknese
Allison Brown
Davina Campbell
Amanda Conrad
Jason Folster
Peter Gerner-Smidt
Julian Grass
Patricia Griffin
Robert Michael Hoekstra
Rebecca Howie
Martha Iwamoto
Kevin Joyce
Maria Karlsson
Beth Karp
Barbara Mahon
Andre McCullough
Felicita Medalla
Allison O'Donnell
Jared Reynolds
Regan Rickert-Hartman
Christina Smith
Robert Tauxe
Lexie Vaughn
Jean Whichard

U.S. Food and Drug Administration

Center for Veterinary Medicine

Heather Tate
Claudine Kabera
Patrick McDermott
Emily Crarey

Participating State and Local Health Departments

Alabama Department of Public Health
Chris Caldwell
Sherri Davidson
Yolanda Gordon
Catrina Hollins
Sharon Massingale
Patricia Morrow
Tina Pippin
Joanna Roberson

Alaska Department of Health and Social Services
Jennifer Faulwetter
Catherine Xavier

Arizona Department of Health Services
Sherry Gower
Ken Komatsu
Tori Reaves
William Slanta
Victor Waddell
Stacy White

Arkansas Department of Health
Rossina Stefanova

California Department of Public Health
Claudia Crandall
Gillian Edwards
Will Probert
Linda Sae-Jang

Colorado Department of Public Health and Environment
Alicia Cronquist
Laura Gillim-Ross
Joyce Knutsen
Hugh Maguire

Connecticut Department of Public Health
Diane Barden
George Goad
Sharon Hurd
Aristea Kinney
Mona Mandour
Christina Nishimura
Kimberly Holmes-Talbot
Alla Zeygerman

Delaware Health and Social Services
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Gaile McLaughlin
Bela Patel
Linda Popels
Debra Rutledge

District of Columbia Department of Health
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Alpha A. Diallo
Sosina Merid

Florida Department of Health
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Beth Burden
Sonia Etheridge

Georgia Division of Public Health
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Cherie Drenzek
Elizabeth Franko
Mahin Park
Lynett Poventud
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Norman O'Connor
Pamela O'Brien

Houston Health and Human Services Department
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Pamela Brown-Bywaters
Gregory Dufour
Vern Juchau
Joan Rogers

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Lisa Smith

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Rebecca Hambelton
Stephen Hendren
Steve Hopkins
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Patrick Miller
Mohammad Nasir
Kiran Patel
Tricia Patterson
Guinevere Reserva
Andrea Stadsholt

Indiana State Department of Health
Brent Barrett
Mark Glazier
Jon Radosevic
Sarah Slette

Iowa Department of Public Health, University Hygienic Laboratory
Mary DeMartino
Randy Groepper

Kansas Department of Health and Environment
Sheri Anderson
Jamie DeMent
Carissa Robertson

Kentucky Department of Public Health
Emily Carmichael
Robin Cotten
Karim George
William Grooms
Carrell Rush
Darrin Sevier
Josh Tobias

Los Angeles County Department of Health Services
Rita Bagby
Sheena Chu
Mary Beth Duke
J. Michael Janda
Laurene Mascola
Roshan Reporter
Michael Stephens
Joan Sturgeon
Wilson Wong

Louisiana Department of Health and Hospitals
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Erin Delaune
Lori Kravet
Steven Martin
Raoult Ratard
Theresa Sokol
Susanne Straif-Bourgeois

Maine Department of Health and Human Services
Stephen Sears
Amy Robbins
Jemelie Bessette
Jeff Randolph
Heather Grieser

Maryland Department of Health and Mental Hygiene
David Blythe
Celere Leonard
Amanda Palmer
Emily Ricotta
Jafar Razeq
Pat Ryan

Massachusetts Department of Public Health
Catherine Brown
Larry Connolly
Alfred DeMaria
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Tracy Stiles

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Sandip Shah

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Fe Leano
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Theresa Weber

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Cathie Hoover
Lucersia Nichols
Alice Singley
Daphne Ware

Missouri Department of Health
John Bos
David Byrd
Steve Gladbach
Jason Herstein
JoAnn Rudroff
Melissa Walker

Montana Department of Public Health and Human Services
Dana Fejes
Debbie Gibson
Karl Milhon
Susanne Zanto

Nebraska Health and Human Services and the Nebraska Public Health Laboratory
Amy Armbrust
Paul Fey
Peter Iwen
Manjiri Joshi
Tom Safranek
Robin Williams

Nevada Department of Health and Human Services
Vince Abitria
Patricia Armour
Michele Bushnik
Jaime Frank
Paul Hug
Bradford Lee
Susanne Quianzon
Lisa Southern
Christine Staskowski
Stephanie Van Hooser

New Hampshire Department of Health and Human Services
Rebecca Adams
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Steffany Cavallo
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Nancy Taylor
Daniel Tullo

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Michelle Malavet
Sylvia Matiuck
Howard Sarubin
Paul Seitz

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Kodi Lockey
Robert Mansman
Cynthia Nicholson
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Erica Pierce
Paul Torres

New York City Department of Health
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Ludwin Chicaiza
Heather Hanson
Lillian Lee
Jennifer Rakeman
Vasudha Reddy

New York State Department of Health
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Kim Musser
Tim Root
Shelley Zansky

North Carolina Department of Health and Human Services
Denise Griffin
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North Dakota Department of Health
Julie Wagendorf
Eric Hieb
Alicia Lepp
Laura Mastel
Tracy Miller
Lisa Well

Ohio Department of Health
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Rebekah Carman
Jane Carmean
Lynn Denny
Dayna Eckels
Larry King
Kimberly Machesky
Marika Mohr
Scott Nowicki
Kim Quinn
Ellen Salehi
Cathy Zuercher

Oklahoma State Department of Health
Rebekah Berry
Sherry Hearon
Mike Lytle
Mike McDermot

Oregon Public Health Division
Debbie Berquist
Hillary Booth
Marianna Cavanaugh
Cathy Ciaffoni
Paul Cieslak
Dawn Daly
Emilio Debess
Julie Hatch
Barbara Olson
Beletsachew Shiferaw
Janie Tierheimer
Robert Vega
Veronica Williams

Pennsylvania Department of Human Service
Carina Davis
Lisa Dettinger
David Faucette
Yu Lung Li
James Lute
Nkuchia M'ikanatha
Barry Perry
Carol Sandt
James Tait
Deepanker Tewari

Rhode Island Department of Health
Tara Cooper
Michael Gosciminski
Sharon Mallard
Deanna Simmons
Cindy Vanner

South Carolina Department of Health and Environmental Control
Gloria Babb
Sandra J. Bandstra
Eddrenna Brown
Dana Giurgiutiu
Jennifer Meredith

South Dakota Department of Health
Christopher Carlson
Laurie Gregg
Lon Kightlinger

Tennessee Department of Health
Parvin Arjmandi
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Amy Woron

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Tori Ponson
Chun Wang

Utah Department of Health
J. Chad Campbell
Lori Smith

Vermont Department of Health
Mary Celotti
Valerie Devlin
Christine LaBarre
Bradley Tompkins

Virginia Division of Consolidated Laboratory Services and Virginia Department of Health
Ellen Bassinger
Stephanie Dela Cruz
Angela Fritzinger
Sherry Giese
Seth Levine
Jody Lowman
Mary Mismas
Denise Toney
Allison Wellman

Washington Department of Health
Romesh Gautom
Brian Hiatt
Yolanda Houze
Kathryn MacDonald
Sandra Moon
Nusrat Syed
Mike Tran
Maryann Watkins

West Virginia Department of Health and Human Resources
Danae Bixler
Christi Clark
Maria del Rosario
Loretta Haddy
Andrea Labik
Suzanne Wilson
Megan Young

Wisconsin Department of Health and Family Services
Susan Ahrabi-Fard
Charles Brokopp
Jeffrey Davis
Rick Hefferman
Rachel Klos
Tim Monson
Dave Warshauer

Wyoming Department of Health
Richard Harris
John Harrison
Clay Van Houten
Tracy Murphy
Jim Walford

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 foods, 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 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).

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.* NARMS participating public health laboratories were asked to forward every isolate of *Vibrio* species other than *V. cholerae* that they received to CDC for antimicrobial susceptibility testing.

This annual report includes CDC's surveillance data for 2012 for non-typhoidal *Salmonella* (refers to serotypes not causing typhoid fever), 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 2012

Epidemiological Cut-Off Values (ECOFFs) for the Interpretation of *Campylobacter* spp. Susceptibility Data

In this report, NARMS used a different approach for interpreting antimicrobial susceptibility data for *Campylobacter* than it has used previously. In previous reports, NARMS used clinical interpretive criteria from the Clinical and Laboratory Standards Institute (CLSI) to define susceptible (S), intermediate (I) and resistant (R) categories. In this report, NARMS instead used epidemiological cut-off values (ECOFFs) provided by the European Committee on Antimicrobial Susceptibility Testing (EUCAST). A more detailed description of ECOFFs can be found on page 17.

Summary of NARMS 2012 Surveillance Data

Surveillance Population

In 2012, all 50 states and the District of Columbia participated in NARMS, representing the entire U.S. population of approximately 314 million persons (Table 1). Surveillance was conducted in all states for *Salmonella* (typhoidal and non-typhoidal), *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 U.S. population).

Clinically Important Antimicrobial Resistance Patterns

In the United States, fluoroquinolones (e.g., ciprofloxacin) and third-generation cephalosporins (e.g., ceftriaxone) are commonly used to treat severe *Salmonella* infections, including typhoid and paratyphoid fever as well as severe non-typhoidal infections. In *Enterobacteriaceae*, (e.g., *Salmonella* and *Shigella*) resistance to nalidixic acid, an elementary quinolone, correlates with decreased susceptibility to ciprofloxacin (Table 2) and possible fluoroquinolone treatment failure. Macrolides (e.g., azithromycin), penicillins (e.g., ampicillin), and trimethoprim-sulfamethoxazole are also of clinical importance. A substantial proportion of *Enterobacteriaceae* isolates tested in 2012 demonstrated clinically important resistance.

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

- 3% (56/2236) of non-typhoidal *Salmonella* isolates were resistant to nalidixic acid. Enteriditis was the most common serotype among nalidixic acid-resistant non-typhoidal *Salmonella* isolates.
    - 50% (28/56) of nalidixic acid-resistant isolates were ser. Enteriditis
    - 8% (28/365) of ser. Enteriditis isolates were resistant to nalidixic acid
- 3% (65/2236) of non-typhoidal *Salmonella* isolates were resistant to ceftriaxone. The most common serotypes among the 65 ceftriaxone-resistant isolates were Newport, Typhimurium, Heidelberg and Dublin. Resistance occurred in
    - 7% (17/259) of ser. Newport isolates
    - 5% (16/295) of ser. Typhimurium isolates
    - 22% (9/41) of ser. Heidelberg isolates
    - 75% (6/8) of ser. Dublin isolates
- 68% (223/326) of *Salmonella* ser. Typhi isolates were resistant to nalidixic acid, and 6% (21/326) were resistant to ciprofloxacin.
- 95% (105/111) of *Salmonella* ser. Paratyphi A isolates were resistant to nalidixic acid, and 3% (3/111) were resistant to ciprofloxacin.
- No *Salmonella* ser. Typhi or *Salmonella* ser. Paratyphi A isolates were resistant to ceftriaxone.

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

- 2% (7/353) of *Shigella* isolates were resistant to ciprofloxacin, including
    - 2% (1/59) of *Shigella flexneri* isolates
    - 3% (6/287) of *Shigella sonnei* isolates
- 5% (16/353) of *Shigella* isolates were resistant to nalidixic acid, including
    - 5% (3/59) of *Shigella flexneri* isolates
    - 4% (12/287) of *Shigella sonnei*
- 4% (15/353) of *Shigella* isolates were resistant to azithromycin, including
    - 15% (9/59) of *Shigella flexneri* isolates
    - 2% (6/287) of *Shigella sonnei* isolates

For *Campylobacte*r, ECOFF values were used for interpreting antimicrobial susceptibility data. Since ECOFFs differ between *Campylobacter* species, the percent resistant for *Campylobacter* overall is not reported.

- 25% (301/1191) of *Campylobacter jejuni* isolates and 34% (45/134) of *Campylobacter coli* isolates were resistant to ciprofloxacin
- 2% (18/1191) of *Campylobacter jejuni* isolates and 9% (12/134) of *Campylobacter coli* isolates were resistant to erythromycin
- 6% (8/134) of *Campylobacter coli* isolates were resistant to gentamicin

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 non-typhoidal *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. 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.

- 4% (78/2236) of non-typhoidal Salmonella isolates were resistant to at least ACSSuT. The most common serotypes were Typhimurium, Newport, and Dublin. ACSSuT resistance occurred in
    - 17% (50/295) ser. Typhimurium isolates
    - 4% (11/259) ser. Newport isolates
    - 88% (7/8) ser. Dublin isolates

- 2% (34/2236) of non-typhoidal *Salmonella* isolates were resistant to at least ACSSuTAuCx. The most common serotypes were Typhimurium, Newport, and Dublin. ACSSuTAuCx resistance occurred in
    - 4% (11/295) ser. Typhimurium isolates
    - 4% (10/259) ser. Newport isolates
    - 75% (6/8) ser. Dublin isolates
- 9% (194/2236) of non-typhoidal *Salmonella* isolates were resistant to three or more CLSI classes. The most common serotypes with this resistance were Typhimurium, I,4,[5],12:i:, Newport, Enteritidis, Heidelberg, and Dublin. Resistance to three or more classes occurred in
    - 24% (72/295) ser. Typhimurium isolates
    - 28% (33/118) ser. I,4,[5],12:i:- isolates
    - 7% (17/259) ser. Newport isolates
    - 3% (11/365) ser. Enteriditis isolates
    - 27% (11/41) ser. Heidelberg isolates
    - 88% (7/8) ser. Dublin isolates

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

- 9% (30/326) of ser. Typhi isolates were resistant to at least ACT/S, and 10% (34/326) were resistant to three or more classes

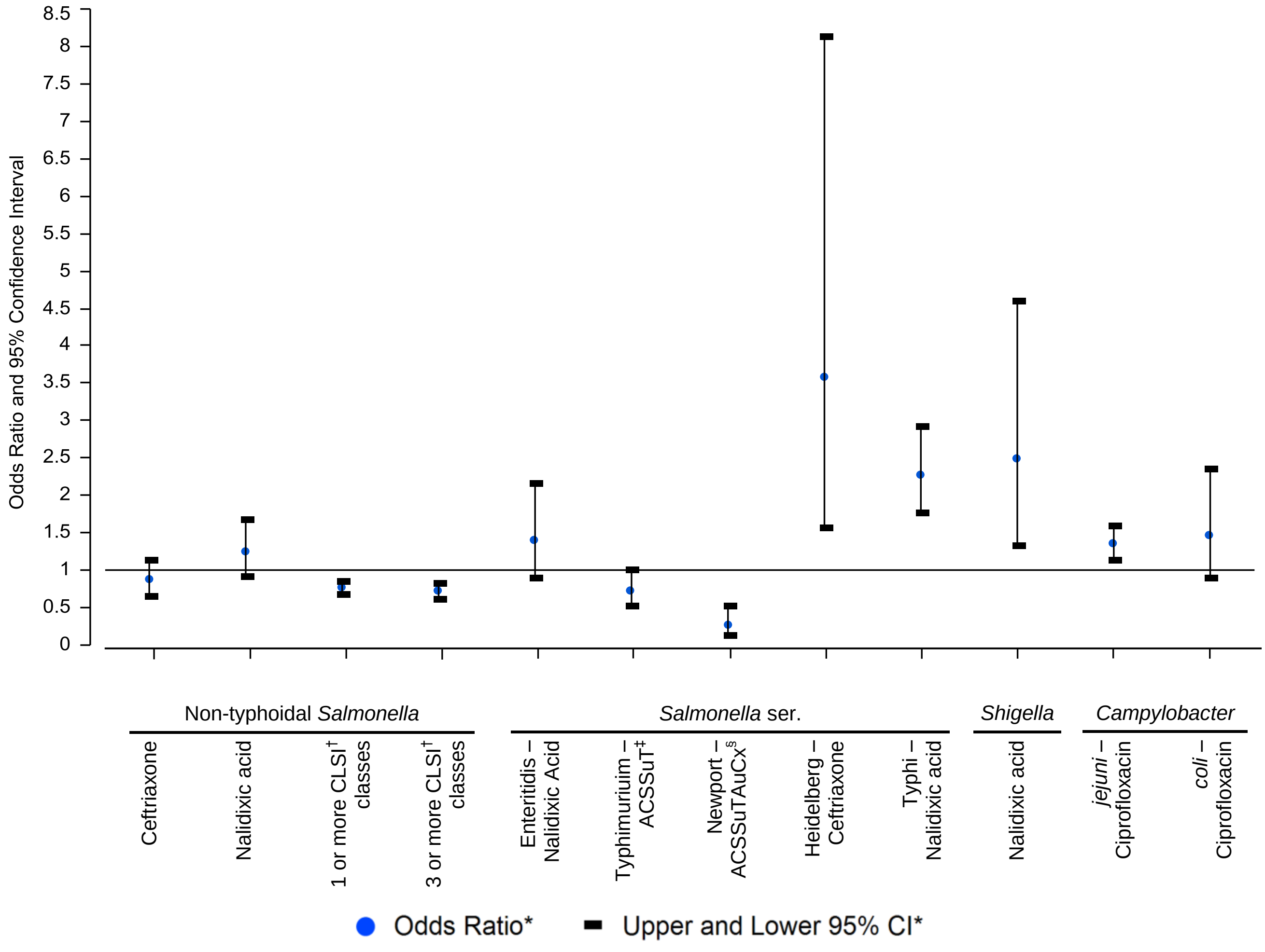
For *Shigella*, an important multidrug-resistance phenotype includes resistance to at least ampicillin and trimethoprim-sulfamethoxazole (AT/S).

- 16% (55/353) of *Shigella* isolates were resistant to at least AT/S, and 37% (132/353) were resistant to three or more classes

Changes in Antimicrobial Resistance: 2012 vs. 2003–2007

To understand changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* over time, we modelled annual data from 2003–2012 using logistic regression. Since 2003, all 50 states have participated in *Salmonella* and *Shigella* surveillance and all 10 FoodNet sites in *Campylobacter* surveillance. We compared the prevalence of selected resistance patterns among isolates tested in 2012 with the average prevalence of resistance in 2003–2007. The methods are described in more detail in Surveillance and Laboratory Testing Methods. Because we defined the prevalence of resistance as the percentage of resistant isolates among total tested, changes in the prevalence of resistance described in this report do not necessarily reflect changes in the incidence of resistant infections. The incidence and relative changes in the incidence of *Salmonella, Shigella,* and *Campylobacter* infections are reported annually from surveillance in FoodNet sites (CDC, 2012).

Figure H1. Summary of trend analysis of the prevalence of selected resistance patterns among *Salmonella, Shigella,* and *Campylobacter* isolates, 2012 compared with 2003–2007*



* The reference is the average prevalence of resistance in 2003–2007. Logistic regression models adjusted for site. The odds ratios (ORs) and 95% confidence intervals (CIs) for 2012 compared with the reference 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 ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone

Changes in Antimicrobial Resistance: 2012 vs. 2003–2007

The differences between the prevalence of resistance in 2012 and the average prevalence of resistance in 2003–2007 (Figure H1) were statistically significant for the following:

- Among non-typhoidal *Salmonella*
    - Resistance to one or more CLSI classes was lower in 2012 than in 2003–2007 (15% vs. 20%; odds ratio [OR]=0.8, 95% confidence interval [CI] 0.7–0.9)
    - Resistance to three or more CLSI classes was lower in 2012 than in 2003–2007 (9% vs. 12%; OR=0.7, 95% CI 0.6–0.8)
- Among *Salmonella* of particular serotypes
    - ACSSuTAuCx resistance in ser. Newport was lower in 2012 than in 2003–2007 (4% vs. 13%; OR=0.3, 95% CI 0.1–0.5)
    - Ceftriaxone resistance in ser. Heidelberg was higher in 2012 than in 2003–2007 (22% vs. 8%; OR=3.6, 95% CI 1.6–8.1). It is important to note both that the number of isolates tested has been declining since 2008 and that only 9 isolates of 41 were resistant in 2012, so the 95% CI is wide.
    - Nalidixic acid resistance in ser. Typhi was higher in 2012 than in 2003–2007 (68% vs. 49%; OR=2.3, 95% CI 1.8–2.9)
- Among *Shigella* spp.
    - Nalidixic acid resistance was higher in 2012 than in 2003–2007 (5% vs. 2%; OR=2.5, 95% CI 1.3–4.6). Only 16 isolates of 353 were resistant in 2012, so the 95% CI is wide.
- Among *Campylobacter jejuni*
    - Ciprofloxacin resistance was higher in 2012 than in 2003–2007 (25% vs. 21%; OR=1.4, 95% CI 1.1–1.6)

The differences between the prevalence of resistance in 2012 and the average prevalence of resistance in 2003–2007 (Figure H1) were not statistically significant for the following selected pathogen-resistance combinations:

- Among non-typhoidal *Salmonella*
    - Ceftriaxone resistance (3% vs. 4%; OR=0.9, 95% CI 0.7–1.1)
    - Nalidixic acid resistance (3% vs. 2%; OR=1.2, 95% CI 0.9–1.7)
- Among *Salmonella* of particular serotypes
    - Nalidixic acid resistance in ser. Enteritidis (8% vs. 6%; OR=1.4, 95% CI 0.9–2.2)
    - ACSSuT resistance in ser. Typhimurium (17% vs. 23%; OR=0.7, 95% CI 0.5–1.0)
- Among *Campylobacter coli,* ciprofloxacin resistance (34% vs. 26%; OR=1.5, 95% CI 0.9–2.4)

Introducing Epidemiological Cut-Off Values (ECOFFs) for the Interpretation of *Campylobacter* spp. Susceptibility Data

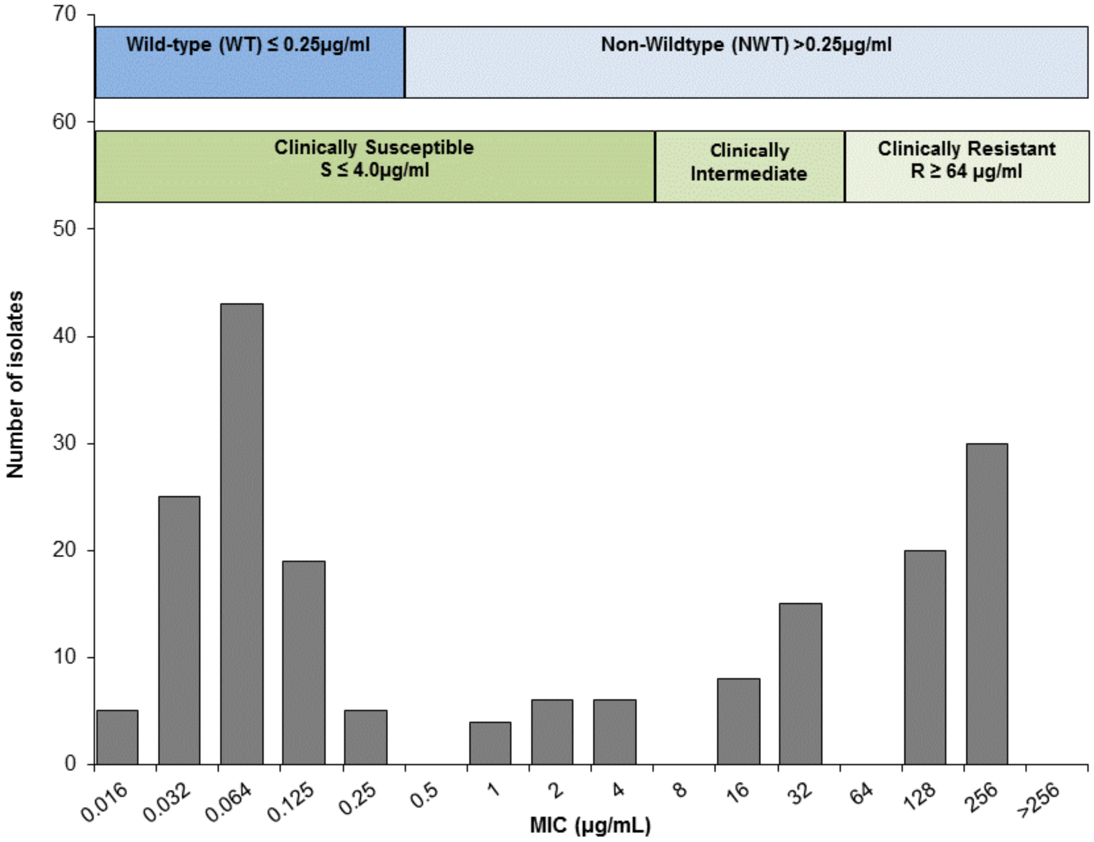
In this report, NARMS used a different approach for interpreting antimicrobial susceptibility data for *Campylobacter* than it has used previously. In previous reports, NARMS used clinical breakpoints from the Clinical and Laboratory Standards Institute (CLSI) to define susceptible (S), intermediate (I) and resistant (R) categories. In this report, NARMS instead used epidemiological cut-off values (ECOFFs) provided by the European Committee on Antimicrobial Susceptibility Testing (EUCAST). This change facilitates detection of emerging resistance and is a step toward globally harmonized methods for *Campylobacter* surveillance. Below is a description of what ECOFFs are and how they differ from clinical breakpoints.

An integral part of antimicrobial susceptibility testing is assigning the results to susceptible and resistant categories using interpretive criteria. The most commonly used criteria, the clinical breakpoints, are essential to guide correct clinical therapy and are also used for comparisons of resistance data between different monitoring programs. When determining clinical breakpoints, several kinds of data are considered, including Minimum Inhibitory Concentration (MIC) distribution data, clinical outcome data, and pharmacological properties of the drug at the site of infection. Since the primary purpose of clinical breakpoints is to guide therapy and predict clinical efficacy, they can have limitations for other purposes, such as detecting emerging resistance or conducting surveillance for emerging resistance. For instance, a breakpoint that appropriately predicts clinical efficacy might not provide the most sensitive detection of isolates that acquired a resistance mechanism.

To facilitate detection of resistance, EUCAST has introduced the concept of ECOFFs to distinguish bacteria without resistance mechanisms (“wild type; (WT)”) from those with an acquired resistance mechanism (“non-wild type; NWT”). The ECOFF value for a given organism/drug combination is derived from analyses of MIC distribution data and is expressed as WT ≤ X mg/L. Thus, while the clinical breakpoint is set to guide therapy, ECOFFs are instead aimed at optimizing the detection of isolates with acquired resistance. ECOFFS do not take into consideration any data on dosages or clinical efficacy. An isolate which is considered non-wild type using ECOFFs may still be considered susceptible using clinical breakpoints (Figure H2). ECOFFs have been determined for a large number of organisms and drugs. Information on ECOFFs can be found on the EUCAST webpage (http://www.eucast.org/).

In this report NARMS has used the EUCAST ECOFFs to interpret results for *Campylobacter*, including historical data as well as data collected in 2012. To highlight the fact that wild type isolates are “microbiologically susceptible” and non-wild type isolates “microbiologically resistant”, isolates are being reported as “susceptible” or “resistant” (rather than “wild type” or “non-wild type”) in the present report. Thus, tables in this report that describe number and percentage resistant, resistance patterns, and MIC distributions for *Campylobacter* all reflect the use of ECOFFs.

Figure H2. Constructed example illustrating the difference between clinical breakpoints and epidemiological cut-offs (ECOFFs)



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Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2012, NARMS conducted nationwide surveillance among approximately 314 million persons (2012 estimates published in the 2013 U.S. Census Bureau report). Public health laboratories systematically selected every 20th non-typhoidal *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. *Salmonella* ser. Paratyphi B was included in the sampling for non-typhoidal *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 also performed susceptibility testing on isolates of *Vibrio* species other than *V*. *cholerae* submitted by the NARMS participating public health laboratories. Participants were asked to forward every *Vibrio* isolate that they received to CDC. Isolates of *Vibrio cholerae* are characterized in CDC’s National Enteric Reference Laboratory. Isolates of species other than *V. cholerae* are confirmed in the Reference Laboratory and tested for antimicrobial susceptibility by NARMS. For Information on toxigenic *Vibrio cholerae*, refer to the Cholera and Other *Vibrio* Illness Surveillance System (COVIS) annual summaries.

Since 2005, public health laboratories of the 10 state health departments that participate in CDC’s Foodborne Diseases Active Surveillance Network (FoodNet) have forwarded a sample of *Campylobacter* isolates received to CDC for susceptibility testing. The FoodNet sites, representing approximately 48 million persons (2012 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. NARMS uses a sampling scheme for *Campylobacter* based on the number of isolates received by each FoodNet site. All isolates received by Oregon and Tennessee; every other isolate from California, Colorado, Connecticut, Georgia, Maryland, and New York; every third isolate from New Mexico; and every fifth isolate from Minnesota are submitted to CDC and tested. From 2005 to 2009, however, all isolates from Georgia, Maryland, and New Mexico were tested. From 1997 to 2004, one *Campylobacter* isolate was submitted each week from participating FoodNet sites.

Table 1. Population size and number of isolates received and tested, NARMS, 2012

State/Site	Population Size*		Non-typhoidal *Salmonella*		Typhoidal[†] *Salmonella*		*Shigella*		*E. coli* O157		*Campylobacter*[‡]		*Vibrio*	
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
Alabama	4,817,528	(1.5)	72	(3.2)	1	(0.2)	16	(4.5)	1	(0.6)			3	(0.5)
Alaska	730,307	(0.2)	2	(0.1)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Arizona	6,551,149	(2.1)	46	(2.1)	9	(2.1)	0	(0)	1	(0.6)			8	(1.3)
Arkansas	2,949,828	(0.9)	28	(1.3)	0	(0)	1	(0.3)	2	(1.2)			0	(0)
California[§]	28,037,089	(8.9)	165	(7.4)	71	(16.2)	2	(0.6)	8	(4.8)	66	(4.9)	79	(13.1)
Colorado	5,189,458	(1.7)	29	(1.3)	6	(1.4)	6	(1.7)	5	(3.0)	38	(2.8)	11	(1.8)
Connecticut	3,591,765	(1.1)	25	(1.1)	4	(0.9)	4	(1.1)	3	(1.8)	129	(9.5)	22	(3.6)
Delaware	917,053	(0.3)	9	(0.4)	0	(0)	1	(0.3)	0	(0)			5	(0.8)
District of Columbia	633,427	(0.2)	18	(0.8)	0	(0)	9	(2.5)	0	(0)			0	(0)
Florida	19,320,749	(6.2)	29	(1.3)	11	(2.5)	5	(1.4)	1	(0.6)			91	(15.1)
Georgia	9,915,646	(3.2)	139	(6.2)	12	(2.7)	26	(7.4)	6	(3.6)	238	(17.5)	17	(2.8)
Hawaii	1,390,090	(0.4)	12	(0.5)	5	(1.1)	3	(0.8)	2	(1.2)			26	(4.3)
Houston, Texas[¶]	2,160,821	(0.7)	51	(2.3)	15	(3.4)	11	(3.1)	1	(0.6)			0	(0)
Idaho	1,595,590	(0.5)	8	(0.4)	0	(0)	1	(0.3)	4	(2.4)			1	(0.2)
Illinois	12,868,192	(4.1)	105	(4.7)	18	(4.1)	18	(5.1)	11	(6.6)			3	(0.5)
Indiana	6,537,782	(2.1)	43	(1.9)	3	(0.7)	4	(1.1)	10	(6.0)			2	(0.3)
Iowa	3,075,039	(1.0)	26	(1.2)	2	(0.5)	5	(1.4)	4	(2.4)			0	(0)
Kansas	2,885,398	(0.9)	15	(0.7)	1	(0.2)	2	(0.6)	1	(0.6)			1	(0.2)
Kentucky	4,379,730	(1.4)	32	(1.4)	0	(0)	4	(1.1)	0	(0)			0	(0)
Los Angeles[**]	9,962,789	(3.2)	58	(2.6)	9	(2.1)	2	(0.6)	0	(0)			0	(0)
Louisiana	4,602,134	(1.5)	0	(0)	0	(0)	0	(0)	0	(0)			0	(0)
Maine	1,328,501	(0.4)	0	(0)	0	(0)	0	(0)	0	(0)			5	(0.8)
Maryland	5,884,868	(1.9)	58	(2.6)	16	(3.7)	7	(2.0)	1	(0.6)	221	(16.3)	25	(4.1)
Massachusetts	6,645,303	(2.1)	54	(2.4)	15	(3.4)	7	(2.0)	4	(2.4)			35	(5.8)
Michigan	9,882,519	(3.1)	46	(2.1)	11	(2.5)	12	(3.4)	4	(2.4)			2	(0.3)
Minnesota	5,379,646	(1.7)	41	(1.8)	6	(1.4)	19	(5.4)	7	(4.2)	185	(13.6)	8	(1.3)
Mississippi	2,986,450	(1.0)	55	(2.5)	1	(0.2)	11	(3.1)	2	(1.2)			8	(1.3)
Missouri	6,024,522	(1.9)	59	(2.6)	3	(0.7)	6	(1.7)	6	(3.6)			6	(1)
Montana	1,005,494	(0.3)	4	(0.2)	0	(0)	1	(0.3)	1	(0.6)			1	(0.2)
Nebraska	1,855,350	(0.6)	12	(0.5)	0	(0)	9	(2.5)	3	(1.8)			0	(0)
Nevada	2,754,354	(0.9)	11	(0.5)	1	(0.2)	3	(0.8)	0	(0)			2	(0.3)
New Hampshire	1,321,617	(0.4)	9	(0.4)	1	(0.2)	1	(0.3)	0	(0)			2	(0.3)
New Jersey	8,867,749	(2.8)	58	(2.6)	22	(5.0)	32	(9.1)	4	(2.4)			23	(3.8)
New Mexico	2,083,540	(0.7)	17	(0.8)	2	(0.5)	4	(1.1)	0	(0)	89	(6.5)	0	(0)
New York[††]	11,239,428	(3.6)	72	(3.2)	31	(7.1)	30	(8.5)	7	(4.2)	178	(13.1)	60	(10.0)
New York City[‡‡]	8,336,697	(2.7)	66	(3.0)	59	(13.5)	16	(4.5)	4	(2.4)			12	(2.0)
North Carolina	9,748,364	(3.1)	0	(0)	0	(0)	0	(0)	0	(0)			14	(2.3)
North Dakota	701,345	(0.2)	4	(0.2)	1	(0.2)	1	(0.3)	1	(0.6)			0	(0)
Ohio	11,553,031	(3.7)	71	(3.2)	13	(3.0)	11	(3.1)	11	(6.6)			7	(1.2)
Oklahoma	3,815,780	(1.2)	36	(1.6)	0	(0)	3	(0.8)	2	(1.2)			0	(0)
Oregon	3,899,801	(1.2)	24	(1.1)	4	(0.9)	5	(1.4)	6	(3.6)	143	(10.5)	16	(2.7)
Pennsylvania	12,764,475	(4.1)	78	(3.5)	14	(3.2)	6	(1.7)	4	(2.4)			7	(1.2)
Rhode Island	1,050,304	(0.3)	6	(0.3)	2	(0.5)	1	(0.3)	1	(0.6)			6	(1.0)
South Carolina	4,723,417	(1.5)	64	(2.9)	4	(0.9)	2	(0.6)	1	(0.6)			2	(0.3)
South Dakota	834,047	(0.3)	9	(0.4)	0	(0)	1	(0.3)	2	(1.2)			0	(0)
Tennessee	6,454,914	(2.1)	52	(2.3)	3	(0.7)	8	(2.3)	5	(3.0)	73	(5.4)	8	(1.3)
Texas[§§]	23,899,975	(7.6)	211	(9.4)	22	(5.0)	15	(4.2)	2	(1.2)			27	(4.5)
Utah	2,854,871	(0.9)	14	(0.6)	2	(0.5)	1	(0.3)	4	(2.4)			0	(0)
Vermont	625,953	(0.2)	5	(0.2)	0	(0)	1	(0.3)	0	(0)			0	(0)
Virginia	8,186,628	(2.6)	58	(2.6)	12	(2.7)	3	(0.8)	2	(1.2)			13	(2.2)
Washington	6,895,318	(2.2)	39	(1.7)	20	(4.6)	8	(2.3)	6	(3.6)			43	(7.1)
West Virginia	1,856,680	(0.6)	36	(1.6)	0	(0)	2	(0.6)	6	(3.6)			0	(0)
Wisconsin	5,724,554	(1.8)	48	(2.1)	6	(1.4)	5	(1.4)	7	(4.2)			2	(0.3)
Wyoming	576,626	(0.2)	7	(0.3)	0	(0)	1	(0.3)	2	(1.2)			0	(0)
Total	**313,873,685**	**(100)**	**2,236**	**(100)**	**438**	**(100)**	**353**	**(100)**	**166**	**(100)**	**1360**	**(100)**	**603**	**(100)**

* 2012 population estimates 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, this report includes susceptibility results only for ser. Typhi and ser. Paratyphi A.

‡ *Campylobacter* isolates are submitted only from FoodNet sites which include Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, and selected counties in California, Colorado, and New York. Of the clinical laboratories in each site that perform on-site testing for *Campylobacter* (range,18 to 94 per site in 2012), the number submitting isolates to the state public health laboratory ranged from one to ninety-four.

§ 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)

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* (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, NARMS, 1996–2012

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

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

[†] Cefepime MICs above the susceptible range, but below the resistant range are now designated by CLSI to be S-DD.

[‡] Amikacin was tested from 1997 to 2010 for *Salmonella*, *Shigella*, and *E. coli* O157

[§] No CLSI breakpoints; resistance breakpoint used in NARMS is ≥64 µg/mL

[¶] Broad-spectrum β-lactam antimicrobial agent only tested for non-typhoidal *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.

[††] Cephalothin was tested from 1996 to 2003 for *Salmonella*, *Shigella*, and *E. coli* O157

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

[§§] CLSI breakpoints are not established for azithromycin. The azithromycin breakpoints used in this report are NARMS-established breakpoints for resistance monitoring and should not be used to predict clinical efficacy.

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 instruction. 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 Muller-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 from 1996 to 2012 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, isolates reported 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 in this report as *Salmonella* ser. I 4,[5],12:i:-.

Testing of *Campylobacter*

Changes in Sampling over Time

Starting in 2005, four changes were made to the *Campylobacter* testing methodology. First, a surveillance scheme for selecting a more representative sample of *Campylobacter* isolates for submission by FoodNet sites was implemented. State public health laboratories within FoodNet sites receive *Campylobacter* isolates from reference and clinical laboratories in their state. Until 2005, FoodNet sites submitted the first isolate received each week. In 2005, they started submitting every isolate (Georgia, Maryland, New Mexico, Oregon, and Tennessee), every other isolate (California, Colorado, Connecticut, and New York), or every fifth isolate received (Minnesota). Starting in 2010, Georgia and Maryland submitted every other isolate, and New Mexico submitted every third. Of the clinical laboratories in each site that perform on-site testing for *Campylobacter* (range,18 to 94 per site in 2012), the number submitting isolates to the state public health laboratory ranged from one to 94.

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). Additionally the *ceuE* PCR was not used in 2010.

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, NARMS, 1997–2012

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

* Etest dilution range used from 1997–2004
† Telithromycin added to NARMS panel in 2005
‡ Chloramphenicol, tested from 1997–2004, replaced by florfenicol in 2005

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 cholerae* are characterized in CDC's National Enteric Reference Laboratory. Isolates of species other than *V. cholerae* are confirmed in the Reference Laboratory and tested for antimicrobial susceptibility by NARMS. Minimum inhibitory concentrations were determined by Etest® (AB bioMerieux, Solna, Sweden) according to manufacturer's instructions for nine antimicrobial agents: ampicillin, cephalothin, chloramphenicol, ciprofloxacin, kanamycin, nalidixic acid, streptomycin, tetracycline, and trimethoprim-sulfamethoxazole (Table 4). CLSI breakpoints specific for *Vibrio* species other than *V. cholerae* were available for ampicillin, ciprofloxacin, tetracycline, and trimethoprim-sulfamethoxazole. Frequency of isolates susceptible, intermediate, and resistant to those agents is shown in this report (Table 55). MIC distributions are shown for all agents tested. 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, NARMS, 2009–2012

CLSI Class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate*	Resistant
Aminoglycosides	Kanamycin	0.016-256	No CLSI or NARMS breakpoints		
	Streptomycin	0.064-1024	No CLSI or NARMS breakpoints		
Cephems	Cephalothin	0.016-256	No CLSI or NARMS breakpoints		
Folate pathway inhibitors	Trimethoprim-sulfamethoxazole	0.002-32	≤2/38	N/A	≥4/76
Penicillins	Ampicillin	0.016-256	≤8	16	≥32
Phenicols	Chloramphenicol	0.016-256	No CLSI or NARMS breakpoints		
Quinolones	Ciprofloxacin	0.002-32	≤1	2	≥4
	Nalidixic acid	0.016-256	No CLSI or NARMS breakpoints		
Tetracyclines	Tetracycline	0.016-256	≤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. Analysis was restricted to the first isolate received per patient in the calendar year (per serotype for *Salmonella*, per species for *Shigella* and *Campylobacter*). 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 15 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 15 agents were considered to have no resistance detected. In the analysis of antimicrobial class resistance among *Campylobacter*, six CLSI classes were represented by azithromycin, ciprofloxacin, chloramphenicol/florfenicol, clindamycin, erythromycin, gentamicin, nalidixic acid, 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 2003–2012 to assess changes in prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* isolates. Since 2003, all 50 states have participated in *Salmonella* and *Shigella* surveillance and all 10 FoodNet sites in *Campylobacter* surveillance. We compared the prevalence of resistance among isolates tested in 2012 with the average prevalence in 2003–2007. Because we defined the prevalence of resistance as the percentage of resistant isolates among all isolates tested, changes in the prevalence of resistance described in this report do not necessarily reflect changes in the incidence of resistant infections. The incidence and relative changes in the incidence of *Salmonella, Shigella,* and *Campylobacter* infections are reported annually from surveillance in FoodNet sites (CDC, 2012). Comparisons were made for the following:

- Non-typhoidal *Salmonella*: resistance to nalidixic acid, ceftriaxone, one or more CLSI classes, three or more CLSI classes

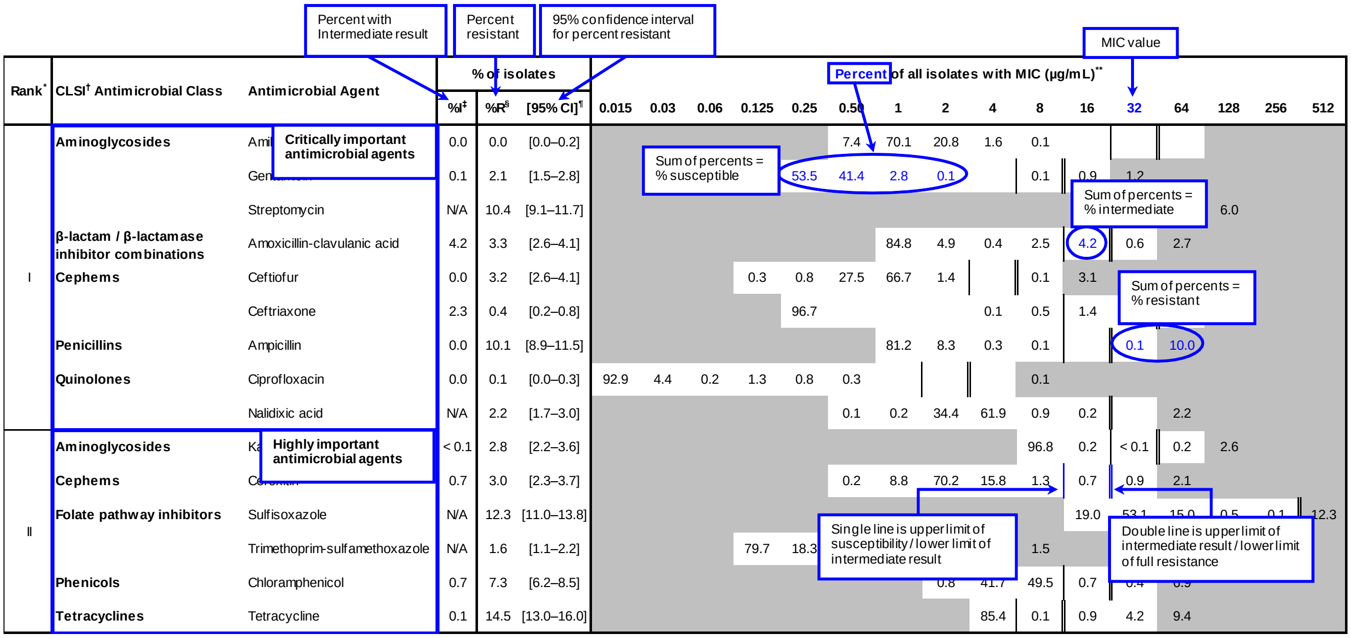
- *Salmonella* of particular serotypes
    - *Salmonella* ser. Enteritidis: resistance to nalidixic acid
    - *Salmonella* ser. Typhimurium: resistance to at least ACSSuT (ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline)
    - *Salmonella* ser. Newport: resistance to at least ACSSuTAuCx (ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone)
    - *Salmonella* ser. Typhi: resistance to nalidixic acid
- *Shigella*: resistance to nalidixic acid
- *Campylobacter* species: resistance to ciprofloxacin
    - *Campylobacter jejuni*: resistance to ciprofloxacin

To account for site-to-site variation in the prevalence of antimicrobial resistance, we included main effects adjustments for site in the analysis. The final regression models for *Salmonella* and *Shigella* adjusted for the submitting site using the nine geographic regions described by the U.S. Census Bureau: East North Central, East South Central, Mid-Atlantic, Mountain, New England, Pacific, South Atlantic, West North Central, and West South Central. For *Campylobacter*, the final regression models adjusted for the submitting FoodNet site. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using unconditional maximum likelihood estimation. The adequacy of model fit was assessed in several ways (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 2012 compared with 2003-2007) that did not include 1.0 as statistically significant.

MIC Distribution Tables and Proportional Figures

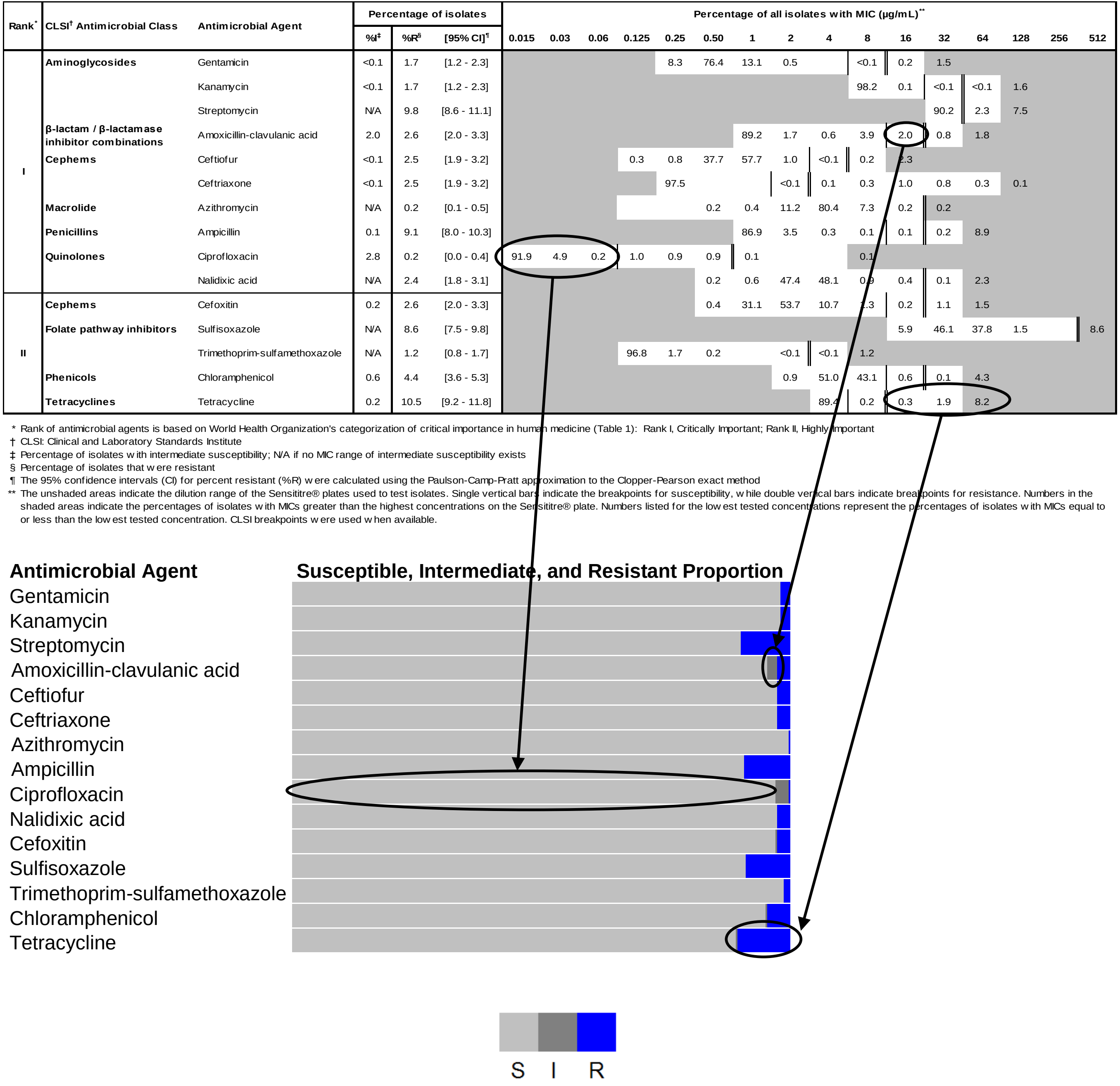
An explanation of “how to read a squashtogram” has been provided to assist the reader with the table (Figure 1). A squashtogram shows the distribution of MICs for antimicrobial agents tested. Proportional figures visually display data from squashtograms for an immediate comparative summary of resistance 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



			% of isolates			Percent of all isolates with MIC (µg/mL)**															
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
I	**Aminoglycosides**	Ami	0.0	0.0	[0.0–0.2]						7.4	70.1	20.8	1.6	0.1						
		Gen	0.1	2.1	[1.5–2.8]					53.5	41.4	2.8	0.1		0.1	0.9	1.2				
		Streptomycin	N/A	10.4	[9.1–11.7]														6.0		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	4.2	3.3	[2.6–4.1]							84.8	4.9	0.4	2.5	4.2	0.6	2.7			
	Cephems	Ceftiofur	0.0	3.2	[2.6–4.1]				0.3	0.8	27.5	66.7	1.4		0.1	3.1					
		Ceftriaxone	2.3	0.4	[0.2–0.8]					96.7				0.1	0.5	1.4					
	Penicillins	Ampicillin	0.0	10.1	[8.9–11.5]							81.2	8.3	0.3	0.1		0.1	10.0			
	Quinolones	Ciprofloxacin	0.0	0.1	[0.0–0.3]	92.9	4.4	0.2	1.3	0.8	0.3				0.1						
		Nalidixic acid	N/A	2.2	[1.7–3.0]						0.1	0.2	34.4	61.9	0.9	0.2		2.2			
II	**Aminoglycosides**	Ka	< 0.1	2.8	[2.2–3.6]										96.8	0.2	< 0.1	0.2	2.6		
	Cephems	Ce	0.7	3.0	[2.3–3.7]						0.2	8.8	70.2	15.8	1.3	0.7	0.9	2.1			
	Folate pathway inhibitors	Sulfisoxazole	N/A	12.3	[11.0–13.8]											19.0	53.1	15.0	0.5	0.1	12.3
		Trimethoprim-sulfamethoxazole	N/A	1.6	[1.1–2.2]				79.7	18.3					1.5						
	Phenicols	Chloramphenicol	0.7	7.3	[6.2–8.5]								0.8	41.7	49.5	0.7	0.4	6.9			
	Tetracyclines	Tetracycline	0.1	14.5	[13.0–16.0]									85.4	0.1	0.9	4.2	9.4			

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. Non-typhoidal *Salmonella*

Table 5. Number of non-typhoidal *Salmonella* isolates of the 20 most common serotypes* tested by NARMS with the number of resistant isolates by class and agent, 2012

			Number of Isolates						Number of Resistant Isolates by CLSI[†] Antimicrobial Class and Agent[‡]														
	Isolates		Number of CLSI[†] Antimicrobial Classes to which Isolates are Resistant						Aminoglycosides			β-lactam/β-lactamase inhibitor combinations	Cephems			Folate pathway inhibitors		Macrolides	Penicillins	Phenicols	Quinolones		Tetracyclines
Serotype*	**N**	**(%)**	**0**	**1**	**2–3**	**4–5**	**6–7**	**8**	**GEN**	**KAN**	**STR**	**AMC**	**FOX**	**TIO**	**AXO**	**FIS**	**COT**	**AZI**	**AMP**	**CHL**	**CIP**	**NAL**	**TET**
Enteritidis	365	(16.3)	**321**	**25**	**13**	**6**	0	0	0	0	**7**	**3**	**3**	**3**	**3**	**10**	**4**	0	**16**	**2**	0	**28**	**13**
Typhimurium	295	(13.2)	**203**	**6**	**25**	**50**	**9**	**2**	**9**	**6**	**70**	**16**	**15**	**16**	**16**	**79**	**5**	0	**69**	**53**	**1**	**5**	**79**
Newport	259	(11.6)	**240**	**1**	**7**	0	**11**	0	0	0	**11**	**16**	**16**	**17**	**17**	**11**	**2**	0	**19**	**11**	0	0	**12**
Javiana	134	(6.0)	**131**	**1**	**2**	0	0	0	0	0	**1**	0	0	0	0	**1**	0	0	**2**	**1**	0	0	**1**
I 4,[5],12:i:-	118	(5.3)	**73**	**8**	**6**	**31**	0	0	**3**	0	**34**	**2**	**1**	**1**	**1**	**34**	0	0	**34**	0	0	**1**	**39**
Infantis	89	(4.0)	**83**	**3**	**2**	0	**1**	0	0	**1**	0	**1**	**1**	**2**	**2**	**2**	**3**	0	**2**	0	0	**3**	**3**
Montevideo	60	(2.7)	**56**	**3**	**1**	0	0	0	**1**	0	**1**	0	0	0	0	**1**	0	0	0	0	0	0	**3**
Muenchen	58	(2.6)	**56**	0	**2**	0	0	0	0	0	**1**	0	0	0	0	**2**	0	0	0	0	0	0	**1**
Oranienburg	51	(2.3)	**50**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0
Saintpaul	50	(2.2)	**42**	**2**	**4**	**1**	**1**	0	**2**	0	**1**	0	0	**1**	**1**	**5**	**4**	0	**3**	**1**	**1**	**1**	**7**
Bareilly	49	(2.2)	**47**	**1**	**1**	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	**1**	0	0	0	**1**
Braenderup	48	(2.1)	**46**	**1**	**1**	0	0	0	0	0	0	0	0	0	0	**1**	**1**	0	**1**	**1**	0	0	**1**
Heidelberg	41	(1.8)	**25**	0	**15**	**1**	0	0	**3**	**4**	**7**	**9**	**9**	**9**	**9**	**1**	0	0	**11**	0	0	0	**6**
Thompson	34	(1.5)	**34**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi	27	(1.2)	**27**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratyphi B var. L(+) tartrate+	27	(1.2)	**27**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schwarzengrund	22	(1.0)	**16**	**4**	**2**	0	0	0	0	0	**2**	**2**	**2**	**2**	**2**	0	0	0	**2**	0	0	**2**	0
Agona	20	(0.9)	**11**	**1**	**5**	**1**	**2**	0	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**7**	0	0	**5**	**2**	0	**1**	**6**
Hadar	18	(0.8)	**1**	**1**	**16**	0	0	0	0	**1**	**16**	0	0	0	0	0	0	0	**2**	0	0	**1**	**16**
Litchfield	17	(0.8)	**14**	**1**	**2**	0	0	0	0	0	**1**	0	0	0	0	0	**1**	0	**1**	0	0	0	**2**
Poona	17	(0.8)	**16**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0
Stanley	16	(0.7)	**11**	0	**5**	0	0	0	**1**	0	**2**	0	0	0	0	**2**	**2**	0	**3**	0	0	0	**5**
Anatum	15	(0.7)	**12**	**1**	**2**	0	0	0	**2**	**2**	**2**	0	0	0	0	**2**	0	0	0	0	0	0	**3**
Sandiego	14	(0.6)	**14**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I 4,[5],12:b:- var. L(+) tartrate+	12	(0.5)	**11**	**1**	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0
Berta	12	(0.5)	**12**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norwich	12	(0.5)	**12**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I 13,23:b:-	11	(0.5)	**11**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubislaw	11	(0.5)	**11**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hartford	10	(0.4)	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mbandaka	10	(0.4)	**7**	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Panama	10	(0.4)	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**1932**	**(86.4)**	**1640**	**65**	**111**	**90**	**24**	**2**	**22**	**15**	**160**	**52**	**50**	**54**	**54**	**159**	**23**	**0**	**171**	**71**	**3**	**44**	**201**
All other serotypes	251	(11.2)	**206**	**11**	**17**	**4**	**10**	**3**	**4**	**9**	**24**	**12**	**10**	**11**	**10**	**26**	**7**	0	**22**	**15**	**5**	**11**	**41**
Partially serotyped	27	(1.2)	**24**	0	0	**2**	**1**	0	0	0	**3**	**1**	**1**	**1**	**1**	**3**	0	0	**3**	**2**	0	0	**3**
Rough/Nonmotile isolates	7	(0.3)	**5**	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	**1**
Unknown serotype	19	(0.8)	**17**	**1**	0	**1**	0	0	0	0	**1**	0	0	0	0	**1**	0	0	**1**	0	0	**1**	**1**
Total	**2236**	**(100)**	**1892**	**79**	**128**	**97**	**35**	**5**	**26**	**24**	**188**	**65**	**61**	**66**	**65**	**189**	**30**	**1**	**197**	**88**	**8**	**56**	**247**

* 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 non-typhoidal *Salmonella* isolates in NARMS with selected resistance patterns, by serotype, 2012

			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	365	0	(0)	0	(0)	0	(0)	**28**	**(50.0)**	**3**	**(4.6)**	0	(0)
2	Typhimurium	295	**50**	**(64.1)**	**2**	**(25.0)**	**11**	**(32.4)**	**5**	**(8.9)**	**16**	**(24.6)**	**2**	**(33.3)**
3	Newport	259	**11**	**(14.1)**	**2**	**(25.0)**	**10**	**(29.4)**	0	(0)	**17**	**(26.2)**	0	(0)
4	Javiana	134	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
5	I 4,[5],12:i:-	118	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	**1**	**(1.5)**	0	(0)
6	Infantis	89	0	(0)	0	(0)	0	(0)	**3**	**(5.4)**	**2**	**(3.1)**	**1**	**(16.7)**
7	Montevideo	60	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
8	Muenchen	58	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
9	Oranienburg	51	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
10	Saintpaul	50	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	**1**	**(1.5)**	0	(0)
11	Bareilly	49	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
12	Braenderup	48	0	(0)	**1**	**(12.5)**	0	(0)	0	(0)	0	(0)	0	(0)
13	Heidelberg	41	0	(0)	0	(0)	0	(0)	0	(0)	**9**	**(13.8)**	0	(0)
14	Thompson	34	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
15	Mississippi	27	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Paratyphi B var. L(+) tartrate+	27	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
17	Schwarzengrund	22	0	(0)	0	(0)	0	(0)	**2**	**(3.6)**	**2**	**(3.1)**	0	(0)
18	Agona	20	**2**	**(2.6)**	0	(0)	**2**	**(5.9)**	**1**	**(1.8)**	**3**	**(4.6)**	0	(0)
19	Hadar	18	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
20	Litchfield	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Poona	17	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
Additional serotypes¶														
	Senftenberg	9	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	Dublin	8	**7**	**(9.0)**	**1**	**(12.5)**	**6**	**(17.6)**	**1**	**(1.8)**	**6**	**(9.2)**	**1**	**(16.7)**
	Reading	8	**1**	**(1.3)**	**1**	**(12.5)**	0	(0)	0	(0)	0	(0)	0	(0)
	Derby	7	**1**	**(1.3)**	0	(0)	**1**	**(2.9)**	0	(0)	**1**	**(1.5)**	0	(0)
	Kentucky	7	**1**	**(1.3)**	0	(0)	0	(0)	**3**	**(5.4)**	0	(0)	0	(0)
	Virchow	5	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	I 6,7:r:-	3	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	Blockley	2	**1**	**(1.3)**	**1**	**(12.5)**	**1**	**(2.9)**	0	(0)	**1**	**(1.5)**	0	(0)
	Albert	1	**1**	**(1.3)**	0	(0)	**1**	**(2.9)**	**1**	**(1.8)**	**1**	**(1.5)**	**1**	**(16.7)**
	Choleraesuis	1	**1**	**(1.3)**	0	(0)	**1**	**(2.9)**	**1**	**(1.8)**	**1**	**(1.5)**	**1**	**(16.7)**
	I 4,[5],12:-:1,2	1	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	IIIa 50:z4,z23:-	1	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
Subtotal		**1852**	**76**	**(97.4)**	**8**	**(100)**	**33**	**(97.1)**	**55**	**(98.2)**	**64**	**(98.5)**	**6**	**(100)**
	All other serotypes	331	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Partially serotyped	27	**2**	**(2.6)**	0	(0)	**1**	**(2.9)**	0	(0)	**1**	**(1.5)**	0	(0)
	Rough/Nonmotile isolates	7	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Unknown serotype	19	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
Total		**2236**	**78**	**(100)**	**8**	**(100)**	**34**	**(100)**	**56**	**(100)**	**65**	**(100)**	**6**	**(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 non-typhoidal *Salmonella* isolates in NARMS with resistance, by number of CLSI* classes and serotype, 2012

			≥ 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	365	11	(5.7)	6	(4.4)	2	(2.2)	0	(0)	0	(0)	0	(0)	0	(0)
2	Typhimurium	295	72	(37.1)	61	(44.5)	54	(60.7)	11	(27.5)	11	(30.6)	2	(40.0)	0	(0)
3	Newport	259	17	(8.8)	11	(8.0)	11	(12.4)	11	(27.5)	10	(27.8)	0	(0)	0	(0)
4	Javiana	134	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
5	I 4,[5],12:i:-	118	33	(17.0)	31	(22.6)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	(0)
6	Infantis	89	3	(1.5)	1	(0.7)	1	(1.1)	1	(2.5)	0	(0)	0	(0)	0	(0)
7	Montevideo	60	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
8	Muenchen	58	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
9	Oranienburg	51	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
10	Saintpaul	50	3	(1.5)	2	(1.5)	1	(1.1)	1	(2.5)	0	(0)	0	(0)	0	(0)
11	Bareilly	49	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
12	Braenderup	48	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
13	Heidelberg	41	11	(5.7)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
14	Thompson	34	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
15	Mississippi	27	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Paratyphi B var. L(+) tartrate+	27	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
17	Schwarzengrund	22	2	(1.0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
18	Agona	20	5	(2.6)	3	(2.2)	2	(2.2)	2	(5.0)	2	(5.6)	0	(0)	0	(0)
19	Hadar	18	2	(1.0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
20	Litchfield	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Poona	17	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Additional serotypes†																
	Stanley	16	2	(1.0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Anatum	15	2	(1.0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Dublin	8	7	(3.6)	7	(5.1)	7	(7.9)	7	(17.5)	7	(19.4)	1	(20.0)	0	(0)
	Reading	8	2	(1.0)	1	(0.7)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	(0)
	Derby	7	4	(2.1)	2	(1.5)	1	(1.1)	1	(2.5)	1	(2.8)	0	(0)	0	(0)
	Kentucky	7	2	(1.0)	2	(1.5)	2	(2.2)	2	(5.0)	1	(2.8)	0	(0)	0	(0)
	Brandenburg	5	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Johannesburg	5	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Ohio	5	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Virchow	5	1	(0.5)	1	(0.7)	1	(1.1)	0	(0)	0	(0)	0	(0)	0	(0)
	Uganda	4	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	I 6,7:r:-	3	1	(0.5)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Blockley	2	1	(0.5)	1	(0.7)	1	(1.1)	1	(2.5)	1	(2.8)	0	(0)	0	(0)
	Albert	1	1	(0.5)	1	(0.7)	1	(1.1)	1	(2.5)	1	(2.8)	1	(20.0)	0	(0)
	Choleraesuis	1	1	(0.5)	1	(0.7)	1	(1.1)	1	(2.5)	1	(2.8)	1	(20.0)	0	(0)
	I 4,[5],12:-:1,2	1	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Subtotal		**1892**	**190**	**(97.9)**	**133**	**(97.1)**	**87**	**(97.8)**	**39**	**(97.5)**	**35**	**(97.2)**	**5**	**(100)**	**0**	**(0)**
	All other serotypes	291	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Partially serotyped	7	3	(1.5)	3	(2.2)	2	(2.2)	1	(2.5)	1	(2.8)	0	(0)	0	(0)
	Rough/Nonmotile isolates	19	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Unknown serotype	27	1	(0.5)	1	(0.7)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total		**2236**	**194**	**(100)**	**137**	**(100)**	**89**	**(100)**	**40**	**(100)**	**36**	**(100)**	**5**	**(100)**	**0**	**(100)**

* 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 non-typhoidal *Salmonella* isolates to antimicrobial agents, 2012 (N=2236)

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	1.2	[0.8 - 1.7]					16.2	72.5	9.2	0.7	0.1	<0.1	0.3	0.9				
		Kanamycin	0.0	1.1	[0.7 - 1.6]										98.9			<0.1	1.0		
		Streptomycin	N/A	8.4	[7.3 - 9.6]												91.6	2.7	5.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	2.6	2.9	[2.3 - 3.7]							89.3	1.7	0.9	2.6	2.6	0.2	2.7			
	Cephems	Ceftiofur	0.1	3.0	[2.3 - 3.7]				0.3	0.6	23.7	70.7	1.7	0.1	0.2	2.8					
		Ceftriaxone	<0.1	2.9	[2.3 - 3.7]					97.0	<0.1		<0.1	<0.1	0.2	1.0	1.2	0.3	0.1		
	Macrolide	Azithromycin	N/A	<0.1	[0.0 - 0.2]						0.1	0.3	9.3	83.2	6.8	0.3	<0.1				
	Penicillins	Ampicillin	0.1	8.8	[7.7 - 10.1]							86.4	4.2	0.4	<0.1	0.1		8.8			
	Quinolones	Ciprofloxacin	3.3	0.4	[0.2 - 0.7]	89.6	6.5	0.3	1.1	1.3	1.0	0.2			0.1						
		Nalidixic acid	N/A	2.5	[1.9 - 3.2]						0.1	0.6	40.2	54.4	1.3	0.8	0.2	2.3			
II	**Cephems**	Cefoxitin	0.2	2.7	[2.1 - 3.5]						0.1	17.7	62.4	15.1	1.7	0.2	0.9	1.8			
	Folate pathway inhibitors	Sulfisoxazole	N/A	8.5	[7.3 - 9.7]											8.8	50.4	31.6	0.7	0.1	8.5
		Trimethoprim-sulfamethoxazole	N/A	1.3	[0.9 - 1.9]				97.1	1.4	<0.1		<0.1	0.2	1.2						
	Phenicols	Chloramphenicol	0.6	3.9	[3.2 - 4.8]								1.1	47.0	47.4	0.6	0.1	3.8			
	Tetracyclines	Tetracycline	0.2	11.0	[9.8 - 12.4]									88.7	0.2	0.5	2.2	8.4			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 3. Antimicrobial resistance pattern for non-typhoidal *Salmonella*, 2012

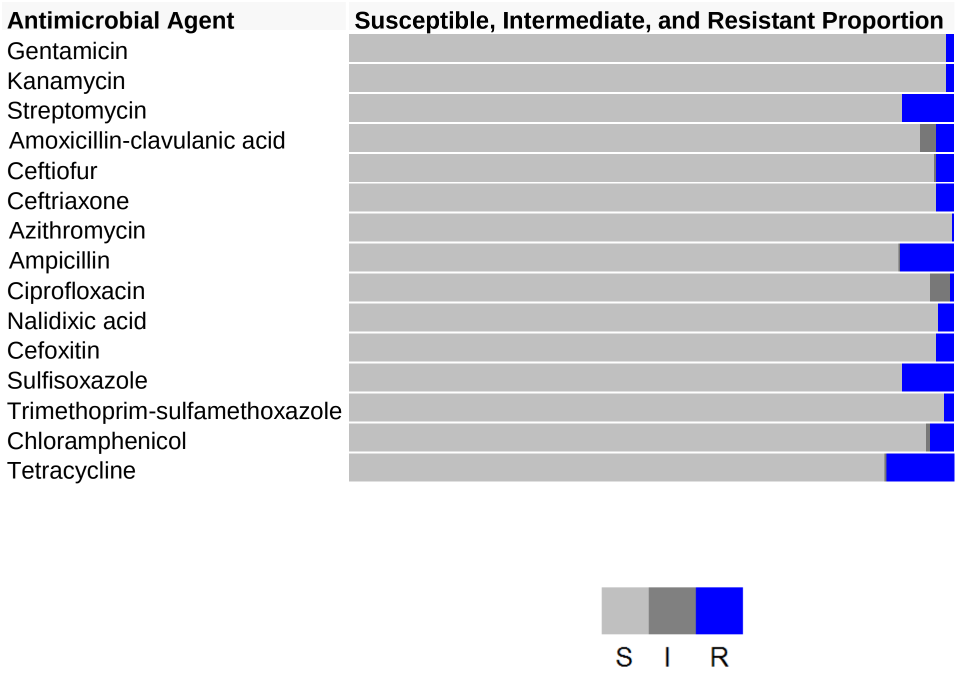


Table 9. Percentage and number of non-typhoidal *Salmonella* isolates resistant to antimicrobial agents, 2003–2012

Year Total Isolates			2003 1855	2004 1782	2005 2036	2006 2171	2007 2145	2008 2384	2009 2193	2010 2449	2011 2338	2012 2236
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	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
		Gentamicin (MIC ≥ 16)	1.4% 26	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
		Kanamycin (MIC ≥ 64)	3.5% 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
		Streptomycin (MIC ≥ 64)	15.0% 279	12.0% 213	11.1% 225	10.7% 233	10.3% 222	10.0% 238	8.9% 196	8.6% 210	9.8% 230	8.4% 188
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	4.6% 86	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
	Cephems	Ceftiofur (MIC ≥ 8)	4.5% 83	3.4% 60	2.9% 60	3.6% 79	3.3% 70	3.1% 73	3.4% 75	2.8% 69	2.5% 58	3.0% 66
		Ceftriaxone (MIC ≥ 4)	4.4% 81	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% 65
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.2% 5	< 0.1% 1
	Penicillins	Ampicillin (MIC ≥ 32)	13.6% 253	12.1% 216	11.4% 232	10.9% 237	10.1% 217	9.7% 232	9.8% 216	9.1% 223	9.1% 213	8.8% 197
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.2% 4	0.3% 5	0.1% 2	0.1% 3	0.1% 2	0.2% 5	0.3% 7	0.2% 6	0.2% 4	0.4% 8
		Nalidixic Acid (MIC ≥ 32)	1.9% 36	2.2% 39	1.9% 38	2.4% 52	2.2% 48	2.1% 49	1.8% 39	2.0% 48	2.2% 51	2.5% 56
II	Cephems	Cefoxitin (MIC ≥ 32)	4.3% 79	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
		Cephalothin (MIC ≥ 32)	5.3% 99	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	15.1% 280	13.3% 237	12.6% 256	12.1% 263	12.3% 264	10.1% 240	9.9% 217	9.0% 221	8.6% 202	8.5% 189
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.9% 36	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% 30
	Phenicols	Chloramphenicol (MIC ≥ 32)	10.1% 187	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% 88
	Tetracyclines	Tetracycline (MIC ≥ 16)	16.3% 302	13.6% 242	13.9% 282	13.5% 293	14.5% 310	11.5% 275	11.9% 261	11.0% 270	10.5% 245	11.0% 247

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 10. Resistance patterns of non-typhoidal *Salmonella* isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**1855**	**1782**	**2036**	**2171**	**2145**	**2384**	**2193**	**2449**	**2338**	**2236**
Resistance Pattern										
No resistance detected	78.0% 1447	79.9% 1424	80.9% 1648	80.5% 1748	81.1% 1739	83.9% 2000	83.2% 1824	84.6% 2073	84.8% 1983	84.6% 1892
Resistance ≥ 1 CLSI class*	22.0% 408	20.1% 358	19.1% 388	19.5% 423	18.9% 406	16.1% 384	16.8% 369	15.4% 376	15.2% 355	15.4% 344
Resistance ≥ 2 CLSI classes*	17.6% 326	15.0% 267	14.8% 302	14.7% 320	14.2% 305	12.5% 298	13.0% 284	11.3% 276	11.1% 260	11.9% 265
Resistance ≥ 3 CLSI classes*	14.2% 263	11.4% 204	12.0% 244	11.8% 256	11.1% 239	9.6% 228	9.6% 211	9.2% 225	9.1% 213	8.7% 194
Resistance ≥ 4 CLSI classes*	11.4% 211	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
Resistance ≥ 5 CLSI classes*	9.8% 182	8.0% 142	7.2% 146	6.3% 137	6.9% 149	6.6% 157	6.2% 137	5.2% 128	4.6% 108	4.0% 89
At least ACSSuT†	9.3% 173	7.2% 129	6.9% 141	5.6% 121	6.3% 136	5.8% 138	5.1% 112	4.4% 107	3.9% 91	3.5% 78
At least ASSuT‡ and not resistant to chloramphenicol	0.9% 17	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
At least ACT/S§	1.2% 23	0.6% 10	0.9% 18	0.7% 15	0.7% 16	0.5% 11	0.7% 15	0.4% 11	0.4% 9	0.4% 8
At least ACSSuTAuCx¶	3.2% 60	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
At least AAuCx**	4.4% 81	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
At least ceftriaxone and nalidixic acid resistant	0.1% 1	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.1% 2	0.0% 0
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	< 0.1% 1	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 non-typhoidal *Salmonella* isolates, 2011–2012

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 (66)	9.1	6.1	[1.7 - 14.8]								6.1	12.1	54.5	12.1	7.6	1.5	3.0	3.0	
	Cephems	Cefepime[§]	2011 (58)	(1.7[§])	1.7	[0.0 - 9.2]				3.4	32.8	41.4	13.8	5.2		1.7[§]			1.7			
			2012 (66)	(6.1[§])	0.0	[0.0 - 5.4]				1.5	13.6	54.5	16.7	7.6	3.0	3.0						
		Cefotaxime	2011 (58)	0.0	100	[93.8 - 100]									1.7	10.3	37.9	34.5	10.3	3.4	1.7	
			2012 (66)	0.0	100	[94.6 - 100]									4.5	4.5	48.5	34.8	4.5	1.5	1.5	
		Ceftazidime	2011 (58)	3.4	96.6	[88.1 - 99.6]										3.4	22.4	53.4	12.1	6.9	1.7	
			2012 (66)	4.5	87.9	[77.5 - 94.6]							1.5		6.1	4.5	39.4	36.4	9.1	3.0		
	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 (66)	54.5	27.3	[17.0 - 39.6]					1.5	1.5		1.5	13.6	54.5	18.2	7.6	1.5			
	Penems	Imipenem	2011 (58)	0.0	1.7	[0.0 - 9.2]				1.7	77.6	19.0			1.7							
			2012 (66)	0.0	0.0	[0.0 - 5.4]				3.0	56.1	40.9										

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, Table 1): 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, 2012 (N=365)

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]					45.2	51.8	2.5	0.5								
		Kanamycin	0.0	0.0	[0.0 - 1.0]										100.0						
		Streptomycin	N/A	1.9	[0.8 - 3.9]												98.1	0.3	1.6		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.3	0.8	[0.2 - 2.4]							92.6	2.7	0.3	3.3	0.3		0.8			
	Cephems	Ceftiofur	0.3	0.8	[0.2 - 2.4]				0.5	1.4	4.7	88.8	3.6	0.3		0.8					
		Ceftriaxone	0.0	0.8	[0.2 - 2.4]					99.2						0.3	0.5				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.0]						0.3	0.5	9.9	84.1	4.9	0.3					
	Penicillins	Ampicillin	0.0	4.4	[2.5 - 7.0]							80.0	14.0	1.4	0.3			4.4			
	Quinolones	Ciprofloxacin	7.9	0.0	[0.0 - 1.0]	61.6	30.1	0.3	4.7	3.0	0.3										
		Nalidixic acid	N/A	7.7	[5.2 - 10.9]						0.3	1.4	14.5	74.0	1.9	0.3	0.3	7.4			
II	**Cephems**	Cefoxitin	0.5	0.8	[0.2 - 2.4]							11.5	70.7	15.1	1.4	0.5	0.3	0.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	2.7	[1.3 - 5.0]											7.1	52.9	37.0	0.3		2.7
		Trimethoprim-sulfamethoxazole	N/A	1.1	[0.3 - 2.8]				97.5	1.4					1.1						
	Phenicols	Chloramphenicol	0.0	0.5	[0.1 - 2.0]								1.1	52.6	45.8		0.3	0.3			
	Tetracyclines	Tetracycline	0.5	3.6	[1.9 - 6.0]									95.9	0.5		0.5	3.0			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 4. Antimicrobial resistance pattern for *Salmonella ser.* Enteritidis, 2012

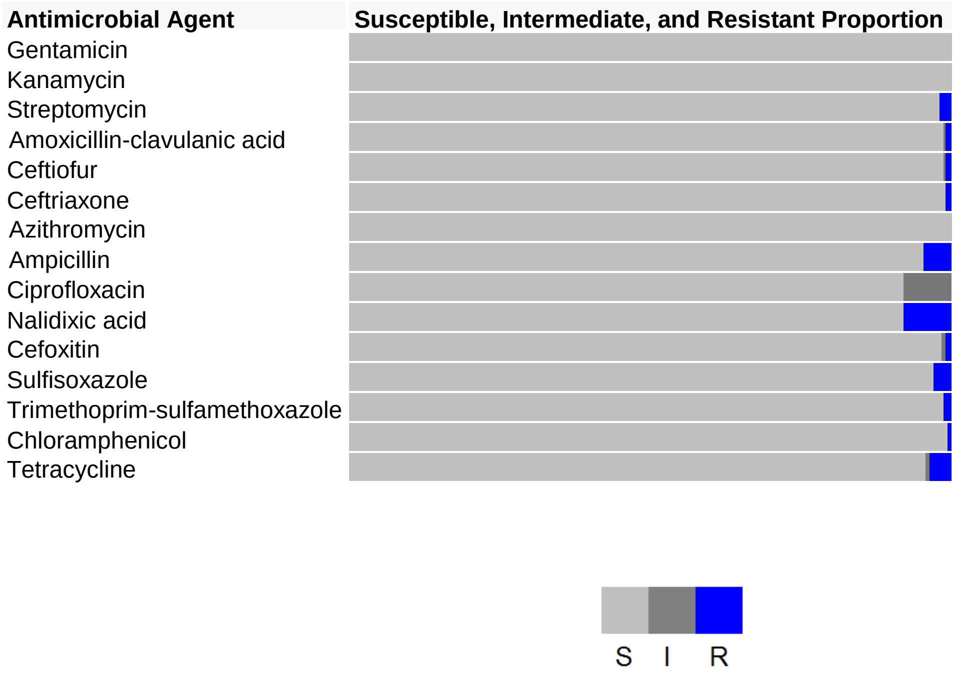


Table 13. Percentage and number of *Salmonella ser.* Enteritidis isolates resistant to antimicrobial agents, 2003–2012

Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates			**257**	**271**	**384**	**412**	**385**	**442**	**410**	**513**	**391**	**365**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.4% 1	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
		Kanamycin (MIC ≥ 64)	0.0% 0	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
		Streptomycin (MIC ≥ 64)	1.2% 3	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.8% 3	0.5% 2	0.5% 2	0.0% 0	0.0% 0	0.4% 2	0.3% 1	0.8% 3
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	0.0% 0	0.5% 2	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.8% 3
		Ceftriaxone (MIC ≥ 4)	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.2% 1	0.0% 0	0.0% 0	0.3% 1	0.8% 3
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	2.3% 6	4.1% 11	2.9% 11	4.1% 17	2.1% 8	4.1% 18	3.9% 16	2.3% 12	5.1% 20	4.4% 16
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	4.7% 12	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	0.0% 0	1.0% 4	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.8% 3
		Cephalothin (MIC ≥ 32)	1.2% 3	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	1.2% 3	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.8% 2	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.4% 1	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	1.6% 4	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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 14. Resistance patterns of *Salmonella* ser. Enteritidis isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**257**	**271**	**384**	**412**	**385**	**442**	**410**	**513**	**391**	**365**
Resistance Pattern										
No resistance detected	91.8% 236	86.7% 235	91.4% 351	88.8% 366	90.4% 348	87.3% 386	92.0% 377	92.0% 472	88.0% 344	87.9% 321
Resistance ≥ 1 CLSI class*	8.2% 21	13.3% 36	8.6% 33	11.2% 46	9.6% 37	12.7% 56	8.0% 33	8.0% 41	12.0% 47	12.1% 44
Resistance ≥ 2 CLSI classes*	2.3% 6	3.0% 8	3.6% 14	2.9% 12	3.4% 13	2.3% 10	2.4% 10	2.9% 15	2.6% 10	5.2% 19
Resistance ≥ 3 CLSI classes*	0.4% 1	1.1% 3	1.6% 6	1.7% 7	1.0% 4	0.7% 3	1.0% 4	2.1% 11	2.3% 9	3.0% 11
Resistance ≥ 4 CLSI classes*	0.4% 1	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
Resistance ≥ 5 CLSI classes*	0.4% 1	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
At least ACSSuT[†]	0.4% 1	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
At least ASSuT[‡] and not resistant to chloramphenicol	0.0% 0	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
At least ACT/S[§]	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx[¶]	0.0% 0	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
At least AAuCx**	0.0% 0	0.0% 0	0.3% 1	0.5% 2	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.8% 3
At least ceftriaxone and nalidixic acid resistant	0.0% 0	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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	Not Tested	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, 2012 (N=295)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	3.1	[1.4 - 5.7]					7.8	76.6	11.2	1.0	0.3		0.7	2.4				
		Kanamycin	0.0	2.0	[0.7 - 4.4]										98.0				2.0		
		Streptomycin	N/A	23.7	[19.0 - 29.0]												76.3	7.5	16.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	15.3	5.4	[3.1 - 8.7]							74.6	2.0	0.3	2.4	15.3	0.3	5.1			
	Cephems	Ceftiofur	0.0	5.4	[3.1 - 8.7]					0.3	16.6	75.3	2.4		0.7	4.7					
		Ceftriaxone	0.0	5.4	[3.1 - 8.7]					94.2	0.3				1.7	2.4	1.4				
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.2]								5.1	92.5	2.4						
	Penicillins	Ampicillin	0.0	23.4	[18.7 - 28.6]							72.2	4.1	0.3				23.4			
	Quinolones	Ciprofloxacin	1.4	0.3	[0.0 - 1.9]	96.9	1.4		0.3	0.7	0.3	0.3									
		Nalidixic acid	N/A	1.7	[0.5 - 3.9]							0.7	42.7	54.2	0.7		0.3	1.4			
II	**Cephems**	Cefoxitin	0.3	5.1	[2.9 - 8.2]						0.3	14.9	70.2	6.8	2.4	0.3	2.7	2.4			
	Folate pathway inhibitors	Sulfisoxazole	N/A	26.8	[21.8 - 32.2]											5.4	59.0	8.1	0.3	0.3	26.8
		Trimethoprim-sulfamethoxazole	N/A	1.7	[0.5 - 3.9]				94.2	4.1				0.3	1.4						
	Phenicols	Chloramphenicol	0.7	18.0	[13.8 - 22.8]								0.3	44.4	36.6	0.7	0.3	17.6			
	Tetracyclines	Tetracycline	0.0	26.8	[21.8 - 32.2]									73.2		3.4	11.5	11.9			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 5. Antimicrobial resistance pattern for *Salmonella* ser. Typhimurium, 2012

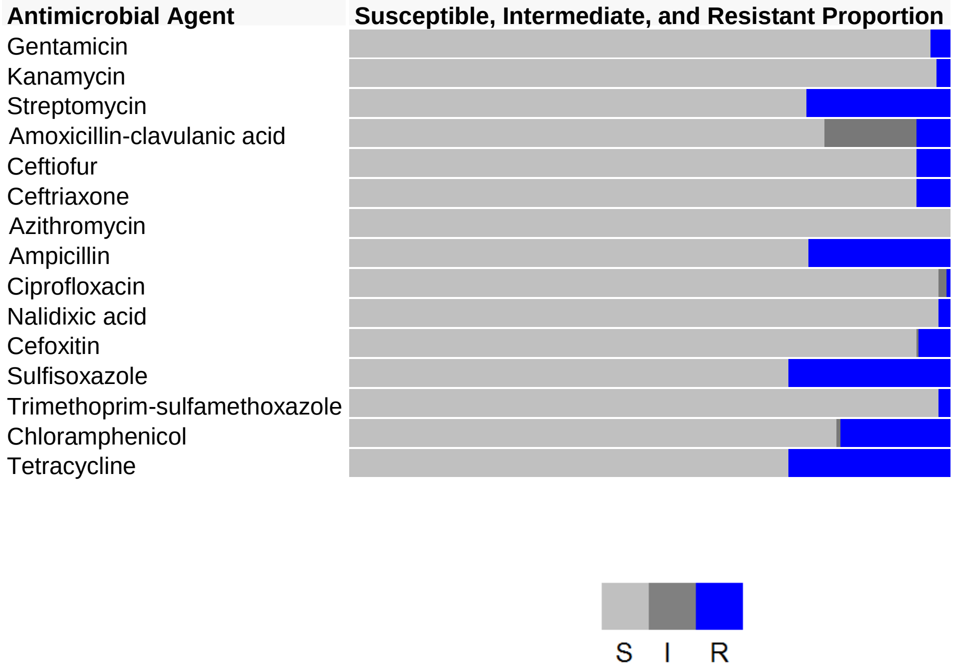


Table 16. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2003–2012

Year Total Isolates			2003 408	2004 382	2005 438	2006 408	2007 405	2008 396	2009 370	2010 359	2011 323	2012 295
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	2.0% 8	2.1% 8	1.8% 8	2.7% 11	2.5% 10	1.5% 6	1.9% 7	0.8% 3	2.2% 7	3.1% 9
		Kanamycin (MIC ≥ 64)	7.1% 29	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
		Streptomycin (MIC ≥ 64)	35.5% 145	31.9% 122	28.1% 123	29.4% 120	32.3% 131	28.5% 113	25.9% 96	25.6% 92	25.7% 83	23.7% 70
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	5.6% 23	4.7% 18	3.2% 14	4.4% 18	6.7% 27	3.5% 14	6.2% 23	4.2% 15	6.8% 22	5.4% 16
	Cephems	Ceftiofur (MIC ≥ 8)	4.9% 20	4.5% 17	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.4% 16
		Ceftriaxone (MIC ≥ 4)	4.9% 20	4.5% 17	2.5% 11	4.2% 17	6.4% 26	3.5% 14	6.5% 24	4.7% 17	6.8% 22	5.4% 16
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	36.3% 148	32.2% 123	29.0% 127	28.2% 115	31.6% 128	26.3% 104	28.1% 104	26.2% 94	25.7% 83	23.4% 69
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.2% 5	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
II	Cephems	Cefoxitin (MIC ≥ 32)	4.4% 18	4.7% 18	2.5% 11	3.9% 16	5.7% 23	3.5% 14	5.4% 20	3.3% 12	6.8% 22	5.1% 15
		Cephalothin (MIC ≥ 32)	6.1% 25	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	38.7% 158	36.1% 138	32.0% 140	33.3% 136	37.3% 151	30.3% 120	30.0% 111	28.7% 103	27.2% 88	26.8% 79
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	3.4% 14	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	28.2% 115	24.3% 93	24.4% 107	22.1% 90	25.4% 103	23.5% 93	20.5% 76	20.3% 73	19.5% 63	18.0% 53
	Tetracyclines	Tetracycline (MIC ≥ 16)	38.0% 155	30.4% 116	30.4% 133	31.6% 129	36.8% 149	27.8% 110	28.9% 107	29.0% 104	27.2% 88	26.8% 79

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

[†] CLSI: Clinical and Laboratory Standards Institute

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

Table 17. Resistance patterns of *Salmonella* ser. Typhimurium isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**408**	**382**	**438**	**408**	**405**	**396**	**370**	**359**	**323**	**295**
Resistance Pattern										
No resistance detected	54.7% 223	60.5% 231	65.1% 285	62.5% 255	57.5% 233	67.9% 269	63.5% 235	66.9% 240	69.0% 223	68.8% 203
Resistance ≥ 1 CLSI class*	45.3% 185	39.5% 151	34.9% 153	37.5% 153	42.5% 172	32.1% 127	36.5% 135	33.1% 119	31.0% 100	31.2% 92
Resistance ≥ 2 CLSI classes*	41.4% 169	37.2% 142	33.3% 146	34.1% 139	39.3% 159	31.3% 124	33.2% 123	30.4% 109	28.8% 93	29.2% 86
Resistance ≥ 3 CLSI classes*	37.3% 152	31.7% 121	30.1% 132	30.4% 124	34.3% 139	27.8% 110	28.1% 104	27.3% 98	26.3% 85	24.4% 72
Resistance ≥ 4 CLSI classes*	32.4% 132	27.7% 106	27.4% 120	27.0% 110	29.9% 121	24.7% 98	24.1% 89	24.2% 87	21.7% 70	20.7% 61
Resistance ≥ 5 CLSI classes*	27.7% 113	24.3% 93	22.8% 100	20.8% 85	24.9% 101	24.0% 95	22.2% 82	20.9% 75	20.7% 67	18.3% 54
At least ACSSuT[†]	26.5% 108	23.6% 90	22.4% 98	19.6% 80	22.7% 92	23.2% 92	19.5% 72	18.7% 67	19.5% 63	16.9% 50
At least ASSuT[‡] and not resistant to chloramphenicol	2.7% 11	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
At least ACT/S[§]	3.2% 13	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
At least ACSSuTAuCx[¶]	2.2% 9	2.6% 10	1.8% 8	2.9% 12	3.7% 15	2.3% 9	1.6% 6	1.7% 6	5.3% 17	3.7% 11
At least AAuCx**	4.9% 20	4.5% 17	2.5% 11	4.2% 17	6.2% 25	3.5% 14	6.2% 23	3.6% 13	6.8% 22	5.4% 16
At least ceftriaxone and nalidixic acid resistant	0.0% 0	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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	Not Tested	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, 2012 (N=259)

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 - 1.4]					8.5	84.9	6.2	0.4								
		Kanamycin	0.0	0.0	[0.0 - 1.4]										100.0						
		Streptomycin	N/A	4.2	[2.1 - 7.5]												95.8		4.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.8	6.2	[3.6 - 9.8]							91.5	0.8	0.4	0.4	0.8		6.2			
	Cephems	Ceftiofur	0.0	6.6	[3.9 - 10.3]						19.3	74.1				6.6					
		Ceftriaxone	0.0	6.6	[3.9 - 10.3]					93.4						2.3	2.7	1.2	0.4		
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.4]							0.8	17.4	77.6	4.2						
	Penicillins	Ampicillin	0.4	7.3	[4.5 - 11.2]							91.1	1.2			0.4		7.3			
	Quinolones	Ciprofloxacin	3.1	0.0	[0.0 - 1.4]	96.1	0.8				3.1										
		Nalidixic acid	N/A	0.0	[0.0 - 1.4]							0.4	39.0	56.8	0.8	3.1					
II	Cephems	Cefoxitin	0.0	6.2	[3.6 - 9.8]							18.9	70.3	3.5	1.2		1.9	4.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.2	[2.1 - 7.5]											4.2	35.5	55.6	0.4		4.2
		Trimethoprim-sulfamethoxazole	N/A	0.8	[0.1 - 2.8]				98.8	0.4					0.8						
	Phenicols	Chloramphenicol	0.0	4.2	[2.1 - 7.5]								0.8	72.6	22.4			4.2			
	Tetracyclines	Tetracycline	0.4	4.6	[2.4 - 8.0]									95.0	0.4		0.4	4.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 6. Antimicrobial resistance pattern for *Salmonella* ser. Newport, 2012

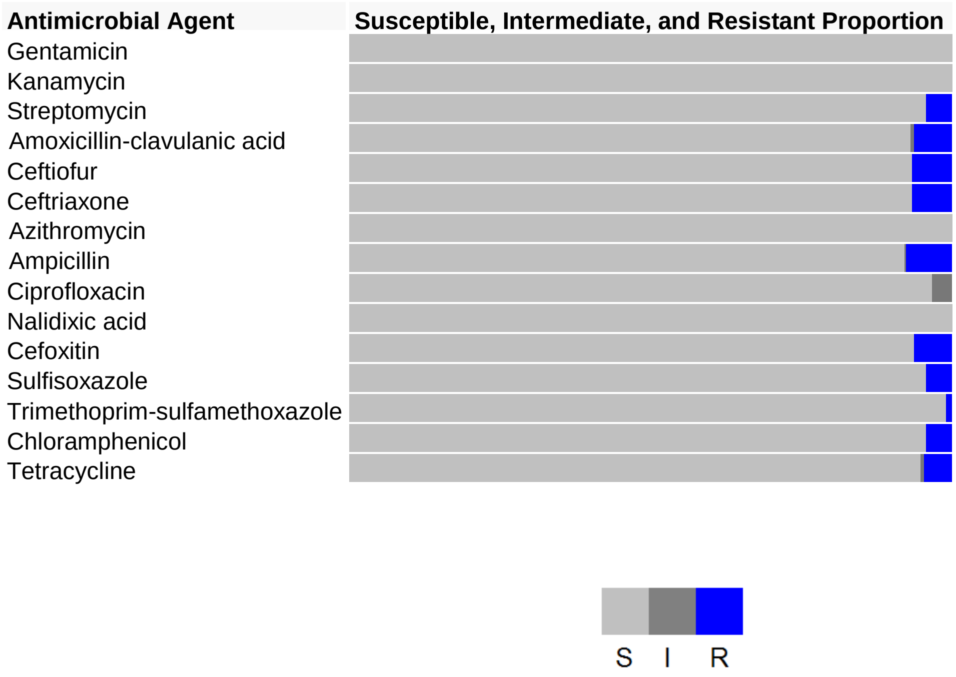


Table 19. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2003–2012

Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates			**226**	**191**	**207**	**218**	**222**	**258**	**239**	**305**	**285**	**259**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	3.1% 7	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
		Kanamycin (MIC ≥ 64)	4.4% 10	2.6% 5	1.9% 4	2.3% 5	0.9% 2	3.5% 9	1.7% 4	0.7% 2	0.4% 1	0.0% 0
		Streptomycin (MIC ≥ 64)	24.3% 55	15.7% 30	14.0% 29	13.8% 30	10.4% 23	13.6% 35	8.4% 20	8.2% 25	4.2% 12	4.2% 11
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	21.7% 49	15.2% 29	12.6% 26	12.4% 27	8.1% 18	12.4% 32	7.5% 18	7.5% 23	3.9% 11	6.2% 16
	Cephems	Ceftiofur (MIC ≥ 8)	22.1% 50	15.2% 29	12.6% 26	12.4% 27	8.1% 18	12.4% 32	7.1% 17	7.2% 22	3.9% 11	6.6% 17
		Ceftriaxone (MIC ≥ 4)	21.7% 49	14.7% 28	12.6% 26	12.8% 28	8.1% 18	12.4% 32	7.1% 17	7.2% 22	3.9% 11	6.6% 17
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	23.0% 52	15.7% 30	14.0% 29	15.1% 33	9.9% 22	14.3% 37	8.4% 20	7.5% 23	3.9% 11	7.3% 19
	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)	0.4% 1	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
II	Cephems	Cefoxitin (MIC ≥ 32)	21.7% 49	15.2% 29	12.6% 26	12.8% 28	8.1% 18	12.4% 32	6.7% 16	7.2% 22	3.9% 11	6.2% 16
		Cephalothin (MIC ≥ 32)	22.6% 51	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	24.8% 56	16.8% 32	15.5% 32	15.1% 33	10.4% 23	13.2% 34	8.8% 21	7.5% 23	4.6% 13	4.2% 11
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.3% 3	2.1% 4	1.9% 4	3.2% 7	1.8% 4	3.1% 8	1.3% 3	1.3% 4	0.0% 0	0.8% 2
	Phenicols	Chloramphenicol (MIC ≥ 32)	22.6% 51	15.2% 29	13.5% 28	12.4% 27	9.5% 21	12.0% 31	7.5% 18	7.2% 22	3.5% 10	4.2% 11
	Tetracyclines	Tetracycline (MIC ≥ 16)	24.3% 55	16.8% 32	14.5% 30	14.2% 31	9.9% 22	14.0% 36	8.8% 21	8.2% 25	4.6% 13	4.6% 12

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

[†] CLSI: Clinical and Laboratory Standards Institute

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

Table 20. Resistance patterns of *Salmonella* ser. Newport isolates, 2003–2012

Year **Total Isolates**	**2003** **226**	**2004** **191**	**2005** **207**	**2006** **218**	**2007** **222**	**2008** **258**	**2009** **239**	**2010** **305**	**2011** **285**	**2012** **259**
Resistance Pattern										
No resistance detected	73.5% 166	82.2% 157	84.1% 174	82.6% 180	89.2% 198	85.3% 220	89.1% 213	90.8% 277	94.4% 269	92.7% 240
Resistance ≥ 1 CLSI class*	26.5% 60	17.8% 34	15.9% 33	17.4% 38	10.8% 24	14.7% 38	10.9% 26	9.2% 28	5.6% 16	7.3% 19
Resistance ≥ 2 CLSI classes*	25.2% 57	17.3% 33	15.0% 31	16.5% 36	10.8% 24	13.6% 35	9.2% 22	7.9% 24	4.6% 13	6.9% 18
Resistance ≥ 3 CLSI classes*	23.5% 53	16.2% 31	14.5% 30	15.1% 33	10.8% 24	13.6% 35	8.4% 20	7.5% 23	3.9% 11	6.6% 17
Resistance ≥ 4 CLSI classes*	23.0% 52	15.7% 30	14.0% 29	13.3% 29	9.5% 21	13.6% 35	7.5% 18	7.5% 23	3.9% 11	4.2% 11
Resistance ≥ 5 CLSI classes*	22.6% 51	14.7% 28	12.6% 26	12.8% 28	8.6% 19	12.8% 33	7.1% 17	7.2% 22	3.5% 10	4.2% 11
At least ACSSuT[†]	22.1% 50	14.7% 28	12.6% 26	11.9% 26	8.6% 19	11.6% 30	7.1% 17	7.2% 22	3.5% 10	4.2% 11
At least ASSuT[‡] and not resistant to chloramphenicol	0.4% 1	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
At least ACT/S[§]	1.3% 3	1.0% 2	1.9% 4	2.3% 5	0.5% 1	2.7% 7	1.3% 3	1.3% 4	0.0% 0	0.8% 2
At least ACSSuTAuCx[¶]	21.2% 48	14.7% 28	12.6% 26	10.6% 23	8.1% 18	11.6% 30	7.1% 17	7.2% 22	3.5% 10	3.9% 10
At least AAuCx**	21.7% 49	14.7% 28	12.6% 26	11.9% 26	8.1% 18	12.4% 32	7.1% 17	7.2% 22	3.9% 11	6.2% 16
At least ceftriaxone and nalidixic acid resistant	0.0% 0	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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	Not Tested	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. Heidelberg

Table 21. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Heidelberg isolates to antimicrobial agents, 2012 (N=41)

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	7.3	[1.5 - 19.9]					4.9	70.7	17.1					7.3				
		Kanamycin	0.0	9.8	[2.7 - 23.1]										90.2				9.8		
		Streptomycin	N/A	17.1	[7.1 - 32.1]												82.9	12.2	4.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	22.0	[10.5 - 37.6]							70.7	2.4		4.9			22.0			
	Cephems	Ceftiofur	0.0	22.0	[10.5 - 37.6]						29.3	46.3	2.4			22.0					
		Ceftriaxone	0.0	22.0	[10.5 - 37.6]					78.0						14.6	4.9	2.4			
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 8.6]								2.4	97.6							
	Penicillins	Ampicillin	0.0	26.8	[14.2 - 42.9]							70.7	2.4					26.8			
	Quinolones	Ciprofloxacin	2.4	0.0	[0.0 - 8.6]	95.1	2.4				2.4										
		Nalidixic acid	N/A	0.0	[0.0 - 8.6]								12.2	85.4		2.4					
II	**Cephems**	Cefoxitin	0.0	22.0	[10.5 - 37.6]							39.0	36.6		2.4		9.8	12.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	2.4	[0.0 - 12.8]											17.1	63.4	17.1			2.4
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 8.6]				100.0												
	Phenicols	Chloramphenicol	0.0	0.0	[0.0 - 8.6]								2.4	24.4	73.2						
	Tetracyclines	Tetracycline	0.0	14.6	[5.5 - 29.2]									85.4			2.4	12.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 7. Antimicrobial resistance pattern for *Salmonella* ser. Heidelberg, 2012

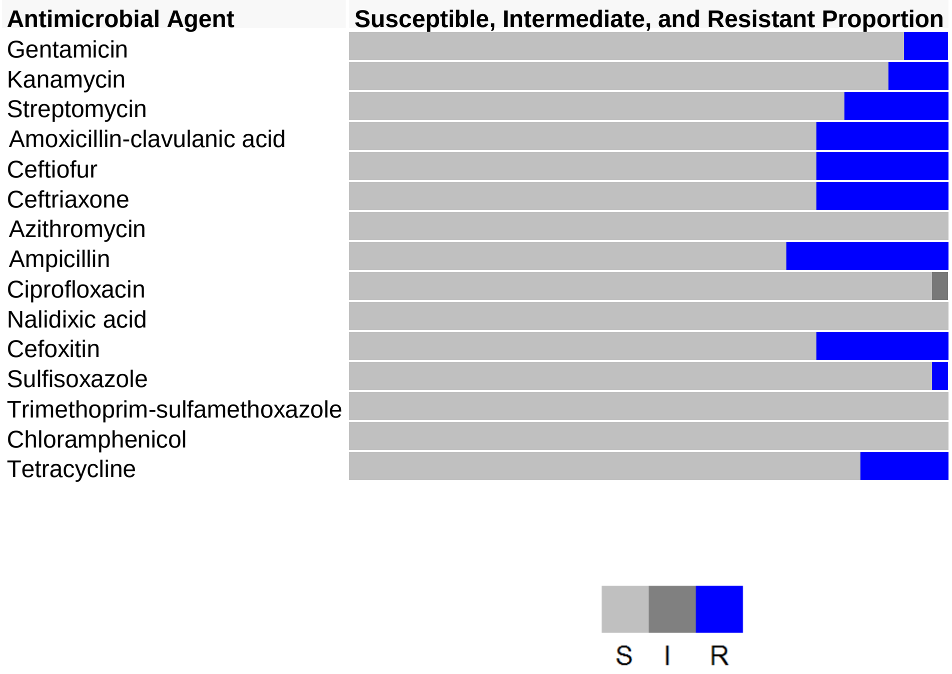


Table 22. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2003–2012

Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates			**96**	**92**	**125**	**102**	**98**	**75**	**86**	**62**	**70**	**41**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	5.2% 5	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
		Kanamycin (MIC ≥ 64)	8.3% 8	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
		Streptomycin (MIC ≥ 64)	12.5% 12	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	5.2% 5	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
	Cephems	Ceftiofur (MIC ≥ 8)	5.2% 5	8.7% 8	8.8% 11	9.8% 10	7.1% 7	8.0% 6	20.9% 18	24.2% 15	8.6% 6	22.0% 9
		Ceftriaxone (MIC ≥ 4)	5.2% 5	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	10.4% 10	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
	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)	1.0% 1	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
II	Cephems	Cefoxitin (MIC ≥ 32)	5.2% 5	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
		Cephalothin (MIC ≥ 32)	7.3% 7	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	7.3% 7	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.1% 2	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	16.7% 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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 23. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**96**	**92**	**125**	**102**	**98**	**75**	**86**	**62**	**70**	**41**
Resistance Pattern										
No resistance detected	68.8% 66	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
Resistance ≥ 1 CLSI class*	31.3% 30	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
Resistance ≥ 2 CLSI classes*	17.7% 17	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
Resistance ≥ 3 CLSI classes*	10.4% 10	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
Resistance ≥ 4 CLSI classes*	0.0% 0	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
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT†	0.0% 0	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
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	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
At least ACT/S§	0.0% 0	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
At least ACSSuTAuCx¶	0.0% 0	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
At least AAuCx**	5.2% 5	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
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	Not Tested	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	Not Tested	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. I 4,[5],12:i:-

Table 24. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. I 4,[5],12:i:- isolates to antimicrobial agents, 2012 (N=118)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	2.5	[0.5 - 7.2]					2.5	80.5	13.6	0.8			0.8	1.7				
		Kanamycin	0.0	0.0	[0.0 - 3.1]										100.0						
		Streptomycin	N/A	28.8	[20.8 - 37.9]												71.2	1.7	27.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	1.7	[0.2 - 6.0]							70.3	0.8	9.3	17.8		0.8	0.8			
	Cephems	Ceftiofur	0.0	0.8	[0.0 - 4.6]					0.8	22.0	73.7	2.5			0.8					
		Ceftriaxone	0.0	0.8	[0.0 - 4.6]					99.2						0.8					
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 3.1]								6.8	89.0	4.2						
	Penicillins	Ampicillin	0.0	28.8	[20.8 - 37.9]							69.5	1.7					28.8			
	Quinolones	Ciprofloxacin	0.8	0.0	[0.0 - 3.1]	98.3	0.8				0.8										
		Nalidixic acid	N/A	0.8	[0.0 - 4.6]							0.8	49.2	48.3	0.8			0.8			
II	**Cephems**	Cefoxitin	0.0	0.8	[0.0 - 4.6]							27.1	63.6	8.5				0.8			
	Folate pathway inhibitors	Sulfisoxazole	N/A	28.8	[20.8 - 37.9]											3.4	47.5	19.5	0.8		28.8
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 3.1]				100.0												
	Phenicols	Chloramphenicol	0.8	0.0	[0.0 - 3.1]								0.8	55.1	43.2	0.8					
	Tetracyclines	Tetracycline	0.0	33.1	[24.7 - 42.3]									66.9				33.1			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 8. Antimicrobial resistance pattern for *Salmonella* ser. I 4,[5],12:i:-, 2012

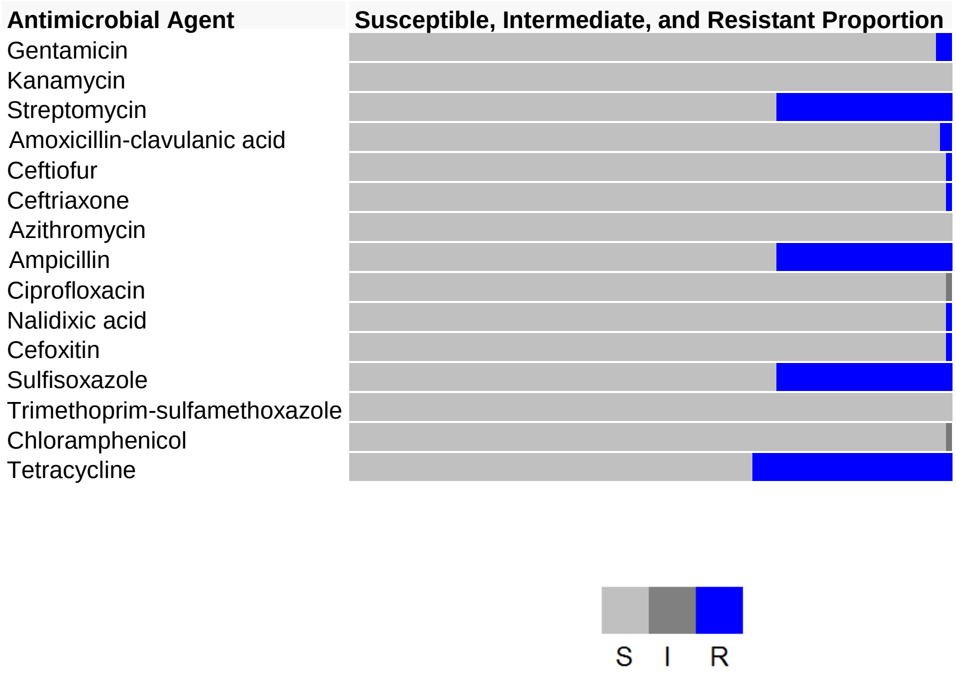


Table 25. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **36**	**2004** **36**	**2005** **33**	**2006** **105**	**2007** **73**	**2008** **84**	**2009** **72**	**2010** **78**	**2011** **82**	**2012** **118**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	5.6% 2	5.6% 2	0.0% 0	4.8% 5	1.4% 1	3.6% 3	2.8% 2	1.3% 1	1.2% 1	2.5% 3
		Kanamycin (MIC ≥ 64)	0.0% 0	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
		Streptomycin (MIC ≥ 64)	8.3% 3	5.6% 2	3.0% 1	3.8% 4	8.2% 6	10.7% 9	12.5% 9	19.2% 15	24.4% 20	28.8% 34
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	5.6% 2	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	4.2% 3	3.8% 3	4.9% 4	1.7% 2
	Cephems	Ceftiofur (MIC ≥ 8)	5.6% 2	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.8% 1
		Ceftriaxone (MIC ≥ 4)	5.6% 2	2.8% 1	3.0% 1	3.8% 4	2.7% 2	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.8% 1
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	8.3% 3	5.6% 2	6.1% 2	6.7% 7	5.5% 4	9.5% 8	11.1% 8	21.8% 17	26.8% 22	28.8% 34
	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	1.3% 1	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	2.8% 1	2.8% 1	0.0% 0	1.0% 1	1.4% 1	1.2% 1	0.0% 0	2.6% 2	0.0% 0	0.8% 1
II	Cephems	Cefoxitin (MIC ≥ 32)	5.6% 2	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	4.9% 4	0.8% 1
		Cephalothin (MIC ≥ 32)	5.6% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	5.6% 2	11.1% 4	0.0% 0	8.6% 9	4.1% 3	13.1% 11	13.9% 10	19.2% 15	23.2% 19	28.8% 34
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.0% 0	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	2.8% 1	0.0% 0	1.9% 2	1.4% 1	6.0% 5	8.3% 6	1.3% 1	2.4% 2	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	11.1% 4	3.0% 1	8.6% 9	9.6% 7	16.7% 14	16.7% 12	28.2% 22	25.6% 21	33.1% 39

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 26. Resistance patterns of *Salmonella* ser. I 4,[5],12:i:- isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**36**	**36**	**33**	**105**	**73**	**84**	**72**	**78**	**82**	**118**
Resistance Pattern										
No resistance detected	77.8% 28	80.6% 29	87.9% 29	85.7% 90	82.2% 60	76.2% 64	76.4% 55	66.7% 52	65.9% 54	61.9% 73
Resistance ≥ 1 CLSI class*	22.2% 8	19.4% 7	12.1% 4	14.3% 15	17.8% 13	23.8% 20	23.6% 17	33.3% 26	34.1% 28	38.1% 45
Resistance ≥ 2 CLSI classes*	11.1% 4	13.9% 5	3.0% 1	11.4% 12	6.8% 5	17.9% 15	16.7% 12	21.8% 17	28.0% 23	31.4% 37
Resistance ≥ 3 CLSI classes*	5.6% 2	8.3% 3	3.0% 1	9.5% 10	5.5% 4	10.7% 9	12.5% 9	21.8% 17	26.8% 22	28.0% 33
Resistance ≥ 4 CLSI classes*	0.0% 0	2.8% 1	0.0% 0	3.8% 4	2.7% 2	7.1% 6	9.7% 7	19.2% 15	20.7% 17	26.3% 31
Resistance ≥ 5 CLSI classes*	0.0% 0	2.8% 1	0.0% 0	2.9% 3	1.4% 1	4.8% 4	6.9% 5	3.8% 3	1.2% 1	0.8% 1
At least ACSSuT[†]	0.0% 0	2.8% 1	0.0% 0	1.9% 2	1.4% 1	3.6% 3	6.9% 5	1.3% 1	1.2% 1	0.0% 0
At least ASSuT[‡] and not resistant to chloramphenicol	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.0% 0	1.2% 1	1.4% 1	16.7% 13	18.3% 15	26.3% 31
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	0.0% 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
At least AAuCx**	5.6% 2	2.8% 1	3.0% 1	3.8% 4	1.4% 1	4.8% 4	2.8% 2	2.6% 2	3.7% 3	0.8% 1
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	Not Tested	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	Not Tested	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 27. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhi isolates to antimicrobial agents, 2012 (N=326)

Rank*	CLSI[†] Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**															
			%I[‡]	%R[§]	[95% CI][¶]	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	0.0	[0.0 - 1.1]					50.3	47.9	1.8									
		Kanamycin	0.0	0.0	[0.0 - 1.1]										100.0						
		Streptomycin	N/A	9.2	[6.3 - 12.9]												90.8		9.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.6	0.0	[0.0 - 1.1]							89.0	0.6	1.5	8.3	0.6					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 1.1]				0.6	3.4	75.5	20.2	0.3								
		Ceftriaxone	0.0	0.0	[0.0 - 1.1]					100.0											
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.1]							1.8	25.8	68.1	4.3						
	Penicillins	Ampicillin	0.0	10.1	[7.1 - 13.9]							88.7	0.9	0.3				10.1			
	Quinolones	Ciprofloxacin	62.0	6.4	[4.0 - 9.7]	30.1	0.3	1.2	9.8	38.7	13.5		0.6	0.3	5.5						
		Nalidixic acid	N/A	68.4	[63.1 - 73.4]						0.9	3.1	25.5	1.2	0.9		1.5	66.9			
II	**Cephems**	Cefoxitin	0.3	0.0	[0.0 - 1.1]						3.1	23.0	16.0	44.5	13.2	0.3					
	Folate pathway inhibitors	Sulfisoxazole	N/A	10.4	[7.3 - 14.3]											45.7	37.7	5.2	0.6	0.3	10.4
		Trimethoprim-sulfamethoxazole	N/A	10.1	[7.1 - 13.9]				89.0	0.3	0.6				10.1						
	Phenicols	Chloramphenicol	0.3	10.1	[7.1 - 13.9]								2.1	70.9	16.6	0.3		10.1			
	Tetracyclines	Tetracycline	0.0	1.5	[0.5 - 3.5]									98.5				1.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 9. Antimicrobial resistance pattern for *Salmonella* ser. Typhi, 2012

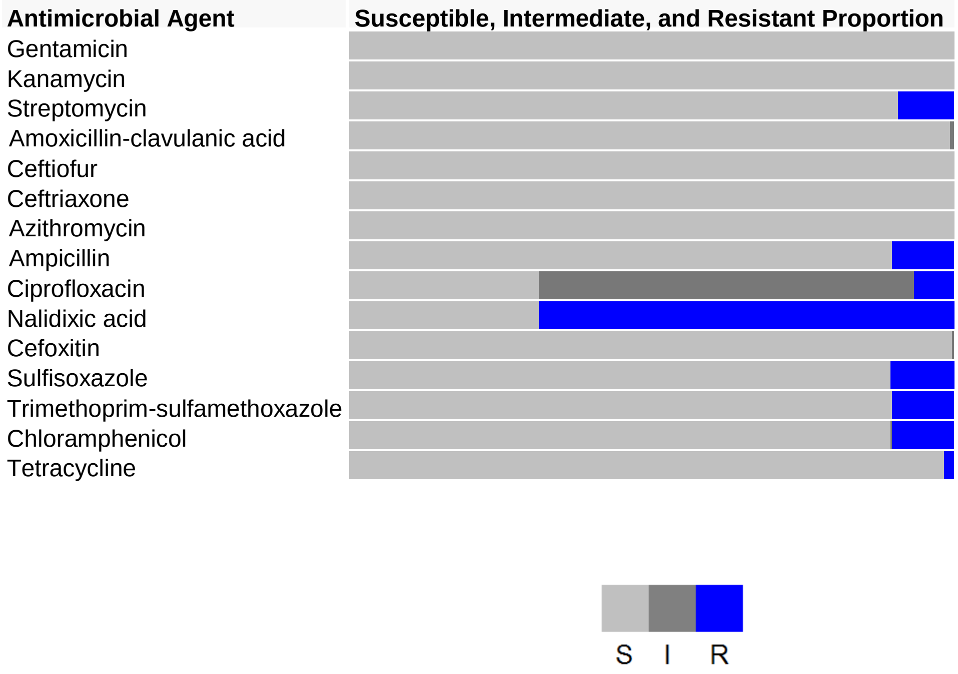


Table 28. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **332**	**2004** **304**	**2005** **318**	**2006** **323**	**2007** **400**	**2008** **407**	**2009** **363**	**2010** **446**	**2011** **383**	**2012** **326**
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	0.0% 0	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	0.0% 0	0.2% 1	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	14.5% 48	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	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
	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	Not Tested	0.0% 0	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	16.0% 53	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.3% 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	6.4% 21
		Nalidixic Acid (MIC ≥ 32)	37.7% 125	41.8% 127	48.4% 154	54.5% 176	62.0% 248	59.0% 240	59.8% 217	69.3% 309	70.8% 271	68.4% 223
II	Cephems	Cefoxitin (MIC ≥ 32)	0.3% 1	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
		Cephalothin (MIC ≥ 32)	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	16.9% 56	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	16.9% 56	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	16.6% 55	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	15.4% 51	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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 29. Resistance patterns of *Salmonella* ser. Typhi isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**332**	**304**	**318**	**323**	**400**	**407**	**363**	**446**	**383**	**326**
Resistance Pattern										
No resistance detected	56.6% 188	56.6% 172	48.1% 153	40.2% 130	35.5% 142	38.3% 156	37.5% 136	29.4% 131	27.9% 107	30.7% 100
Resistance ≥ 1 CLSI class*	43.4% 144	43.4% 132	51.9% 165	59.8% 193	64.5% 258	61.7% 251	62.5% 227	70.6% 315	72.1% 276	69.3% 226
Resistance ≥ 2 CLSI classes*	17.5% 58	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
Resistance ≥ 3 CLSI classes*	16.6% 55	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
Resistance ≥ 4 CLSI classes*	16.3% 54	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
Resistance ≥ 5 CLSI classes*	14.2% 47	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
At least ACSSuT†	12.7% 42	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
At least ASSuT‡ and not resistant to chloramphenicol	0.0% 0	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
At least ACT/S§	15.7% 52	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
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	Not Tested	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	Not Tested	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 30. Frequency of *Salmonella* ser. Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C, 2012 (see Methods for varying sampling method by serotype)

Serotype	2012	
	n	(%)
Paratyphi A	111	(99.1)
Paratyphi B	1	(0.9)
Paratyphi C	0	(0)
Total	**112**	**(100)**

Table 31. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Paratyphi A isolates to antimicrobial agents, 2012 (N=111)

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 - 3.3]					98.2	1.8										
		Kanamycin	0.0	0.0	[0.0 - 3.3]										100.0						
		Streptomycin	N/A	0.0	[0.0 - 3.3]												100.0				
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 3.3]							49.5	46.8	3.6							
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 3.3]				0.9		4.5	94.6									
		Ceftriaxone	0.0	0.0	[0.0 - 3.3]					100.0											
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 3.3]								1.8	38.7	55.9	3.6					
	Penicillins	Ampicillin	0.0	0.0	[0.0 - 3.3]							7.2	87.4	5.4							
	Quinolones	Ciprofloxacin	92.8	2.7	[0.5 - 7.7]	4.5			0.9	1.8	90.1	2.7									
		Nalidixic acid	N/A	94.6	[88.6 - 98.0]								1.8	2.7	0.9			94.6			
II	Cephems	Cefoxitin	0.0	0.0	[0.0 - 3.3]								4.5	72.1	23.4						
	Folate pathway inhibitors	Sulfisoxazole	N/A	0.0	[0.0 - 3.3]											6.3	82.9	10.8			
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 3.3]				93.7	6.3											
	Phenicols	Chloramphenicol	9.0	0.9	[0.0 - 4.9]									2.7	87.4	9.0		0.9			
	Tetracyclines	Tetracycline	0.0	0.9	[0.0 - 4.9]									99.1				0.9			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 10. Antimicrobial resistance pattern for *Salmonella* ser. Paratyphi A, 2012

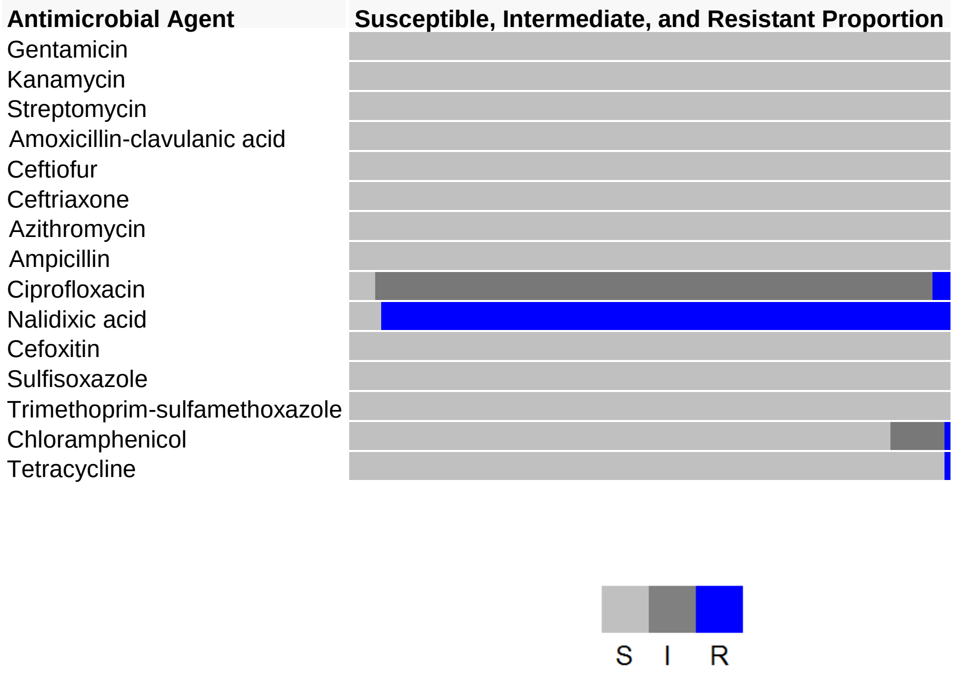


Table 32. Percentage and number of *Salmonella* ser. Paratyphi A isolates resistant to antimicrobial agents, 2003–2012

Year			**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates			**6**	**8**	**13**	**10**	**16**	**116**	**99**	**145**	**152**	**111**
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	0.0% 0	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	0.7% 1	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	0.0% 0	0.7% 1	0.0% 0	0.0% 0
		Streptomycin (MIC ≥ 64)	0.0% 0	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
	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	Not Tested	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	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.0% 0
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	100.0% 6	100.0% 8	92.3% 12	80.0% 8	93.8% 15	88.8% 103	86.9% 86	92.4% 134	96.7% 147	94.6% 105
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
		Cephalothin (MIC ≥ 32)	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	1.4% 2	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	0.0% 0	1.0% 1	2.1% 3	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	0.0% 0	1.0% 1	1.4% 2	0.0% 0	0.9% 1
	Tetracyclines	Tetracycline (MIC ≥ 16)	0.0% 0	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

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

[†] CLSI: Clinical and Laboratory Standards Institute

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

Table 33. Resistance patterns of *Salmonella* ser. Paratyphi A isolates, 2003–2012

Year Total Isolates	**2003 6**	**2004 8**	**2005 13**	**2006 10**	**2007 16**	**2008 116**	**2009 99**	**2010 145**	**2011 152**	**2012 111**
Resistance Pattern										
No resistance detected	0.0% 0	0.0% 0	7.7% 1	20.0% 2	6.3% 1	10.3% 12	12.1% 12	5.5% 8	3.3% 5	5.4% 6
Resistance ≥ 1 CLSI class*	100.0% 6	100.0% 8	92.3% 12	80.0% 8	93.8% 15	89.7% 104	87.9% 87	94.5% 137	96.7% 147	94.6% 105
Resistance ≥ 2 CLSI classes*	0.0% 0	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
Resistance ≥ 3 CLSI classes*	0.0% 0	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
Resistance ≥ 4 CLSI classes*	0.0% 0	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
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT[†]	0.0% 0	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
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	0.7% 1	0.0% 0	0.0% 0
At least ACT/S[§]	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 1	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	Not Tested	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	Not Tested	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 34. Frequency of *Shigella* species, 2012

Species	2012	
	n	(%)
Shigella sonnei	287	(81.3)
Shigella flexneri	59	(16.7)
Shigella boydii	5	(1.4)
Other	2	(0.6)
Total	**353**	**(100)**

Table 35. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2012 (N=353)

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]					2.3	14.7	78.5	4.5								
		Kanamycin	0.0	0.3	[0.0 - 1.6]										99.7				0.3		
		Streptomycin	N/A	83.0	[78.7 - 86.8]												17.0	43.1	39.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	14.2	1.7	[0.6 - 3.7]							5.9	6.2	56.9	15.0	14.2	1.1	0.6			
	Cephems	Ceftiofur	0.0	1.1	[0.3 - 2.9]				10.2	70.5	13.0	5.1			0.3	0.8					
		Ceftriaxone	0.0	1.1	[0.3 - 2.9]					98.3	0.6				0.3	0.3		0.6			
	Macrolide	Azithromycin	N/A	4.2	[2.4 - 6.9]					0.3	2.0	6.5	9.3	72.5	4.5	0.6	4.2				
	Penicillins	Ampicillin	0.3	25.5	[21.0 - 30.4]							9.6	53.0	11.6		0.3	0.3	25.2			
	Quinolones	Ciprofloxacin	0.0	2.0	[0.8 - 4.0]	93.5	0.8	0.6	1.4	0.6	0.8	0.3		0.8	1.1						
		Nalidixic acid	N/A	4.5	[2.6 - 7.3]						0.6	74.8	17.0	3.1			0.6	4.0			
II	**Cephems**	Cefoxitin	0.6	0.6	[0.1 - 2.0]							5.7	69.7	22.4	1.1	0.6	0.6				
	Folate pathway inhibitors	Sulfisoxazole	N/A	34.8	[29.9 - 40.1]											51.6	9.3	4.0	0.3		34.8
		Trimethoprim-sulfamethoxazole	N/A	43.3	[38.1 - 48.7]				12.2	2.3	3.7	19.5	19.0	7.9	35.4						
	Phenicols	Chloramphenicol	0.0	11.3	[8.2 - 15.1]								12.7	69.4	6.5		2.0	9.3			
	Tetracyclines	Tetracycline	0.0	37.1	[32.1 - 42.4]									62.9		0.3	4.5	32.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 11. Antimicrobial resistance pattern for *Shigella*, 2012

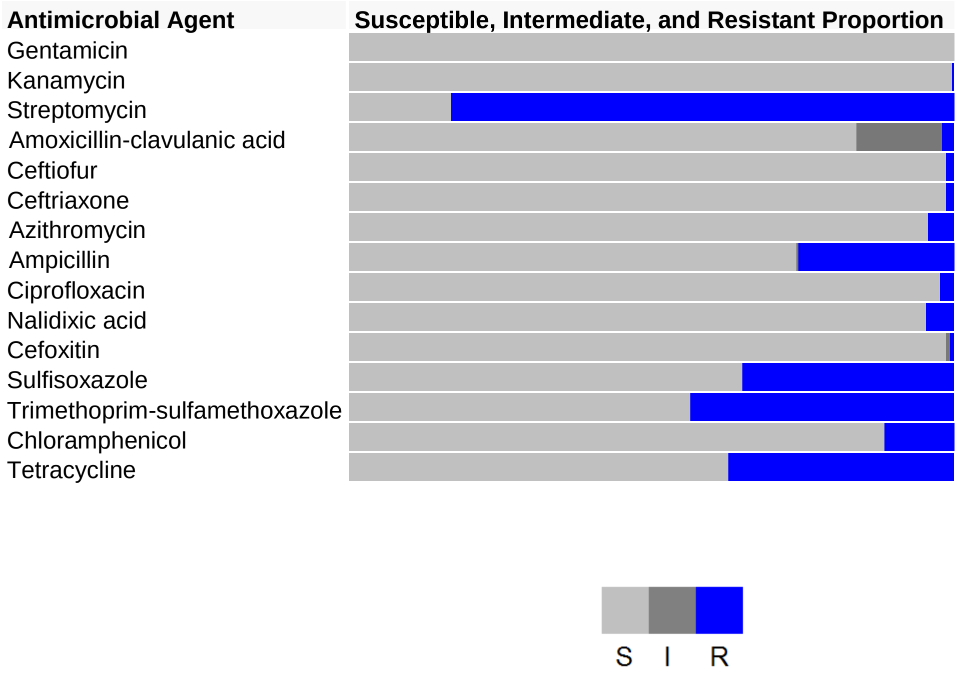


Table 36. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **495**	**2004** **316**	**2005** **396**	**2006** **402**	**2007** **480**	**2008** **551**	**2009** **475**	**2010** **411**	**2011** **293**	**2012** **353**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.4% 2	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
		Streptomycin (MIC ≥ 64)	57.0% 282	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.4% 7	1.6% 5	1.0% 4	1.5% 6	0.4% 2	3.3% 18	2.1% 10	0.0% 0	2.0% 6	1.7% 6
	Cephems	Ceftiofur (MIC ≥ 8)	0.2% 1	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
		Ceftriaxone (MIC ≥ 4)	0.2% 1	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	3.1% 9	4.2% 15
	Penicillins	Ampicillin (MIC ≥ 32)	79.4% 393	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.0% 5	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	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
		Cephalothin (MIC ≥ 32)	9.3% 46	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	33.9% 168	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	38.6% 191	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	8.5% 42	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	29.1% 144	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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 37. Resistance patterns of *Shigella* isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**495**	**316**	**396**	**402**	**480**	**551**	**475**	**411**	**293**	**353**
Resistance Pattern										
No resistance detected	8.5% 42	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
Resistance ≥ 1 CLSI class*	91.5% 453	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
Resistance ≥ 2 CLSI classes*	57.8% 286	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
Resistance ≥ 3 CLSI classes*	40.2% 199	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
Resistance ≥ 4 CLSI classes*	24.8% 123	32.9% 104	19.4% 77	15.4% 62	11.7% 56	10.3% 57	13.3% 63	14.1% 58	22.2% 65	19.5% 69
Resistance ≥ 5 CLSI classes*	3.6% 18	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
At least ACSSuT†	3.2% 16	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
At least ACT/S‡	3.6% 18	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
At least AT/S§	33.7% 167	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
At least ANT/S¶	0.8% 4	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
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	0.2% 1	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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	Not Tested	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 38. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2012 (N=287)

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]					2.1	12.9	79.8	5.2								
		Kanamycin	0.0	0.3	[0.0 - 1.9]										99.7				0.3		
		Streptomycin	N/A	89.2	[85.0 - 92.5]												10.8	49.8	39.4		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	6.6	1.7	[0.6 - 4.0]							4.9	2.4	67.9	16.4	6.6	1.0	0.7			
	Cephems	Ceftiofur	0.0	1.0	[0.2 - 3.0]				4.5	76.3	12.5	5.6			0.3	0.7					
		Ceftriaxone	0.0	1.0	[0.2 - 3.0]					98.3	0.7				0.3			0.7			
	Macrolide	Azithromycin	N/A	2.1	[0.8 - 4.5]					0.3		1.4	3.8	86.8	5.2	0.3	2.1				
	Penicillins	Ampicillin	0.3	18.1	[13.8 - 23.1]							4.9	63.1	13.6		0.3	0.3	17.8			
	Quinolones	Ciprofloxacin	0.0	2.1	[0.8 - 4.5]	94.4	0.3	0.3	1.0	0.7	0.7	0.3		1.0	1.0						
		Nalidixic acid	N/A	4.2	[2.2 - 7.2]						0.7	77.7	14.6	2.8			0.3	3.8			
II	**Cephems**	Cefoxitin	0.7	0.7	[0.1 - 2.5]							6.6	78.4	13.6		0.7	0.7				
	Folate pathway inhibitors	Sulfisoxazole	N/A	30.0	[24.7 - 35.6]											55.1	10.5	4.5			30.0
		Trimethoprim-sulfamethoxazole	N/A	41.8	[36.0 - 47.8]				6.3	1.4	3.5	24.0	23.0	9.8	32.1						
	Phenicols	Chloramphenicol	0.0	3.1	[1.4 - 5.9]								5.6	83.3	8.0			3.1			
	Tetracyclines	Tetracycline	0.0	27.5	[22.4 - 33.1]									72.5			4.5	23.0			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 12. Antimicrobial resistance pattern for *Shigella sonnei*, 2012

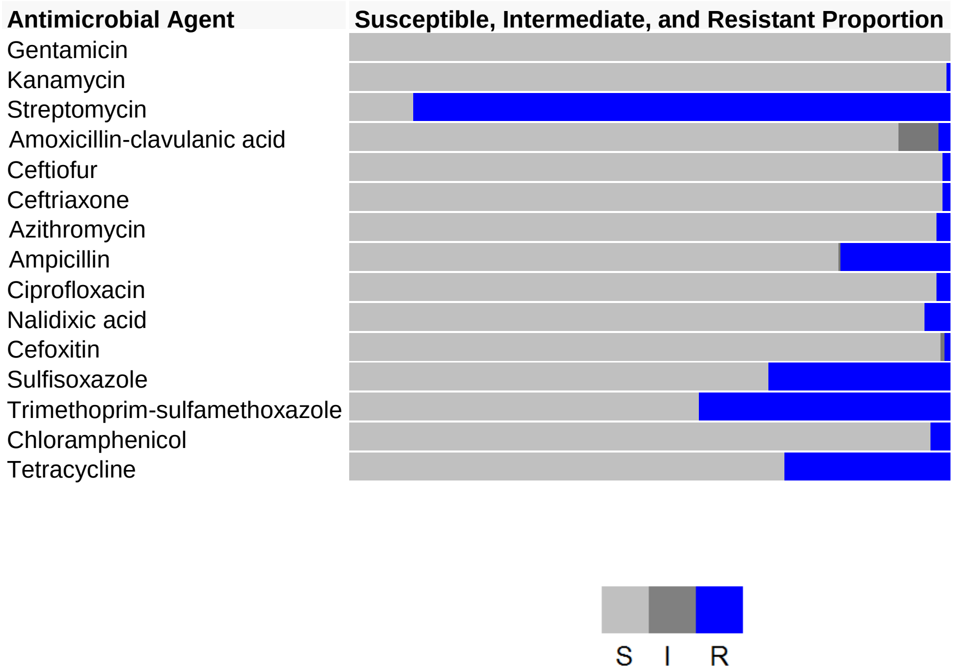


Table 39. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **434**	**2004** **241**	**2005** **340**	**2006** **321**	**2007** **414**	**2008** **494**	**2009** **410**	**2010** **337**	**2011** **225**	**2012** **287**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.0% 0	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
		Streptomycin (MIC ≥ 64)	56.5% 245	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.4% 6	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
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	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
		Ceftriaxone (MIC ≥ 4)	0.0% 0	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.9% 2	2.1% 6
	Penicillins	Ampicillin (MIC ≥ 32)	79.7% 346	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	0.5% 2	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	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
		Cephalothin (MIC ≥ 32)	10.1% 44	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	31.3% 136	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	38.5% 167	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.2% 5	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	22.1% 96	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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 40. Resistance patterns of *Shigella sonnei* isolates, 2003–2012

Year **Total Isolates**	**2003** **434**	**2004** **241**	**2005** **340**	**2006** **321**	**2007** **414**	**2008** **494**	**2009** **410**	**2010** **337**	**2011** **225**	**2012** **287**
Resistance Pattern										
No resistance detected	8.5% 37	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
Resistance ≥ 1 CLSI class*	91.5% 397	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
Resistance ≥ 2 CLSI classes*	54.1% 235	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
Resistance ≥ 3 CLSI classes*	35.3% 153	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
Resistance ≥ 4 CLSI classes*	20.5% 89	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
Resistance ≥ 5 CLSI classes*	0.5% 2	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
At least ACSSuT[†]	0.2% 1	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
At least ACT/S[‡]	0.9% 4	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
At least AT/S[§]	33.6% 146	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
At least ANT/S[¶]	0.2% 1	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
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	1.3% 3	0.7% 2
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.3% 1
At least ceftriaxone and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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 and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2012 (N=59)

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 - 6.1]					1.7	22.0	74.6	1.7								
		Kanamycin	0.0	0.0	[0.0 - 6.1]										100.0						
		Streptomycin	N/A	55.9	[42.4 - 68.8]												44.1	15.3	40.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	52.5	1.7	[0.0 - 9.1]							6.8	25.4	5.1	8.5	52.5	1.7				
	Cephems	Ceftiofur	0.0	1.7	[0.0 - 9.1]				32.2	47.5	16.9	1.7				1.7					
		Ceftriaxone	0.0	1.7	[0.0 - 9.1]					98.3						1.7					
	Macrolide	Azithromycin	N/A	15.3	[7.2 - 27.0]						11.9	25.4	33.9	10.2	1.7	1.7	15.3				
	Penicillins	Ampicillin	0.0	61.0	[47.4 - 73.5]							28.8	6.8	3.4				61.0			
	Quinolones	Ciprofloxacin	0.0	1.7	[0.0 - 9.1]	93.2	1.7		1.7		1.7				1.7						
		Nalidixic acid	N/A	5.1	[1.0 - 14.1]							64.4	27.1	3.4				5.1			
II	**Cephems**	Cefoxitin	0.0	0.0	[0.0 - 6.1]							1.7	25.4	66.1	6.8						
	Folate pathway inhibitors	Sulfisoxazole	N/A	55.9	[42.4 - 68.8]											37.3	3.4	1.7	1.7		55.9
		Trimethoprim-sulfamethoxazole	N/A	50.8	[37.5 - 64.1]				37.3	5.1	5.1		1.7		50.8						
	Phenicols	Chloramphenicol	0.0	52.5	[39.1 - 65.7]								39.0	8.5			11.9	40.7			
	Tetracyclines	Tetracycline	0.0	84.7	[73.0 - 92.8]									15.3			5.1	79.7			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 13. Antimicrobial resistance pattern for *Shigella flexneri*, 2012

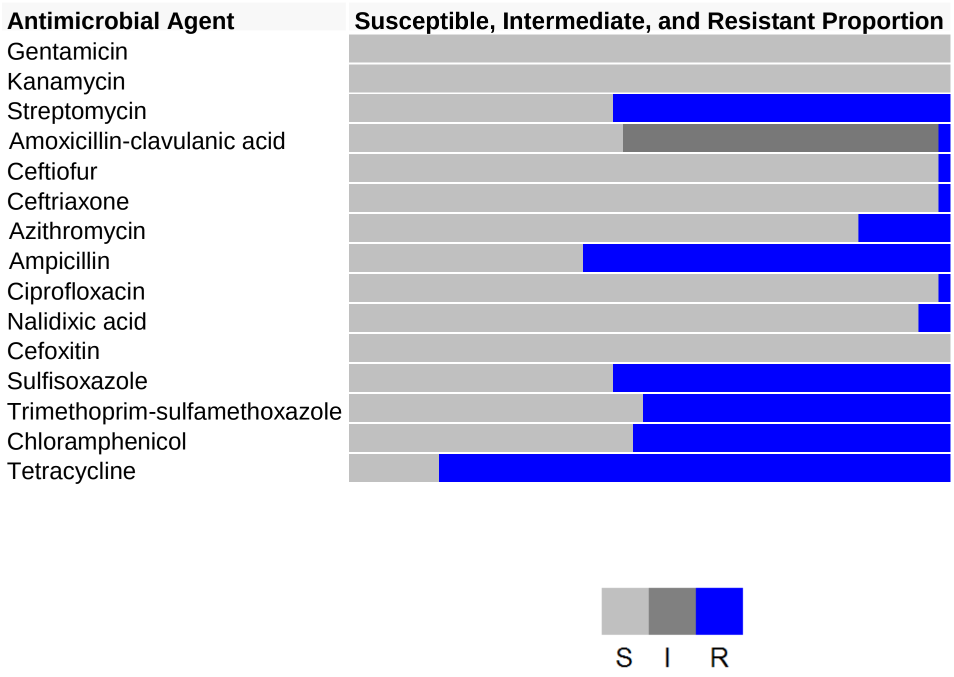


Table 42. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **51**	**2004** **62**	**2005** **52**	**2006** **74**	**2007** **61**	**2008** **49**	**2009** **57**	**2010** **61**	**2011** **58**	**2012** **59**
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	3.9% 2	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
		Streptomycin (MIC ≥ 64)	60.8% 31	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.0% 1	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
	Cephems	Ceftiofur (MIC ≥ 8)	2.0% 1	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
		Ceftriaxone (MIC ≥ 4)	2.0% 1	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	10.3% 6	15.3% 9
	Penicillins	Ampicillin (MIC ≥ 32)	84.3% 43	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	5.9% 3	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
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
		Cephalothin (MIC ≥ 32)	3.9% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole[‡] (MIC ≥ 512)	52.9% 27	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	39.2% 20	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	68.6% 35	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	82.4% 42	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

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

† Important

‡ CLSI: Clinical and Laboratory Standards Institute

Table 43. Resistance patterns of *Shigella flexneri* isolates, 2003–2012

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Isolates	**51**	**62**	**52**	**74**	**61**	**49**	**57**	**61**	**58**	**59**
Resistance Pattern										
No resistance detected	7.8% 4	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
Resistance ≥ 1 CLSI class*	92.2% 47	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
Resistance ≥ 2 CLSI classes*	86.3% 44	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
Resistance ≥ 3 CLSI classes*	80.4% 41	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
Resistance ≥ 4 CLSI classes*	62.7% 32	64.5% 40	65.4% 34	47.3% 35	55.7% 34	57.1% 28	63.2% 36	57.4% 35	56.9% 33	59.3% 35
Resistance ≥ 5 CLSI classes*	31.4% 16	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
At least ACSSuT†	29.4% 15	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
At least ACT/S‡	27.5% 14	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
At least AT/S§	37.3% 19	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
At least ANT/S¶	5.9% 3	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
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	2.0% 1	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
At least nalidixic acid and azithromycin resistant	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	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	Not Tested	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 44. Minimum inhibitory concentrations (MICs) and resistance of *Escherichia coli* O157 isolates to antimicrobial agents, 2012 (N=166)

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	0.6	[0.0 - 3.3]					7.8	78.3	13.3					0.6				
		Kanamycin	0.0	0.0	[0.0 - 2.2]										100.0						
		Streptomycin	N/A	2.4	[0.7 - 6.1]												97.6	0.6	1.8		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.6	[0.0 - 3.3]							3.0	6.0	88.6	1.8			0.6			
	Cephems	Ceftiofur	0.0	0.6	[0.0 - 3.3]				1.2	6.0	90.4	1.8				0.6					
		Ceftriaxone	0.0	0.6	[0.0 - 3.3]					99.4							0.6				
	Macrolide	Azithromycin	N/A	0.6	[0.0 - 3.3]						0.6	7.8	77.1	13.9			0.6				
	Penicillins	Ampicillin	0.0	1.8	[0.4 - 5.2]							5.4	77.7	15.1				1.8			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 2.2]	95.8	1.8			1.8	0.6										
		Nalidixic acid	N/A	2.4	[0.7 - 6.1]						0.6	1.2	81.9	13.3		0.6		2.4			
II	**Cephems**	Cefoxitin	1.2	0.6	[0.0 - 3.3]							1.2	6.0	73.5	17.5	1.2		0.6			
	Folate pathway inhibitors	Sulfisoxazole	N/A	3.6	[1.3 - 7.7]											77.7	15.7	3.0			3.6
		Trimethoprim-sulfamethoxazole	N/A	1.2	[0.1 - 4.3]				98.2	0.6					1.2						
	Phenicols	Chloramphenicol	1.2	1.8	[0.4 - 5.2]								0.6	15.1	81.3	1.2	0.6	1.2			
	Tetracyclines	Tetracycline	0.0	5.4	[2.5 - 10.0]									94.6		0.6	0.6	4.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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.

Figure 14. Antimicrobial resistance pattern for *Escherichia coli* O157, 2012

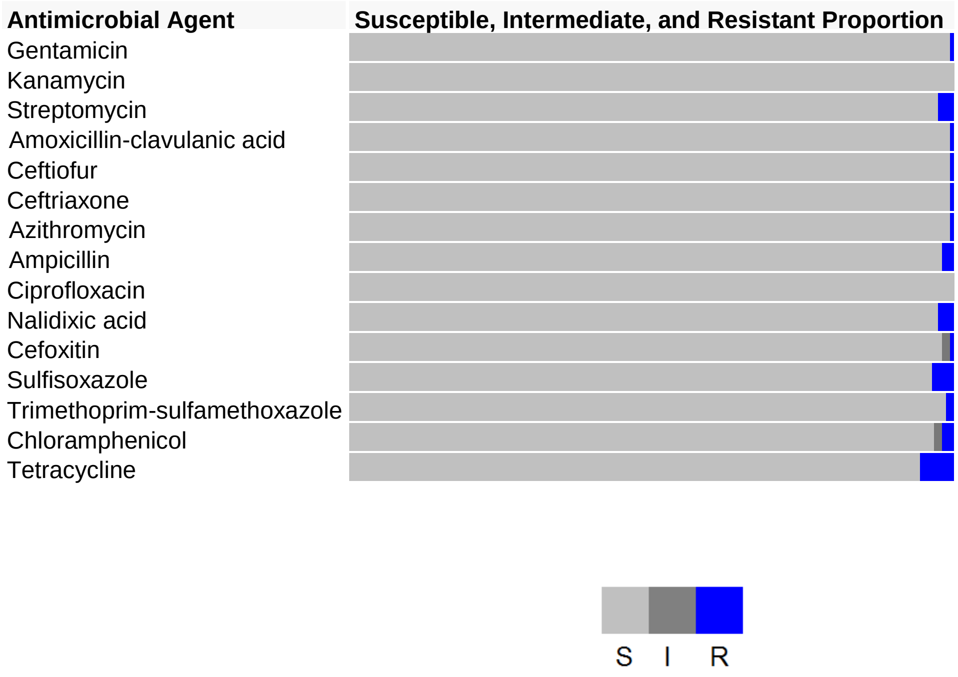


Table 45. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2003–2012

Year Total Isolates			2003 158	2004 169	2005 194	2006 233	2007 189	2008 161	2009 187	2010 170	2011 162	2012 166
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	0.0% 0	Not Tested	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.0% 0	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
		Streptomycin (MIC ≥ 64)	1.9% 3	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	1.3% 2	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
	Cephems	Ceftiofur (MIC ≥ 8)	1.3% 2	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
		Ceftriaxone (MIC ≥ 4)	1.3% 2	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0	0.6% 1
	Penicillins	Ampicillin (MIC ≥ 32)	3.2% 5	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	0.6% 1	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
II	Cephems	Cefoxitin (MIC ≥ 32)	1.3% 2	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
		Cephalothin (MIC ≥ 32)	3.2% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	3.8% 6	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.6% 1	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.3% 2	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	5.7% 9	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

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

† CLSI: Clinical and Laboratory Standards Institute

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

Table 46. Resistance patterns of *Escherichia coli* O157 isolates, 2003–2012

Year Total Isolates	2003 158	2004 169	2005 194	2006 233	2007 189	2008 161	2009 187	2010 170	2011 162	2012 166
Resistance Pattern										
No resistance detected	90.5% 143	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
Resistance ≥ 1 CLSI class*	9.5% 15	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
Resistance ≥ 2 CLSI classes*	5.1% 8	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
Resistance ≥ 3 CLSI classes*	3.2% 5	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
Resistance ≥ 4 CLSI classes*	1.3% 2	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
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT†	0.0% 0	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
At least ACT/S‡	0.0% 0	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
At least ACSSuTAuCx§	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.0% 0	0.4% 1	0.0% 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 47. Frequency of *Campylobacter* species, 2012

Species	2012	
	n	(%)
Campylobacter jejuni	1191	(86.3)
Campylobacter coli	134	(10.0)
Other	35	(3.7)
Total	**1360**	**(100)**

Table 48. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2012 (N=1191)

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	1.0	[0.5 - 1.8]				3.0	27.0	57.4	11.4	0.2	0.1			0.3	0.7			
	Ketolide	Telithromycin	N/A	1.4	[0.8 - 2.3]	0.1			0.3	3.3	19.1	38.8	31.0	6.0	0.3	1.1					
	Macrolides	Azithromycin	N/A	1.8	[1.1 - 2.7]	0.7	9.6	32.8	34.3	20.9	0.3	0.1						0.3	1.2		
		Erythromycin	N/A	1.5	[0.9 - 2.4]		0.1		1.6	19.5	26.1	35.3	14.4	1.5	0.1			0.3	1.2		
	Quinolones	Ciprofloxacin	N/A	25.3	[22.8 - 27.8]	0.2	0.6	22.8	42.1	8.2	0.8	0.3	0.1	1.7	9.1	8.1	3.4	1.6	1.1		
		Nalidixic acid	N/A	25.5	[23.1 - 28.1]									56.7	16.6	1.2		2.0	23.5		
II	**Lincosamides**	Clindamycin	N/A	10.8	[9.1 - 12.7]		0.7	8.9	30.1	23.3	26.2	8.4	0.8	0.2	0.3	0.3	0.8				
	Phenicols	Florfenicol	N/A	1.4	[0.8 - 2.3]						2.9	53.7	34.4	7.5	1.0	0.3			0.2		
	Tetracyclines	Tetracycline	N/A	47.8	[44.9 - 50.7]			1.3	14.9	21.7	11.1	3.2	1.9	0.5		0.3	1.2	6.0	37.9		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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. ECOFFs were used when available.

Figure 15. Antimicrobial resistance pattern for *Campylobacter jejuni*, 2012

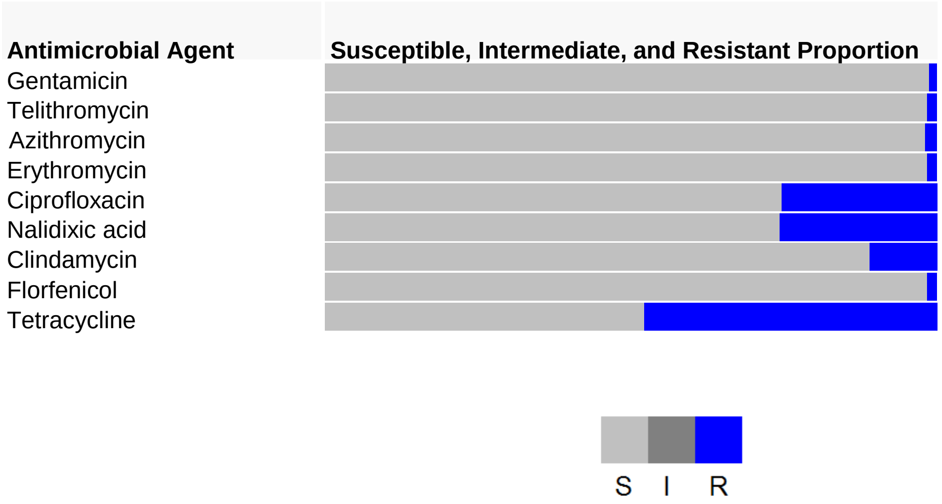


Table 49. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **303**	**2004** **320**	**2005** **788**	**2006** **709**	**2007** **992**	**2008** **1033**	**2009** **1350**	**2010** **1159**	**2011** **1275**	**2012** **1191**
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	0.0% 0	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
	Ketolides	Telithromycin (MIC ≥ 8)	Not Tested	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
	Macrolides	Azithromycin (MIC ≥ 0.5)	1.3% 4	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
		Erythromycin (MIC ≥ 8)	0.3% 1	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	17.5% 53	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
		Nalidixic Acid (MIC ≥ 32)	17.8% 54	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
II	Lincosamides	Clindamycin (MIC ≥ 1)	4.3% 13	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	1.6% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol (MIC ≥ 8)	Not Tested	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
	Tetracyclines	Tetracycline (MIC ≥ 2)	40.9% 124	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

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

Table 50. Resistance patterns of *Campylobacter jejuni* isolates, 2003–2012

Year **Total Isolates**	**2003** **303**	**2004** **320**	**2005** **788**	**2006** **709**	**2007** **992**	**2008** **1033**	**2009** **1350**	**2010** **1159**	**2011** **1275**	**2012** **1191**
Resistance Pattern										
No resistance detected	48.5% 147	41.9% 134	46.4% 366	42.5% 301	44.4% 440	45.2% 467	46.0% 621	39.6% 459	33.2% 423	38.6% 460
Resistance ≥ 1 CLSI class*	51.5% 156	58.1% 186	53.6% 422	57.5% 408	55.6% 552	54.8% 566	54.0% 729	60.4% 700	66.8% 852	61.4% 731
Resistance ≥ 2 CLSI classes*	11.6% 35	19.7% 63	16.2% 128	12.8% 91	18.9% 187	15.8% 163	15.0% 203	18.5% 214	23.5% 299	19.9% 237
Resistance ≥ 3 CLSI classes*	1.0% 3	5.3% 17	2.3% 18	1.3% 9	2.0% 20	3.1% 32	2.5% 34	3.8% 44	7.4% 94	4.7% 56
Resistance ≥ 4 CLSI classes*	0.3% 1	1.9% 6	0.5% 4	0.3% 2	1.2% 12	1.6% 17	1.0% 14	1.6% 18	3.1% 39	1.4% 17
Resistance ≥ 5 CLSI classes*	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.7% 7	0.6% 6	0.5% 7	0.5% 6	1.2% 15	0.6% 7
At least quinolone and macrolide resistant	0.3% 1	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

* CLSI: Clinical and Laboratory Standards Institute

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2012 (N=134)

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	6.0	[2.6 - 11.4]					25.4	38.1	29.1	1.5				1.5	4.5			
	Ketolide	Telithromycin	N/A	11.2	[6.4 - 17.8]			0.7	1.5	12.7	25.4	4.5	17.2	26.9	4.5	6.7					
	Macrolides	Azithromycin	N/A	9.0	[4.7 - 15.1]		1.5	16.4	36.6	25.4	11.2							1.5	7.5		
		Erythromycin	N/A	9.0	[4.7 - 15.1]				0.7	5.2	27.6	21.6	19.4	14.9	1.5			1.5	7.5		
	Quinolones	Ciprofloxacin	N/A	33.6	[25.7 - 42.2]	0.7	1.5	9.0	29.9	20.1	5.2			2.2	5.2	11.2	13.4	1.5			
		Nalidixic acid	N/A	33.6	[25.7 - 42.2]									23.1	40.3	3.0		4.5	29.1		
II	**Lincosamides**	Clindamycin	N/A	16.4	[10.6 - 23.8]			0.7	6.7	34.3	24.6	17.2	6.7	0.7	0.7	5.2	3.0				
	Phenicols	Florfenicol	N/A	1.5	[0.2 - 5.3]						3.7	35.8	42.5	16.4	0.7		0.7				
	Tetracyclines	Tetracycline	N/A	45.5	[36.9 - 54.3]			1.5	4.5	23.9	15.7	7.5	1.5		0.7		0.7	4.5	39.6		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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. ECOFFs were used when available.

Figure 16. Antimicrobial resistance pattern for *Campylobacter coli*, 2012

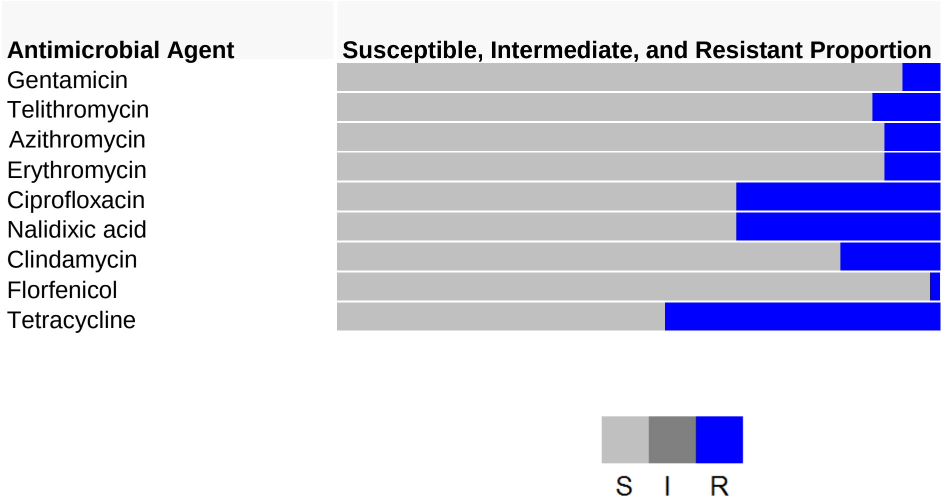


Table 52. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2003–2012

Year **Total Isolates**			**2003** **22**	**2004** **26**	**2005** **99**	**2006** **97**	**2007** **105**	**2008** **115**	**2009** **142**	**2010** **115**	**2011** **148**	**2012** **134**
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 4)	4.5% 1	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
	Ketolides	Telithromycin (MIC ≥ 8)	Not Tested	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
	Macrolides	Azithromycin (MIC ≥ 1)	13.6% 3	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
		Erythromycin (MIC ≥ 16)	9.1% 2	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	22.7% 5	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
		Nalidixic Acid (MIC ≥ 32)	22.7% 5	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
II	Lincosamides	Clindamycin (MIC ≥ 2)	18.2% 4	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol (MIC ≥ 8)	Not Tested	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
	Tetracyclines	Tetracycline (MIC ≥ 4)	45.5% 10	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

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

Table 53. Resistance patterns of *Campylobacter coli* isolates, 2003–2012

Year **Total Isolates**	**2003** **22**	**2004** **26**	**2005** **99**	**2006** **97**	**2007** **105**	**2008** **115**	**2009** **142**	**2010** **115**	**2011** **148**	**2012** **134**
Resistance Pattern										
No resistance detected	40.9% 9	34.6% 9	50.5% 50	44.3% 43	39.0% 41	44.3% 51	43.7% 62	35.7% 41	31.8% 47	43.3% 58
Resistance ≥ 1 CLSI class*	59.1% 13	65.4% 17	49.5% 49	55.7% 54	61.0% 64	55.7% 64	56.3% 80	64.3% 74	68.2% 101	56.7% 76
Resistance ≥ 2 CLSI classes*	22.7% 5	26.9% 7	17.2% 17	19.6% 19	19.0% 20	27.0% 31	19.7% 28	35.7% 41	41.2% 61	32.1% 43
Resistance ≥ 3 CLSI classes*	13.6% 3	0.0% 0	6.1% 6	8.2% 8	7.6% 8	7.8% 9	5.6% 8	11.3% 13	10.8% 16	11.2% 15
Resistance ≥ 4 CLSI classes*	4.5% 1	0.0% 0	2.0% 2	3.1% 3	1.0% 1	3.5% 4	2.8% 4	3.5% 4	2.0% 3	6.7% 9
Resistance ≥ 5 CLSI classes*	4.5% 1	0.0% 0	0.0% 0	1.0% 1	0.0% 0	1.7% 2	0.7% 1	2.6% 3	0.0% 0	4.5% 6
At least quinolone and macrolide resistant	9.1% 2	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

* CLSI: Clinical and Laboratory Standards Institute

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

Table 54. Frequency of *Vibrio* species other than *V. cholerae*, 2009–2012

Species	2009		2010		2011		2012	
	n	(%)	n	(%)	n	(%)	n	(%)
Vibrio parahaemolyticus	149	(52.8)	179	(54.2)	201	(50.3)	370	(61.4)
Vibrio alginolyticus	46	(16.3)	49	(14.8)	103	(25.8)	117	(19.4)
Vibrio vulnificus	50	(17.7)	61	(18.5)	63	(15.8)	65	(10.8)
Vibrio fluvialis	21	(7.4)	24	(7.3)	18	(4.5)	28	(4.6)
Vibrio mimicus	11	(3.9)	9	(2.7)	9	(2.3)	11	(1.8)
Vibrio harveyi	0	(0)	2	(0.6)	4	(1.0)	3	(0.5)
Other	5	(1.8)	6	(1.8)	2	(0.5)	9	(1.5)
Total	**282**	**(100)**	**330**	**(100)**	**400**	**(100)**	**603**	**(100)**

Table 55. Minimum inhibitory concentrations (MICs) and resistance of isolates of *Vibrio* species other than *V. cholerae* to antimicrobial agents, 2012 (N=603)

Rank*	CLSI[†] Antimicrobial Class		Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**																				
	Antimicrobial Agent	Species (# of isolates)	%I[‡]	%R[§]	[95% CI][¶]	0.002	0.004	0.007	0.015	0.03	0.06	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	512	1024	2048
I	**Aminoglycosides**																									
	Kanamycin[††]	**All** (603)	N/A	N/A	N/A											2.5	49.3	42.3	5.6	0.3						
		parahaemolyticus (370)	N/A	N/A	N/A											1.6	50.0	47.0	1.4							
		alginolyticus (117)	N/A	N/A	N/A											1.7	64.1	33.3	0.9							
		vulnificus (65)	N/A	N/A	N/A												6.2	50.8	40.0	3.1						
	Streptomycin[††]	**All** (603)	N/A	N/A	N/A										0.2	1.8	5.8	50.1	40.8	1.0	0.2	0.2				
		parahaemolyticus (370)	N/A	N/A	N/A											0.5	1.1	50.5	46.8	0.5	0.3	0.3				
		alginolyticus (117)	N/A	N/A	N/A										0.9		7.7	82.9	8.5							
		vulnificus (65)	N/A	N/A	N/A												3.1	6.2	86.2	4.6						
	Penicillins																									
	Ampicillin	**All** (603)	15.8	29.9	[26.2 - 33.7]									0.3	10.0	10.3	20.2	13.6	15.8	8.5	2.8	1.7	2.5	14.4		
		parahaemolyticus (370)	23.2	14.1	[10.7 - 18.0]										0.8	13.8	28.1	20.0	23.2	9.7	2.7	0.3		1.4		
		alginolyticus (117)	0.9	98.3	[94.0 - 99.8]											0.9			0.9	6.0	6.0	6.8	10.3	69.2		
		vulnificus (65)	0.0	1.5	[0.0 - 8.3]									1.5	84.6	9.2	3.1			1.5						
	Quinolones																									
	Ciprofloxacin	**All** (603)	0.0	0.0	[0.0 - 0.6]	0.2	0.8	4.5	0.7	6.3	12.4	46.8	26.9	1.5												
		parahaemolyticus (370)	0.0	0.0	[0.0 - 1.0]		0.3	0.5	0.3	3.0	5.4	61.9	28.4	0.3												
		alginolyticus (117)	0.0	0.0	[0.0 - 3.1]					3.4	8.5	40.2	45.3	2.6												
		vulnificus (65)	0.0	0.0	[0.0 - 5.5]		1.5	1.5		32.3	61.5	3.1														
	Nalidixic acid[††]	**All** (603)	N/A	N/A	N/A								0.5	3.2	25.0	60.9	9.3	0.8	0.2					0.2		
		parahaemolyticus (370)	N/A	N/A	N/A									2.2	21.9	67.0	7.6	1.1	0.3							
		alginolyticus (117)	N/A	N/A	N/A								0.9	2.6	25.6	58.1	12.0							0.9		
		vulnificus (65)	N/A	N/A	N/A								1.5	3.1	30.8	47.7	16.9									
II	**Cephems**																									
	Cephalothin[††]	**All** (603)	N/A	N/A	N/A										0.3	1.8	4.8	31.2	52.2	5.8	0.2	0.2	0.2	3.3		
		parahaemolyticus (370)	N/A	N/A	N/A												3.0	24.9	64.1	7.3	0.3		0.3	0.3		
		alginolyticus (117)	N/A	N/A	N/A										0.9	0.9	0.9	34.2	59.0	4.3						
		vulnificus (65)	N/A	N/A	N/A												10.8	81.5	6.2					1.5		
	Folate pathway inhibitors																									
	Trimethoprim-sulfamethoxazole	**All** (603)	N/A	0.0	[0.0 - 0.6]				0.2	0.3	4.0	49.3	44.4	1.8												
		parahaemolyticus (370)	N/A	0.0	[0.0 - 1.0]					0.3	0.5	28.4	68.1	2.7												
		alginolyticus (117)	N/A	0.0	[0.0 - 3.1]					0.9	0.9	88.9	9.4													
		vulnificus (65)	N/A	0.0	[0.0 - 5.5]				1.5		24.6	70.8	1.5	1.5												
	Phenicols																									
	Chloramphenicol[††]	**All** (603)	N/A	N/A	N/A							0.2		1.8	75.6	21.2	0.5	0.3	0.3							
		parahaemolyticus (370)	N/A	N/A	N/A										68.6	29.7	0.8	0.3	0.5							
		alginolyticus (117)	N/A	N/A	N/A							0.9		3.4	88.0	7.7										
		vulnificus (65)	N/A	N/A	N/A									7.7	90.8	1.5										
	Tetracyclines																									
	Tetracycline	**All** (603)	0.3	0.3	[0.0 - 1.2]							0.2	0.5	3.3	36.3	52.6	6.5	0.3		0.2				0.2		
		parahaemolyticus (370)	0.5	0.5	[0.1 - 1.9]									0.3	28.6	63.8	6.2	0.5		0.3				0.3		
		alginolyticus (117)	0.0	0.0	[0.0 - 3.1]									2.6	51.3	45.3	0.9									
		vulnificus (65)	0.0	0.0	[0.0 - 5.5]							1.5	3.1	20.0	67.7	7.7										

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix B, 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 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 56. Percentage and number of isolates of *Vibrio* species other than *V. cholerae* resistant to ampicillin, 2009–2012

Species	2009	2010	2011	2012
Vibrio parahaemolyticus	9.4% 14	8.4% 15	40.3% 81	14.1% 52
Vibrio alginolyticus	82.6% 38	89.8% 44	95.1% 98	98.3% 115
Vibrio vulnificus	2.0% 1	0.0% 0	4.8% 3	1.5% 1
Vibrio fluvialis	33.3% 7	12.5% 3	44.4% 8	21.4% 6
Vibrio mimicus	9.1% 1	0.0% 0	0.0% 0	9.1% 1
Vibrio harveyi	N/A* 0	50.0% 1	100% 4	100% 3
Other	20.0% 1	0.0% 0	0.0% 0	22.2% 2
Total	22.0% 62	19.1% 63	48.5% 194	29.9% 180

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

Antimicrobial Resistance: 1996–2012

The following figures display resistance to selected agents and combinations of agents from 1996–2012 for non-typhoidal *Salmonella*, 1999–2012 for *Salmonella* ser. Typhi, 1997–2012 for *Campylobacter*, and 1999–2012 for *Shigella*.

Figure 17. Percentage of non-typhoidal *Salmonella* isolates resistant to nalidixic acid, by year, 1996–2012

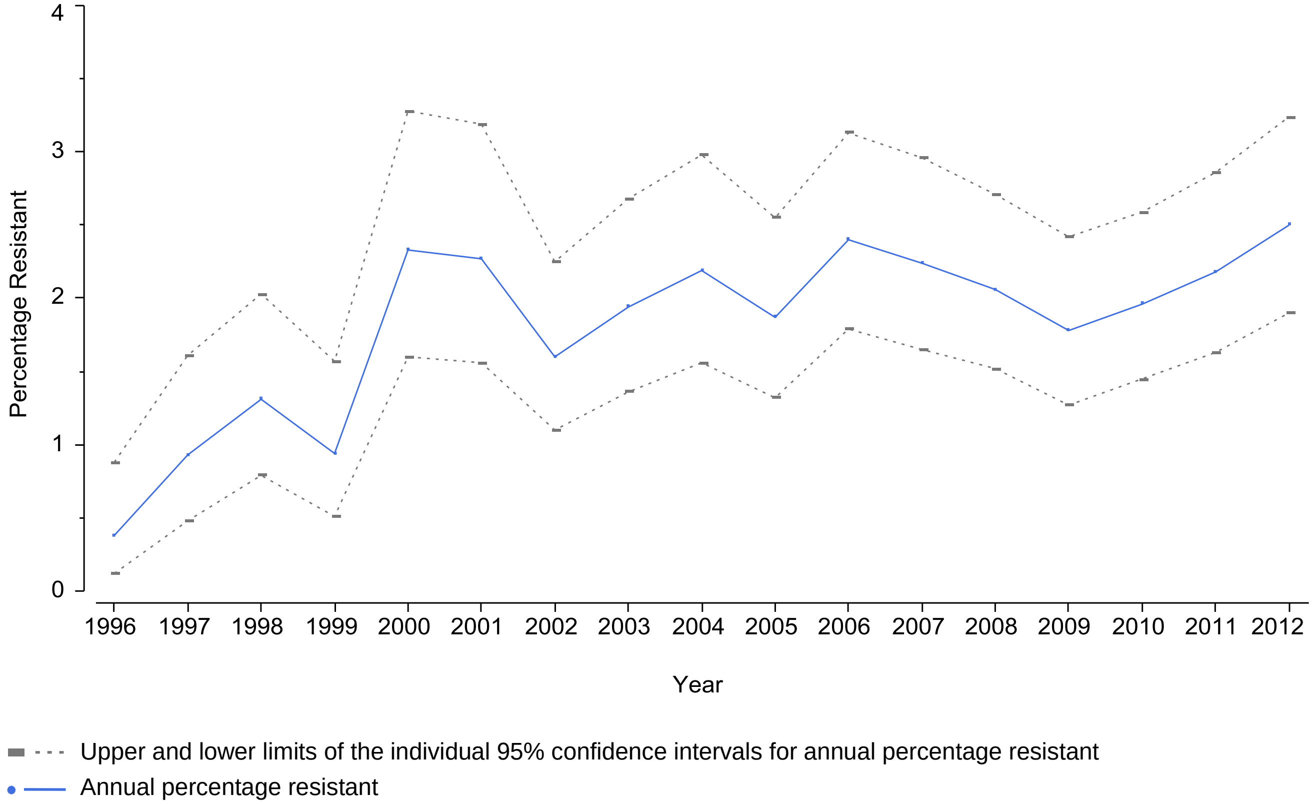


Figure 18. Percentage of non-typhoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2012

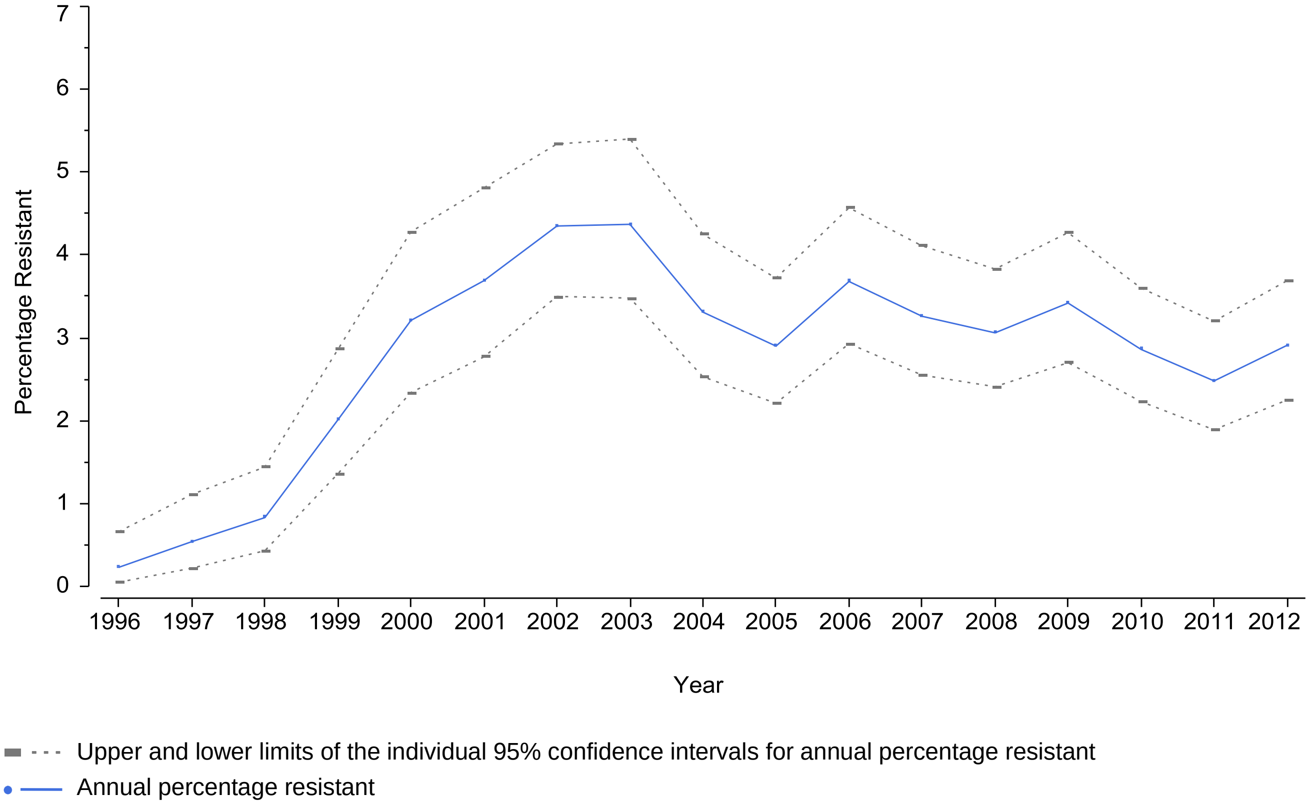


Figure 19. Percentage of *Salmonella* ser. Enteritidis isolates resistant to nalidixic acid, by year, 1996–2012

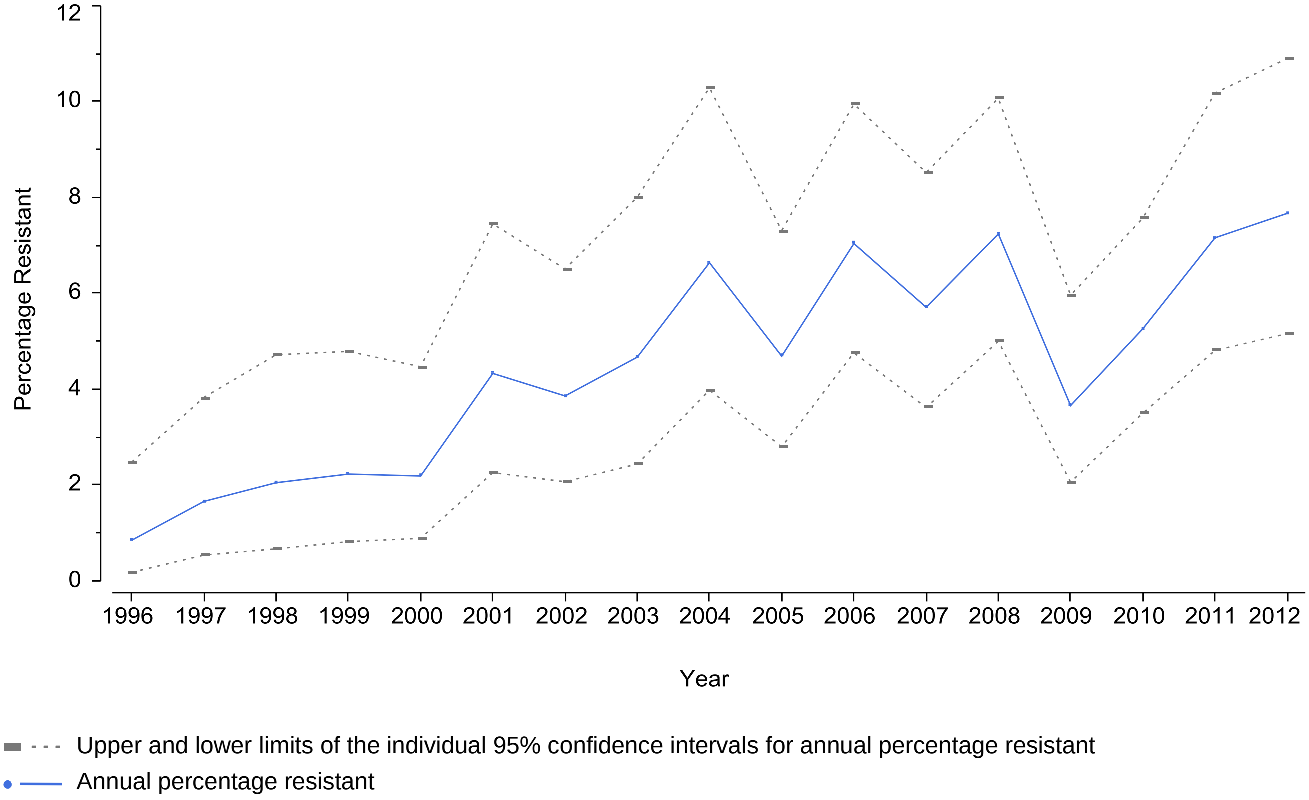


Figure 20. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2012

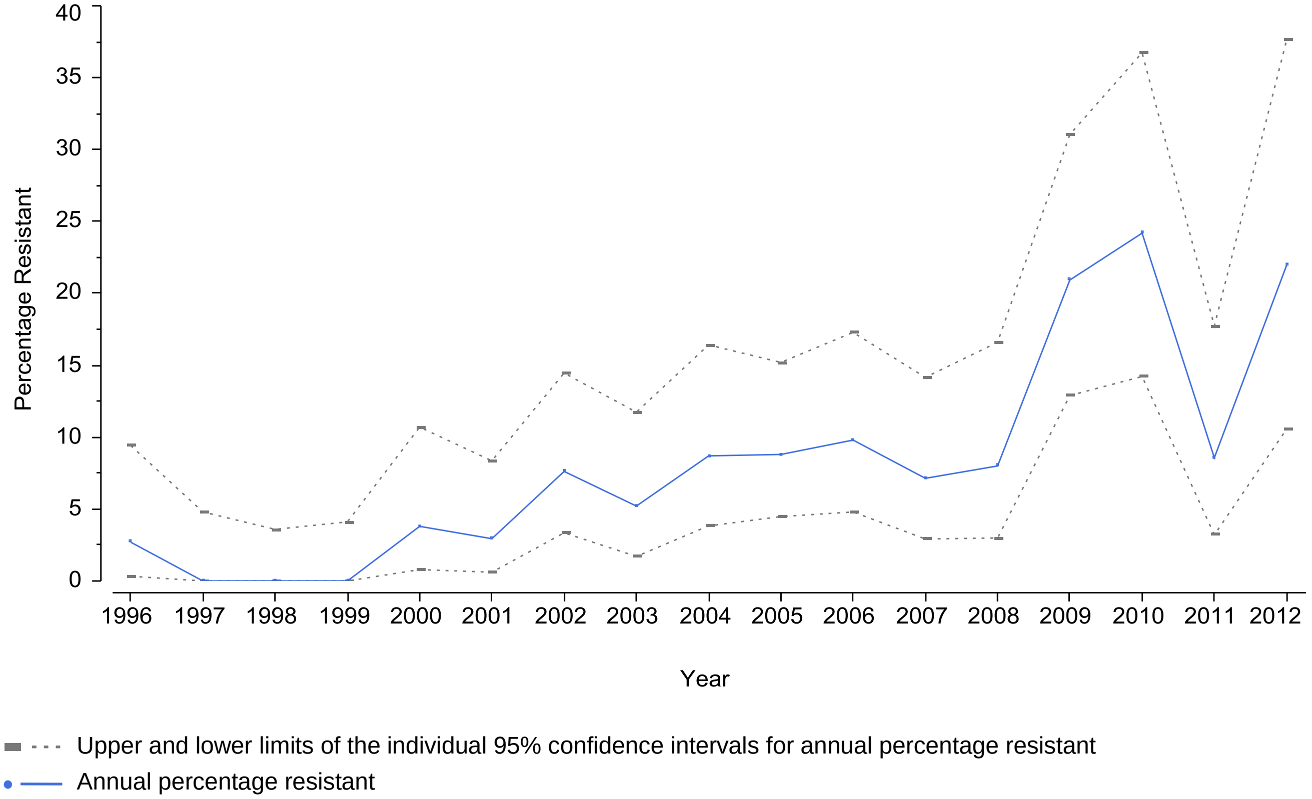


Figure 21. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2012

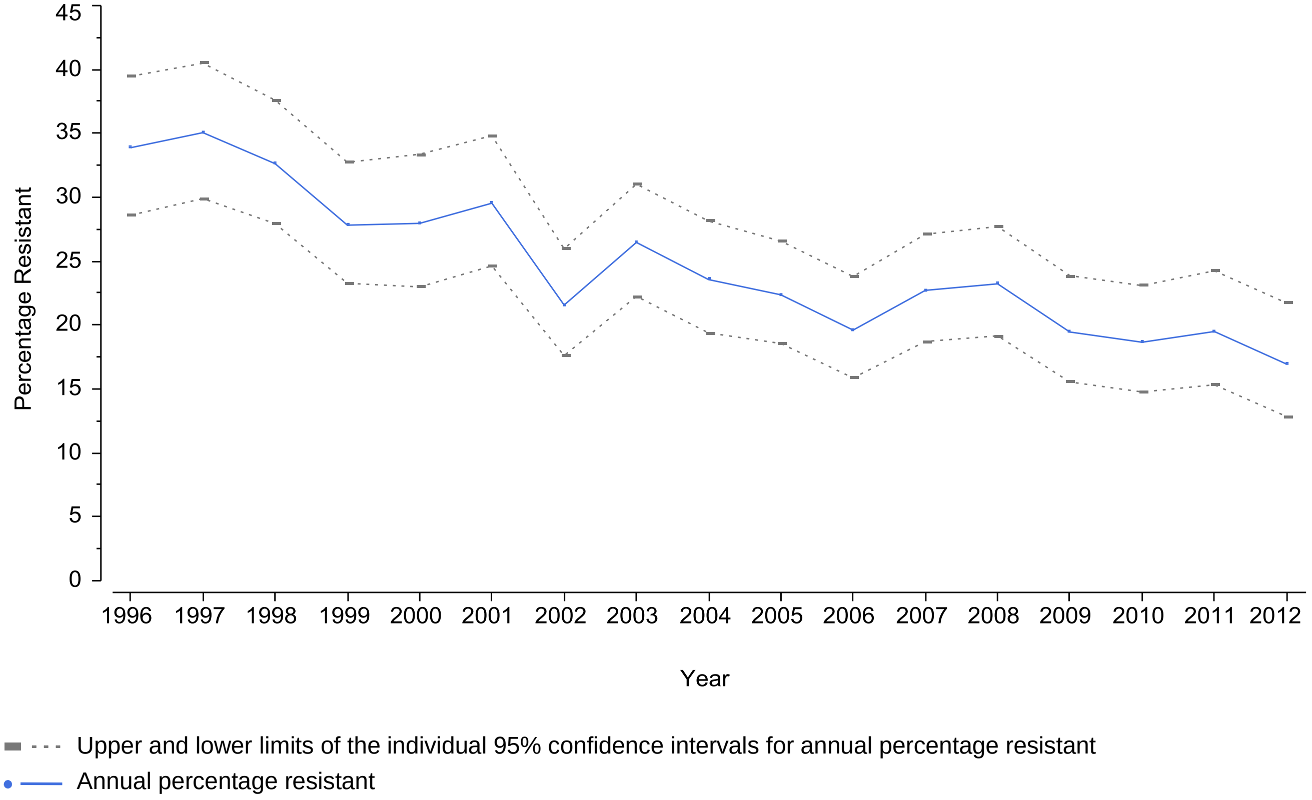


Figure 22. Percentage of *Salmonella* ser. Newport isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx), by year, 1996–2012

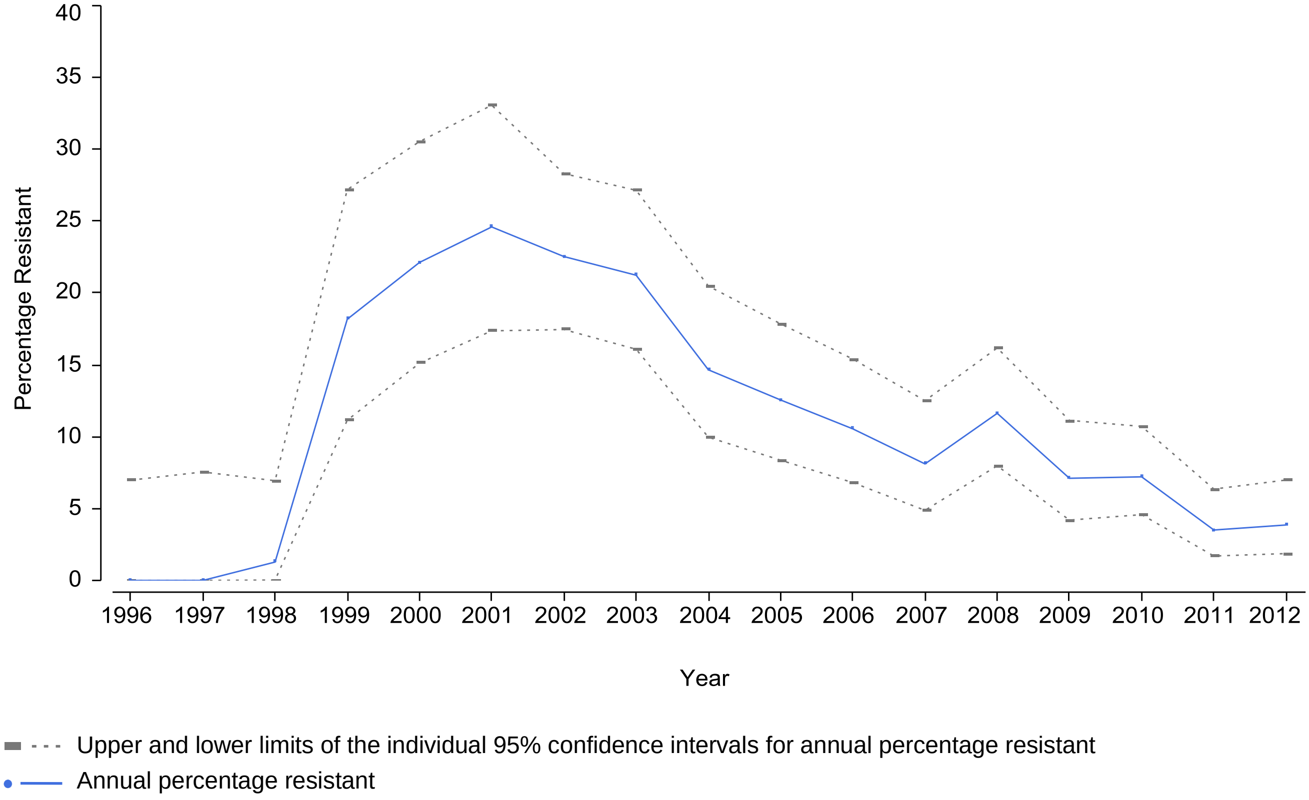


Figure 23. Percentage of non-typhoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2012

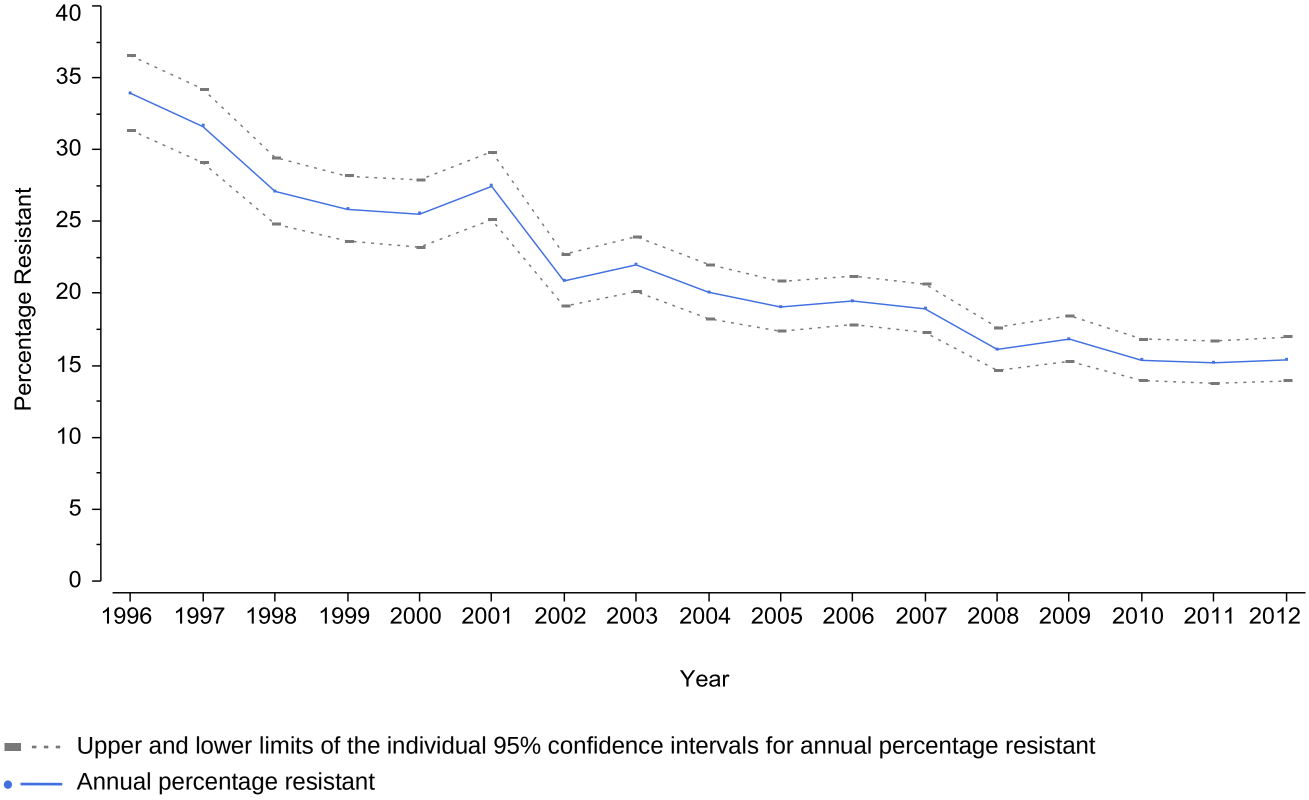


Figure 24. Percentage of non-typhoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2012

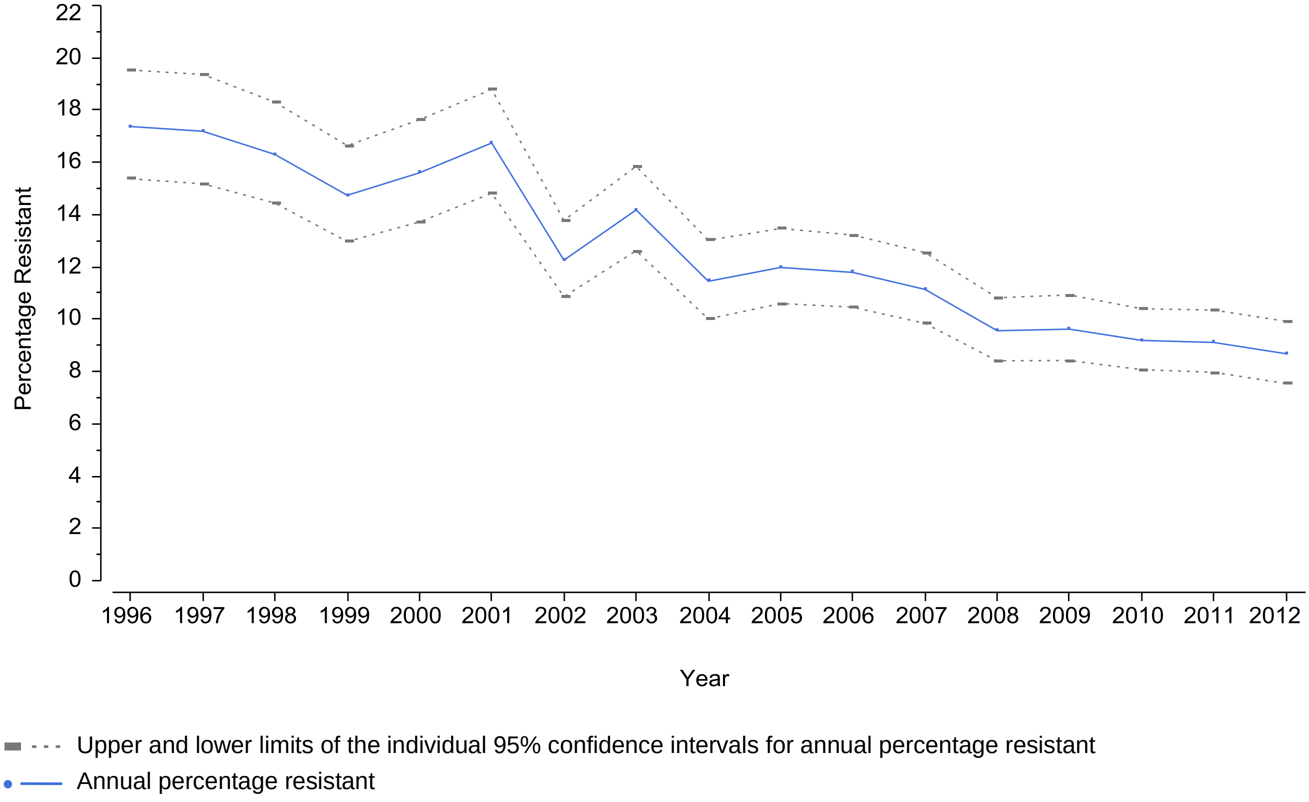


Figure 25. Percentage of *Salmonella* ser. Typhi isolates resistant to nalidixic acid, by year, 1999–2012

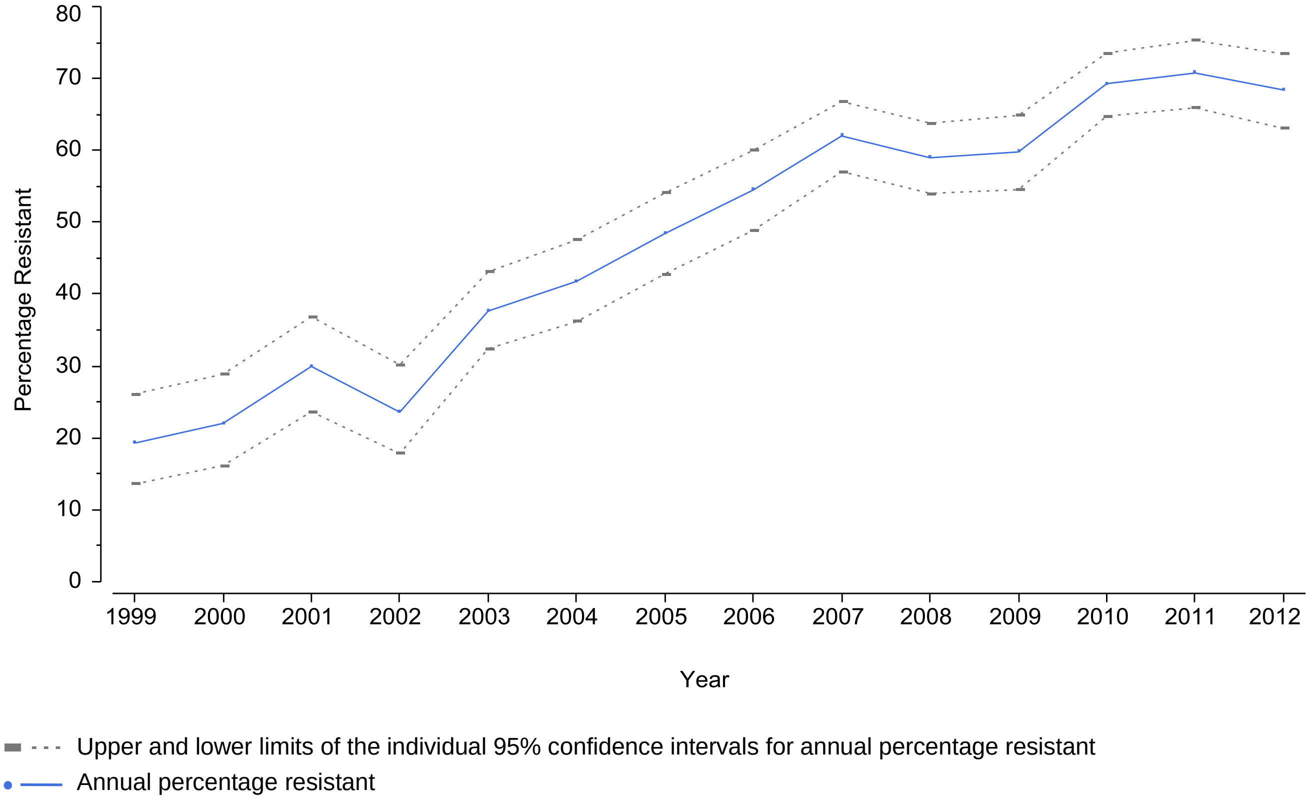


Figure 26. Percentage of *Campylobacter jejuni* isolates resistant to ciprofloxacin, by year, 1997–2012

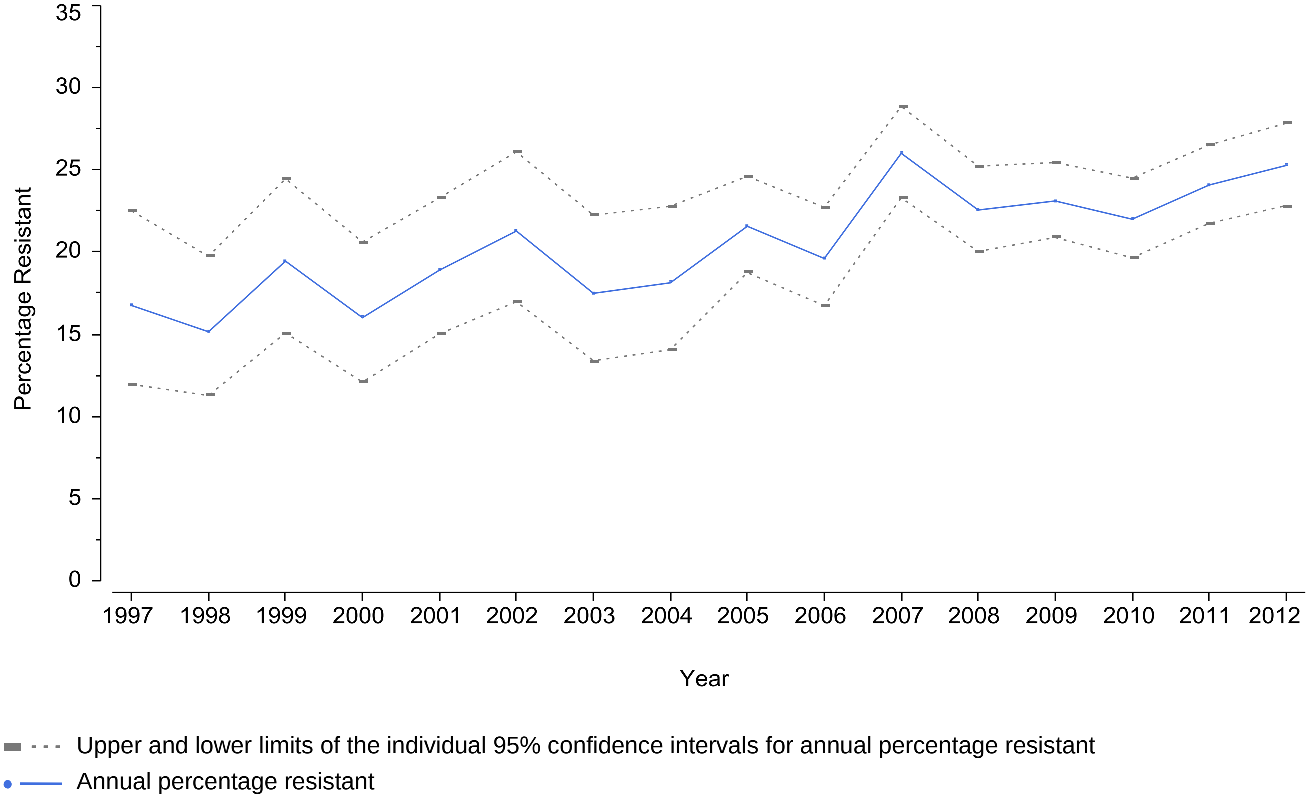


Figure 27. Percentage of *Campylobacter coli* isolates resistant to ciprofloxacin, by year, 1997–2012

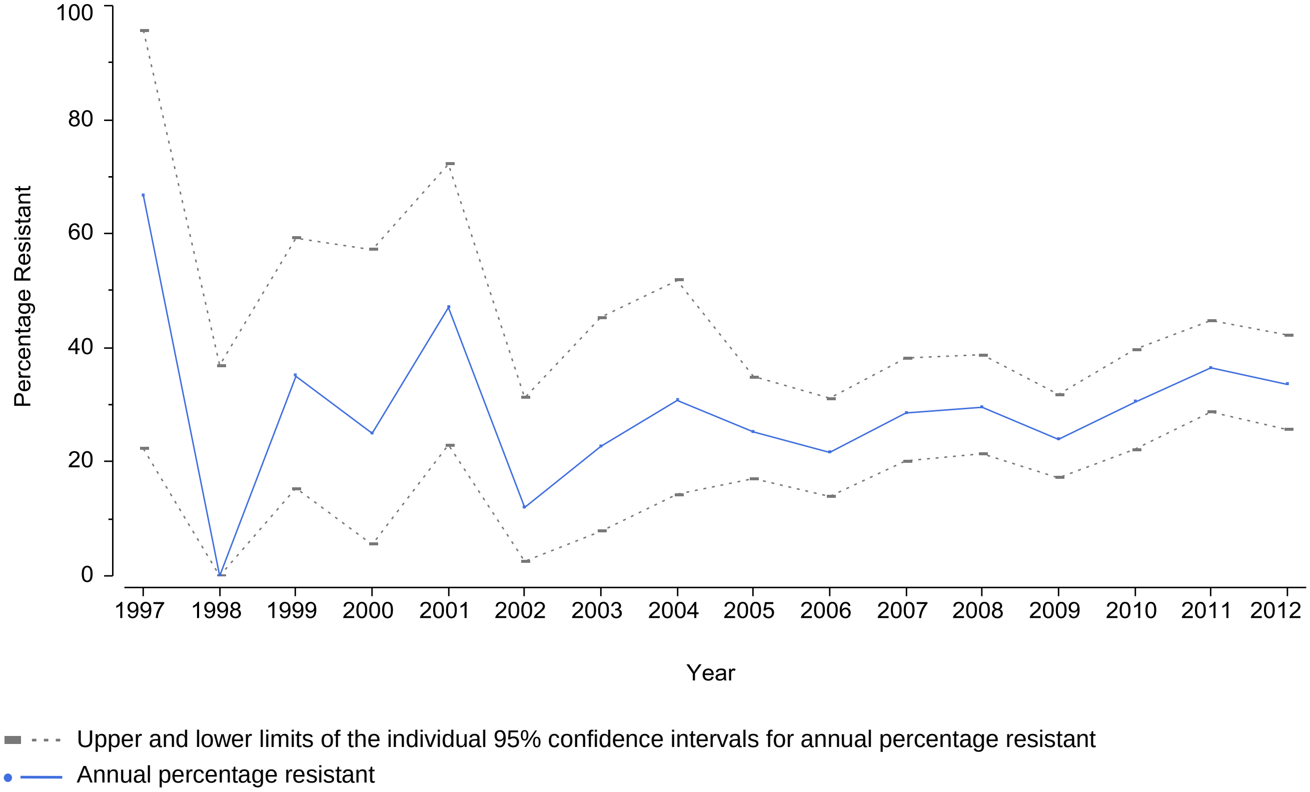
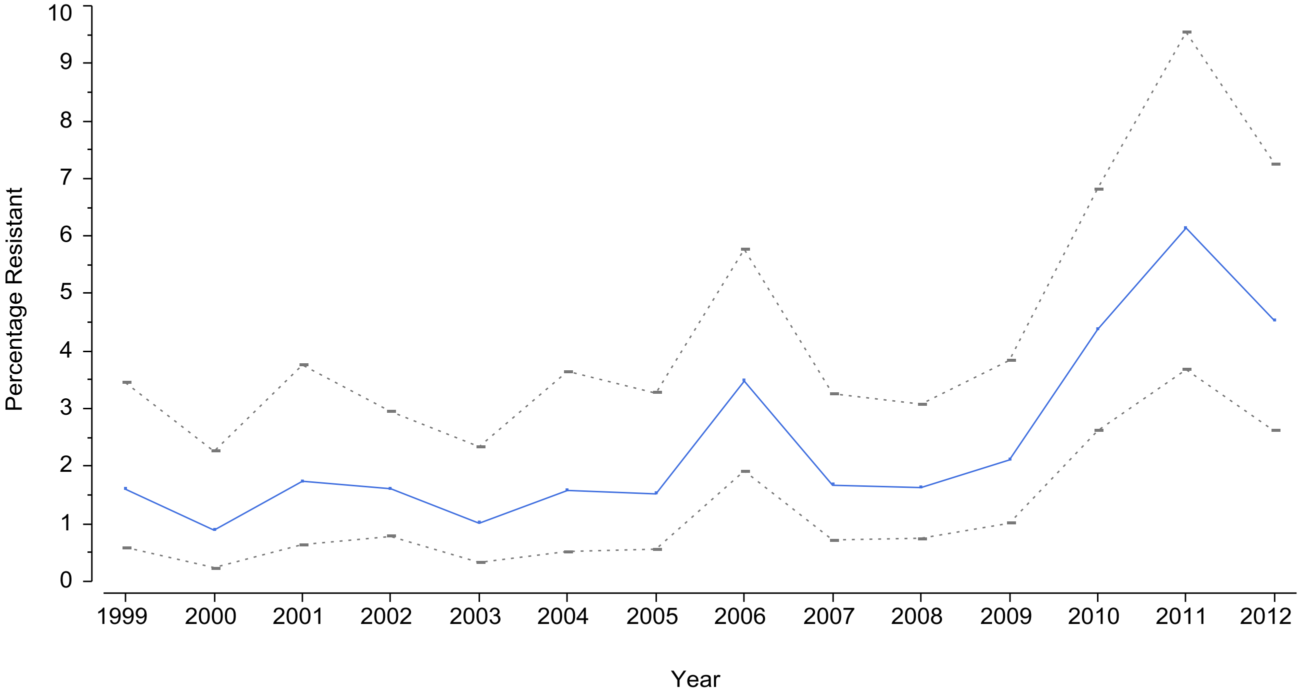


Figure 28. Percentage of *Shigella* isolates resistant to nalidixic acid, by year, 1999–2012



▬ · · · Upper and lower limits of the individual 95% confidence intervals for annual percentage resistant

● —— Annual percentage resistant

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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 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)