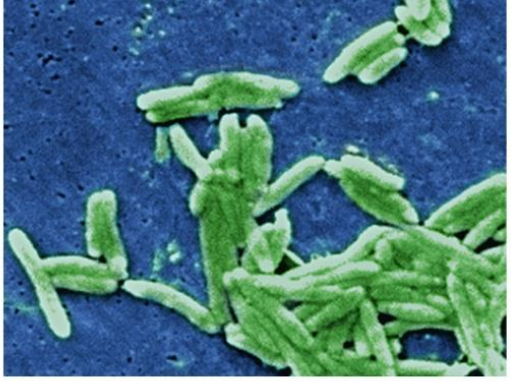


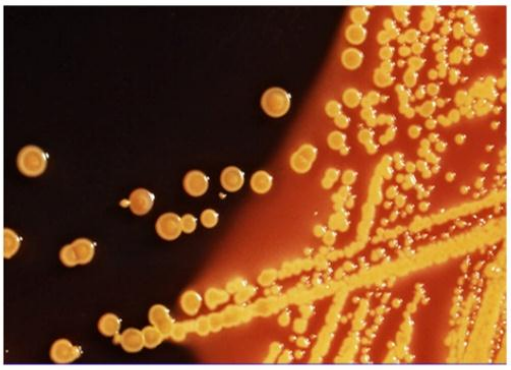
NARMS

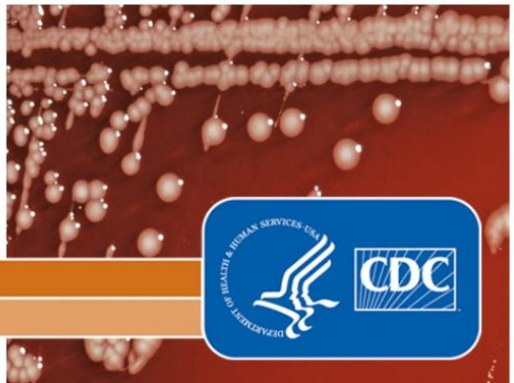
National Antimicrobial Resistance Monitoring System: Enteric Bacteria

NARMS

2011

Human Isolates Final Report





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

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Information Available Online: Previous reports and additional information about NARMS are posted on the CDC NARMS website: http://www.cdc.gov/narms

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List of Abbreviations and Acronyms

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
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
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
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
Amanda Conrad
Jason Folster
Peter Gerner-Smidt
Julian Grass
Patricia Griffin
Robert Michael Hoekstra
Rebecca Howie
Martha Iwamoto
Kevin Joyce
Maria Karlsson
Beth Karp
Amy Krueger
Andre McCullough
Felicita Medalla
Allison O'Donnell
Gary Pecic
Melissa Pitcher
Jared Reynolds
Regan Rickert
Robert Tauxe
Julia Taylor
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
Yolonda Gordon
Catrina Hollins
Sharon Massingale
Patricia Morrow
Tina Pippin
Joanna Roberson

Alaska Department of Health and Social Services
Shellie Smith
Catherine Xavier

Arizona Department of Health Services
Shoana Anderson
Aarikha D'Souza
Sherry Gower
Ken Komatsu
William Slanta
Victor Waddell

Arkansas Department of Health
Rossina Stefanova

California Department of Health Services
Claudia Crandall
Gillian Edwards

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

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

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

Florida Department of Health
Ronald Baker
Beth Burden
Sonia Etheridge
Robyn Kay

Georgia Division of Public Health
Jim Benson
Cherie Drenzek
Elizabeth Franko
Mahin Park
Lynett Poventud
Melissa Tobin-D'Angelo

Hawaii Department of Health
Rebecca Kanenaka
Norman O'Connor

Houston Health and Human Services Department
Raouf Arafat
Adebowale Awosika-Olumo
Pamela Brown-Bywaters
Gregory Dufour
Vern Juchau
Sudha Pottumarthy
Joan Rogers

Idaho Department of Health and Welfare
Colleen Greenwalt
Vivian Lockary
Raemi Nolevanko

Illinois Department of Public Health
Nancy Barstead
Robert Cox
Rebecca Hambelton
Stephen Hendren
Steve Hopkins
Patricia Kloppenburg
Mary Konczyk
Patrick Miller
Mohammad Nasir
Kiran Patel
Tricia Patterson
Guinevere Reserva
Andrea Stadsholt

Indiana State Department of Health
Brent Barrett
Sarah Popovich
Jon Radosevic

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
Robin Cotton
Karim George
William Grooms
Darrin Sevier
Jack Wiedo

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

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

Maine Department of Human Services
Geoff Beckett
Kathleen Gensheimer
Jeff Randolph
Vicki Rea
Lori Webber
Donna Wrigley
Anthony Yartel

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

Massachusetts Department of Public Health
Catherine Brown
Larry Connolly
Alfred DeMaria
Emily Harvey
Patricia Kludt
Tracy Stiles

Michigan Department of Community Health
Carrie Anglewicz
Jennifer Beggs
Frances Downes
Jennie Finks
James Rudrik
Kelly Scott
Sandip Shah

Minnesota Department of Health
Billie Juni
Fe Leano
Stephanie Meyer
Kirk Smith
Charlotte Taylor
Theresa Weber

Mississippi Department of Health
Jannifer Anderson
Jane Campbell
Sheryl Hand
Cathie Hoover
Lucersia Nichols
Alice Singley
Daphne Ware

Missouri Department of Health
David Byrd
Russ Drury
Steve Gladbach
Jason Herstein
Harvey Marx
Katy Morgan
JoAnn Rudroff

Montana Department of Public Health and Human Services
Allison Bishop
Debbie Gibson
Karl Milhon
Susanne Zanto

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

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

New Hampshire Department of Health and Human Services
Christine Adamski
Christine Bean
Elizabeth Daly
Wendy Lamothe
Nancy Taylor
Daniel Tullo

New Jersey Department of Health
Ruth Besco
Michelle Malavet
Sylvia Matiuck
Paul Seitz

New Mexico Department of Health
Lisa Butler
Sarah Khanlian
Robert Mansman
Cynthia Nicholson
Lisa Onischuk
Erica Pierce
Paul Torres

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

New York State Department of Health
Leanna Armstrong
Nellie Dumas
Dale Morse
Tim Root
Shelley Zansky

North Carolina Department of Health and Human Services
Denise Griffin
Debra Springer

North Dakota Department of Health
Julie Wagendorf
Eric Hieb
Laura Mastel
Tracy Miller
Lisa Well

Ohio Department of Health
Tammy Bannerman
Rick Bokanyi
Rebekah Carman
Jane Carmean
Larry King
Marika Mohr
Scott Nowicki
Kim Quinn
Ellen Salehi
Mindy Schwartz

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
Beletsachew Shiferaw
Janie Tierheimer
Robert Vega
Veronica Williams

Pennsylvania Department of Human Service
Lisa Dettinger
James Lute
Nkuchia M'ikanatha
Carol Sandt
James Tait

Rhode Island Department of Health
Tara Cooper
Deanna Simmons
Cindy Vanner

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

South Dakota Department of Health
Christopher Carlson
Laurie Gregg
Lon Kightlinger

Tennessee Department of Health
Parvin Arjmandi
John Dunn
Samir Hanna
Henrietta Hardin
Tim Jones
Sheri Roberts
Amy Woron

Texas Department of State Health Services
Tamara Baldwin
Elizabeth Delamater
Linda Gaul
Grace Kubin
Tori Ponson
Chun Wang

Utah Department of Health
Kim Christensen
Jana Coombs
David Jackson
Barbara Jepson
Susan Mottice

Vermont Department of Health
Erica Berl
Mary CelottiValerie Cook
Christine LaBarre
Bradley Tompkins

Virginia Division of Consolidated Laboratory Services and Virginia Department of Health
Ellen Bassinger
Sherry Giese
Jody Lowman
Mary Mismas
Denise Toney

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
John Archer
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/main/site_main.htm?modecode=66-12-05-08).

Many NARMS activities are conducted within the framework of the Foodborne Diseases Active Surveillance Network (FoodNet), which is part of CDC's Emerging Infections Program (EIP), and also with CDC's Epidemiology and Laboratory Capacity (ELC) Program. In addition to 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 that 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 prospective monitoring of antimicrobial resistance among clinical non-Typhi *Salmonella* (refers to all serotypes other than Typhi, which causes typhoid fever) and *Escherichia coli* O157 isolates in 14 sites. In 1997, testing of clinical *Campylobacter* isolates was initiated in the five sites participating in FoodNet. Testing of clinical *Salmonella enterica* serotype Typhi and *Shigella* isolates was added in 1999. Since 2003, all 50 states have been forwarding 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 FoodNet states have been participating in *Campylobacter* surveillance. Since 2008, all 50 states have been forwarding every *Salmonella* 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 2011 for non-typhoidal *Salmonella*, typhoidal *Salmonella, Shigella*, *Campylobacter, E. coli* O157, and *Vibrio* species other than *V. cholerae*. Surveillance data include the number of isolates tested by NARMS for each pathogen, 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 concentration (MIC) and percent resistant tables.

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 2011

Azithromycin Susceptibility Data for *E. coli* O157, *Salmonella* and *Shigella*

For the first time, we present azithromycin susceptibility data for *Escherichia coli* O157, *Shigella*, and *Salmonella*. Currently, azithromycin is recommended for the treatment of both shigellosis and invasive salmonellosis by the World Health Organization and The American Academy of Pediatrics, and this drug is increasingly being used for the management of uncomplicated enteric fever (World Health Organization, 2005; American Academy of Pediatrics, 2012) At present, no CLSI clinical azithromycin breakpoints have been defined for *Enterobacteriaceae*, including *Salmonella* and *Shigella*. The azithromycin breakpoints used in this report are based on epidemiological cut-offs determined from NARMS MIC distributions of *Salmonella* and *Shigella* (Sjölund-Karlsson et al, 2011; Howie at al 2010). It should be noted that these NARMS-developed breakpoints cannot be used to predict clinical efficacy. Azithromycin replaced the aminoglycoside amikacin on the panel of drugs being tested, so only historical susceptibility data are provided for amikacin.

Fluoroquinolone Breakpoints for *Enterobacteriaceae*

In 2012, CLSI revised the fluoroquinolone interpretive criteria for invasive *Salmonella*. In our 2010 report, fluoroquinolone susceptibility data using both the outgoing and new breakpoints were reported. In this report, all interpretations are based on the new breakpoints published in the January 2012 CLSI M100 document. For public health surveillance purposes, the new breakpoints were applied to all *Salmonella* isolates (not just those from sterile sites) because all *Salmonella* serotypes have the potential to cause invasive infection.

Testing of Ceftriaxone/Ceftiofur-Resistant Non-Typhoidal *Salmonella* for Resistance to Additional Broad-Spectrum β-lactams

Starting in 2011, all non-typhoidal *Salmonella* isolates displaying resistance to the third-generation cephalosporins ceftriaxone (MIC ≥4 µg/mL) or ceftiofur (MIC ≥8 µg/mL) were subjected to additional testing. Results for six broad-spectrum β-lactam drugs, including aztreonam, cefepime, cefotaxime, ceftazidime, imipenem, and piperacillin-tazobactam are reported. The results are presented on page 15.

Summary of NARMS 2011 Surveillance Data

Population

In 2011, all 50 states and the District of Columbia participated in NARMS, representing the entire U.S. population of approximately 312 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 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 those caused by *Salmonella* ser. Typhi, the organism that causes typhoid fever. In *Enterobacteriaceae*, resistance to nalidixic acid, an elementary quinolone, correlates with decreased susceptibility to ciprofloxacin (MIC≥0.12 µg/mL) and possible fluoroquinolone treatment failure. Macrolides (e.g., azithromycin) are also of clinical importance. A substantial proportion of *Enterobacteriaceae* isolates tested in 2011 demonstrated clinically important resistance.

Among *Salmonella* isolates, antimicrobial resistance varies by serotype. Changes in resistance among all non-typhoidal *Salmonella* may reflect changes in resistance within serotypes, changes in serotype distribution, or both.

- 2.4% (57/2344) of non-typhoidal *Salmonella* isolates were resistant to nalidixic acid. Enteriditis was the most common serotype among nalidixic acid-resistant non-typhoidal *Salmonella* isolates.
    - 49% (28/57) of nalidixic acid-resistant isolates were ser. Enteriditis
    - 7.2% (28/391) of ser. Enteriditis isolates were resistant to nalidixic acid
- 2.5% (58/2344) of non-typhoidal *Salmonella* isolates were resistant to ceftriaxone. The most common serotypes among the 58 ceftriaxone-resistant isolates were Typhimurium, Newport, and Heidelberg. Resistance was detected in
    - 6.8% (22/323) of ser. Typhimurium isolates
    - 3.9% (11/285) of ser. Newport isolates
    - 8.6% (6/70) of ser. Heidelberg isolates
- 0.2% (5/2344) of non-typhoidal *Salmonella* isolates were resistant to azithromycin.
- 71% (271/383) of *Salmonella* ser. Typhi isolates were resistant to nalidixic acid and 7.3% (28/383) were resistant to ciprofloxacin.
- 97% (141/146) of *Salmonella* ser. Paratyphi A isolates were resistant to nalidixic acid and 2.1% (3/146) were resistant to ciprofloxacin.

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

- 2.4% (7/293) of *Shigella* isolates were resistant to ciprofloxacin, including
    - 6.9% (4/58) of *Shigella flexneri* isolates
- 6.1% (18/293) of *Shigella* isolates were resistant to nalidixic acid, including
    - 12% (7/58) of *Shigella flexneri* isolates
- 3.1% (9/293) of *Shigella* isolates were resistant to azithromycin, including
    - 10% (6/58) of *Shigella flexneri* isolates
    - 0.9% (2/225) of *Shigella sonnei* isolates

In *Campylobacte*r, fluoroquinolones and macrolides (e.g., erythromycin) are important agents in the treatment of severe infections. Gentamicin is less commonly used for treatment.

- 24% (357/1478) of *Campylobacter* isolates were resistant to ciprofloxacin, including
    - 24% (299/1275) of *Campylobacter jejuni* isolates
    - 36% (53/148) of *Campylobacter coli* isolates
- 1.8% (27/1478) of *Campylobacter* isolates were resistant to erythromycin, including
    - 1.7% (22/1275) of *Campylobacter jejuni* isolates
    - 2.7% (4/148) of *Campylobacter coli* isolates
- 2.0% (30/1478) of *Campylobacter* isolates were resistant to gentamicin, including
    - 12% (18/148) of *Campylobacter coli* isolates

Multidrug Resistance

Multidrug resistance is reported in NARMS in different ways, including resistance to multiple 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 encompass five CLSI classes. Another important phenotype includes resistance to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCX); these agents encompass seven CLSI classes.

- 9.1% (213/2344) of non-typhoidal *Salmonella* isolates were resistant to three or more CLSI classes. The most common serotypes with this resistance pattern were Typhimurium, I,4,[5],12:i:, Heidelberg, Newport, Enteritidis, and Dublin. Resistance to three or more classes occurred in
    - 26% (85/323) ser. Typhimurium isolates
    - 27% (22/82) ser. I,4,[5],12:i:- isolates
    - 30% (21/70) ser. Heidelberg isolates
    - 3.9% (11/285) ser. Newport isolates
    - 2.3% (9/391) ser. Enteriditis isolates
    - 60% (6/10) ser. Dublin isolates

- 1.5% (36/2344) of non-typhoidal *Salmonella* isolates were at least ACSSuTAuCx resistant. The most common serotypes were Typhimurium, Newport, and Dublin. ACSSuTAuCx resistance occurred in
    - 5.3% (17/323) ser. Typhimurium isolates
    - 3.5% (10/285) ser. Newport isolates
    - 40.0% (4/10) ser. Dublin isolates

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

- 10.4% (40/383) of ser. Typhi isolates were resistant to at least ACT/S and 12.3% (47/383) were resistant to three or more classes

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

- 26% (76/293) of *Shigella* isolates were resistant to at least AT/S and 51% (150/293) were resistant to three or more classes

Changes in Antimicrobial Resistance: 2011 vs. 2003–2007

To understand changes in the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* over time, we used logistic regression to compare the prevalence of specific resistance patterns among isolates tested in 2011 with the average prevalence of resistance in 2003–2007. The prevalence of resistance was defined as the percentage of resistant isolates among total isolates tested. The methods are described in more detail in Surveillance and Laboratory Testing Methods. Changes in the prevalence of resistance do not provide information about 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). Since 2003, all 50 states have participated in NARMS *Salmonella* and *Shigella* surveillance and all 10 FoodNet sites in *Campylobacter* surveillance.

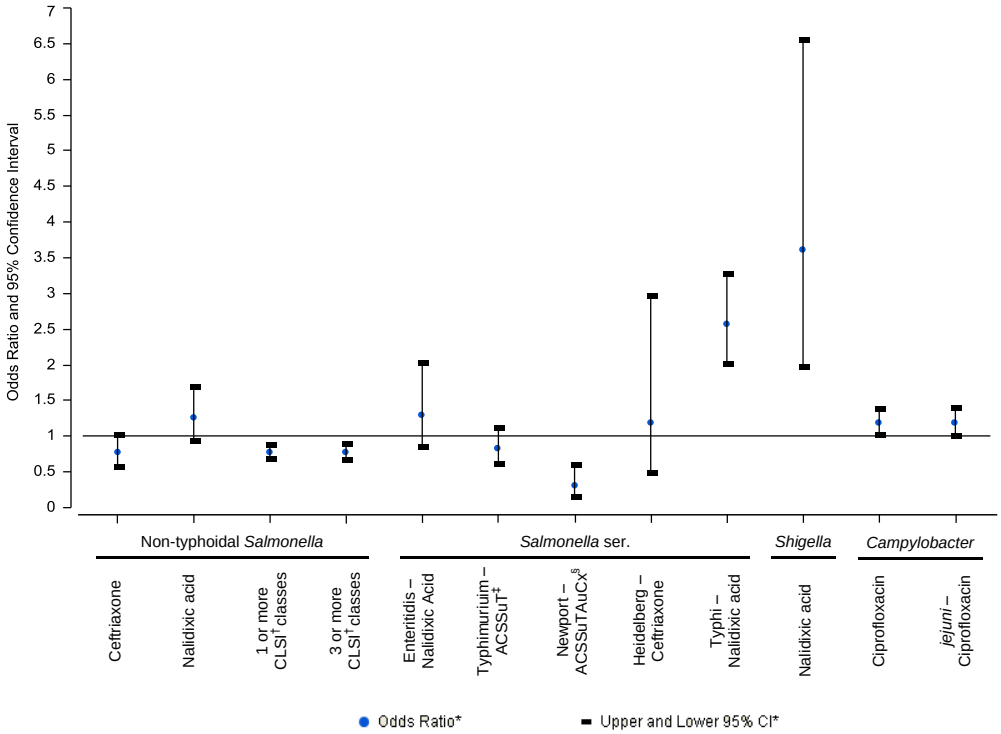
The differences between the prevalence of resistance in 2011 and the average prevalence of resistance in 2003–2007 (Figure 1) were statistically significant for the following:

- Among non-typhoidal *Salmonella*
  - Resistance to one or more CLSI classes was lower in 2011 than in 2003–2007 (15.4% vs. 19.9%; odds ratio [OR]=0.78, 95% confidence interval [CI] 0.69–0.88)
  - Resistance to three or more CLSI classes was lower in 2011 than in 2003–2007 (9.1% vs. 12.1%; OR=0.77, 95% CI 0.66–0.90)
- Among *Salmonella* of particular serotypes
  - ACSSuTAuCx resistance in ser. Newport was lower in 2011 than in 2003–2007 (3.5% vs. 13.4%; OR=0.30, 95% CI 0.15–0.59)
  - Nalidixic acid resistance in ser. Typhi was higher in 2011 than in 2003–2007 (70.8% vs. 48.9%; OR=2.56, 95% CI 2.01–3.27)
- Among *Shigella* spp.
  - Nalidixic acid resistance was higher in 2011 than in 2003–2007 (6.1% vs. 1.9%; OR=3.61, 95% CI 1.98–6.55)
- Among *Campylobacter* spp.
  - Ciprofloxacin resistance was higher in 2011 than in 2003–2007 (24.2% vs. 20.8%; OR=1.19, 95% CI 1.02–1.39)

The differences between the prevalence of resistance in 2011 and the average prevalence of resistance in 2003–2007 (Figure 1) were not statistically significant for the following:

- Among non-typhoidal *Salmonella*
  - Ceftriaxone resistance (2.5% vs. 3.5%; OR=0.78, 95% CI 0.58–1.03)
  - Nalidixic acid resistance (2.4% vs. 2.1%; OR=1.25, 95% CI 0.93–1.69)
- Among *Salmonella* of particular serotypes
  - Nalidixic acid resistance in ser. Enteritidis (7.2% vs. 5.8%; OR=1.30, 95% CI 0.84–2.03)
  - ACSSuT resistance in ser. Typhimurium (19.5% vs. 22.9%; OR=0.83, 95% CI 0.61–1.11)
  - Ceftriaxone resistance in ser. Heidelberg (8.6% vs. 7.9%; OR=1.19, 95% CI 0.48–2.96)
- Among *Campylobacter jejuni,* ciprofloxacin resistance (23.5% vs. 20.4%; OR=1.18, 95% CI 1.00–1.40)

Figure H1. Summary of trend analysis of the prevalence of specific resistance patterns among *Salmonella, Shigella,* and *Campylobacter* isolates, 2011 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 2011 compared with the reference were calculated using unconditional maximum likelihood estimation. ORs that do not include 1.00 in the 95% CIs are reported as statistically significant. California may have submitted more than 1 in 20 non-typhoidal *Salmonella* isolates from 3 counties during 2008–09; however, analysis excluding isolates from those counties showed equivalent results.

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

‡ 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

Testing of Ceftriaxone/Ceftiofur Resistant Non-Typhoidal *Salmonella* to Additional Broad-Spectrum β-Lactams, 2011

Among 2,344 isolates of non-typhoidal *Salmonella* collected by NARMS in 2011, 58 displayed resistance to the third-generation cephalosporins ceftriaxone (MIC ≥4 µg/mL) or ceftiofur (MIC ≥8 µg/mL). The antimicrobial susceptibility patterns of these isolates were further investigated by determining the MICs to additional β-lactam drugs. Results are reported for six additional β-lactam drugs (aztreonam, cefepime, ceftazidime, cefotaxime, piperacillin-tazobactam, and imipenem). Susceptibility testing was performed using broth microdilution (Sensititre®, Trek Diagnostics, Cleveland, OH) according to the manufacturer's instructions.

Among the 58 isolates tested, 6 (10.3%) showed resistance to the β-lactam/β-lactamase inhibitor combination piperacillin-tazobactam. In the cephem class, 1 (1.7%) was resistant to cefipime, all 58 to cefotaxime, and 56 (97%) ceftazidime. Twenty-four (41%) were resistant to the monobactam aztreonam and 1 (1.7%) to the penem imipenem.

A single isolate, ser. Senftenberg, displayed resistance to the carbapenem imipenem (MIC 4 µg/mL). The same isolate also displayed elevated MICs to the other drugs tested (aztreonam MIC >32 µg/mL, cefepime MIC >32 µg/mL, ceftazidime MIC >128 µg/mL, cefotaxime >128 µg/mL, and piperacillin-tazobactam MIC >128 µg/mL). Molecular characterization of this isolate revealed the presence of a gene encoding a New Delhi metallo-β-lactamase (NDM) carbapenemase, as well as two additional β-lactamase genes (bla_{TEM} and bla_{CMY} classes of genes). A NDM carbapenemase was first described by Yong et al. in 2009 and has been detected in other clinical isolates of *Enterobacteriaceae* in the United States.[1,2,3] The present isolate represents the first NDM-positive *Salmonella* identified in the United States and has been described in a previous report.[2] The detection of a NDM carbapenemase in *Salmonella* highlights the continued need for and importance of performing additional testing against broad-spectrum β-lactam drugs.

Table H1. Broad-spectrum β-lactam resistance among all ceftriaxone/ceftiofur-resistant non-typhoidal *Salmonella* isolates, 2011 (N=58)

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	β-lactam / β-lactamase inhibitor combinations	Piperacillin-tazobactam	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	
	Cephems	Cefepime	0.0	1.7	[0.0 - 9.2]				3.4	32.8	41.4	13.8	5.2		1.7			1.7			
		Cefotaxime	0.0	100	[93.8 - 100]									1.7	10.3	37.9	34.5	10.3	3.4	1.7	
		Ceftazidime	3.4	96.6	[88.1 - 99.6]										3.4	22.4	53.4	12.1	6.9	1.7	
	Monobactams	Aztreonam	43.1	41.4	[28.6 - 55.1]								6.9	8.6	43.1	27.6	8.6	5.2			
	Penems	Imipenem	0.0	1.7	[0.0 - 9.2]				1.7	77.6	19.0			1.7							

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table 1): Rank I, Critically Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Percentage of isolates with intermediate susceptibility
§ 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 areas indicate the dilution range of the Sensititre® plates used to test isolates. Single vertical bars indicate the breakpoints for susceptibility, while double vertical bars indicate breakpoints for resistance. Numbers in the shaded areas indicate the percentages of isolates with MICs greater than the highest concentrations on the Sensititre® plate. Numbers listed for the lowest tested concentrations represent the percentages of isolates with MICs equal to or less than the lowest tested concentration. CLSI breakpoints were used when available.

[1] Yong D, Toleman MA, Giske CG, Cho HS, Sundman K, Lee K, Walsh TR. Characterization of a new metallo-beta-lactamase gene, bla(NDM-1), and a novel erythromycin esterase gene carried on a unique genetic structure in Klebsiella pneumoniae sequence type 14 from India. Antimicrob Agents Chemother. 2009 Dec;53(12):5046-54.

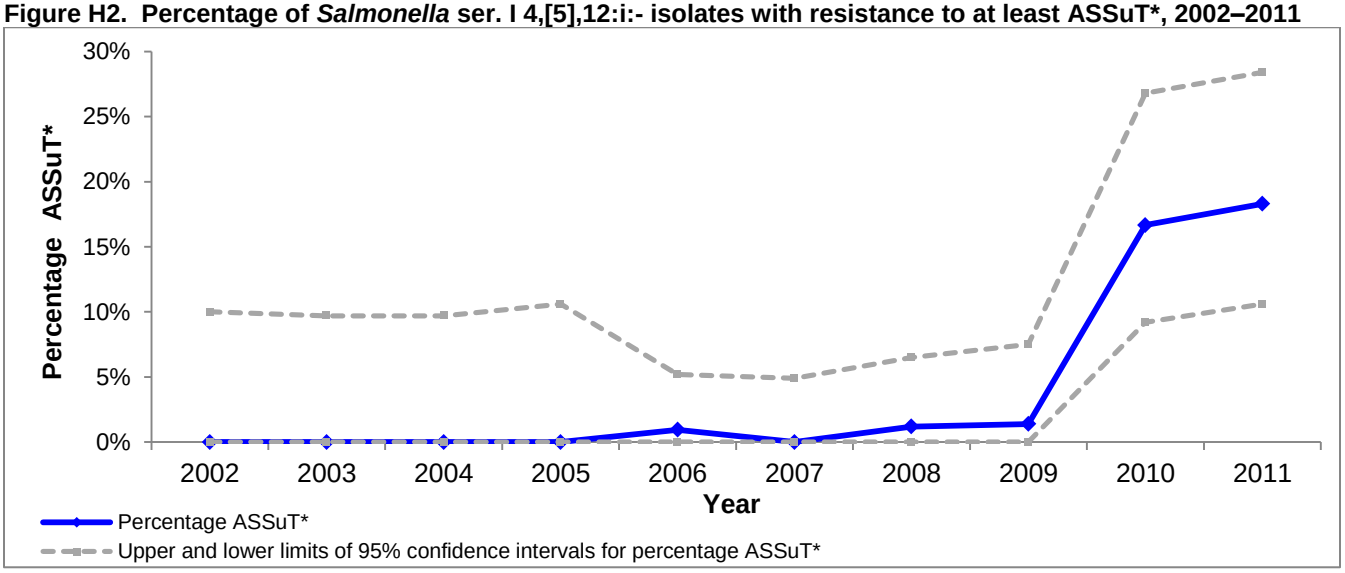
[2] Savard P, Gopinath R, Zhu W, Kitchel BJ, Rasheed K, Tekle T, Roberts A, Ross T, Razeq J, B. Landrum BM, Wilson LE, Limbago B, Perl TM, and Carroll KC. First NDM-Positive Salmonella sp. Strain Identified in the United States. Antimicrob Agents Chemother. 2011 Dec; 55(12): 5957–5958.

[3] Mochon AB, Garner OB, Hindler JA, Krogstad P, Ward KW, Lewinski MA, Rasheed JK, Anderson KF, Limbago BM, and Humphries RM. New Delhi Metallo-β-Lactamase (NDM-1)-Producing Klebsiella pneumoniae: Case Report and Laboratory Detection Strategies. J Clin Microbiol. 2011 April; 49(4): 1667–1670.

Emergence of ASSuT Resistance in *Salmonella* ser. I 4,[5],12:i:- in the United States

Over the last 10 years, a notable increase of *Salmonella* ser. I 4,[5],12:i:- infections with resistance to ampicillin, streptomycin, sulfonamide, and tetracycline (ASSuT) but not chloramphenicol, has been observed throughout Europe. Serotype I 4,[5],12:i:- is related to serotype Typhimurium (I 4,[5],12:i:1,2). Resistance is conferred by bla_{TEM}, *strA/B*, *sul2,* and *tet*(B) genes on the chromosome.[1,2] In the United States, ASSuT resistance among human *Salmonella* ser. I 4,[5],12:i:- isolates emerged in 2010; thirteen (17%) of 78 isolates in NARMS had this resistance pattern in 2010 compared with 1 (1.4%) of 72 in 2009 (Figure H2 and Table H2). Resistance to ampicillin, streptomycin, sulfonamide, and tetracycline has also been observed among NARMS isolates of *Salmonella* ser. Typhimurium; however, the majority of Typhimurium isolates resistant to these four agents showed additional resistance to chloramphenicol (ACSSuT) (Table H2), a pattern which is associated with the presence of a chromosomal resistance region called *Salmonella* Genomic Island 1 (SGI1). In Europe, infections with ASSuT-resistant *Salmonella* ser. I 4,[5],12:i:- have frequently been reported among persons exposed to pigs or pork products, and the organism has been isolated from pigs. Investigations are underway to determine the source(s) and molecular mechanisms responsible for ASSuT-resistant *Salmonella* ser. I 4,[5],12:i:- infections in the United States.

Figure H2. Percentage of *Salmonella* ser. I 4,[5],12:i:- isolates with resistance to at least ASSuT*, 2002–2011



* Resistance to ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline, and no resistance to chloramphenicol

Table H2. Percentage and number of *Salmonella* ser. I 4,[5],12;i:- and ser. Typhimurium isolates with selected resistance patterns, 2002–2011

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
I 4,[5],12:i:- isolates	**35**	**36**	**36**	**33**	**105**	**73**	**84**	**72**	**78**	**82**
At least ASSuT* and not resistant to chloramphenicol	0.0% 0	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
At least ACSSuT†	2.9% 1	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
Typhimurium isolates	**394**	**408**	**382**	**438**	**408**	**405**	**397**	**370**	**359**	**323**
At least ASSuT* and not resistant to chloramphenicol	4.3% 17	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
At least ACSSuT†	21.6% 85	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

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

[1] Hopkins KL, Kirchner M, Guerra B. Granier SA, Lucarelli C, Porrero MC, Jakubczak A, Threlfall EJ, Mevius DJ. Multiresistant *Salmonella* enterica serovar 4,[5],12:i:- in Europe: a new pandemic strain?. Euro Surveill. 2010; 15(22):pij=19580. Available online: http://www.eurosurveillance.org/images/dynamic/EE/V15N22/art19580.pdf

[2] Lucarelli C, Dionisi AM, Filetici E, Owczarek S, Luzzi I, Villa L. Nucleotide sequence of the chromosomal region conferring multidrug resistance (R-type ASSuT) in *Salmonella* Typhimurium and monophasic *Salmonella* Typhimurium strains. JAC 2012;67(1):pp111-4. Available online: http://jac.oxfordjournals.org/content/67/1/111.full.pdf+html

Surveillance and Laboratory Testing Methods

Surveillance Sites and Isolate Submissions

In 2011, NARMS conducted nationwide surveillance among approximately 312 million persons (2011 estimates published in the 2012 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 every 20th sampling for non-typhoidal *Salmonella* because available laboratory methods do not always allow for consistent distinction between serotype Paratyphi B (which typically causes typhoidal illness) and serotype Paratyphi B var. L(+) tartrate+ (which does not typically cause typhoidal illness). Because the number of serotype Paratyphi B (tartrate negative) and serotype Paratyphi C isolates is small, this report includes susceptibility results only for serotype 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 isolate of *Vibrio* species other than *V*. *cholerae* that they received to CDC for antimicrobial susceptibility testing by NARMS and confirmation by CDC's National Enteric Reference Laboratory.

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 (2011 estimates published in 2012 U.S. Census Bureau report), include Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, and selected counties in California, Colorado, and New York. Depending on the burden of *Campylobacter* in each FoodNet site, one of the following four methods was used to obtain and test a sample of *Campylobacter* isolates: 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. Isolates received from 2005 to 2009 had the same methods except all isolates were sent from Georgia, Maryland, and New Mexico. 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, 2011

State/Site	Population Size*		Non-typhoidal *Salmonella*		Typhoidal† *Salmonella*		*Shigella*		*E. coli* O157		*Campylobacter*‡		*Vibrio*	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Alabama	4,803,689	(1.5)	55	(2.3)	4	(0.8)	9	(3.1)	0	(0)			0	(0)
Alaska	723,860	(0.2)	4	(0.2)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Arizona	6,467,315	(2.1)	46	(2.0)	1	(0.2)	13	(4.4)	2	(1.2)			6	(1.5)
Arkansas	2,938,582	(0.9)	35	(1.5)	1	(0.2)	1	(0.3)	0	(0)			0	(0)
California§	27,794,877	(8.9)	161	(6.9)	81	(15.2)	1	(0.3)	3	(1.9)	146	(9.9)	0	(0)
Colorado	5,116,302	(1.6)	27	(1.2)	7	(1.3)	4	(1.4)	3	(1.9)	37	(2.5)	6	(1.5)
Connecticut	3,586,717	(1.2)	28	(1.2)	5	(0.9)	1	(0.3)	3	(1.9)	168	(11.4)	11	(2.8)
Delaware	908,137	(0.3)	9	(0.4)	6	(1.1)	0	(0)	0	(0)			3	(0.8)
District of Columbia	619,020	(0.2)	8	(0.3)	0	(0)	0	(0)	0	(0)			0	(0)
Florida	19,082,262	(6.1)	68	(2.9)	15	(2.8)	0	(0)	1	(0.6)			93	(23.3)
Georgia	9,812,460	(3.1)	147	(6.3)	15	(2.8)	30	(10.2)	16	(9.9)	273	(18.5)	17	(4.3)
Hawaii	1,378,129	(0.4)	18	(0.8)	2	(0.4)	6	(2.0)	1	(0.6)			16	(4.0)
Houston, Texas¶	2,145,146	(0.7)	52	(2.2)	11	(2.1)	7	(2.4)	1	(0.6)			5	(1.3)
Idaho	1,583,744	(0.5)	6	(0.3)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Illinois	12,859,752	(4.1)	86	(3.7)	44	(8.3)	13	(4.4)	8	(4.9)			1	(0.3)
Indiana	6,516,353	(2.1)	32	(1.4)	11	(2.1)	3	(1.0)	3	(1.9)			0	(0)
Iowa	3,064,097	(1.0)	20	(0.9)	7	(1.3)	0	(0)	5	(3.1)			0	(0)
Kansas	2,870,386	(0.9)	17	(0.7)	1	(0.2)	2	(0.7)	2	(1.2)			0	(0)
Kentucky	4,366,814	(1.4)	27	(1.2)	0	(0)	0	(0)	0	(0)			0	(0)
Los Angeles**	9,889,056	(3.2)	56	(2.4)	21	(3.9)	3	(1.0)	1	(0.6)			0	(0)
Louisiana	4,574,766	(1.5)	57	(2.4)	1	(0.2)	13	(4.4)	0	(0)			30	(7.5)
Maine	1,328,544	(0.4)	1	(< 0.1)	0	(0)	0	(0)	1	(0.6)			1	(0.3)
Maryland	5,839,572	(1.9)	57	(2.4)	21	(3.9)	5	(1.7)	2	(1.2)	183	(12.4)	19	(4.8)
Massachusetts	6,607,003	(2.1)	51	(2.2)	30	(5.6)	9	(3.1)	3	(1.9)			24	(6.0)
Michigan	9,876,801	(3.2)	37	(1.6)	6	(1.1)	5	(1.7)	0	(0)			2	(0.5)
Minnesota	5,347,299	(1.7)	35	(1.5)	6	(1.1)	5	(1.7)	7	(4.3)	180	(12.2)	7	(1.8)
Mississippi	2,977,457	(1.0)	60	(2.6)	1	(0.2)	10	(3.4)	2	(1.2)			10	(2.5)
Missouri	6,008,984	(1.9)	60	(2.6)	3	(0.6)	13	(4.4)	10	(6.2)			1	(0.3)
Montana	997,667	(0.3)	5	(0.2)	1	(0.2)	5	(1.7)	3	(1.9)			0	(0)
Nebraska	1,842,234	(0.6)	12	(0.5)	1	(0.2)	5	(1.7)	4	(2.5)			0	(0)
Nevada	2,720,028	(0.9)	8	(0.3)	6	(1.1)	2	(0.7)	1	(0.6)			1	(0.3)
New Hampshire	1,317,807	(0.4)	16	(0.7)	0	(0)	1	(0.3)	0	(0)			0	(0)
New Jersey	8,834,773	(2.8)	34	(1.5)	49	(9.2)	8	(2.7)	5	(3.1)			0	(0)
New Mexico	2,078,674	(0.7)	18	(0.8)	1	(0.2)	6	(2.0)	0	(0)	87	(5.9)	0	(0)
New York††	11,256,706	(3.6)	73	(3.1)	22	(4.1)	6	(2.0)	6	(3.7)	205	(13.9)	29	(7.3)
New York City‡‡	8,244,910	(2.6)	68	(2.9)	45	(8.4)	23	(7.8)	3	(1.9)			13	(3.3)
North Carolina	9,651,103	(3.1)	115	(4.9)	10	(1.9)	3	(1.0)	3	(1.9)			1	(0.3)
North Dakota	684,740	(0.2)	3	(0.1)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Ohio	11,541,007	(3.7)	64	(2.7)	6	(1.1)	6	(2.0)	6	(3.7)			1	(0.3)
Oklahoma	3,784,163	(1.2)	0	(0)	2	(0.4)	1	(0.3)	1	(0.6)			0	(0)
Oregon	3,868,229	(1.2)	20	(0.9)	5	(0.9)	3	(1.0)	4	(2.5)	160	(10.8)	6	(1.5)
Pennsylvania	12,743,948	(4.1)	84	(3.6)	24	(4.5)	5	(1.7)	4	(2.5)			0	(0)
Rhode Island	1,050,646	(0.3)	9	(0.4)	0	(0)	0	(0)	0	(0)			2	(0.5)
South Carolina	4,673,348	(1.5)	75	(3.2)	3	(0.6)	4	(1.4)	2	(1.2)			10	(2.5)
South Dakota	823,593	(0.3)	9	(0.4)	0	(0)	1	(0.3)	3	(1.9)			0	(0)
Tennessee	6,399,787	(2.1)	54	(2.3)	1	(0.2)	10	(3.4)	4	(2.5)	39	(2.6)	5	(1.3)
Texas§§	23,486,632	(7.5)	245	(10.5)	32	(6.0)	28	(9.6)	5	(3.1)			36	(9.0)
Utah	2,814,347	(0.9)	11	(0.5)	1	(0.2)	3	(1.0)	2	(1.2)			0	(0)
Vermont	626,592	(0.2)	6	(0.3)	0	(0)	1	(0.3)	1	(0.6)			0	(0)
Virginia	8,104,384	(2.6)	39	(1.7)	7	(1.3)	1	(0.3)	3	(1.9)			6	(1.5)
Washington	6,823,267	(2.2)	35	(1.5)	13	(2.4)	6	(2.0)	8	(4.9)			33	(8.3)
West Virginia	1,854,908	(0.6)	35	(1.5)	0	(0)	4	(1.4)	3	(1.9)			0	(0)
Wisconsin	5,709,843	(1.8)	39	(1.7)	4	(0.8)	3	(1.0)	11	(6.8)			4	(1.0)
Wyoming	567,356	(0.2)	7	(0.3)	0	(0)	2	(0.7)	3	(1.9)			1	(0.3)
Total	**311,587,816**	**(100)**	**2344**	**(100)**	**533**	**(100)**	**293**	**(100)**	**162**	**(100)**	**1478**	**(100)**	**400**	**(100)**

* 2011 state estimates published in 2012 U.S. Census Bureau population estimates; county and city estimates published in 2011 population estimates

† Typhoidal *Salmonella* includes Typhi, Paratyphi A, Paratyphi B (isolates negative for tartrate fermentation), and Paratyphi C

‡ *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 2011), the number submitting isolates to the state public health laboratory ranged from one to all.

§ Excluding Los Angeles County

¶ Houston City

** Los Angeles County

†† Excluding New York City

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

§§ Excluding Houston, Texas

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

Antimicrobial Susceptibility Testing

Salmonella, *Shigella*, and *E. coli* O157 isolates were tested using broth microdilution (Sensititre®, Trek Diagnostics, part of Thermo Fisher Scientific, Cleveland, OH) according to manufacturer's instructions to determine the 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). Before 2004, sulfamethoxazole was used instead of sulfisoxazole to represent the sulfonamides. Interpretive criteria defined by CLSI were used when available. In 2011, azithromycin replaced amikacin on the panel of drugs being 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. For public health surveillance purposes, the new breakpoints were applied to all *Salmonella* isolates because all serotypes have the potential to cause invasive infection.

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, 1996–2011

CLSI Class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate*	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	≤8	16	≥32
	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§§	0.015–4	≤1	2	≥4
	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
† 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 2011 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.
§§ CLSI breakpoints for invasive *Salmonella* infections were updated, effective January 2012. For *Salmonella*, 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.

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 (described above) 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

Salmonella isolates tested in NARMS during 1996 to 1998 had conflicting 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, we retested using the 2003 NARMS Sensititre® plate, isolates of *Salmonella* tested in NARMS during 1996 to 1998 that exhibited an MIC ≥2 µg/mL to ceftiofur or ceftriaxone. The retest results have been included in the NARMS annual reports since 2003.

Serotype Confirmation/Categorization

Salmonella serotype reported by the submitting laboratory was used for reporting with few exceptions. Serotype was confirmed by CDC for isolates that underwent subsequent molecular analysis for publication. Because of challenges associated with interpretation of tartrate fermentation assays, ability to ferment tartrate was confirmed for isolates reported as *Salmonella* ser. Paratyphi B by the submitting laboratory (serotype Paratyphi B is by definition unable to ferment L(+) tartrate). To distinguish *Salmonella* serotypes Paratyphi B and Paratyphi B var. L(+) tartrate+ (formerly serotype 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 2011 for which the tartrate result was not reported or was reported to be negative. Isolates negative for tartrate fermentation by both assays were categorized as serotype Paratyphi B. Isolates that were positive for tartrate fermentation by either assay were categorized as serotype Paratyphi B var. L(+) tartrate+. 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 2011 were reviewed for additional information; 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 Scheme in 2010

The number of isolates received from Georgia, Maryland, and New Mexico increased over time. To avoid oversampling from these sites, instead of testing all isolates that had been received for 2010, the scheme for testing isolates was changed to every other isolate from Georgia and Maryland and every third from New Mexico.

Changes in Testing Methods in 2005

Starting in 2005, there were four changes in the methodology used for *Campylobacter*. 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 within their state. In 2005, FoodNet sites changed from submitting the first isolate received each week to 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). Of the clinical laboratories in each site that perform on-site testing for *Campylobacter* (range,18 to 94 per site in 2011), the number submitting isolates to the state public health laboratory ranged from one to all. Second, the method of species identification was updated to parallel what is used by the CDC National *Campylobacter* Laboratory. Third, the susceptibility testing method changed from Etest® (AB bioMerieux, Solna, Sweden) to broth microdilution. Fourth, there were changes in the antimicrobial agents tested. Florfenicol replaced chloramphenicol as the phenicol class representative drug, and telithromycin was added to the panel of agents tested. These changes in methods began in 2005 and continue through this report except for noted changes to submissions from Georgia, Maryland, and New Mexico beginning in 2010.

Identification/Speciation and Antimicrobial Susceptibility Testing

All 2011 isolates were confirmed as *Campylobacter* using a genus polymerase chain reaction (PCR) (Linton *et al*. 1996) and run on a multiplex PCR assay (Vandamme *et al*. 1997) to identify *C*. *jejuni* and *C*. *coli*. Isolates needing further characterization were tested using a short set of biochemical and other species-specific PCR assays, if necessary. 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 *jejuni* and suspected *coli* isolates were also confirmed through a multiplex PCR (Vandamme *et al.* 1997). Additionally the *ceuE* PCR was not used in 2010. From 2003 to 2004, putative *Campylobacter* isolates were identified as *C. jejuni* or *C. coli* using BAX® System PCR Assay according to the manufacturer's instructions (DuPont Qualicon, 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.

The methods for susceptibility testing of *Campylobacter* and criteria for interpreting the results have changed during the course of NARMS surveillance. 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. 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. The breakpoints listed in Table 3 have been applied to MIC data collected for all years so that resistance prevalence is comparable over time. Repeat testing of isolates was done based on criteria in Appendix B.

Table 3. Antimicrobial agents used for susceptibility testing of *Campylobacter* isolates, NARMS, 1997–2011

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

N/A indicates that no MIC range of either intermediate or resistant susceptibility exists

* Etest dilution range used from 1997–2004

† Telithromycin added to NARMS panel in 2005

‡ Chloramphenicol, tested from 1997–2004, was replaced by florfenicol in 2005

§ Only a susceptible breakpoint (≤4 µg/mL) has been established by CLSI. In this report isolates with a MIC ≥8 µg/mL are categorized as resistant.

Testing 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* they received to CDC for antimicrobial susceptibility testing by the NARMS laboratory and confirmation of identity by CDC's National Enteric Reference Laboratory. 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 54). MIC distributions are shown for all agents tested.

Table 4. Antimicrobial agents used for susceptibility testing of *Vibrio* species other than *V. cholerae* isolates, NARMS, 2009–2011

CLSI Class	Antimicrobial Agent	Antimicrobial Agent Concentration Range (µg/mL)	MIC Interpretive Standard (µg/mL)		
			Susceptible	Intermediate*	Resistant
Aminoglycosides	Kanamycin†	0.016-256			
	Streptomycin†	0.064-1024			
Cephems	Cephalothin†	0.016-256			
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			
Quinolones	Ciprofloxacin	0.002-32	≤1	2	≥4
	Nalidixic acid†	0.016-256			
Tetracyclines	Tetracycline	0.016-256	≤4	8	≥16

* N/A indicates that no MIC range of intermediate susceptibility exists
† No CLSI or NARMS breakpoints established

Testing of Representative Bacteria from Outbreaks

To aid in outbreak investigations and food source attribution, CDC NARMS performs antimicrobial susceptibility testing on isolates from outbreaks submitted by state and local health departments to determine their resistance patterns. In the 2010 NARMS Annual Report, CDC published an analysis of antimicrobial susceptibility data from non-typhoidal *Salmonella* outbreaks in the United States from 2004 through 2008. CDC is currently updating and reanalyzing these data. A summary report of updated non-typhoidal *Salmonella* outbreak data will be published in the future.

Data Analysis

For all pathogens, isolates were categorized as resistant, intermediate (if applicable), or susceptible. Analysis was restricted to the first isolate received (per serotype for *Salmonella*, per species for *Shigella* and *Campylobacter*) per patient in the calendar year. If two or more *Salmonella* ser. Typhi isolates were received for the same patient, the first blood isolate collected was included in the analysis; if no blood isolates were 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.

Logistic regression was used to compare the prevalence of antimicrobial resistance among *Salmonella, Shigella,* and *Campylobacter* isolates tested in 2011 with the average prevalence of resistance in the first five years that NARMS surveillance was nationwide (2003–2007). The prevalence of resistance was defined as the percentage of resistant isolates among total isolates tested. Changes in the prevalence of resistance do not provide information about 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. Having assessed that the main effect of year was significant, we reported ORs with 95% CIs (for 2011 compared with 2003-2007) that did not include 1.0 as statistically significant.

MIC Distribution Tables and Proportional Figures

An explanation on “how to read a squashtogram” has been provided to assist the reader with the different parts of 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 categorical visual aid for the interpretation of MIC values. For most antimicrobial agents tested, three categories (susceptible, intermediate, and resistant) are used to interpret MICs.The proportion representing each category is shown in a horizontal proportional bar chart (Figure 2).

Figure 1. How to read a squashtogram

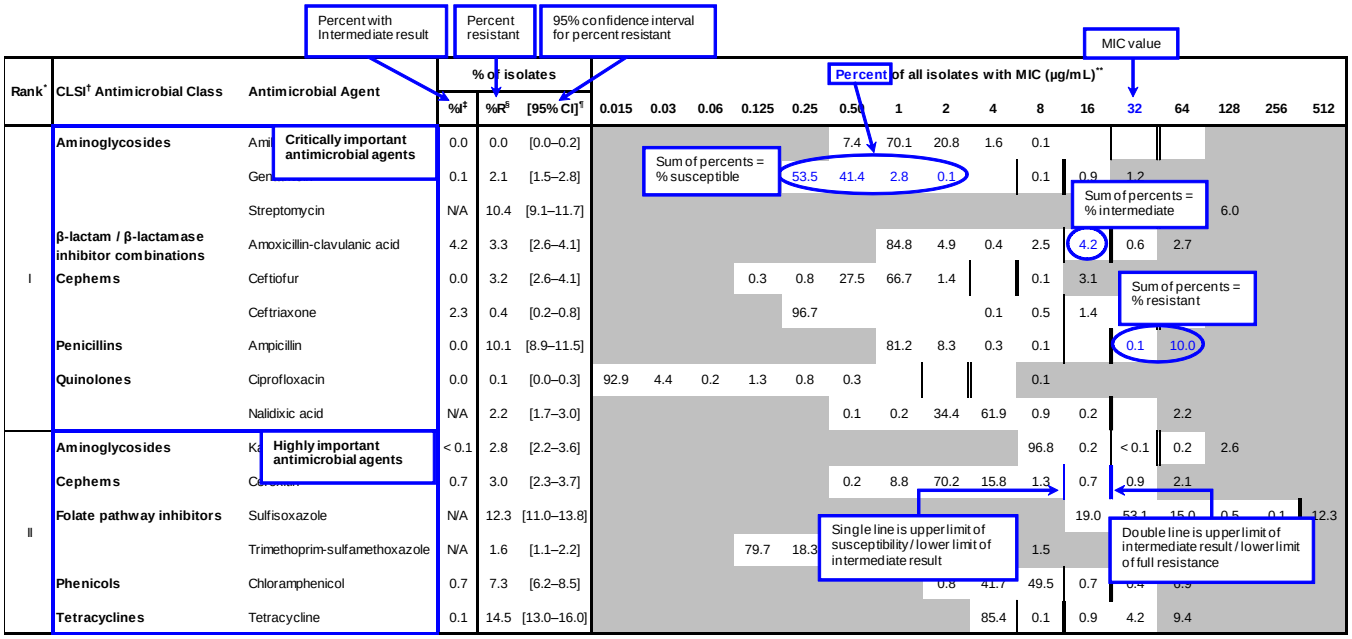
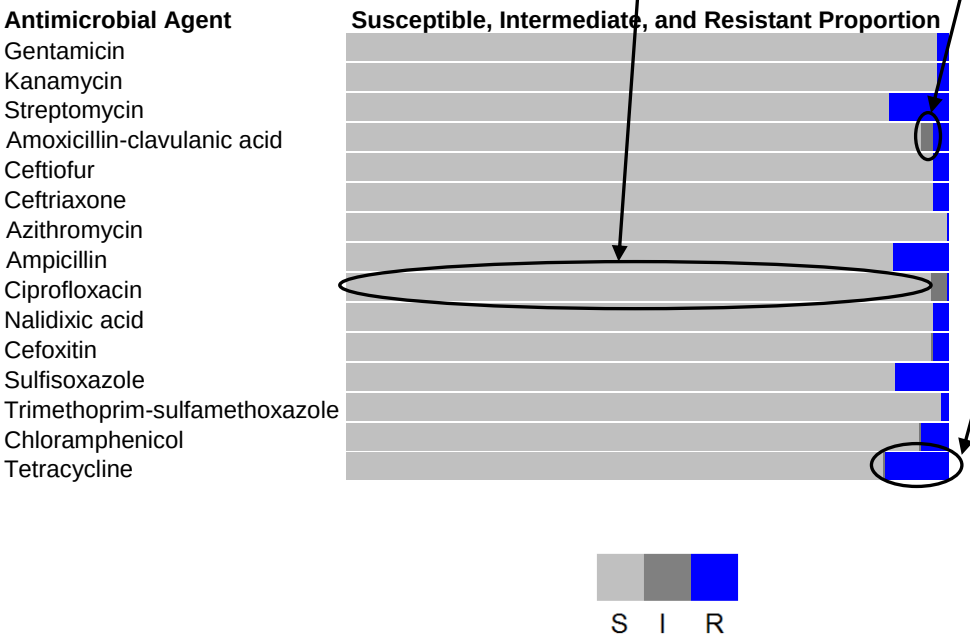


Figure 2. Proportional chart, a categorical graph of a squashtogram

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

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



Results

1. Non-typhoidal *Salmonella*

Table 5. Number of non-typhoidal *Salmonella* isolates among the 20 most common serotypes tested by NARMS with the number of resistant isolates by class and agent, 2011

		Isolates		Number of Isolates: Number of CLSI* Antimicrobial Classes to which Isolates are Resistant						Number of Resistant Isolates by CLSI* Antimicrobial Class and Agent†												
										Aminoglycosides			β-lactam/β-lactamase inhibitor combinations	Cephems			Folate pathway inhibitors		Macrolides	Penicillins	Phenicols	Quinolones		Tetracyclines
Rank	Serotype	N	(%)	0	1	2–3	4–5	6–7	8–9	GEN	KAN	STR	AMC	FOX	TIO	AXO	FIS	COT	AZI	AMP	CHL	CIP	NAL	TET
1	Enteritidis	391	(16.7)	**344**	**37**	**5**	**5**	0	0	**2**	**1**	**7**	**1**	**1**	**1**	**1**	**8**	**2**	0	**20**	0	0	**28**	**7**
2	Typhimurium	323	(13.8)	**223**	**7**	**23**	**50**	**20**	0	**7**	**13**	**83**	**22**	**22**	**22**	**22**	**88**	**6**	0	**83**	**63**	0	**1**	**88**
3	Newport	285	(12.2)	**269**	**3**	**2**	**1**	**9**	**1**	**2**	**1**	**12**	**11**	**11**	**11**	**11**	**13**	0	0	**11**	**10**	0	**1**	**13**
4	Javiana	170	(7.3)	**168**	**1**	**1**	0	0	0	0	0	0	**1**	**1**	**1**	**1**	0	0	0	**2**	0	0	0	0
5	I 4,[5],12:I:-	82	(3.5)	**54**	**5**	**6**	**16**	**1**	0	**1**	0	**20**	**4**	**4**	**3**	**3**	**19**	**1**	0	**22**	**2**	0	0	**21**
6	Heidelberg	70	(3.0)	**39**	0	**28**	0	**3**	0	**14**	**15**	**26**	**7**	**6**	**6**	**6**	**5**	**1**	0	**21**	**3**	0	0	**24**
7	Montevideo	65	(2.8)	**61**	**1**	**2**	0	**1**	0	0	0	**2**	**1**	**1**	**1**	**1**	**2**	**1**	0	**1**	**1**	0	**1**	**4**
8	Infantis	63	(2.7)	**59**	0	**2**	**2**	0	0	**1**	0	**3**	**1**	**1**	**1**	**1**	**3**	**1**	0	**1**	**1**	0	**1**	**3**
9	Muenchen	49	(2.1)	**48**	**1**	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Braenderup	48	(2.0)	**45**	**1**	**1**	**1**	0	0	**1**	0	**2**	0	0	0	0	**2**	**1**	**1**	**1**	0	0	0	**3**
11	Oranienburg	48	(2.0)	**46**	0	0	**1**	**1**	0	0	0	**2**	0	0	0	0	**2**	**1**	**1**	**2**	**1**	0	**1**	**2**
12	Paratyphi B var. L(+) tartrate+	42	(1.8)	**38**	**2**	**1**	**1**	0	0	0	0	**2**	0	**1**	0	0	**2**	0	0	**1**	**1**	0	**1**	**1**
13	Saintpaul	36	(1.5)	**28**	**2**	**5**	**1**	0	0	**2**	0	**2**	**1**	0	**1**	**1**	**3**	0	0	**4**	**1**	0	**2**	**4**
14	Agona	30	(1.3)	**17**	**8**	**2**	**1**	**2**	0	**1**	**1**	**12**	**2**	**2**	**2**	**2**	**5**	0	0	**3**	**1**	0	0	**6**
15	Poona	25	(1.1)	**25**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Mississippi	22	(0.9)	**21**	0	0	**1**	0	0	0	0	**1**	0	0	0	0	**1**	**1**	**1**	**1**	0	0	0	**1**
17	Rubislaw	22	(0.9)	**22**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Thompson	22	(0.9)	**22**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Berta	21	(0.9)	**15**	**2**	**4**	0	0	0	**3**	0	**2**	**1**	**1**	**1**	**1**	**2**	0	0	**4**	0	0	0	**2**
20	Bareilly	20	(0.9)	**18**	0	**2**	0	0	0	0	0	0	0	0	0	0	**2**	**2**	0	0	0	0	0	**2**
	Subtotal	**1834**	**(78.2)**	1562	70	84	80	37	1	34	32	176	52	51	50	50	157	17	3	177	84	0	36	181
	All other serotypes	411	(17.5)	**353**	**17**	**22**	**9**	**9**	**1**	**5**	**5**	**37**	**8**	**8**	**8**	**8**	**28**	**9**	**2**	**20**	**14**	**4**	**7**	**46**
	Unknown serotype	54	(2.3)	**34**	**10**	**2**	**6**	**2**	0	**1**	**1**	**10**	0	**1**	0	0	**10**	**1**	0	**8**	**4**	0	**13**	**9**
	Partially serotyped	24	(1.0)	**22**	**1**	0	**1**	0	0	0	0	**1**	0	0	0	0	**1**	0	0	**1**	0	0	0	**2**
	Rough/Nonmotile isolates	21	(0.9)	**12**	**3**	0	**6**	0	0	0	**1**	**6**	0	0	0	0	**6**	**1**	0	**7**	**1**	0	**1**	**7**
	Total	**2344**	**(100)**	**1983**	**101**	**108**	**102**	**48**	**2**	**40**	**39**	**230**	**60**	**60**	**58**	**58**	**202**	**28**	**5**	**213**	**103**	**4**	**57**	**245**

* 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, 2011

			ACSSuT*		ACT/S†		ACSSuTAuCx‡		Nalidixic Acid		Ceftriaxone		CxNal§	
		N	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Twenty most common serotypes														
1	Enteritidis	391	0	(0)	0	(0)	0	(0)	**28**	**(49.1)**	**1**	**(1.7)**	0	(0)
2	Typhimurium	323	**63**	**(69.2)**	**2**	**(22.2)**	**17**	**(47.2)**	**1**	**(1.8)**	**22**	**(37.9)**	0	(0)
3	Newport	285	**10**	**(11.0)**	0	(0)	**10**	**(27.8)**	**1**	**(1.8)**	**11**	**(19.0)**	**1**	**(50.0)**
4	Javiana	170	0	(0)	0	(0)	0	(0)	0	(0)	**1**	**(1.7)**	0	(0)
5	I 4,[5],12:i:-	82	**1**	**(1.1)**	0	(0)	0	(0)	0	(0)	**3**	**(5.2)**	0	(0)
6	Heidelberg	70	**1**	**(1.1)**	**1**	**(11.1)**	**1**	**(2.8)**	0	(0)	**6**	**(10.3)**	0	(0)
7	Montevideo	65	**1**	**(1.1)**	0	(0)	**1**	**(2.8)**	**1**	**(1.8)**	**1**	**(1.7)**	0	(0)
8	Infantis	63	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	**1**	**(1.7)**	0	(0)
9	Muenchen	49	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
10	Braenderup	48	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
11	Oranienburg	48	**1**	**(1.1)**	**1**	**(11.1)**	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
12	Paratyphi B var. L(+) tartrate+	42	**1**	**(1.1)**	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
13	Saintpaul	36	0	(0)	0	(0)	0	(0)	**2**	**(3.5)**	**1**	**(1.7)**	0	(0)
14	Agona	30	**1**	**(1.1)**	0	(0)	**1**	**(2.8)**	0	(0)	**2**	**(3.4)**	0	(0)
15	Poona	25	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
16	Mississippi	22	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
17	Rubislaw	22	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
18	Thompson	22	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
19	Berta	21	0	(0)	0	(0)	0	(0)	0	(0)	**1**	**(1.7)**	0	(0)
20	Bareilly	20	0	(0)	0	(0)	0	(0)	0	(0)	0	**(0)**	0	(0)
Additional serotypes¶														
	Panama	16	**1**	**(1.1)**	**2**	**(22.2)**	0	(0)	0	(0)	0	(0)	0	(0)
	Hadar	14	0	(0)	0	(0)	0	(0)	**2**	**(3.5)**	0	(0)	0	(0)
	Senftenberg	12	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	**2**	**(3.4)**	**1**	**(50.0)**
	Dublin	10	**4**	**(4.4)**	0	(0)	**4**	**(11.1)**	**1**	**(1.8)**	**4**	**(6.9)**	0	(0)
	Kentucky	4	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	Virchow	4	0	(0)	0	(0)	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
	Muenster	3	**1**	**(1.1)**	0	(0)	**1**	**(2.8)**	0	(0)	**1**	**(1.7)**	0	(0)
	Reading	3	**1**	**(1.1)**	0	(0)	**1**	**(2.8)**	0	(0)	**1**	**(1.7)**	0	(0)
	Choleraesuis	1	0	(0)	**1**	**(11.1)**	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
Subtotal		**1901**	**86**	**(94.5)**	**7**	**(77.8)**	**36**	**(100)**	**43**	**(75.4)**	**58**	**(100)**	**2**	**(100)**
	All other serotypes	344	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Unknown serotype	54	**4**	**(4.4)**	**1**	**(11.1)**	0	(0)	**13**	**(22.8)**	0	(0)	0	(0)
	Partially serotyped	24	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
	Rough/Nonmotile isolates	21	**1**	**(1.1)**	**1**	**(11.1)**	0	(0)	**1**	**(1.8)**	0	(0)	0	(0)
Total		**2344**	**91**	**(100)**	**9**	**(100)**	**36**	**(100)**	**57**	**(100)**	**58**	**(100)**	**2**	**(100)**

* ACSSuT: at least resistant to ampicillin, chloramphenicol, streptomycin, sulfisoxazole, tetracycline
† ACT/S: at least resistant to ampicillin, chloramphenicol, trimethoprim-sulfamethoxazole
‡ ACSSuTAuCx: at least resistant to ACSSuT, amoxicillin-clavulanic acid, and ceftriaxone
§ CxNal: at least resistant to ceftriaxone and nalidixic acid
¶ Additional serotypes that displayed resistance to at least one of the selected patterns

Table 7. Minimum inhibitory concentrations (MICs) and resistance of non-typhoidal *Salmonella* isolates to antimicrobial agents, 2011 (N=2344)

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 (Appendix A, 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*, 2011

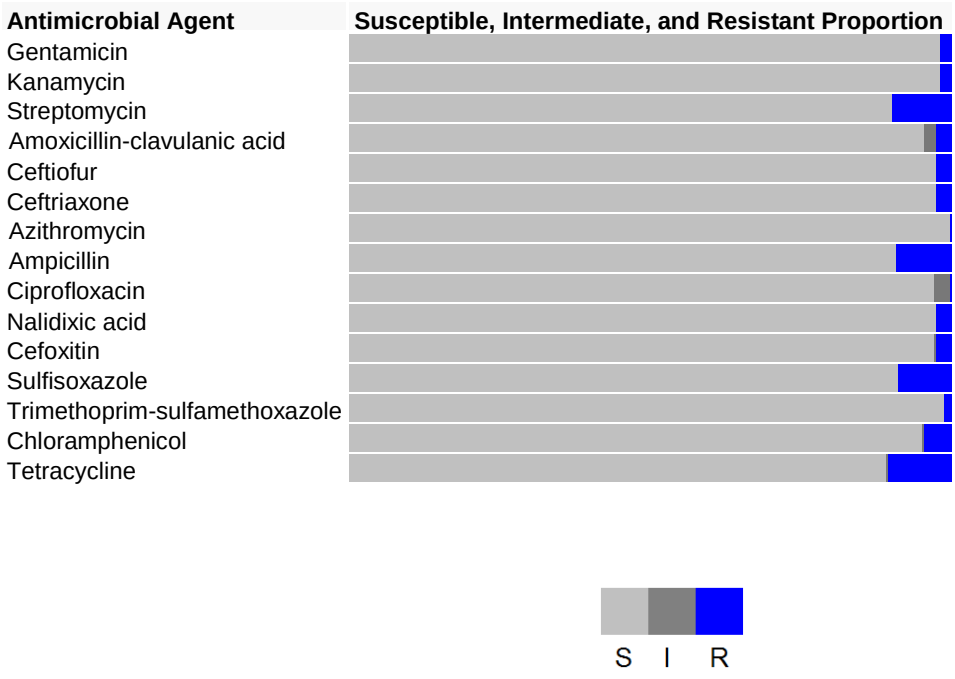


Table 8. Percentage and number of non-typhoidal *Salmonella* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 1998	2003 1855	2004 1782	2005 2036	2006 2171	2007 2145	2008 2384	2009 2193	2010 2449	2011 2344
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Amikacin (MIC ≥ 64)	0.0% 0	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
		Gentamicin (MIC ≥ 16)	1.4% 27	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
		Kanamycin (MIC ≥ 64)	3.8% 76	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
		Streptomycin (MIC ≥ 64)	13.2% 264	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	5.3% 106	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
	Cephems	Ceftiofur (MIC ≥ 8)	4.4% 87	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
		Ceftriaxone (MIC ≥ 4)	4.4% 87	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.2% 5
	Penicillins	Ampicillin (MIC ≥ 32)	13.0% 259	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.1% 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
		Nalidixic Acid (MIC ≥ 32)	1.6% 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	2.4% 57
II	Cephems	Cefoxitin (MIC ≥ 32)	4.3% 86	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
		Cephalothin (MIC ≥ 32)	5.1% 101	5.3% 99	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	12.9% 258	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.4% 28	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	8.6% 172	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	14.9% 298	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 9. Resistance patterns of non-typhoidal *Salmonella* isolates, 2002–2011

Year Total Isolates	2002 1998	2003 1855	2004 1782	2005 2036	2006 2171	2007 2145	2008 2384	2009 2193	2010 2449	2011 2344
Resistance Pattern										
No resistance detected	79.1% 1580	78.0% 1447	79.9% 1424	80.9% 1648	80.5% 1748	81.1% 1739	83.9% 2000	83.2% 1824	84.6% 2073	84.6% 1983
Resistance ≥ 1 CLSI class*	20.9% 418	22.0% 408	20.1% 358	19.1% 388	19.5% 423	18.9% 406	16.1% 384	16.8% 369	15.4% 376	15.4% 361
Resistance ≥ 2 CLSI classes*	15.8% 315	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
Resistance ≥ 3 CLSI classes*	12.3% 245	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
Resistance ≥ 4 CLSI classes*	9.8% 195	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
Resistance ≥ 5 CLSI classes*	8.2% 164	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
At least ACSSuT†	7.8% 156	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
At least ACT/S‡	1.1% 21	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
At least ACSSuTAuCx§	3.4% 67	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
At least ceftriaxone and nalidixic acid resistant	0.2% 4	0.1% 1	0.1% 2	0.0% 1	0.2% 4	0.2% 5	0.0% 1	0.2% 4	0.1% 2	0.1% 2

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

A. *Salmonella* ser. Enteritidis

Table 10. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Enteritidis isolates to antimicrobial agents, 2011 (N=391)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.5	[0.1 - 1.8]					24.6	70.3	4.3	0.3			0.3	0.3				
		Kanamycin	0.0	0.3	[0.0 - 1.4]										99.7				0.3		
		Streptomycin	N/A	1.8	[0.7 - 3.7]												98.2	0.5	1.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.3	[0.0 - 1.4]							91.8	3.1		4.9		0.3				
	Cephems	Ceftiofur	0.0	0.3	[0.0 - 1.4]				0.3	0.3	10.2	87.7	1.3			0.3					
		Ceftriaxone	0.0	0.3	[0.0 - 1.4]					99.7						0.3					
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 0.9]						0.3	0.3	15.6	81.3	2.3	0.3					
	Penicillins	Ampicillin	0.0	5.1	[3.2 - 7.8]							87.0	7.2	0.8				5.1			
	Quinolones	Ciprofloxacin	7.2	0.0	[0.0 - 0.9]	72.6	19.4	0.8	4.1	3.1											
		Nalidixic acid	N/A	7.2	[4.8 - 10.2]							0.5	20.7	70.1	1.3	0.3		7.2			
II	Cephems	Cefoxitin	0.5	0.3	[0.0 - 1.4]						0.3	24.6	69.1	4.6	0.8	0.5	0.3				
	Folate pathway inhibitors	Sulfisoxazole	N/A	2.0	[0.9 - 4.0]											5.1	47.6	45.0	0.3		2.0
		Trimethoprim-sulfamethoxazole	N/A	0.5	[0.1 - 1.8]				99.0	0.5					0.5						
	Phenicols	Chloramphenicol	0.3	0.0	[0.0 - 0.9]								0.5	58.3	40.9	0.3					
	Tetracyclines	Tetracycline	0.8	1.8	[0.7 - 3.7]									97.4	0.8	0.3		1.5			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

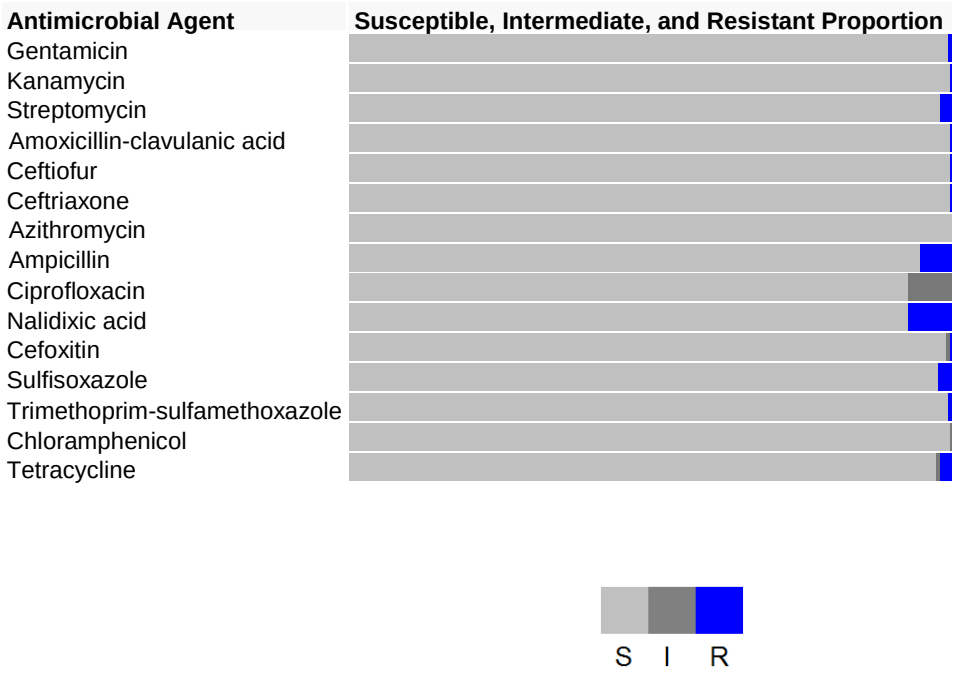


Table 11. Percentage and number of *Salmonella ser.* Enteritidis isolates resistant to antimicrobial agents, 2002–2011

Year / Total Isolates			2002 337	2003 257	2004 271	2005 384	2006 412	2007 385	2008 441	2009 410	2010 513	2011 391
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	0.3% 1	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
		Kanamycin (MIC ≥ 64)	0.3% 1	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
		Streptomycin (MIC ≥ 64)	1.5% 5	1.2% 3	2.2% 6	1.0% 4	1.2% 5	0.5% 2	0.5% 2	1.2% 5	0.6% 3	1.8% 7
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.6% 2	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
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	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
		Ceftriaxone (MIC ≥ 4)	0.0% 0	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	6.8% 23	2.3% 6	4.1% 11	2.9% 11	4.1% 17	2.1% 8	3.9% 17	3.9% 16	2.3% 12	5.1% 20
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.2% 1	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	3.9% 13	4.7% 12	6.6% 18	4.7% 18	7.0% 29	5.7% 22	7.0% 31	3.7% 15	5.3% 27	7.2% 28
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	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
		Cephalothin (MIC ≥ 32)	0.6% 2	1.2% 3	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	1.5% 5	1.2% 3	1.8% 5	1.6% 6	1.5% 6	1.6% 6	1.1% 5	1.7% 7	1.9% 10	2.0% 8
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.6% 2	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.3% 1	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	4.2% 14	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 12. Resistance patterns of *Salmonella* ser. Enteritidis isolates, 2002–2011

Year / Total Isolates	2002 337	2003 257	2004 271	2005 384	2006 412	2007 385	2008 441	2009 410	2010 513	2011 391
Resistance Pattern										
No resistance detected	87.5% 295	91.8% 236	86.7% 235	91.4% 351	88.8% 366	90.4% 348	87.5% 386	92.0% 377	92.0% 472	88.0% 344
Resistance ≥ 1 CLSI class*	12.5% 42	8.2% 21	13.3% 36	8.6% 33	11.2% 46	9.6% 37	12.5% 55	8.0% 33	8.0% 41	12.0% 47
Resistance ≥ 2 CLSI classes*	3.9% 13	2.3% 6	3.0% 8	3.6% 14	2.9% 12	3.4% 13	2.0% 9	2.4% 10	2.9% 15	2.6% 10
Resistance ≥ 3 CLSI classes*	2.1% 7	0.4% 1	1.1% 3	1.6% 6	1.7% 7	1.0% 4	0.5% 2	1.0% 4	2.1% 11	2.3% 9
Resistance ≥ 4 CLSI classes*	0.6% 2	0.4% 1	0.7% 2	1.0% 4	0.7% 3	0.3% 1	0.0% 0	0.5% 2	0.4% 2	1.3% 5
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT†	0.0% 0	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
At least ACT/S‡	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ACSSuTAuCx§	0.0% 0	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
At least ceftriaxone and nalidixic acid resistant	0.0% 0	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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

B. *Salmonella* ser. Typhimurium

Table 13. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhimurium isolates to antimicrobial agents, 2011 (N=323)

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	2.2	[0.9 - 4.4]					3.1	78.3	16.1	0.3				2.2				
		Kanamycin	0.0	4.0	[2.2 - 6.8]										96.0			4.0			
		Streptomycin	N/A	25.7	[21.0 - 30.8]												74.3	5.0	20.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	12.1	6.8	[4.3 - 10.1]							73.4	0.6	1.2	5.9	12.1	1.5	5.3			
	Cephems	Ceftiofur	0.0	6.8	[4.3 - 10.1]					0.3	30.0	62.2	0.6		0.6	6.2					
		Ceftriaxone	0.0	6.8	[4.3 - 10.1]					93.2				0.3	0.9	3.7	1.5	0.3			
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.1]								11.8	83.0	5.0						
	Penicillins	Ampicillin	0.0	25.7	[21.0 - 30.8]							71.8	2.2		0.3		0.3	25.4			
	Quinolones	Ciprofloxacin	1.9	0.0	[0.0 - 1.1]	96.0	2.2		0.3		1.5										
		Nalidixic acid	N/A	0.3	[0.0 - 1.7]								55.1	42.4	1.5	0.6		0.3			
II	Cephems	Cefoxitin	0.3	6.8	[4.3 - 10.1]						0.3	30.7	54.2	6.2	1.5	0.3	3.4	3.4			
	Folate pathway inhibitors	Sulfisoxazole	N/A	27.2	[22.5 - 32.4]											1.5	59.1	11.8	0.3		27.2
		Trimethoprim-sulfamethoxazole	N/A	1.9	[0.7 - 4.0]				92.6	4.6	0.9				1.9						
	Phenicols	Chloramphenicol	0.3	19.5	[15.3 - 24.3]								0.9	42.7	36.5	0.3		19.5			
	Tetracyclines	Tetracycline	0.0	27.2	[22.5 - 32.4]									72.8		0.9	10.5	15.8			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

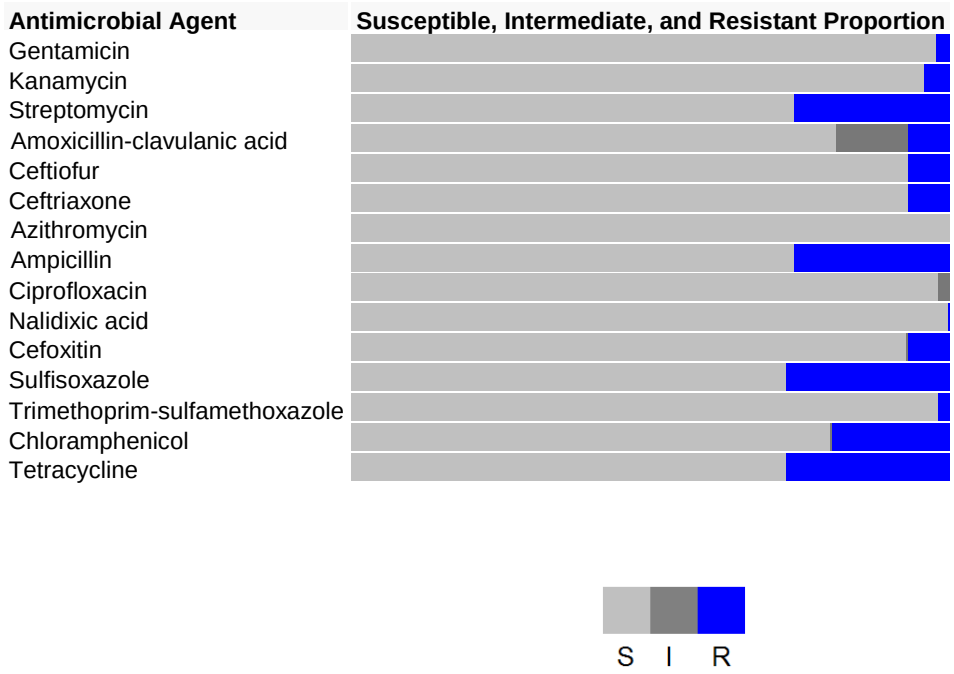


Table 14. Percentage and number of *Salmonella* ser. Typhimurium isolates resistant to antimicrobial agents, 2002–2011

Year			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Isolates			394	408	382	438	408	405	397	370	359	323
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	2.3% 9	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
		Kanamycin (MIC ≥ 64)	7.6% 30	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
		Streptomycin (MIC ≥ 64)	32.0% 126	35.5% 145	31.9% 122	28.1% 123	29.4% 120	32.3% 131	28.7% 114	25.9% 96	25.6% 92	25.7% 83
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	7.6% 30	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
	Cephems	Ceftiofur (MIC ≥ 8)	4.3% 17	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
		Ceftriaxone (MIC ≥ 4)	4.3% 17	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	33.8% 133	36.3% 148	32.2% 123	29.0% 127	28.2% 115	31.6% 128	26.4% 105	28.1% 104	26.2% 94	25.7% 83
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.3% 5	1.2% 5	0.5% 2	0.9% 4	0.7% 3	1.5% 6	1.3% 5	2.2% 8	1.4% 5	0.3% 1
II	Cephems	Cefoxitin (MIC ≥ 32)	4.3% 17	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
		Cephalothin (MIC ≥ 32)	5.6% 22	6.1% 25	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	32.2% 127	38.7% 158	36.1% 138	32.0% 140	33.3% 136	37.3% 151	30.5% 121	30.0% 111	28.7% 103	27.2% 88
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.3% 9	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	23.4% 92	28.2% 115	24.3% 93	24.4% 107	22.1% 90	25.4% 103	23.4% 93	20.5% 76	20.3% 73	19.5% 63
	Tetracyclines	Tetracycline (MIC ≥ 16)	32.0% 126	38.0% 155	30.4% 116	30.4% 133	31.6% 129	36.8% 149	27.7% 110	28.9% 107	29.0% 104	27.2% 88

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 15. Resistance patterns of *Salmonella* ser. Typhimurium isolates, 2002–2011

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Isolates	394	408	382	438	408	405	397	370	359	323
Resistance Pattern										
No resistance detected	59.9% 236	54.7% 223	60.5% 231	65.1% 285	62.5% 255	57.5% 233	67.8% 269	63.5% 235	66.9% 240	69.0% 223
Resistance ≥ 1 CLSI class*	40.1% 158	45.3% 185	39.5% 151	34.9% 153	37.5% 153	42.5% 172	32.2% 128	36.5% 135	33.1% 119	31.0% 100
Resistance ≥ 2 CLSI classes*	36.3% 143	41.4% 169	37.2% 142	33.3% 146	34.1% 139	39.3% 159	31.5% 125	33.2% 123	30.4% 109	28.8% 93
Resistance ≥ 3 CLSI classes*	32.5% 128	37.3% 152	31.7% 121	30.1% 132	30.4% 124	34.3% 139	28.0% 111	28.1% 104	27.3% 98	26.3% 85
Resistance ≥ 4 CLSI classes*	28.4% 112	32.4% 132	27.7% 106	27.4% 120	27.0% 110	29.9% 121	24.9% 99	24.1% 89	24.2% 87	21.7% 70
Resistance ≥ 5 CLSI classes*	23.1% 91	27.7% 113	24.3% 93	22.8% 100	20.8% 85	24.9% 101	23.9% 95	22.2% 82	20.9% 75	20.7% 67
At least ACSSuT†	21.6% 85	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
At least ACT/S‡	2.0% 8	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
At least ACSSuTAuCx§	1.8% 7	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
At least ceftriaxone and nalidixic acid resistant	0.5% 2	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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

C. *Salmonella* ser. Newport

Table 16. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Newport isolates to antimicrobial agents, 2011 (N=285)

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	0.7	[0.1 - 2.5]					2.5	86.3	10.2	0.4				0.7				
		Kanamycin	0.0	0.4	[0.0 - 1.9]										99.6			0.4			
		Streptomycin	N/A	4.2	[2.2 - 7.2]												95.8	0.4	3.9		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	3.9	[1.9 - 6.8]							95.4	0.7				1.4	2.5			
	Cephems	Ceftiofur	0.0	3.9	[1.9 - 6.8]				0.4		31.6	63.2	1.1			3.9					
		Ceftriaxone	0.0	3.9	[1.9 - 6.8]					96.1					0.4	0.7	2.5		0.4		
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.3]						0.4	0.4	18.2	78.6	2.5						
	Penicillins	Ampicillin	0.4	3.9	[1.9 - 6.8]							93.3	2.5			0.4		3.9			
	Quinolones	Ciprofloxacin	0.4	0.0	[0.0 - 1.3]	99.3	0.4				0.4										
		Nalidixic acid	N/A	0.4	[0.0 - 1.9]						0.4	0.4	50.2	48.8			0.4				
II	Cephems	Cefoxitin	0.4	3.9	[1.9 - 6.8]						0.7	30.5	60.7	3.9		0.4	0.4	3.5			
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.6	[2.4 - 7.7]											0.7	26.7	63.9	4.2		4.6
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 1.3]				99.6	0.4											
	Phenicols	Chloramphenicol	0.0	3.5	[1.7 - 6.4]								0.7	83.2	12.6			3.5			
	Tetracyclines	Tetracycline	0.0	4.6	[2.4 - 7.7]									95.4				4.6			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

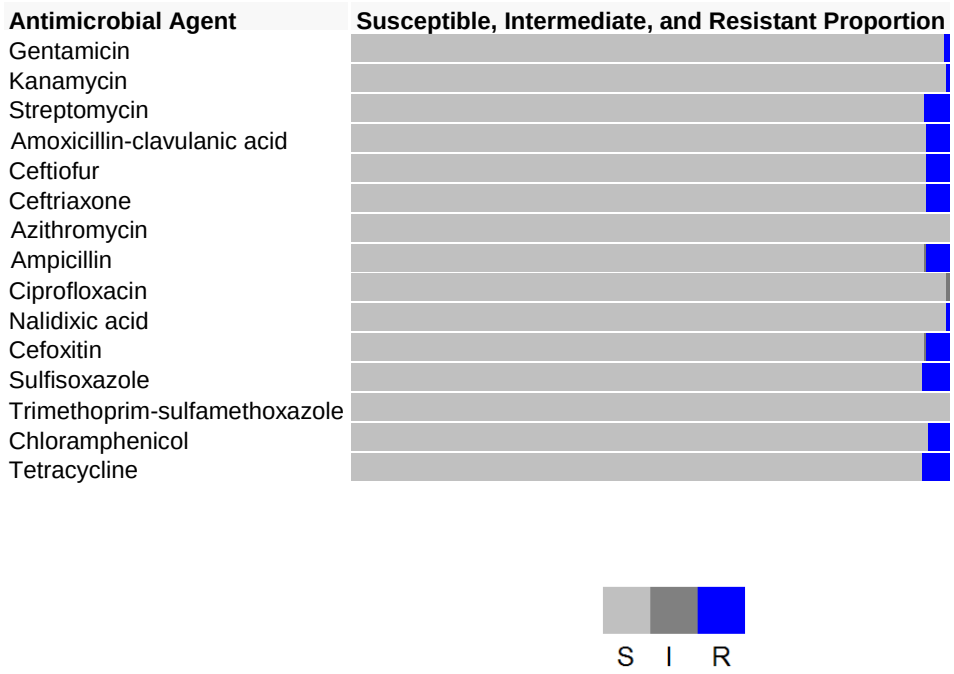


Table 17. Percentage and number of *Salmonella* ser. Newport isolates resistant to antimicrobial agents, 2002–2011

Year / Total Isolates			2002 244	2003 226	2004 191	2005 207	2006 218	2007 222	2008 258	2009 238	2010 305	2011 285
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	3.3% 8	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
		Kanamycin (MIC ≥ 64)	9.8% 24	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
		Streptomycin (MIC ≥ 64)	25.0% 61	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	22.5% 55	21.7% 49	15.2% 29	12.6% 26	12.4% 27	8.1% 18	12.4% 32	7.6% 18	7.5% 23	3.9% 11
	Cephems	Ceftiofur (MIC ≥ 8)	22.5% 55	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
		Ceftriaxone (MIC ≥ 4)	22.5% 55	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	24.6% 60	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
	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)	0.8% 2	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
II	Cephems	Cefoxitin (MIC ≥ 32)	22.1% 54	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
		Cephalothin (MIC ≥ 32)	22.5% 55	22.6% 51	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	25.4% 62	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	4.1% 10	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	25.0% 61	22.6% 51	15.2% 29	13.5% 28	12.4% 27	9.5% 21	12.0% 31	7.6% 18	7.2% 22	3.5% 10
	Tetracyclines	Tetracycline (MIC ≥ 16)	25.4% 62	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 18. Resistance patterns of *Salmonella* ser. Newport isolates, 2002–2011

Year / Total Isolates	2002 244	2003 226	2004 191	2005 207	2006 218	2007 222	2008 258	2009 238	2010 305	2011 285
Resistance Pattern										
No resistance detected	72.5% 177	73.5% 166	82.2% 157	84.1% 174	82.6% 180	89.2% 198	85.3% 220	89.1% 212	90.8% 277	94.4% 269
Resistance ≥ 1 CLSI class*	27.5% 67	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
Resistance ≥ 2 CLSI classes*	25.0% 61	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
Resistance ≥ 3 CLSI classes*	25.0% 61	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
Resistance ≥ 4 CLSI classes*	25.0% 61	23.0% 52	15.7% 30	14.0% 29	13.3% 29	9.5% 21	13.6% 35	7.6% 18	7.5% 23	3.9% 11
Resistance ≥ 5 CLSI classes*	23.4% 57	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
At least ACSSuT†	23.4% 57	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
At least ACT/S‡	3.7% 9	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
At least ACSSuTAuCx§	22.5% 55	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
At least ceftriaxone and nalidixic acid resistant	0.4% 1	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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

D. *Salmonella* ser. Heidelberg

Table 19. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Heidelberg isolates to antimicrobial agents, 2011 (N=70)

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	20.0	[11.4 - 31.3]					8.6	48.6	22.9					20.0				
		Kanamycin	0.0	21.4	[12.5 - 32.9]										75.7	2.9		1.4	20.0		
		Streptomycin	N/A	37.1	[25.9 - 49.5]												62.9	12.9	24.3		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	1.4	10.0	[4.1 - 19.5]							68.6	1.4		18.6	1.4	2.9	7.1			
	Cephems	Ceftiofur	1.4	8.6	[3.2 - 17.7]					1.4	51.4	34.3	2.9	1.4		8.6					
		Ceftriaxone	1.4	8.6	[3.2 - 17.7]					90.0			1.4			5.7	1.4	1.4			
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 5.1]							1.4	1.4	90.0	7.1						
	Penicillins	Ampicillin	0.0	30.0	[19.6 - 42.1]							68.6	1.4				1.4	28.6			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 5.1]	98.6		1.4													
		Nalidixic acid	N/A	0.0	[0.0 - 5.1]						1.4		44.3	52.9	1.4						
II	Cephems	Cefoxitin	0	8.6	[3.2 - 17.7]						1.4	54.3	31.4	1.4	2.9		4.3	4.3			
	Folate pathway inhibitors	Sulfisoxazole	N/A	7.1	[2.3 - 15.9]											21.4	61.4	10.0			7.1
		Trimethoprim-sulfamethoxazole	N/A	1.4	[0.0 - 7.7]				98.6						1.4						
	Phenicols	Chloramphenicol	1.4	4.3	[0.9 - 12.0]								1.4	27.1	65.7	1.4	1.4	2.9			
	Tetracyclines	Tetracycline	0.0	34.3	[23.3 - 46.6]									65.7				34.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

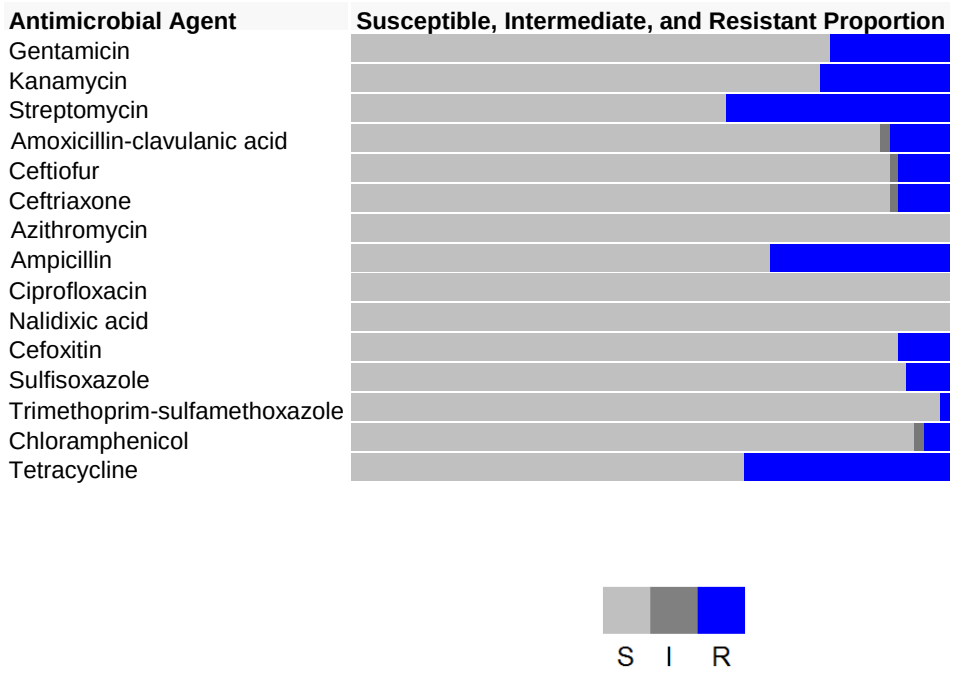


Table 20. Percentage and number of *Salmonella* ser. Heidelberg isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 105	2003 96	2004 92	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	3.8% 4	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
		Kanamycin (MIC ≥ 64)	10.5% 11	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
		Streptomycin (MIC ≥ 64)	17.1% 18	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	9.5% 10	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
	Cephems	Ceftiofur (MIC ≥ 8)	7.6% 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
		Ceftriaxone (MIC ≥ 4)	7.6% 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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	12.4% 13	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	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
II	Cephems	Cefoxitin (MIC ≥ 32)	8.6% 9	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
		Cephalothin (MIC ≥ 32)	10.5% 11	7.3% 7	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	6.7% 7	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	1.0% 1	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.0% 1	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	19.0% 20	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 21. Resistance patterns of *Salmonella* ser. Heidelberg isolates, 2002–2011

Year Total Isolates	2002 105	2003 96	2004 92	2005 125	2006 102	2007 98	2008 75	2009 86	2010 62	2011 70
Resistance Pattern										
No resistance detected	67.6% 71	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
Resistance ≥ 1 CLSI class*	32.4% 34	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
Resistance ≥ 2 CLSI classes*	25.7% 27	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
Resistance ≥ 3 CLSI classes*	12.4% 13	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
Resistance ≥ 4 CLSI classes*	1.9% 2	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
Resistance ≥ 5 CLSI classes*	1.9% 2	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
At least ACSSuT†	1.0% 1	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
At least ACT/S‡	1.0% 1	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
At least ACSSuTAuCx§	1.0% 1	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
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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

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

Table 22. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. I 4,[5],12:i:- isolates to antimicrobial agents, 2011 (N=82)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**													
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	**Aminoglycosides**	Gentamicin	0.0	1.2	[0.0 - 6.6]					2.4	85.4	11.0				1.2					
		Kanamycin	0.0	0.0	[0.0 - 4.4]										100.0						
		Streptomycin	N/A	24.4	[15.6 - 35.1]												75.6	1.2	23.2		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	4.9	[1.3 - 12.0]							69.5	2.4	4.9	18.3		1.2	3.7			
	Cephems	Ceftiofur	0.0	3.7	[0.7 - 10.3]					2.4	37.8	54.9	1.2			3.7					
		Ceftriaxone	0.0	3.7	[0.7 - 10.3]					96.3						2.4		1.2			
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 4.4]								8.5	84.1	6.1	1.2					
	Penicillins	Ampicillin	0.0	26.8	[17.6 - 37.8]							69.5	1.2	2.4				26.8			
	Quinolones	Ciprofloxacin	0.0	0.0	[0.0 - 4.4]	97.6	2.4														
		Nalidixic acid	N/A	0.0	[0.0 - 4.4]								59.8	39.0	1.2						
II	**Cephems**	Cefoxitin	0.0	4.9	[1.3 - 12.0]						1.2	39.0	51.2	2.4	1.2		3.7	1.2			
	Folate pathway inhibitors	Sulfisoxazole	N/A	23.2	[14.6 - 33.8]											2.4	50.0	24.4			23.2
		Trimethoprim-sulfamethoxazole	N/A	1.2	[0.0 - 6.6]				98.8						1.2						
	Phenicols	Chloramphenicol	1.2	2.4	[0.3 - 8.5]								1.2	56.1	39.0	1.2		2.4			
	Tetracyclines	Tetracycline	0.0	25.6	[16.6 - 36.4]									74.4				25.6			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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:-, 2011

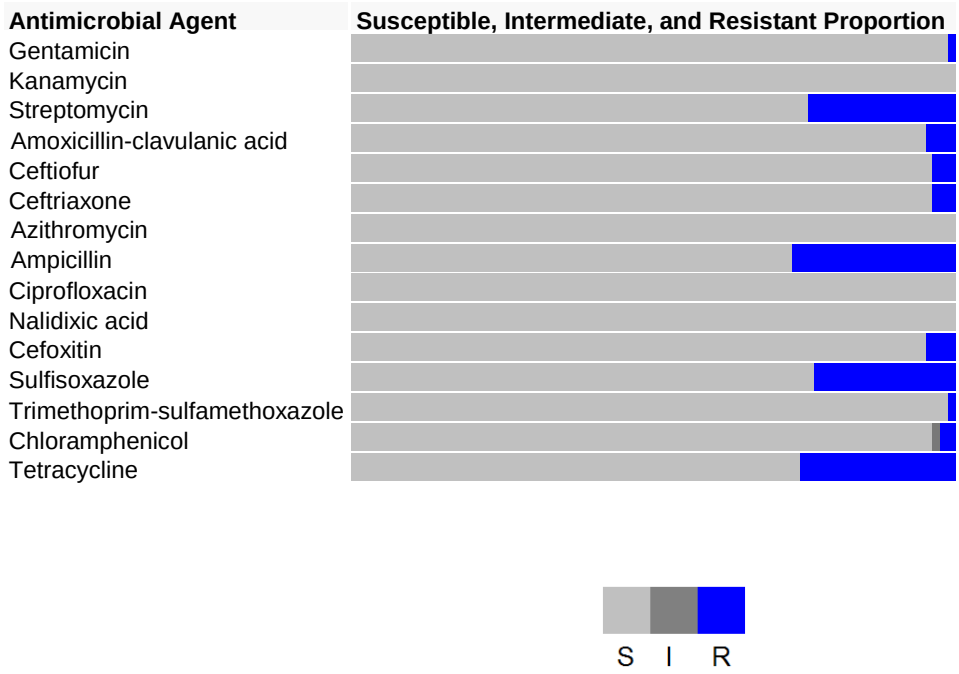


Table 23. Percentage and number of *Salmonella* ser. I 4,[5],12:i:- isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 35	2003 36	2004 36	2005 33	2006 105	2007 73	2008 84	2009 72	2010 78	2011 82
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.0% 0	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
		Streptomycin (MIC ≥ 64)	2.9% 1	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.9% 1	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
	Cephems	Ceftiofur (MIC ≥ 8)	2.9% 1	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
		Ceftriaxone (MIC ≥ 4)	2.9% 1	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	8.6% 3	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
	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	1.3% 1	0.0% 0
		Nalidixic Acid (MIC ≥ 32)	0.0% 0	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
II	Cephems	Cefoxitin (MIC ≥ 32)	2.9% 1	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
		Cephalothin (MIC ≥ 32)	2.9% 1	5.6% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	2.9% 1	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	2.9% 1	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	2.9% 1	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	5.7% 2	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 24. Resistance patterns* of *Salmonella* ser. I 4,[5],12:i:- isolates, 2002–2011

Year Total Isolates	2002 35	2003 36	2004 36	2005 33	2006 105	2007 73	2008 84	2009 72	2010 78	2011 82
Resistance Pattern										
No resistance detected	91.4% 32	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
Resistance ≥ 1 CLSI class†	8.6% 3	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
Resistance ≥ 2 CLSI classes†	8.6% 3	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
Resistance ≥ 3 CLSI classes†	5.7% 2	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
Resistance ≥ 4 CLSI classes†	2.9% 1	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
Resistance ≥ 5 CLSI classes†	2.9% 1	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
At least ACSSuT‡	2.9% 1	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
At least ACT/S§	2.9% 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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	2.4% 2	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

* Emerging resistance to ASSuT (ampicillin, streptomycin, sulfamethoxazole/sulfisoxazole, and tetracycline, but not chloramphenicol) in *Salmonella* ser. I 4,[5],12:i:- is described on page 16 of this report
† 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

2. Typhoidal *Salmonella*

A. *Salmonella* ser. Typhi

Table 25. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Typhi isolates to antimicrobial agents, 2011 (N=383)

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]					55.1	43.3	1.6									
		Kanamycin	0.0	0.0	[0.0 - 1.0]										100.0						
		Streptomycin	N/A	10.7	[7.8 - 14.2]												89.3	0.3	10.4		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 1.0]							88.3	0.5	3.1	8.1						
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 1.0]				0.5	2.1	81.5	15.9									
		Ceftriaxone	0.3	0.0	[0.0 - 1.0]					99.7			0.3								
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 1.0]				0.3			2.9	43.3	52.2	1.3						
	Penicillins	Ampicillin	0.0	11.2	[8.2 - 14.8]							88.5	0.3					11.2			
	Quinolones	Ciprofloxacin	64.2	7.3	[4.9 - 10.4]	26.1	0.3	2.1	12.0	42.3	9.9		0.5		6.8						
		Nalidixic acid	N/A	70.8	[65.9 - 75.3]							6.5	17.5	4.2	1.0		1.8	68.9			
II	Cephems	Cefoxitin	0.0	0.0	[0.0 - 1.0]						3.7	27.2	12.3	52.0	5.0						
	Folate pathway inhibitors	Sulfisoxazole	N/A	12.0	[8.9 - 15.7]											19.8	50.4	12.5	5.0	0.3	12.0
		Trimethoprim-sulfamethoxazole	N/A	11.7	[8.7 - 15.4]				88.0		0.3				11.7						
	Phenicols	Chloramphenicol	0.3	10.7	[7.8 - 14.2]								3.7	68.4	17.0	0.3		10.7			
	Tetracyclines	Tetracycline	0.0	4.4	[2.6 - 7.0]									95.6		0.3		4.2			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

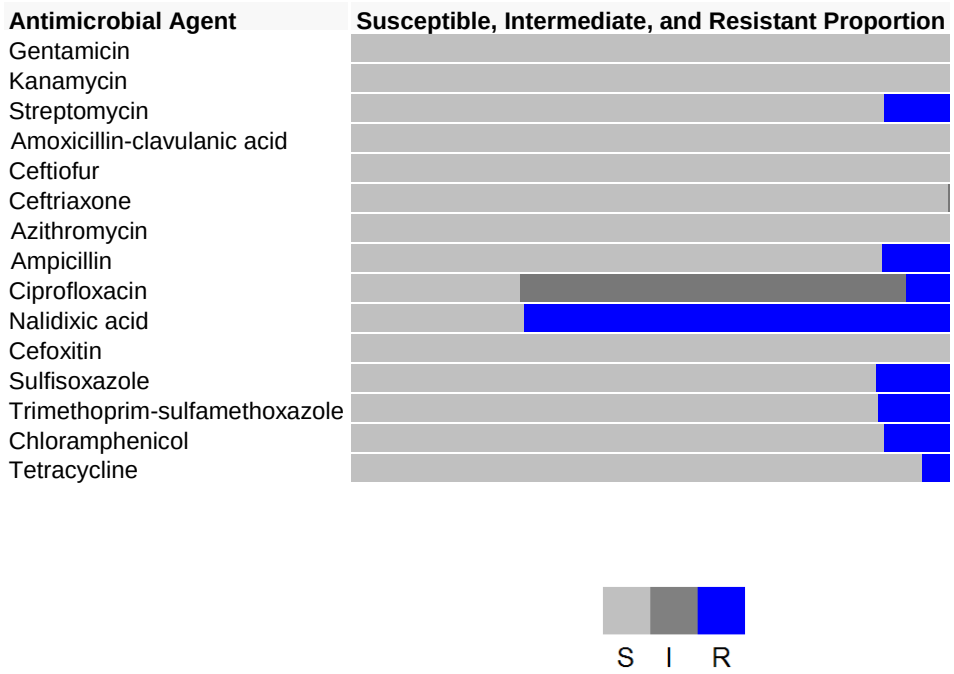


Table 26. Percentage and number of *Salmonella* ser. Typhi isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 195	2003 332	2004 304	2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383
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	0.0% 0	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	0.0% 0	0.2% 1	0.0% 0
		Streptomycin (MIC ≥ 64)	7.2% 14	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.3% 1	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	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	5.6% 11	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
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	23.6% 46	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	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
		Cephalothin (MIC ≥ 32)	1.5% 3	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	6.2% 12	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	6.7% 13	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	6.2% 12	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	6.7% 13	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 27. Resistance patterns of *Salmonella* ser. Typhi isolates, 2002–2011

Year Total Isolates	2002 195	2003 332	2004 304	2005 318	2006 323	2007 400	2008 407	2009 363	2010 446	2011 383
Resistance Pattern										
No resistance detected	74.4% 145	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
Resistance ≥ 1 CLSI class*	25.6% 50	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
Resistance ≥ 2 CLSI classes*	7.2% 14	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
Resistance ≥ 3 CLSI classes*	6.7% 13	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
Resistance ≥ 4 CLSI classes*	6.2% 12	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
Resistance ≥ 5 CLSI classes*	5.6% 11	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
At least ACSSuT†	5.6% 11	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
At least ACT/S‡	5.6% 11	15.7% 52	11.8% 36	12.9% 41	18.6% 60	15.3% 61	12.0% 49	11.0% 40	10.5% 47	10.4% 40
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	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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

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

Table 28. Frequency of *Salmonella* ser. Paratyphi A, Paratyphi B (tartrate negative), and Paratyphi C, 2011 (see Methods for varying sampling method by serotype)

Serotype	2011	
	n	(%)
Paratyphi A	146	(97.3)
Paratyphi B	2	(1.3)
Paratyphi C	2	(1.3)
Total	**150**	**(100)**

Table 29. Minimum inhibitory concentrations (MICs) and resistance of *Salmonella* ser. Paratyphi A isolates to antimicrobial agents, 2011 (N=146)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**													
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	0.0	[0.0 - 2.5]					98.6	0.7	0.7									
		Kanamycin	0.0	0.0	[0.0 - 2.5]										100.0						
		Streptomycin	N/A	0.0	[0.0 - 2.5]												100.0				
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.0	0.0	[0.0 - 2.5]							63.0	34.2	2.7							
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 2.5]					0.7	2.7	93.2	3.4								
		Ceftriaxone	0.0	0.0	[0.0 - 2.5]					100.0											
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 2.5]								3.4	51.4	41.1	4.1					
	Penicillins	Ampicillin	0.0	0.0	[0.0 - 2.5]							4.1	89.0	6.2	0.7						
	Quinolones	Ciprofloxacin	95.2	2.1	[0.4 - 5.9]	2.1	0.7		1.4	2.1	91.8	2.1									
		Nalidixic acid	N/A	96.6	[92.2 - 98.9]								0.7	2.1	0.7			96.6			
II	Cephems	Cefoxitin	2.1	0.0	[0.0 - 2.5]								7.5	74.0	16.4	2.1					
	Folate pathway inhibitors	Sulfisoxazole	N/A	0.0	[0.0 - 2.5]											9.6	67.1	23.3			
		Trimethoprim-sulfamethoxazole	N/A	0.0	[0.0 - 2.5]				97.3	2.7											
	Phenicols	Chloramphenicol	6.2	0.0	[0.0 - 2.5]									4.8	89.0	6.2					
	Tetracyclines	Tetracycline	0.0	0.0	[0.0 - 2.5]									100.0							

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

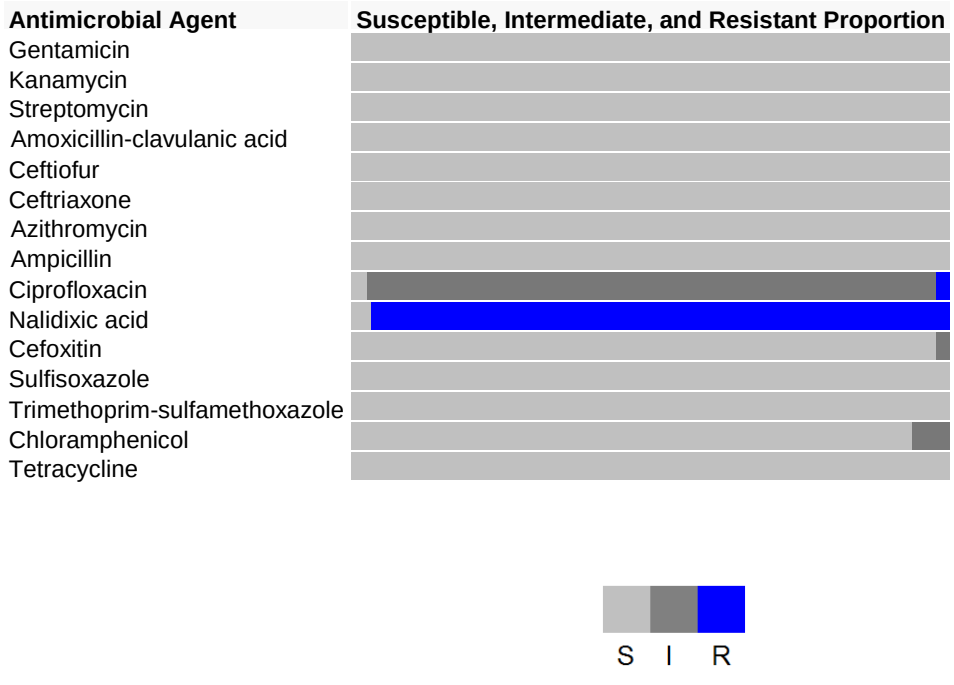


Table 30. Percentage and number of *Salmonella* ser. Paratyphi A isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 9	2003 6	2004 8	2005 13	2006 10	2007 16	2008 116	2009 99	2010 145	2011 146
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	0.0% 0	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	0.7% 1	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	0.0% 0	0.7% 1	0.0% 0
		Streptomycin (MIC ≥ 64)	11.1% 1	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
	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	Not Tested	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	0.0% 0	1.0% 1	1.4% 2	0.0% 0
	Quinolones	Ciprofloxacin (MIC ≥ 1)	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.9% 1	0.0% 0	2.8% 4	2.1% 3
		Nalidixic Acid (MIC ≥ 32)	44.4% 4	100.0% 6	100.0% 8	92.3% 12	80.0% 8	93.8% 15	88.8% 103	86.9% 86	92.4% 134	96.6% 141
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	0.0% 0	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	0.0% 0	1.0% 1	1.4% 2	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	0.0% 0	1.0% 1	2.1% 3	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	0.0% 0	1.0% 1	1.4% 2	0.0% 0
	Tetracyclines	Tetracycline (MIC ≥ 16)	11.1% 1	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 31. Resistance patterns of *Salmonella* ser. Paratyphi A isolates, 2002–2011

Year Total Isolates	2002 9	2003 6	2004 8	2005 13	2006 10	2007 16	2008 116	2009 99	2010 145	2011 146
Resistance Pattern										
No resistance detected	44.4% 4	0.0% 0	0.0% 0	7.7% 1	20.0% 2	6.3% 1	10.3% 12	12.1% 12	5.5% 8	3.4% 5
Resistance ≥ 1 CLSI class*	55.6% 5	100.0% 6	100.0% 8	92.3% 12	80.0% 8	93.8% 15	89.7% 104	87.9% 87	94.5% 137	96.6% 141
Resistance ≥ 2 CLSI classes*	11.1% 1	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
Resistance ≥ 3 CLSI classes*	0.0% 0	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
Resistance ≥ 4 CLSI classes*	0.0% 0	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
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT†	0.0% 0	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
At least ACT/S‡	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	1.0% 1	0.7% 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	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

* 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

3. *Shigella*

Table 32. Frequency of *Shigella* species, 2011

Species	2011	
	n	(%)
Shigella sonnei	225	(76.8)
Shigella flexneri	58	(19.8)
Shigella boydii	9	(3.1)
Other	1	(0.3)
Total	**293**	**(100)**

Table 33. Minimum inhibitory concentrations (MICs) and resistance of *Shigella* isolates to antimicrobial agents, 2011 (N=293)

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	0.7	[0.1 - 2.4]					0.7	12.6	80.5	5.5				0.7				
		Kanamycin	0.0	0.0	[0.0 - 1.3]										100.0						
		Streptomycin	N/A	87.7	[83.4 - 91.2]												12.3	38.6	49.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	16.7	2.0	[0.8 - 4.4]							2.0	5.8	53.2	20.1	16.7	1.7	0.3			
	Cephems	Ceftiofur	0.0	1.7	[0.6 - 3.9]				11.6	74.7	7.8	4.1			0.3	1.4					
		Ceftriaxone	0.0	1.7	[0.6 - 3.9]					97.6	0.7					0.3		0.3	1.0		
	Macrolide	Azithromycin	N/A	3.1	[1.4 - 5.8]				0.3	1.7	1.7	7.8	11.6	68.3	5.1	0.3	3.1				
	Penicillins	Ampicillin	0.7	33.8	[28.4 - 39.5]							6.8	47.8	9.9	1.0	0.7	0.3	33.4			
	Quinolones	Ciprofloxacin	0.0	2.4	[1.0 - 4.9]	91.5	0.7	1.4	2.4	1.4	0.3			1.7	0.7						
		Nalidixic acid	N/A	6.1	[3.7 - 9.5]						3.4	75.1	11.6	2.7	1.0		2.7	3.4			
II	Cephems	Cefoxitin	1.4	1.0	[0.2 - 3.0]							3.1	75.4	18.8	0.3	1.4	0.7	0.3			
	Folate pathway inhibitors	Sulfisoxazole	N/A	44.7	[38.9 - 50.6]											31.1	16.4	6.1	1.0	0.7	44.7
		Trimethoprim-sulfamethoxazole	N/A	66.9	[61.2 - 72.3]				7.5	1.7	1.7	10.2	11.9	15.4	51.5						
	Phenicols	Chloramphenicol	0.3	12.3	[8.8 - 16.6]								16.4	66.2	4.8	0.3	2.4	9.9			
	Tetracyclines	Tetracycline	1.0	40.6	[34.9 - 46.5]									58.4	1.0		10.2	30.4			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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*, 2011

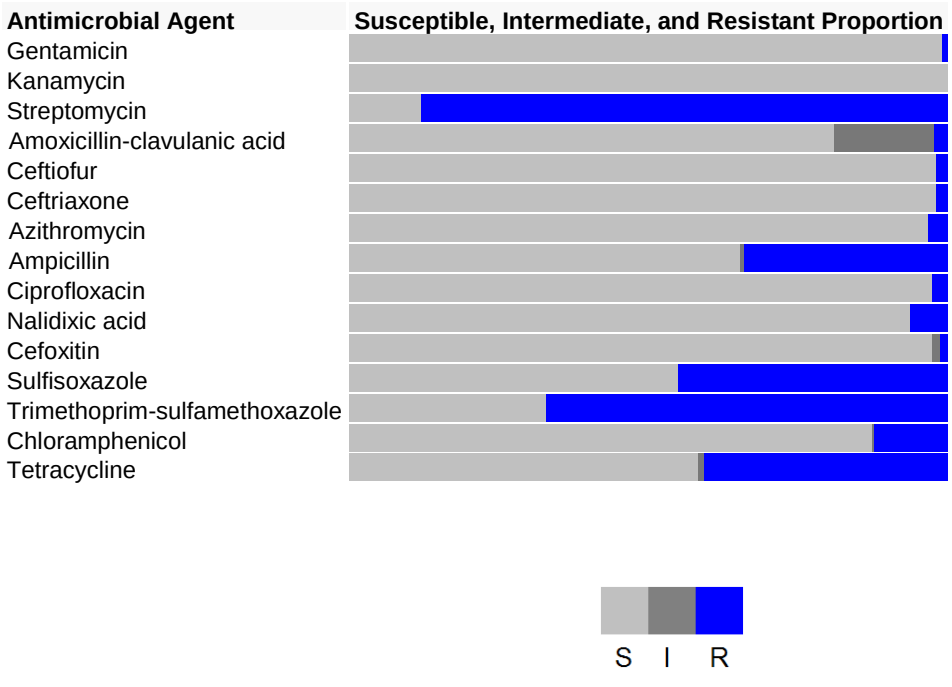


Table 34. Percentage and number of *Shigella* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 620	2003 495	2004 316	2005 396	2006 402	2007 480	2008 551	2009 475	2010 411	2011 293
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	0.2% 1	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
		Kanamycin (MIC ≥ 64)	0.8% 5	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
		Streptomycin (MIC ≥ 64)	54.4% 337	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.6% 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
	Cephems	Ceftiofur (MIC ≥ 8)	0.2% 1	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
		Ceftriaxone (MIC ≥ 4)	0.2% 1	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	3.1% 9
	Penicillins	Ampicillin (MIC ≥ 32)	76.6% 475	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.6% 10	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.3% 2	0.0% 0	0.3% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.6% 3	0.0% 0	1.0% 3
		Cephalothin (MIC ≥ 32)	6.6% 41	9.3% 46	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	31.8% 197	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	37.3% 231	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	7.6% 47	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	30.6% 190	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 35. Resistance patterns of *Shigella* isolates, 2002–2011

Year Total Isolates	2002 620	2003 495	2004 316	2005 396	2006 402	2007 480	2008 551	2009 475	2010 411	2011 293
Resistance Pattern										
No resistance detected	8.2% 51	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
Resistance ≥ 1 CLSI class*	91.8% 569	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
Resistance ≥ 2 CLSI classes*	55.2% 342	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
Resistance ≥ 3 CLSI classes*	41.6% 258	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
Resistance ≥ 4 CLSI classes*	24.4% 151	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
Resistance ≥ 5 CLSI classes*	2.9% 18	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
At least ACSSuT†	1.8% 11	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
At least ACT/S‡	2.7% 17	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
At least AT/S§	29.8% 185	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
At least ANT/S¶	0.3% 2	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
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	0.2% 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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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 36. Minimum inhibitory concentrations (MICs) and resistance of *Shigella sonnei* isolates to antimicrobial agents, 2011 (N=225)

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	0.9	[0.1 - 3.2]						6.7	87.1	5.3				0.9				
		Kanamycin	0.0	0.0	[0.0 - 1.6]										100.0						
		Streptomycin	N/A	95.6	[92.0 - 97.9]												4.4	44.4	51.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	10.2	2.7	[1.0 - 5.7]							0.9	0.9	63.6	21.8	10.2	2.2	0.4			
	Cephems	Ceftiofur	0.0	1.8	[0.5 - 4.5]				2.7	82.7	8.4	4.4			0.4	1.3					
		Ceftriaxone	0.0	1.8	[0.5 - 4.5]					97.3	0.9					0.4		0.4	0.9		
	Macrolide	Azithromycin	N/A	0.9	[0.1 - 3.2]							1.3	5.8	85.3	6.7		0.9				
	Penicillins	Ampicillin	0.9	27.6	[21.8 - 33.9]							0.9	57.3	12.4	0.9	0.9	0.4	27.1			
	Quinolones	Ciprofloxacin	0.0	1.3	[0.3 - 3.8]	95.1	0.4	1.3	0.9	0.9				1.3								
		Nalidixic acid	N/A	3.6	[1.5 - 6.9]						3.6	81.8	8.4	2.2	0.4		1.8	1.8			
II	**Cephems**	Cefoxitin	1.3	1.3	[0.3 - 3.8]							3.1	81.3	12.9		1.3	0.9	0.4			
	Folate pathway inhibitors	Sulfisoxazole	N/A	39.6	[33.1 - 46.3]											30.7	20.4	7.6	1.3	0.4	39.6
		Trimethoprim-sulfamethoxazole	N/A	68.9	[62.4 - 74.9]				1.3	0.4	0.9	12.9	15.6	20.0	48.9						
	Phenicols	Chloramphenicol	0.0	2.7	[1.0 - 5.7]								8.9	83.6	4.9		0.4	2.2			
	Tetracyclines	Tetracycline	0.9	29.8	[23.9 - 36.2]									69.3	0.9		11.1	18.7			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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*, 2011

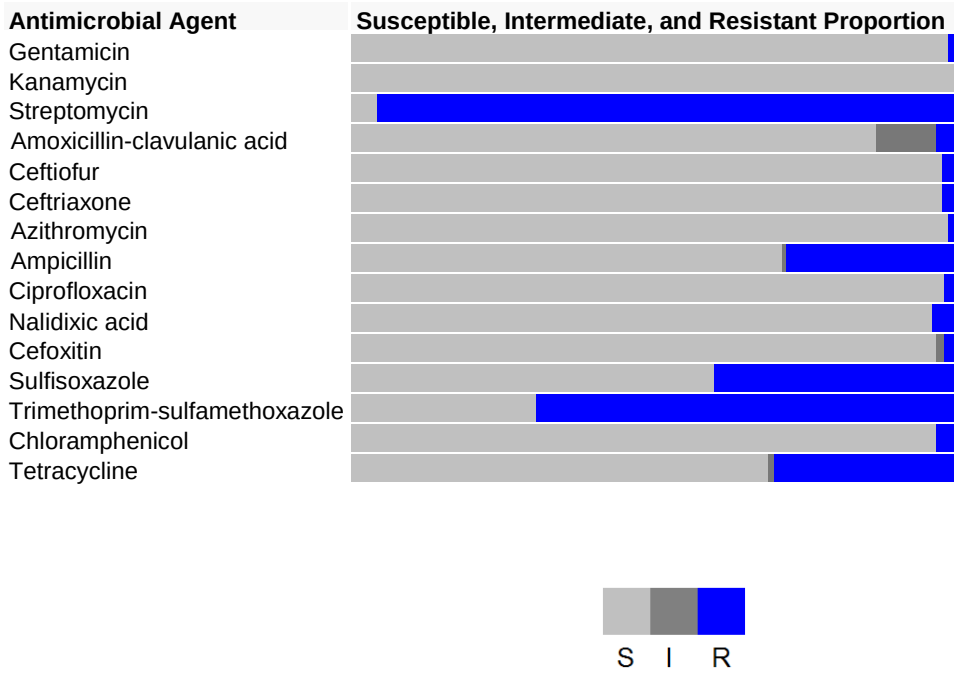


Table 37. Percentage and number of *Shigella sonnei* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 536	2003 434	2004 241	2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 225
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.4% 2	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
		Streptomycin (MIC ≥ 64)	55.4% 297	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	2.2% 12	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
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	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
		Ceftriaxone (MIC ≥ 4)	0.0% 0	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.9% 2
	Penicillins	Ampicillin (MIC ≥ 32)	77.6% 416	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.5% 8	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.4% 2	0.0% 0	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.7% 3	0.0% 0	1.3% 3
		Cephalothin (MIC ≥ 32)	7.3% 39	10.1% 44	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	29.9% 160	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	37.9% 203	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.2% 1	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	23.5% 126	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 38. Resistance patterns of *Shigella sonnei* isolates, 2002–2011

Year Total Isolates	2002 536	2003 434	2004 241	2005 340	2006 321	2007 414	2008 494	2009 410	2010 337	2011 225
Resistance Pattern										
No resistance detected	7.1% 38	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
Resistance ≥ 1 CLSI class*	92.9% 498	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
Resistance ≥ 2 CLSI classes*	51.9% 278	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
Resistance ≥ 3 CLSI classes*	36.6% 196	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
Resistance ≥ 4 CLSI classes*	19.8% 106	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
Resistance ≥ 5 CLSI classes*	0.7% 4	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
At least ACSSuT†	0.0% 0	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
At least ACT/S‡	0.2% 1	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
At least AT/S§	30.2% 162	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
At least ANT/S¶	0.2% 1	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
At least ACSSuTAuCx**	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0
At least ceftriaxone and nalidixic acid resistant	0.0% 0	0.0% 0	0.4% 1	0.3% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.3% 1	1.3% 3

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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 39. Minimum inhibitory concentrations and resistance of *Shigella flexneri* isolates to antimicrobial agents, 2011 (N=58)

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 - 6.2]					3.4	31.0	58.6	6.9								
		Kanamycin	0.0	0.0	[0.0 - 6.2]										100.0						
		Streptomycin	N/A	58.6	[44.9 - 71.4]												41.4	19.0	39.7		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	43.1	0.0	[0.0 - 6.2]							5.2	24.1	13.8	13.8	43.1					
	Cephems	Ceftiofur	0.0	1.7	[0.0 - 9.2]				39.7	48.3	6.9	3.4				1.7					
		Ceftriaxone	0.0	1.7	[0.0 - 9.2]					98.3									1.7		
	Macrolide	Azithromycin	N/A	10.3	[3.9 - 21.2]				1.7	8.6	8.6	29.3	27.6	12.1		1.7	10.3				
	Penicillins	Ampicillin	0.0	60.3	[46.6 - 73.0]							25.9	12.1	1.7				60.3			
	Quinolones	Ciprofloxacin	0.0	6.9	[1.9 - 16.7]	81.0	1.7	1.7	3.4	3.4	1.7			3.4	3.4						
		Nalidixic acid	N/A	12.1	[5.0 - 23.3]						1.7	56.9	20.7	5.2	3.4		3.4	8.6			
II	Cephems	Cefoxitin	1.7	0.0	[0.0 - 6.2]							1.7	53.4	41.4	1.7	1.7					
	Folate pathway inhibitors	Sulfisoxazole	N/A	60.3	[46.6 - 73.0]											32.8	3.4	1.7		1.7	60.3
		Trimethoprim-sulfamethoxazole	N/A	58.6	[44.9 - 71.4]				29.3	6.9	5.2				58.6						
	Phenicols	Chloramphenicol	1.7	50.0	[36.6 - 63.4]								36.2	6.9	5.2	1.7	10.3	39.7			
	Tetracyclines	Tetracycline	1.7	79.3	[66.6 - 88.8]									19.0	1.7		6.9	72.4			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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*, 2011

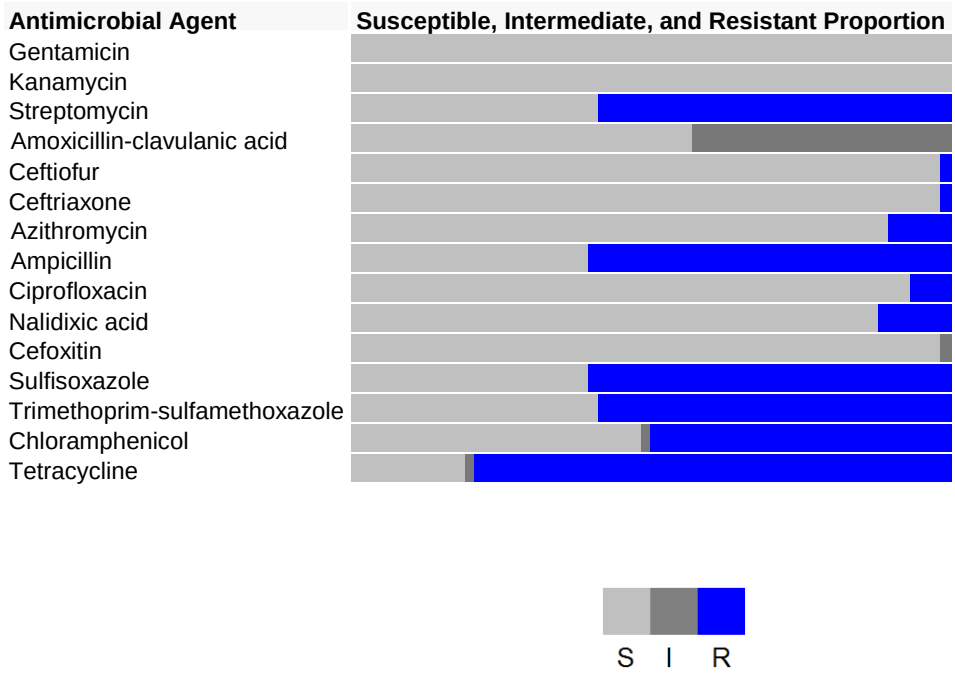


Table 40. Percentage and number of *Shigella flexneri* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 73	2003 51	2004 62	2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	1.4% 1	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
		Kanamycin (MIC ≥ 64)	4.1% 3	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
		Streptomycin (MIC ≥ 64)	43.8% 32	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	5.5% 4	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
	Cephems	Ceftiofur (MIC ≥ 8)	1.4% 1	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
		Ceftriaxone (MIC ≥ 4)	1.4% 1	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	10.3% 6
	Penicillins	Ampicillin (MIC ≥ 32)	75.3% 55	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	2.7% 2	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
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)	2.7% 2	3.9% 2	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	41.1% 30	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	28.8% 21	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	63.0% 46	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	78.1% 57	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

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 41. Resistance patterns of *Shigella flexneri* isolates, 2002–2011

Year Total Isolates	2002 73	2003 51	2004 62	2005 52	2006 74	2007 61	2008 49	2009 57	2010 61	2011 58
Resistance Pattern										
No resistance detected	15.1% 11	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
Resistance ≥ 1 CLSI class*	84.9% 62	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
Resistance ≥ 2 CLSI classes*	76.7% 56	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
Resistance ≥ 3 CLSI classes*	75.3% 55	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
Resistance ≥ 4 CLSI classes*	57.5% 42	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
Resistance ≥ 5 CLSI classes*	19.2% 14	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
At least ACSSuT†	15.1% 11	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
At least ACT/S‡	21.9% 16	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
At least AT/S§	27.4% 20	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
At least ANT/S¶	1.4% 1	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
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	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

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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 42. Minimum inhibitory concentrations (MICs) and resistance of *Escherichia coli* O157 isolates to antimicrobial agents, 2011 (N=162)

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 - 3.4]					4.3	77.8	16.7	0.6				0.6				
		Kanamycin	0.0	1.9	[0.4 - 5.3]										98.1				1.9		
		Streptomycin	N/A	4.3	[1.7 - 8.7]												95.7	1.2	3.1		
	β-lactam / β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid	0.6	0.0	[0.0 - 2.3]							2.5	7.4	87.0	2.5	0.6					
	Cephems	Ceftiofur	0.0	0.0	[0.0 - 2.3]				1.2	7.4	90.1	1.2									
		Ceftriaxone	0.0	0.0	[0.0 - 2.3]					100.0											
	Macrolide	Azithromycin	N/A	0.0	[0.0 - 2.3]							6.2	82.1	9.9	0.6	1.2					
	Penicillins	Ampicillin	0.0	3.7	[1.4 - 7.9]							4.9	80.9	10.5				3.7			
	Quinolones	Ciprofloxacin	0.0	0.6	[0.0 - 3.4]	98.8			0.6						0.6						
		Nalidixic acid	N/A	1.2	[0.1 - 4.4]							2.5	88.9	7.4				1.2			
II	Cephems	Cefoxitin	1.2	0.0	[0.0 - 2.3]							3.7	4.9	74.1	16.0	1.2					
	Folate pathway inhibitors	Sulfisoxazole	N/A	4.9	[2.2 - 9.5]											71.0	19.1	4.9			4.9
		Trimethoprim-sulfamethoxazole	N/A	2.5	[0.7 - 6.2]				96.9	0.6					2.5						
	Phenicols	Chloramphenicol	0.6	1.2	[0.1 - 4.4]								1.2	21.0	75.9	0.6		1.2			
	Tetracyclines	Tetracycline	0.0	4.9	[2.2 - 9.5]									95.1		0.6		4.3			

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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, 2011

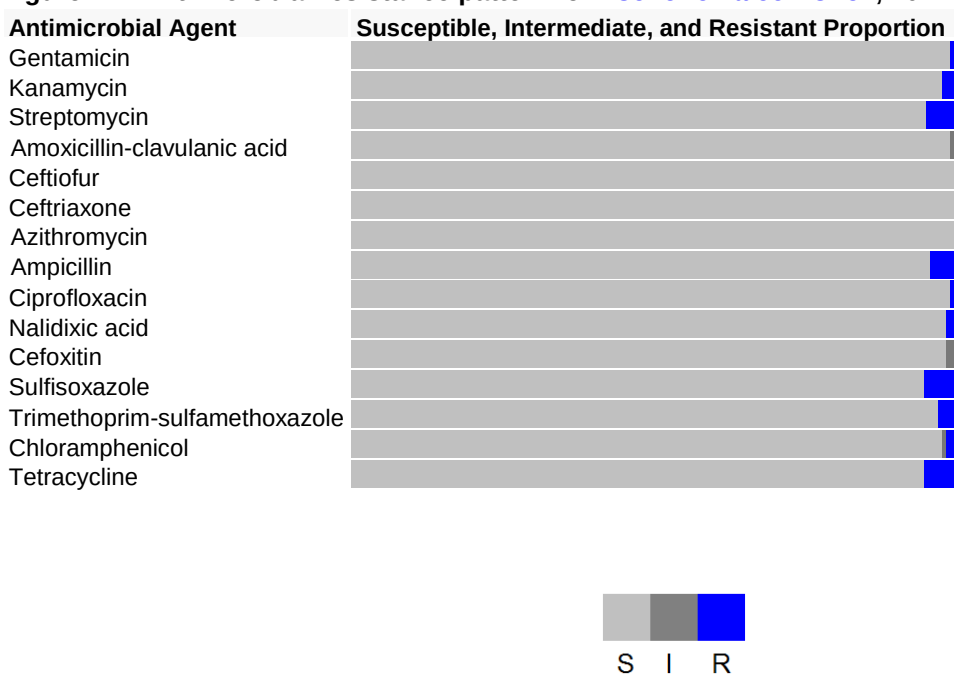


Table 43. Percentage and number of *Escherichia coli* O157 isolates resistant to antimicrobial agents, 2002–2011

Year			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Isolates			399	158	169	194	233	190	161	187	170	162
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	0.0% 0	Not Tested
		Gentamicin (MIC ≥ 16)	0.0% 0	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
		Kanamycin (MIC ≥ 64)	0.5% 2	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
		Streptomycin (MIC ≥ 64)	2.3% 9	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
	β-lactam/β-lactamase inhibitor combinations	Amoxicillin-clavulanic acid (MIC ≥ 32/16)	0.0% 0	1.3% 2	0.0% 0	0.0% 0	1.3% 3	0.5% 1	0.6% 1	0.5% 1	0.0% 0	0.0% 0
	Cephems	Ceftiofur (MIC ≥ 8)	0.0% 0	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
		Ceftriaxone (MIC ≥ 4)	0.0% 0	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
	Macrolides	Azithromycin (MIC ≥ 32)	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	0.0% 0
	Penicillins	Ampicillin (MIC ≥ 32)	1.5% 6	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
	Quinolones	Ciprofloxacin (MIC ≥ 4)	0.0% 0	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
		Nalidixic Acid (MIC ≥ 32)	1.0% 4	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
II	Cephems	Cefoxitin (MIC ≥ 32)	0.0% 0	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
		Cephalothin (MIC ≥ 32)	1.5% 6	3.2% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
	Folate pathway inhibitors	Sulfamethoxazole/Sulfisoxazole‡ (MIC ≥ 512)	3.5% 14	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
		Trimethoprim-sulfamethoxazole (MIC ≥ 4/76)	0.5% 2	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
	Phenicols	Chloramphenicol (MIC ≥ 32)	1.3% 5	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	3.0% 12	5.7% 9	1.8% 3	8.8% 17	4.7% 11	4.7% 9	1.9% 3	7.5% 14	4.7% 8	4.9% 8

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 44. Resistance patterns of *Escherichia coli* O157 isolates, 2002–2011

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Isolates	399	158	169	194	233	190	161	187	170	162
Resistance Pattern										
No resistance detected	94.0% 375	90.5% 143	94.7% 160	87.6% 170	91.8% 214	92.1% 175	91.9% 148	89.8% 168	93.5% 159	92.6% 150
Resistance ≥ 1 CLSI class*	6.0% 24	9.5% 15	5.3% 9	12.4% 24	8.2% 19	7.9% 15	8.1% 13	10.2% 19	6.5% 11	7.4% 12
Resistance ≥ 2 CLSI classes*	3.8% 15	5.1% 8	2.4% 4	6.7% 13	4.7% 11	3.2% 6	3.1% 5	7.5% 14	4.7% 8	4.9% 8
Resistance ≥ 3 CLSI classes*	2.0% 8	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
Resistance ≥ 4 CLSI classes*	0.8% 3	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
Resistance ≥ 5 CLSI classes*	0.0% 0	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
At least ACSSuT†	0.0% 0	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
At least ACT/S‡	0.0% 0	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
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	0.0% 0	0.4% 1	0.0% 0	0.0% 0	0.0% 0	0.0% 0	0.0% 0

* CLSI: Clinical and Laboratory Standards Institute; starting in 2011, testing included nine classes with the addition of the macrolide azithromycin
† 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 45. Frequency of *Campylobacter* species, 2011

Species	2011	
	N	(%)
Campylobacter jejuni	1275	(86.3)
Campylobacter coli	148	(10.0)
Other	55	(3.7)
Total	**1478**	**(100)**

Table 46. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter* isolates to antimicrobial agents, 2011 (N=1478)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**														
			%I‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.1	2.0	[1.4 - 2.9]				3.4	33.2	57.8	3.3	0.3	0.1			0.1	2.0			
	Ketolide	Telithromycin	1.4	2.1	[1.4 - 3.0]	0.1			0.1	1.6	10.1	34.9	37.7	12.0	1.4	2.1					
	Macrolides	Azithromycin	0.0	1.8	[1.2 - 2.6]		1.5	10.1	46.2	35.6	4.3	0.2	0.3						1.8		
		Erythromycin	0.0	1.8	[1.2 - 2.6]				0.3	2.0	14.6	49.3	26.1	5.5	0.4				1.8		
	Quinolones	Ciprofloxacin	0.3	24.2	[22.0 - 26.4]		0.4	17.6	43.5	10.4	3.2	0.5	0.3	0.6	7.1	9.7	4.7	1.6	0.5		
		Nalidixic acid	0.3	24.8	[22.6 - 27.0]									56.7	15.2	3.0	0.3	0.4	24.4		
II	Lincosamides	Clindamycin	0.3	2.0	[1.4 - 2.9]			0.1	3.8	28.1	43.4	17.9	4.4	0.3	0.3	0.3	1.4				
	Phenicols	Florfenicol††	N/A	2.0	[1.4 - 2.9]			0.1			0.8	25.4	59.4	12.2	1.4	0.5	0.1				
	Tetracyclines	Tetracycline	0.1	45.1	[42.5 - 47.6]			0.1	2.4	24.2	18.9	6.5	1.9	0.9	0.1	0.2	0.4	1.6	42.8		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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.
†† Only a susceptible breakpoint (≤ 4 µg/mL) has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

Figure 15. Antimicrobial resistance pattern for *Campylobacter*, 2011

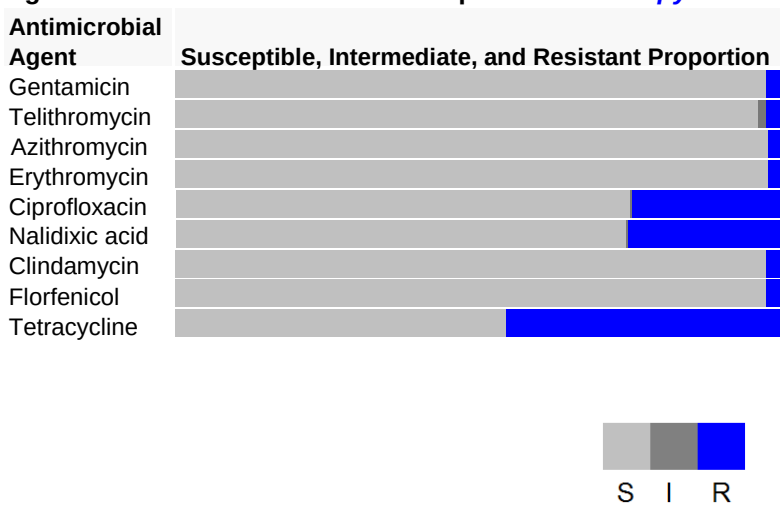


Table 47. Percentage and number of *Campylobacter* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 354	2003 328	2004 347	2005 888	2006 816	2007 1100	2008 1155	2009 1495	2010 1310	2011 1478
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	0.3% 1	0.3% 1	0.5% 4	0.1% 1	0.6% 7	1.1% 13	0.9% 13	1.6% 21	2.0% 30
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	1.0% 9	1.6% 13	1.5% 16	2.5% 29	1.5% 22	1.6% 21	2.1% 31
	Macrolides	Azithromycin (MIC ≥ 8)	2.0% 7	0.9% 3	0.6% 2	1.8% 16	1.7% 14	2.0% 22	3.0% 35	1.7% 25	1.5% 19	1.8% 27
		Erythromycin (MIC ≥ 32)	1.4% 5	0.9% 3	0.3% 1	1.7% 15	1.7% 14	2.0% 22	3.0% 35	1.7% 25	1.5% 19	1.8% 27
	Quinolones	Ciprofloxacin (MIC ≥ 4)	20.1% 71	17.7% 58	19.0% 66	21.6% 192	19.6% 160	26.0% 286	23.0% 266	22.9% 342	22.4% 294	24.2% 357
		Nalidixic Acid (MIC ≥ 64)	20.6% 73	18.9% 62	19.6% 68	22.3% 198	20.1% 164	26.5% 291	23.5% 272	23.1% 346	22.7% 298	24.8% 366
II	Lincosamides	Clindamycin (MIC ≥ 8)	2.0% 7	0.6% 2	2.0% 7	1.4% 12	2.0% 16	1.7% 19	2.8% 32	1.4% 21	1.7% 22	2.0% 30
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.3% 1	0.0% 0	1.4% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	Not Tested	Not Tested	0.5% 4	0.0% 0	0.0% 0	0.5% 6	0.5% 8	1.3% 17	2.0% 30
	Tetracyclines	Tetracycline (MIC ≥ 16)	41.2% 146	38.4% 126	46.1% 160	40.5% 360	46.0% 375	44.4% 488	43.6% 504	43.5% 651	42.1% 552	45.1% 666

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table 1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Only a susceptible breakpoint (≤ 4 µg/mL) has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

Table 48. Resistance patterns of *Campylobacter* isolates, 2002–2011

Year Total Isolates	2002 354	2003 328	2004 347	2005 888	2006 816	2007 1100	2008 1155	2009 1495	2010 1310	2011 1478
Resistance Pattern										
No resistance detected	48.0% 170	50.9% 167	46.1% 160	48.5% 431	43.9% 358	45.2% 497	45.9% 530	46.4% 694	47.3% 619	45.0% 665
Resistance ≥ 1 CLSI class*	52.0% 184	49.1% 161	53.9% 187	51.5% 457	56.1% 458	54.8% 603	54.1% 625	53.6% 801	52.7% 691	55.0% 813
Resistance ≥ 2 CLSI classes*	12.7% 45	8.5% 28	14.1% 49	13.6% 121	12.0% 98	17.5% 192	15.6% 180	14.2% 212	14.3% 187	17.4% 257
Resistance ≥ 3 CLSI classes*	1.4% 5	0.9% 3	1.7% 6	1.7% 15	1.5% 12	1.7% 19	2.7% 31	1.7% 25	2.1% 28	3.0% 45
Resistance ≥ 4 CLSI classes*	0.0% 0	0.3% 1	0.3% 1	0.3% 3	0.5% 4	0.9% 10	1.4% 16	1.1% 16	0.8% 10	1.2% 18
Resistance ≥ 5 CLSI classes*	0.0% 0	0.3% 1	0.0% 0	0.0% 0	0.1% 1	0.6% 7	0.7% 8	0.5% 8	0.6% 8	0.7% 11
At least quinolone and macrolide resistant	0.8% 3	0.9% 3	0.6% 2	1.0% 9	0.9% 7	1.4% 15	1.7% 20	1.2% 18	0.9% 12	1.7% 25

* CLSI: Clinical and Laboratory Standards Institute

Table 49. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter jejuni* isolates to antimicrobial agents, 2011 (N=1275)

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	0.9	[0.5 - 1.6]				3.4	33.7	59.1	2.7	0.2	< 0.1				0.9			
	Ketolide	Telithromycin	0.7	1.9	[1.2 - 2.8]	< 0.1				0.9	8.5	38.0	40.0	10.0	0.7	1.9					
	Macrolides	Azithromycin	0.0	1.7	[1.1 - 2.6]		1.6	10.4	47.7	35.4	3.1		0.2						1.7		
		Erythromycin	0.0	1.7	[1.1 - 2.6]				0.3	1.8	13.7	52.2	26.2	3.9	< 0.1				1.7		
	Quinolones	Ciprofloxacin	0.2	23.5	[21.1 - 25.9]		0.4	19.5	45.3	9.1	1.6	0.4	0.2	0.6	7.2	9.5	4.2	1.3	0.6		
		Nalidixic acid	0.4	23.7	[21.4 - 26.1]									61.5	12.6	1.8	0.4	0.3	23.4		
II	Lincosamides	Clindamycin	0.2	1.8	[1.1 - 2.7]			0.2	3.8	29.2	45.4	15.9	3.5	0.2	0.2	0.3	1.3				
	Phenicols	Florfenicol††	N/A	2.1	[1.4 - 3.1]			< 0.1			0.9	27.0	60.1	9.9	1.4	0.6	< 0.1				
	Tetracyclines	Tetracycline	0.2	45.9	[43.1 - 48.7]			0.2	2.4	24.8	18.3	6.1	1.3	0.9	0.2	< 0.1	0.5	1.8	43.5		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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.
†† Only a susceptible breakpoint (≤ 4 µg/mL) has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

Figure 16. Antimicrobial resistance pattern for *Campylobacter jejuni*, 2011

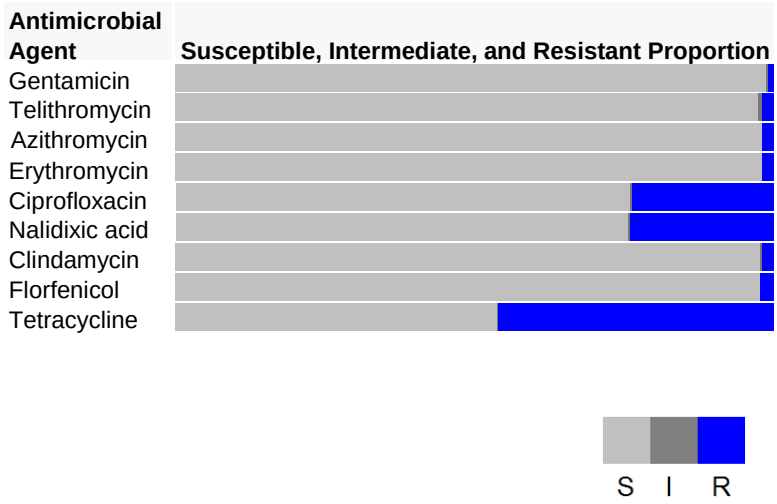


Table 50. Percentage and number of *Campylobacter jejuni* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 329	2003 303	2004 320	2005 788	2006 709	2007 992	2008 1042	2009 1350	2010 1158	2011 1275
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	0.0% 0	0.3% 1	0.1% 1	0.0% 0	0.7% 7	1.1% 11	0.6% 8	0.6% 7	0.9% 12
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	0.5% 4	0.8% 6	1.0% 10	2.1% 22	1.3% 18	1.2% 14	1.9% 24
	Macrolides	Azithromycin (MIC ≥ 8)	1.8% 6	0.3% 1	0.6% 2	1.5% 12	0.8% 6	1.6% 16	2.2% 23	1.5% 20	1.1% 13	1.7% 22
		Erythromycin (MIC ≥ 32)	1.2% 4	0.3% 1	0.3% 1	1.4% 11	0.8% 6	1.6% 16	2.2% 23	1.5% 20	1.1% 13	1.7% 22
	Quinolones	Ciprofloxacin (MIC ≥ 4)	20.7% 68	17.2% 52	18.1% 58	21.3% 168	19.5% 138	25.8% 256	22.3% 232	23.0% 310	21.8% 252	23.5% 299
		Nalidixic Acid (MIC ≥ 64)	21.3% 70	17.8% 54	18.4% 59	21.7% 171	19.0% 135	26.1% 259	22.7% 237	23.1% 312	21.9% 254	23.7% 302
II	Lincosamides	Clindamycin (MIC ≥ 8)	1.8% 6	0.0% 0	2.2% 7	0.9% 7	1.0% 7	1.3% 13	2.0% 21	1.3% 17	1.2% 14	1.8% 23
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.3% 1	0.0% 0	1.6% 5	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	41.3% 136	38.3% 116	46.9% 150	41.8% 329	47.4% 336	44.8% 444	44.1% 460	43.4% 586	42.7% 495	45.9% 585

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table 1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Only a susceptible breakpoint (≤ 4 µg/mL) has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

Table 51. Minimum inhibitory concentrations (MICs) and resistance of *Campylobacter coli* isolates to antimicrobial agents, 2011 (N=148)

Rank*	CLSI† Antimicrobial Class	Antimicrobial Agent	Percentage of isolates			Percentage of all isolates with MIC (µg/mL)**													
			%‡	%R§	[95% CI]¶	0.015	0.03	0.06	0.125	0.25	0.50	1	2	4	8	16	32	64	128	256	512
I	Aminoglycosides	Gentamicin	0.0	12.2	[7.4 - 18.5]					23.6	62.2	1.4	0.7				0.7	11.5			
	Ketolide	Telithromycin	7.4	3.4	[1.1 - 7.7]				1.4	8.1	23.6	8.1	20.3	27.7	7.4	3.4					
	Macrolides	Azithromycin	0.0	2.7	[0.7 - 6.8]		0.7	6.8	33.1	37.8	16.2	2	0.7						2.7		
		Erythromycin	0.0	2.7	[0.7 - 6.8]					3.4	22.3	23.6	25.7	18.9	3.4				2.7		
	Quinolones	Ciprofloxacin	0.0	35.8	[28.1 - 44.1]		0.7	3.4	30.4	17.6	11.5	0.7			7.4	14.9	9.5	4.1			
		Nalidixic acid	0.0	35.8	[28.1 - 44.1]									18.9	36.5	8.8			35.8		
II	Lincosamides	Clindamycin	0.7	4.1	[1.5 - 8.6]				2.0	21.6	31.1	28.4	12.2	0.7	1.4		2.7				
	Phenicols	Florfenicol††	N/A	0.7	[0.0 - 3.7]						0.7	15.5	58.1	25	0.7						
	Tetracyclines	Tetracycline	0.0	50.7	[42.3 - 59.0]				1.4	17.6	20.9	6.8	2.7			1.4		0.7	48.6		

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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.
†† Only a susceptible breakpoint (≤ 4 µg/mL has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

Figure 17. Antimicrobial resistance pattern for *Campylobacter coli*, 2011

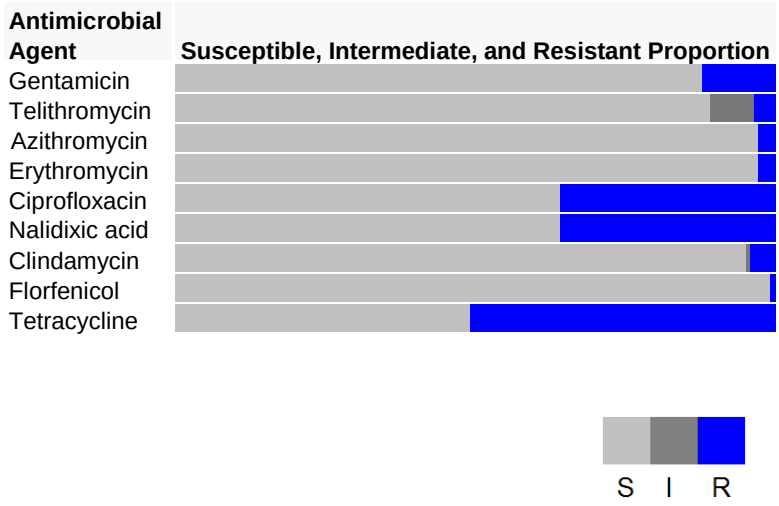


Table 52. Percentage and number of *Campylobacter coli* isolates resistant to antimicrobial agents, 2002–2011

Year Total Isolates			2002 25	2003 22	2004 26	2005 99	2006 97	2007 105	2008 110	2009 142	2010 116	2011 148
Rank*	CLSI† Antimicrobial Class	Antibiotic (Resistance breakpoint)										
I	Aminoglycosides	Gentamicin (MIC ≥ 8)	0.0% 0	4.5% 1	0.0% 0	3.0% 3	1.0% 1	0.0% 0	1.8% 2	3.5% 5	12.1% 14	12.2% 18
	Ketolides	Telithromycin (MIC ≥ 16)	Not Tested	Not Tested	Not Tested	5.1% 5	7.2% 7	5.7% 6	6.4% 7	2.8% 4	5.2% 6	3.4% 5
	Macrolides	Azithromycin (MIC ≥ 8)	4.0% 1	9.1% 2	0.0% 0	4.0% 4	8.2% 8	5.7% 6	10.9% 12	3.5% 5	5.2% 6	2.7% 4
		Erythromycin (MIC ≥ 32)	4.0% 1	9.1% 2	0.0% 0	4.0% 4	8.2% 8	5.7% 6	10.9% 12	3.5% 5	5.2% 6	2.7% 4
	Quinolones	Ciprofloxacin (MIC ≥ 4)	12.0% 3	22.7% 5	30.8% 8	24.2% 24	21.6% 21	28.6% 30	30.9% 34	22.5% 32	31.9% 37	35.8% 53
		Nalidixic Acid (MIC ≥ 64)	12.0% 3	22.7% 5	34.6% 9	27.3% 27	23.7% 23	30.5% 32	30.9% 34	23.9% 34	31.9% 37	35.8% 53
II	Lincosamides	Clindamycin (MIC ≥ 8)	4.0% 1	9.1% 2	0.0% 0	5.1% 5	9.3% 9	5.7% 6	10.0% 11	2.8% 4	6.9% 8	4.1% 6
	Phenicols	Chloramphenicol (MIC ≥ 32)	0.0% 0	0.0% 0	0.0% 0	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
		Florfenicol‡ Susceptible breakpoint: (MIC ≤ 4)	Not Tested	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
	Tetracyclines	Tetracycline (MIC ≥ 16)	40.0% 10	45.5% 10	38.5% 10	31.3% 31	39.2% 38	41.9% 44	40.0% 44	45.1% 64	49.1% 57	50.7% 75

* Rank of antimicrobials is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, Table 1): Rank I, Critically Important; Rank II, Highly Important
† CLSI: Clinical and Laboratory Standards Institute
‡ Only a susceptible breakpoint (≤ 4 µg/mL) has been established. In this report, isolates with an MIC ≥ 8 µg/mL are categorized as resistant.

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

Table 53. Frequency of *Vibrio* species other than *V. cholerae*, 2009–2011

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

Table 54. Minimum inhibitory concentrations (MICs) and resistance of isolates of *Vibrio* species other than *V. cholerae* to antimicrobial agents, 2009–2011

Rank*	CLSI† Antimicrobial Class / Antimicrobial Agent	Year (# of isolates)	Percentage of isolates %I‡	%R§	[95% CI]¶	Percentage of all isolates with MIC (µg/mL)** 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††	**2009** (282)	N/A	N/A	N/A										0.4	5.7	55.7	34.0	4.3							
		2010 (330)	N/A	N/A	N/A										0.6	7.0	60.0	30.9	0.9	0.6						
		2011 (400)	N/A	N/A	N/A										0.5	1.3	39.5	50.3	7.3	1.0	0.3					
	Streptomycin††	**2009** (282)	N/A	N/A	N/A											2.5	9.9	39	47.2	1.4						
		2010 (330)	N/A	N/A	N/A										0.9	2.7	9.4	55.8	30.6		0.6					
		2011 (400)	N/A	N/A	N/A												3.8	41.0	52.0	3.0	0.3					
	Penicillins																									
	Ampicillin	**2009** (282)	21.6	22.0	[17.3 - 27.3]								0.4		14.2	11.3	11.3	19.1	21.6	9.2	4.6	1.4		6.7		
		2010 (330)	16.7	19.1	[15.0 - 23.8]									0.9	14.8	10.3	19.1	19.1	16.7	6.7	3.0	0.6		8.8		
		2011 (400)	16.3	48.5	[43.5 - 53.5]						0.3			0.5	10.3	5.3	10.3	8.8	16.3	15.3	8.5	2.0	1.3	21.5		
	Quinolones																									
	Ciprofloxacin	**2009** (282)	0.0	0.0	[0.0 - 1.3]		6.4	2.8	2.8	7.8	18.1	58.2	3.5	0.4												
		2010 (330)	0.0	0.0	[0.0 - 1.1]		5.2	4.5	1.2	9.7	16.1	57.6	4.8	0.9												
		2011 (400)	0.0	0.0	[0.0 - 0.9]		1.8	3.3	2.5	6.8	11.8	42.8	29.3	2.0												
	Nalidixic acid††	**2009** (282)	N/A	N/A	N/A								1.1	5.7	27.3	61.7	3.5	0.7								
		2010 (330)	N/A	N/A	N/A								1.2	5.8	33.6	50.9	8.5									
		2011 (400)	N/A	N/A	N/A								0.8	2.5	20.0	63.8	12.5	0.3		0.3						
II	**Cephems**																									
	Cephalothin††	**2009** (282)	N/A	N/A	N/A								0.7		2.8	5.0	19.1	59.6	7.8				0.7	4.3		
		2010 (330)	N/A	N/A	N/A										0.6	2.7	12.1	50.0	28.2	0.6				5.8		
		2011 (400)	N/A	N/A	N/A								0.3			3.0	4.5	30.5	50.5	7.5	0.3			3.5		
	Folate pathway inhibitors																									
	Trimethoprim-sulfamethoxazole	**2009** (282)	N/A	0.0	[0.0 - 1.3]					0.4	8.2	61.3	30.1													
		2010 (330)	N/A	0.3	[0.0 - 1.7]	0.3			0.3	0.9	13.9	70.0	13.6	0.3		0.3					0.3					
		2011 (400)	N/A	0.3	[0.0 - 1.4]						14.8	73.0	12.0								0.3					
	Phenicols																									
	Chloramphenicol††	**2009** (282)	N/A	N/A	N/A									9.6	82.6	7.8										
		2010 (330)	N/A	N/A	N/A							0.3	0.6	11.8	82.1	4.5	0.3	0.3								
		2011 (400)	N/A	N/A	N/A									5.5	72	21.5	0.5	0.3	0.3							
	Tetracyclines																									
	Tetracycline	**2009** (282)	0.0	0.0	[0.0 - 1.3]							1.1	0.7	5.7	44.0	48.2	0.4									
		2010 (330)	0.0	0.0	[0.0 - 1.1]						0.3		0.9	6.7	63.9	27.3	0.9									
		2011 (400)	0.0	0.3	[0.0 - 1.4]							0.3	1.0	9.0	70.3	17.8	1.5				0.3					

* Rank of antimicrobial agents is based on World Health Organization's categorization of critical importance in human medicine (Appendix A, 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 55. Percentage and number of isolates of *Vibrio* species other than *V. cholerae* resistant to ampicillin, 2009–2011

Species	2009	2010	2011
Vibrio parahaemolyticus	9.4% 14	8.4% 15	40.3% 81
Vibrio alginolyticus	82.6% 38	89.8% 44	95.1% 98
Vibrio vulnificus	2.0% 1	0.0% 0	4.8% 3
Vibrio fluvialis	33.3% 7	12.5% 3	44.4% 8
Vibrio mimicus	9.1% 1	0.0% 0	0.0% 0
Vibrio harveyi	0.0% 0	50.0% 1	100.0% 4
Other	20.0% 1	0.0% 0	0.0% 0
Total	22.0% 62	19.1% 63	48.5% 194

Antimicrobial Resistance: 1996–2011

The following figures display resistance to selected agents and combinations of agents from 1996–2011 for non-typhoidal *Salmonella*, 1999–2011 for *Salmonella* ser. Typhi, 1997–2011 for *Campylobacter*, and 1999–2011 for *Shigella*.

Figure 18. Percentage of non-typhoidal *Salmonella* isolates resistant to nalidixic acid, by year, 1996–2011

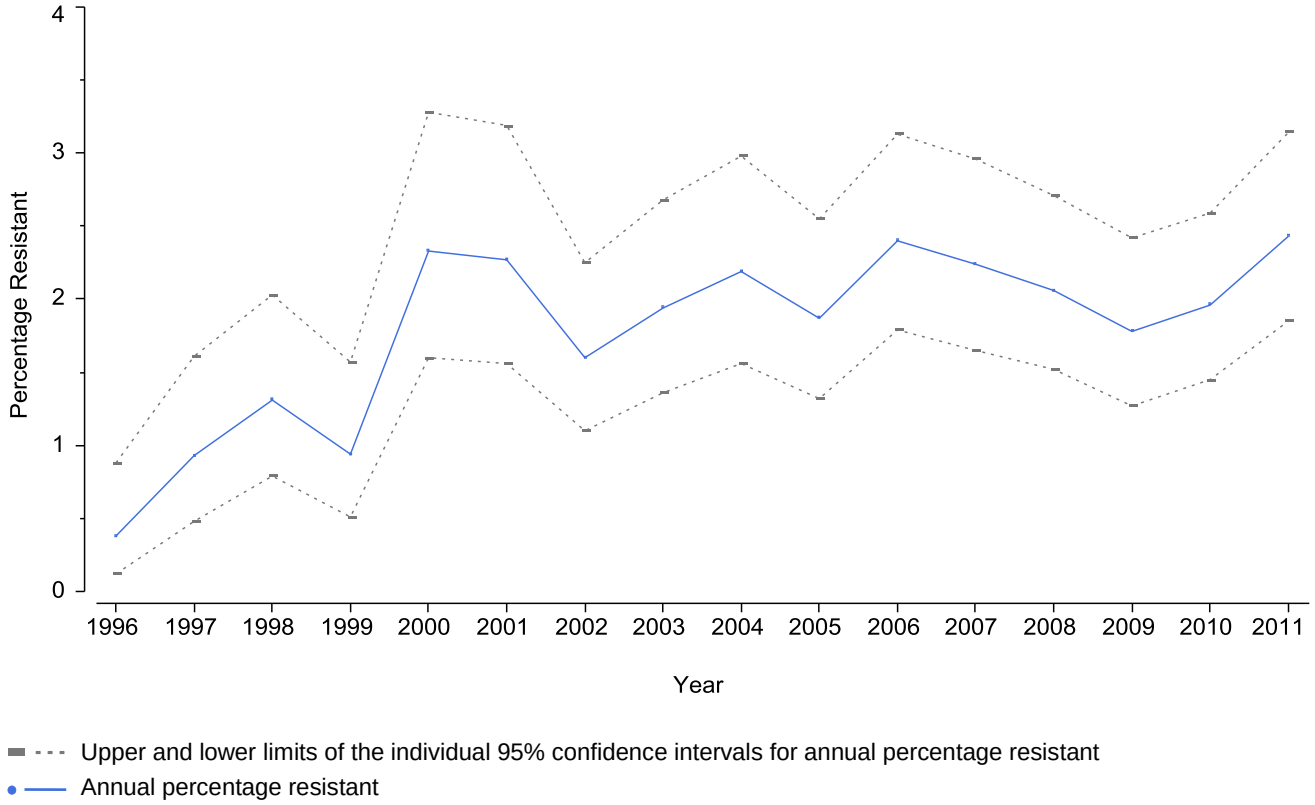


Figure 19. Percentage of non-typhoidal *Salmonella* isolates resistant to ceftriaxone, by year, 1996–2011

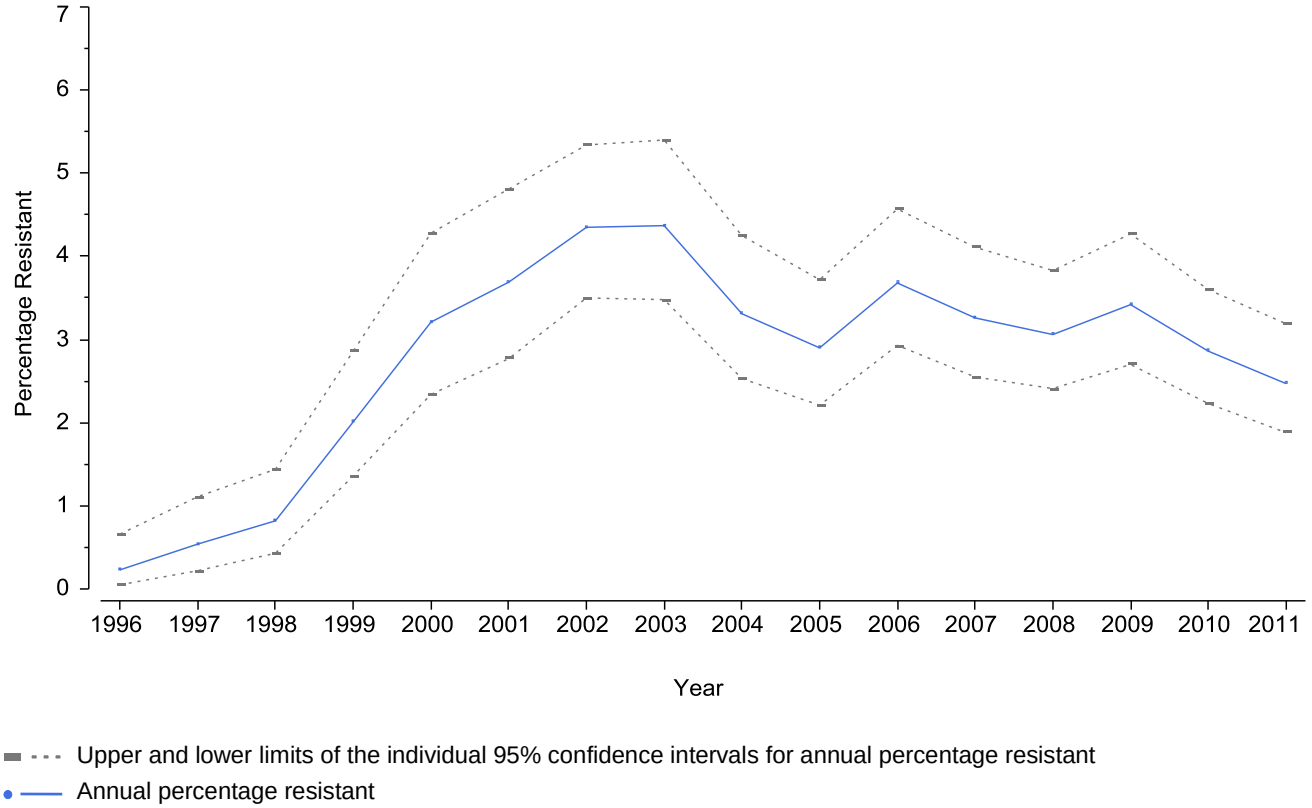


Figure 20. Percentage of *Salmonella* ser. Enteritidis isolates resistant to nalidixic acid, by year, 1996–2011

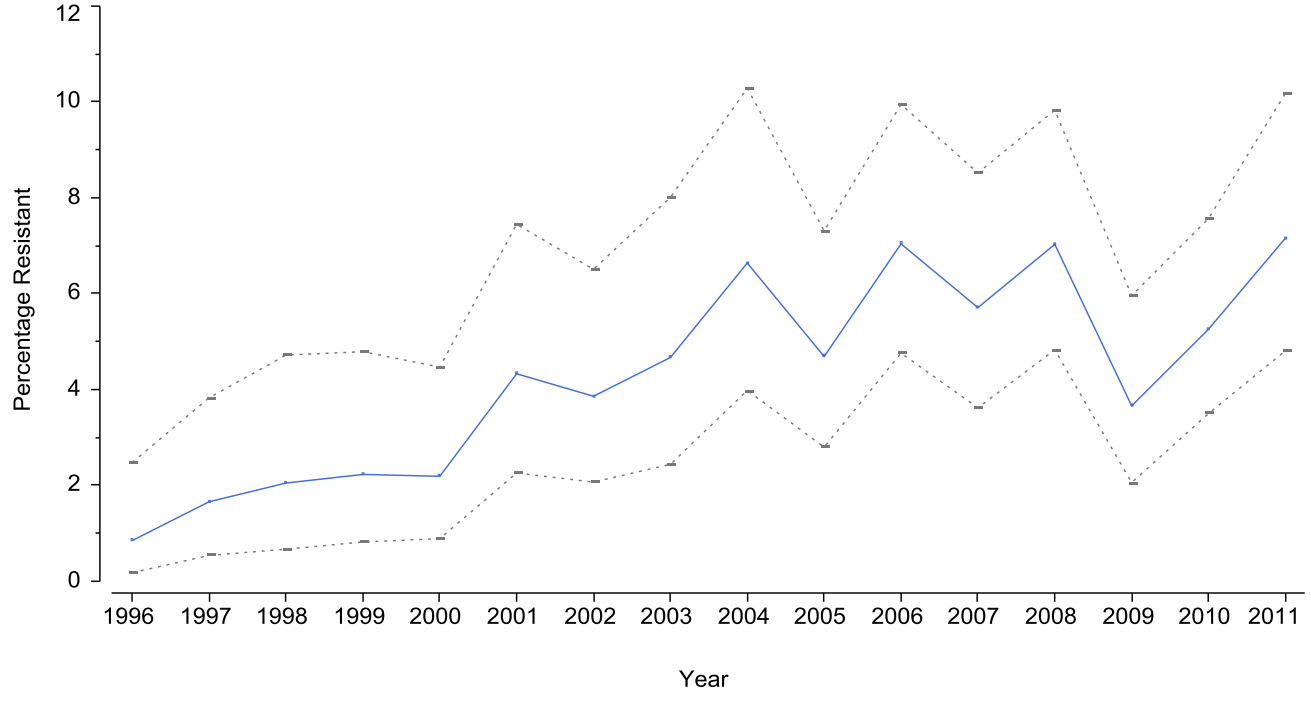


Figure 21. Percentage of *Salmonella* ser. Heidelberg isolates resistant to ceftriaxone, by year, 1996–2011

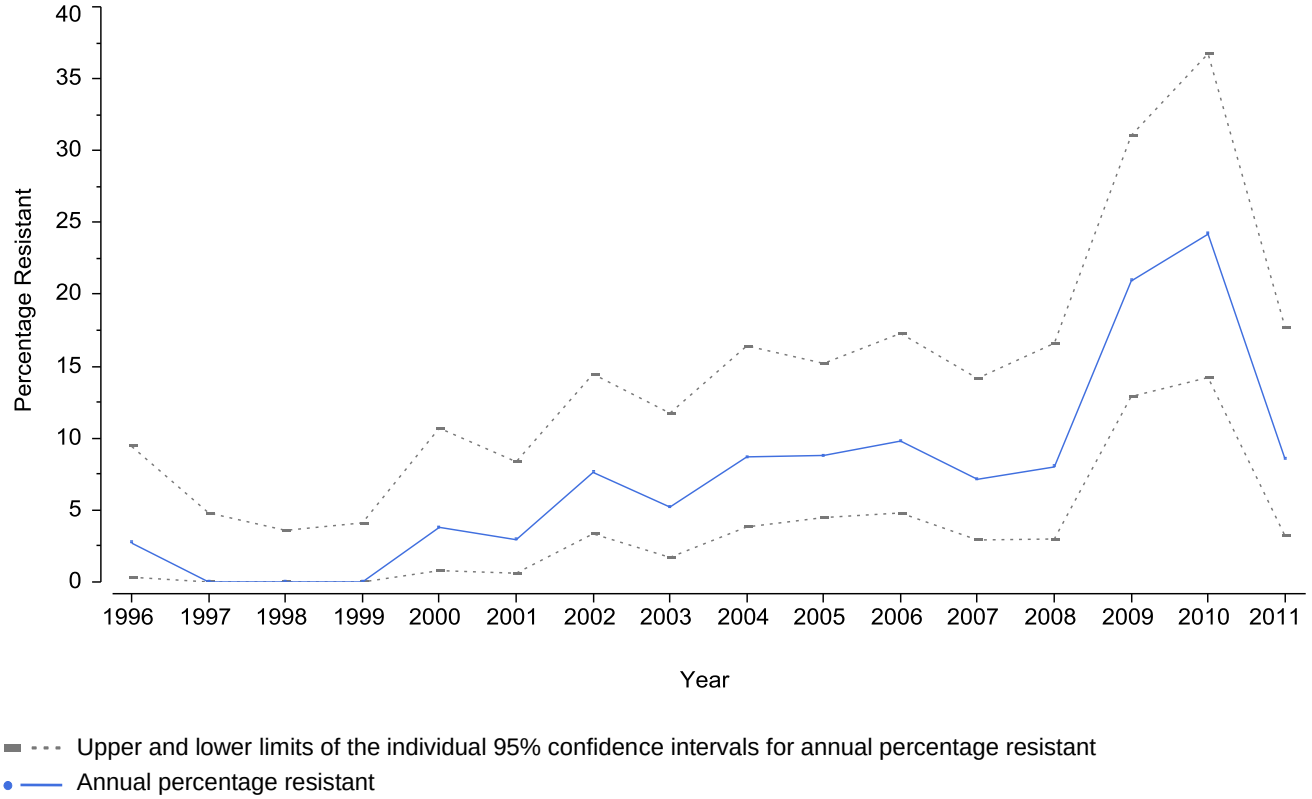


Figure 22. Percentage of *Salmonella* ser. Typhimurium isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), by year, 1996–2011

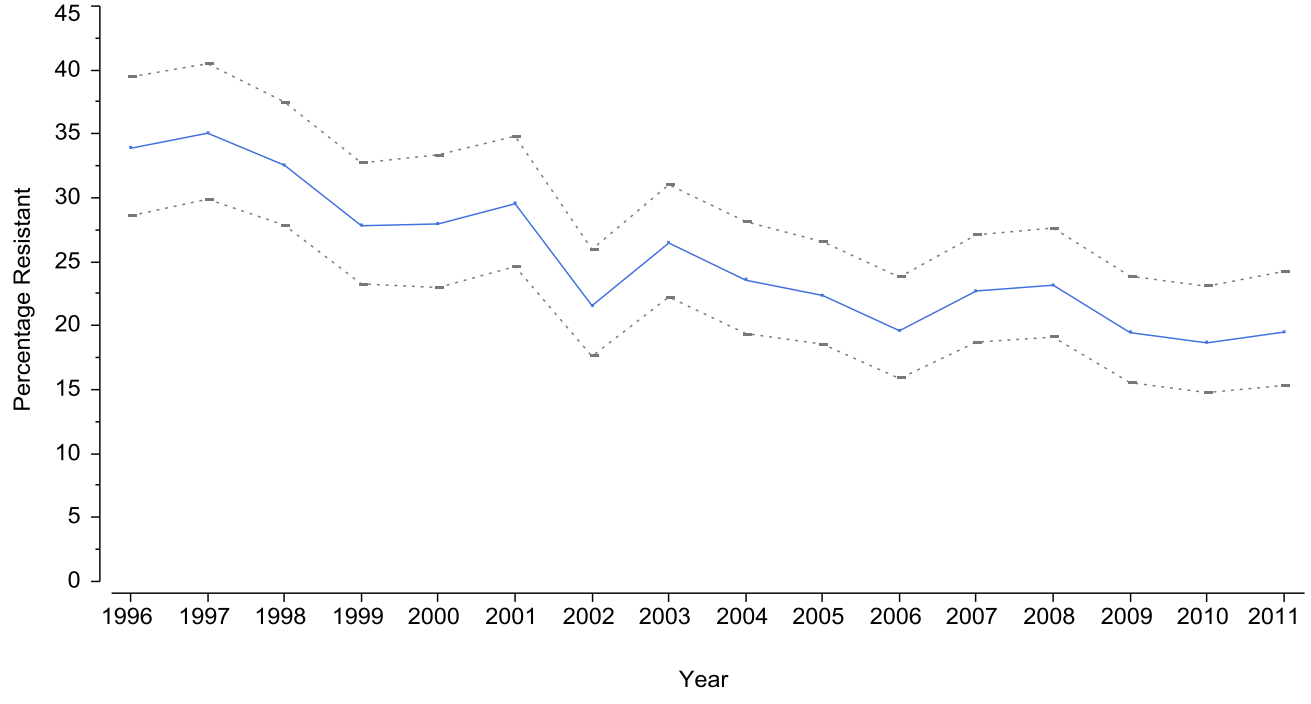


Figure 23. Percentage of *Salmonella* ser. Newport isolates resistant to at least ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline, amoxicillin-clavulanic acid, and ceftriaxone (ACSSuTAuCx), by year, 1996–2011

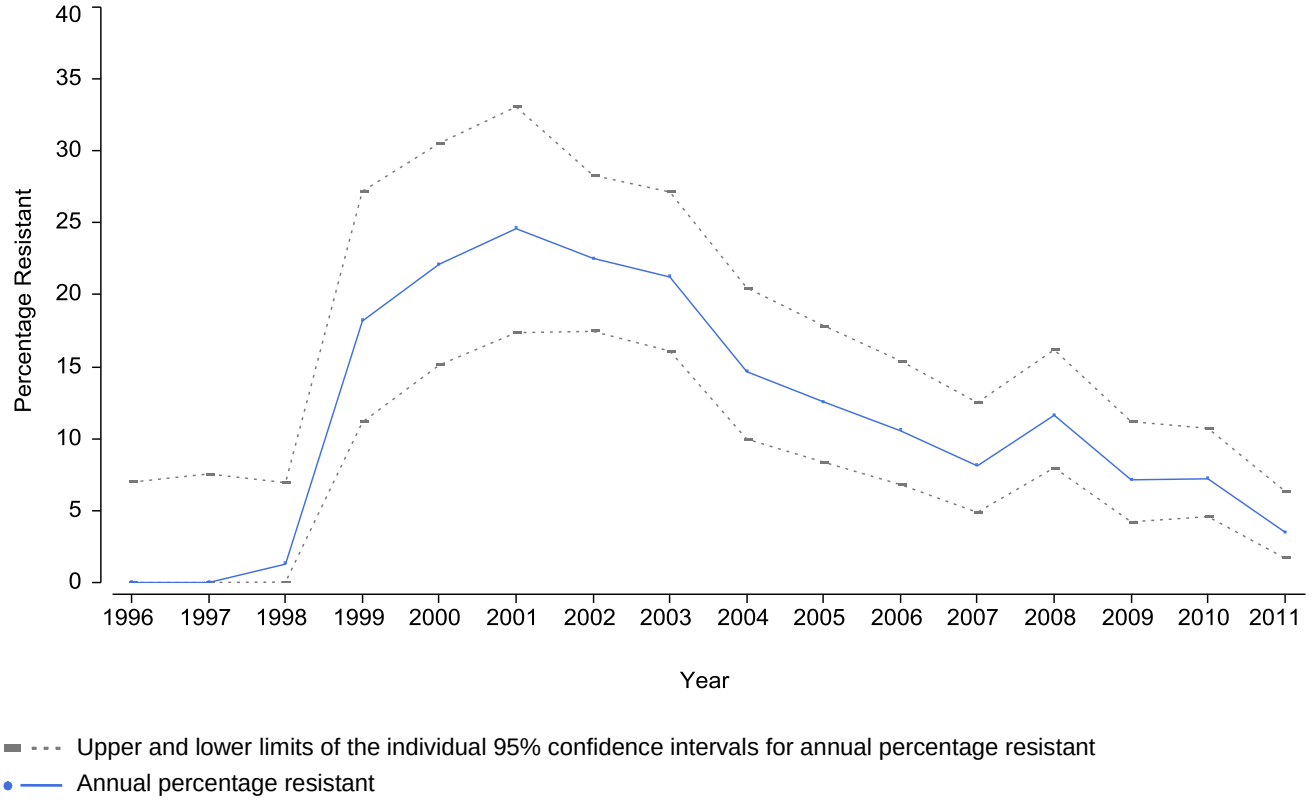


Figure 24. Percentage of non-typhoidal *Salmonella* isolates resistant to 1 or more antimicrobial classes, by year, 1996–2011

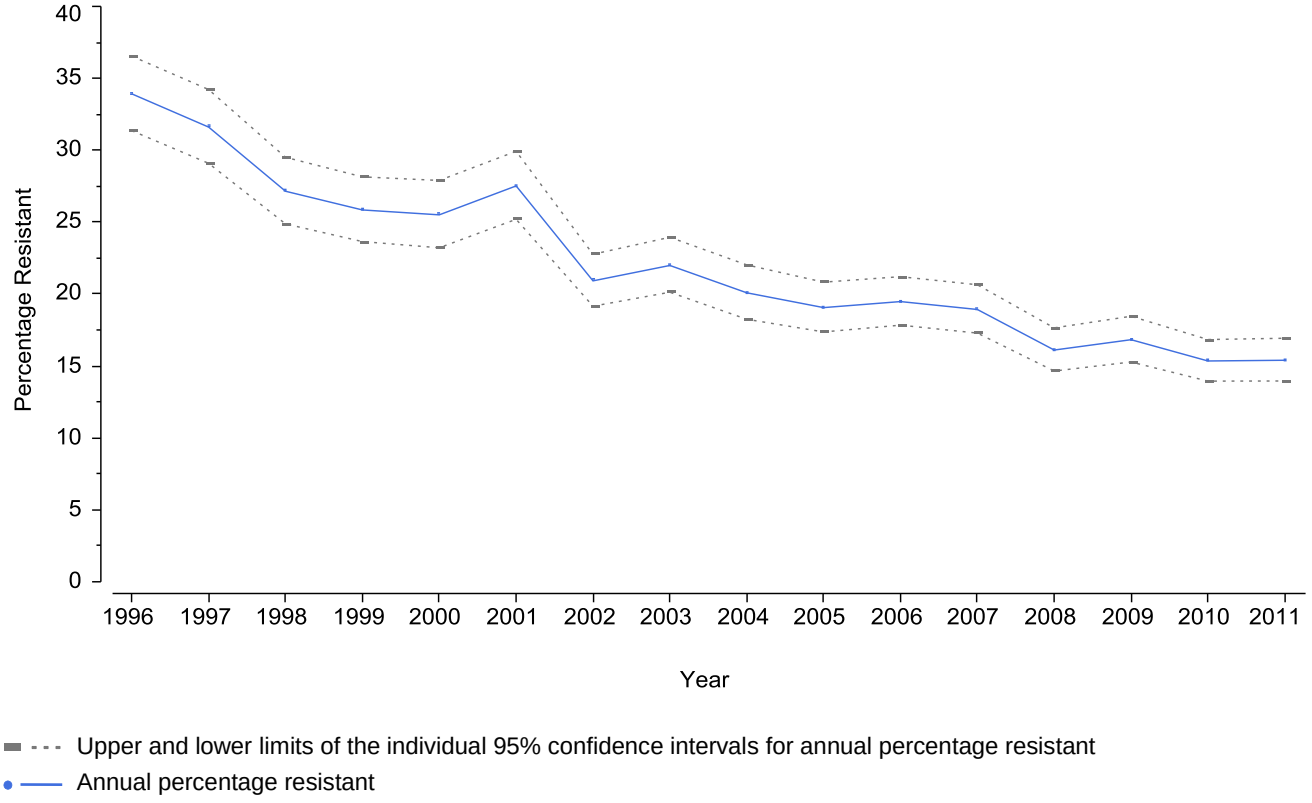


Figure 25. Percentage of non-typhoidal *Salmonella* isolates resistant to 3 or more antimicrobial classes, by year, 1996–2011

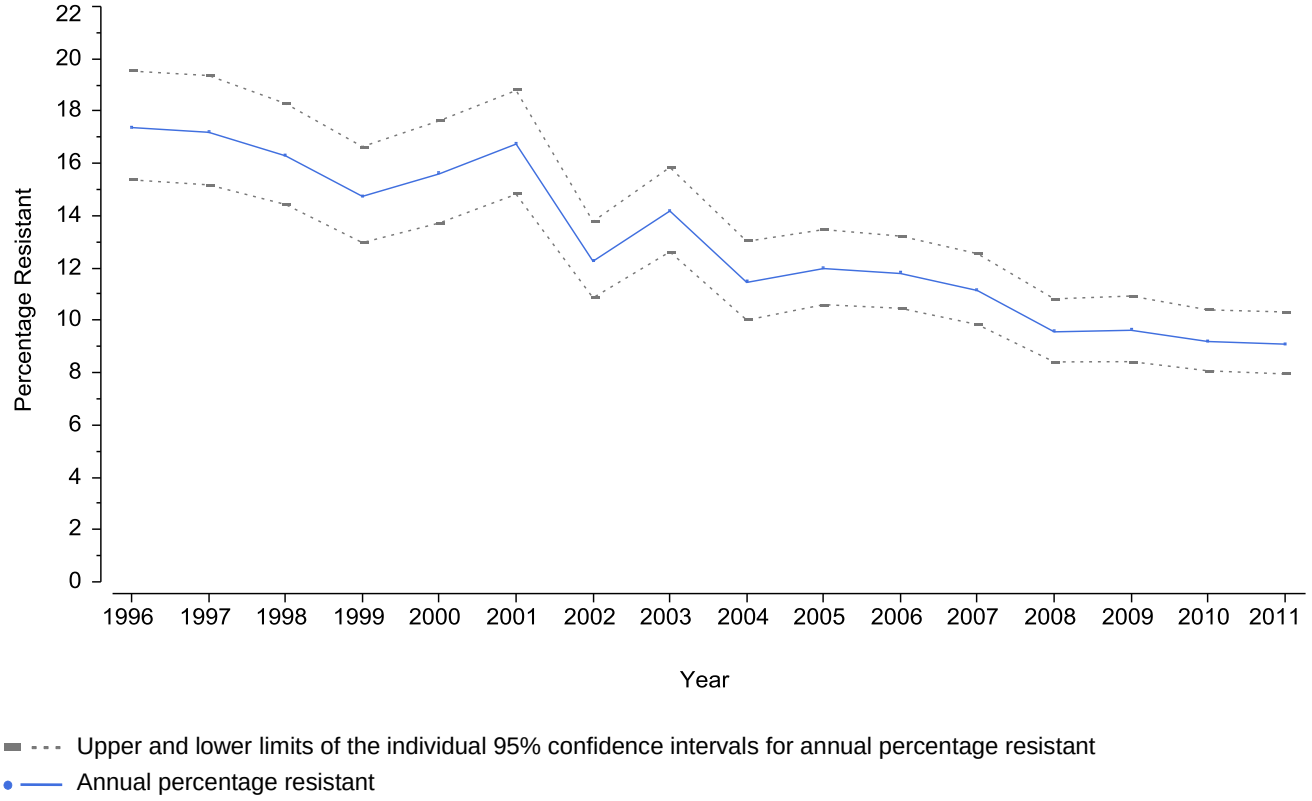


Figure 26. Percentage of *Salmonella* ser. Typhi isolates resistant to nalidixic acid, by year, 1999–2011

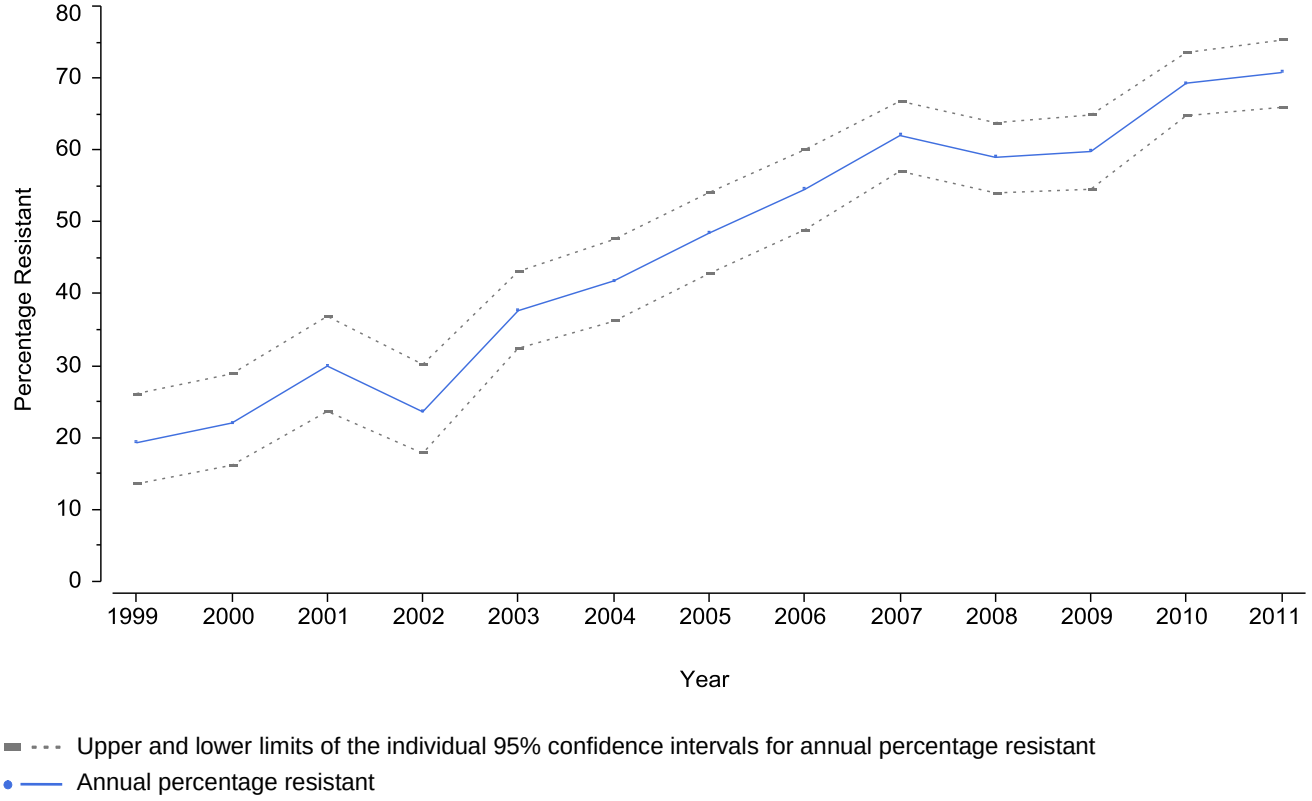


Figure 27. Percentage of *Campylobacter* isolates resistant to ciprofloxacin, by year, 1997–2011

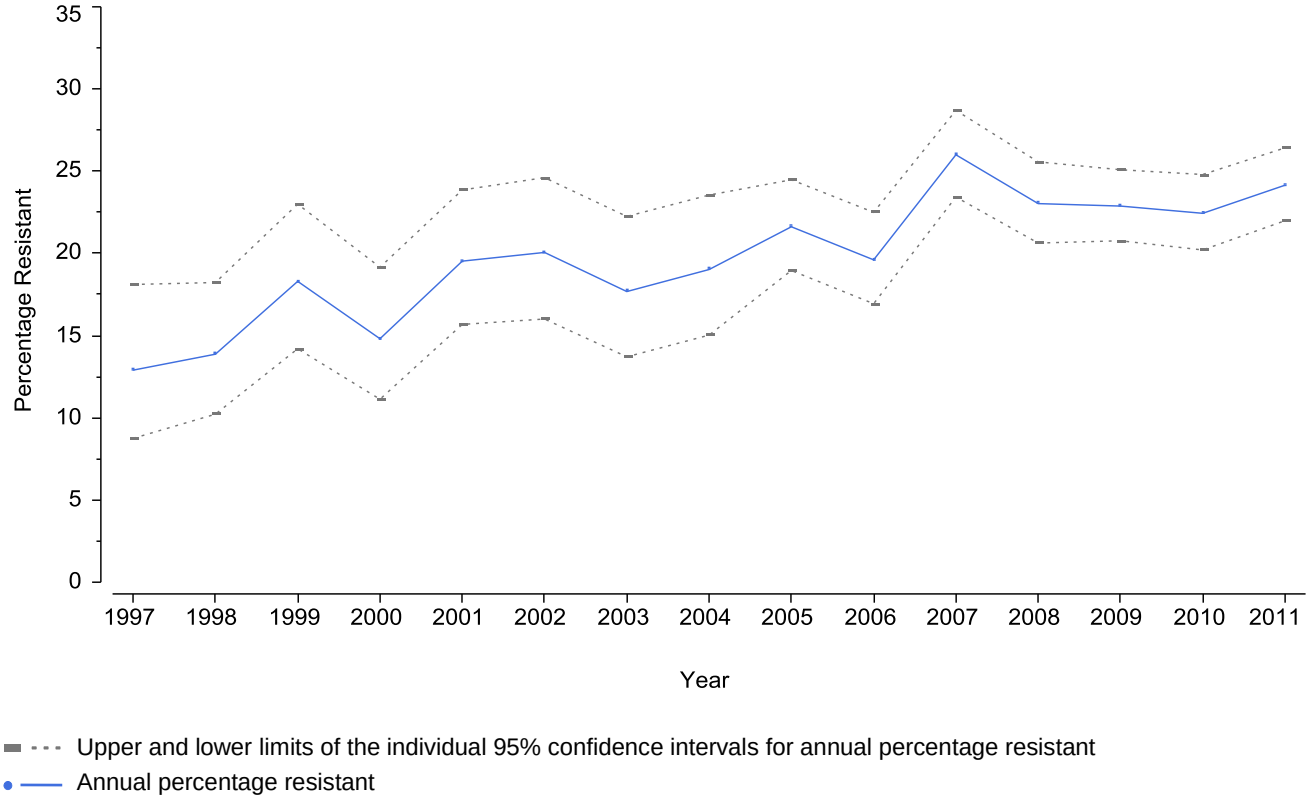
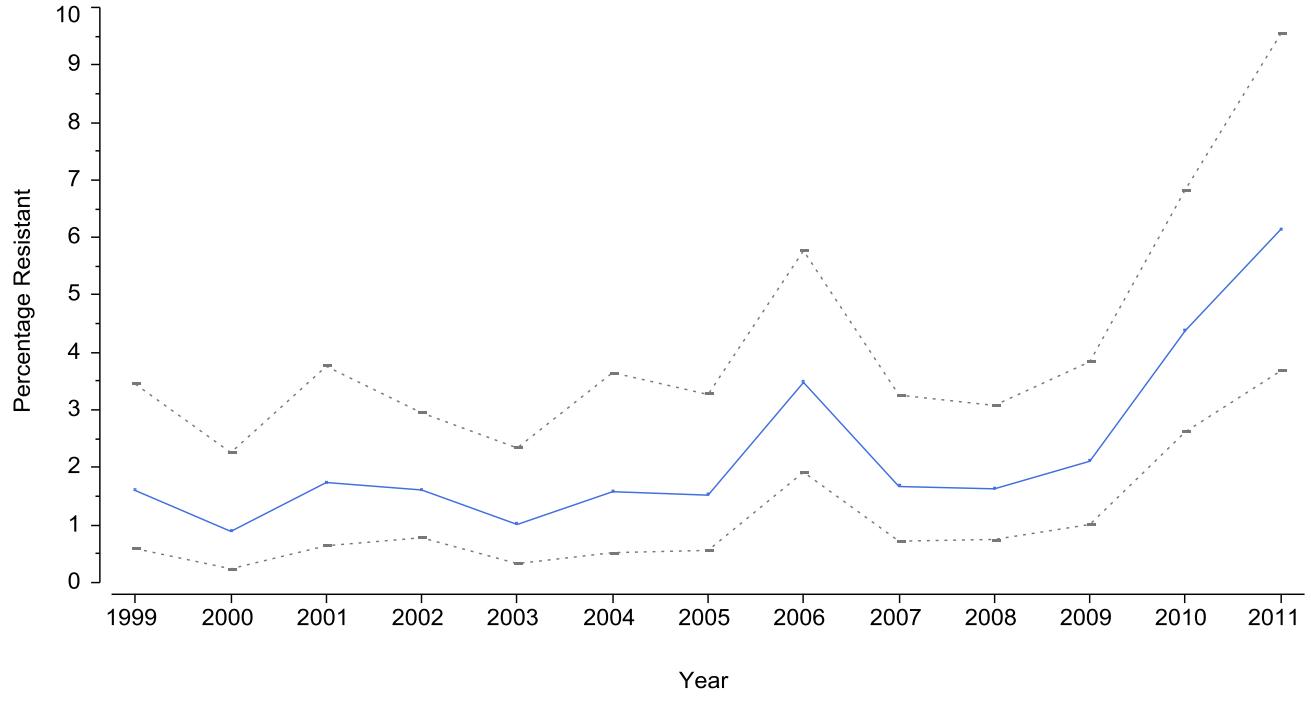


Figure 28. Percentage of *Shigella* isolates resistant to nalidixic acid, by year, 1999–2011



References

American Academy of Pediatrics. 2012. Shigella infections. In: L.K. Pickering (ed.), Red Book: 2012 Report of the Committee on Infectious Diseases, 29 ed. American Academy of Pediatrics, Elk Frove Village, IL.

CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS): 2005 human isolates final report. Atlanta, Georgia: U.S. Department of Health and Human Services, CDC, 2007.

CDC. Foodborne Diseases Active Surveillance Network (FoodNet): FoodNet Surveillance Report for 2011 (Final Report). Atlanta, Georgia: U.S. Department of Health and Human Services, CDC. 2012.

Clinical and Laboratory Standards Institute. Methods for antimicrobial dilution and disk susceptibility testing of infrequently isolated or fastidious bacteria: approved guideline—Second Edition. CLSI Document M45-A2. CLSI, Wayne, Pennsylvania, 2010.

Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; Twenty-Second Informational Supplement. CLSI Document M100-S22. CLSI, Wayne, Pennsylvania, 2012.

Clinical and Laboratory Standards Institute. Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically; Approved Standard---Eighth Edition. CLSI Document M07-A8. CLSI, Wayne, Pennsylvania, 2009.

Clinical and Laboratory Standards Institute. Performance standards for antimicrobial disk and dilution susceptibility tests for bacteria isolated from animals; Approved Standard-Third Edition. CLSI Document M31-A3. CLSI, Wayne, Pennsylvania, 2008.

Crump JA, Barrett TJ, Nelson JT, Angulo FJ. Reevaluating fluoroquinolone breakpoints for *Salmonella enterica* serotype Typhi and for non-Typhi salmonellae. Clin Infect Dis 2003;37:75–81.

Fleiss JL, Levin B, Paik MC. Statistical methods in for rates and proportions. In: Shewart WA, Wilks SS, eds. Wiley Series in Probability and Statistics. Published Online; 2004:284–308.

Gonzalez, I, Grant KA, Richardson PT, Park SF, Collins MD. Specific identification of the enteropathogens *Campylobacter jejuni* and *Campylobacter coli* by using a PCR test based on the *ceuE* gene encoding a putative virulence determinant. Journal of Clinical Microbiology 1997;35:759–63.

Howie RL, Folster JP, Bowen A, Barzilay EJ, Whichard JM. Reduced azithromycin susceptibility in Shigella sonnei, United States. Microb Drug Resist. 2010 Dec;16(4):245-8.

Kleinbaum DG, Kupper LL, Nizam A, Muller KE. Applied Regression Analysis and Other Multivariable Methods, 4th ed. Belmont. CA: Duxbury; 2008.

Linton D, Lawson AJ, Owen RJ, Stanley J. PCR detection, identification to species level, and fingerprinting of *Campylobacter jejuni* and *Campylobacter coli* direct from diarrheic samples. Journal of Clinical Microbiology 1997;35:2568–72.

Linton D, Owen RJ, Stanley J. Rapid Identification by PCR of the genus *Campylobacter* and of five *Campylobacter* species enteropathogenic for man and animals. Research in Microbiology 1996;147:707–18.
Pruckler J et al., Comparison of four real-time PCR methods for the identification of the genus *Campylobacter* and speciation of *C. jejuni* and *C. coli*. ASM 106th General meeting; Poster C282.

Sjölund-Karlsson M, Joyce K, Blickenstaff K. et al. Antimicrobial Susceptibility to Azithromycin among *Salmonella enterica* isolated in the United States. Antimicrob Agents Chemother. 2011 Jun 20.

U.S. Census Bureau. Guide to State and Local Geography – Selected Data from the 2011 Census. Washington, D.C.: U.S. Department of Commerce, U.S. Census Bureau, 2012.

U.S. Census Bureau. Census Regions and Divisions of the United States. Washington, D.C.: U.S. Department of Commerce, U.S. Census Bureau, 2012.

Vandamme P, Van Doorn LJ, al Rashid ST, Quint WG, van der Plas J, Chan VL, On SL. *Campylobacter hyoilei* Alderton et al. 1995 and *Campylobacter coli* Veron and Chatelain 1973 are subjective synonyms. Inter. J. Syst. Bacteriol 1997; 47:1055–60.

World Health Organization (WHO). Critically Important Antimicrobials for Human Medicine. 3rd Revision. Switzerland, 2011.

World Health Organization, Guidelines for the control of shigellosis, including epidemics due to Shigella dysenteriae type 1, 2005, World Health Organization: Geneva.

NARMS Publications in 2011

Crump JA, Medalla FM, Joyce KW, Krueger AL, Hoekstra RM, Whichard JM, et al. Antimicrobial resistance among invasive nontyphoidal *Salmonella enterica* isolates in the United States: National Antimicrobial Resistance Monitoring System, 1996 to 2007. Antimicrob Agents Chemother. 2011 Mar;55(3):1148-54.

Folster JP, Pecic G, Taylor E, Whichard J. Characterization of Isolates from an outbreak of multidrug-resistant, Shiga toxin-producing *Escherichia coli* O145 in the United States. Antimicrob Agents Chemother. 2011 Dec;55(12):5955-6.

Folster JP, Pecic G, McCullough A, Rickert R, Whichard JM. Characterization of bla(CMY)-encoding plasmids among *Salmonella* isolated in the United States in 2007. Foodborne Pathog Dis. 2011 Dec;8(12):1289-94.

Folster JP, Pecic G, Bowen A, Rickert R, Carattoli A, Whichard JM. Decreased susceptibility to ciprofloxacin among *Shigella* isolates in the United States, 2006 to 2009. Antimicrob Agents Chemother. 2011 Apr;55(4):1758-60.

Krueger AL, Folster J, Medalla F, Joyce K, Perri MB, Johnson L, et al. Commensal *Escherichia coli* isolate resistant to eight classes of antimicrobial agents in the United States. Foodborne Pathog Dis. 2011 Feb;8(2):329-32.

Medalla F, Sjölund-Karlsson M, Shin S, Harvey E, Joyce K, Theobald L, et al. Ciprofloxacin-resistant *Salmonella enterica* Serotype Typhi, United States, 1999–2008. Emerg Infect Dis. 2011 Jun;17(6):1095-8.

Sjölund-Karlsson M, Reimer A, Folster JP, Walker M, Dahourou GA, Batra DG, et al. Drug-resistance mechanisms in *Vibrio cholerae* O1 outbreak strain, Haiti, 2010. Emerg Infect Dis. 2011 Nov;17(11):2151-4.

Sjölund-Karlsson M, Joyce K, Blickenstaff K, Ball T, Haro J, Medalla FM, et al. Antimicrobial susceptibility to azithromycin among *Salmonella enterica* isolates from the United States. Antimicrob Agents Chemother. 2011 Sep;55(9):3985-9.

Sjölund-Karlsson M, Howie R, Krueger A, Rickert R, Pecic G, Lupoli K, et al. CTX-M-producing non-Typhi *Salmonella* spp. Isolated from humans, United States. Emerg Infect Dis. 2011 Jan;17(1):97-9.

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* and *E. coli* O157**	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)	
	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**	nalidixic acid^{S} (≤16) **AND** ciprofloxacin^{R} (≥4)	The stepwise selection of mutations in the QRDR† does not support this phenotype
Campylobacter	erythromycin^{S} (≤8) **AND** azithromycin^{R} (≥8)	Erythromycin is class representative for 14- and 15-membered macrolides (azithromycin, clarithromycin, roxithromycin, and dirithromycin)
	erythromycin^{R} (≥32) **AND** azithromycin^{S} (≤2)	
	nalidixic acid^{S} (≤16) **AND** ciprofloxacin^{R} (≥4)	In *Campylobacter*, one mutation is sufficient to confer resistance to both nalidixic acid and ciprofloxacin
	nalidixic acid^{R} (≥64) **AND** ciprofloxacin^{S} (≤1)	
	For *C. fetus* and *C. lari* isolates: nalidixic Acid^{S} (≤16) **OR** ciprofloxicin^{S} (≤1)	*C. fetus* and *C. lari* are intrinsically resistant to quinolones; consider likelihood of misidentification

* 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* and *E. coli* O157**	Pan-resistance
	Resistance to azithromycin (>16)
	ceftriaxone and/or ceftiofur MIC ≥2 **AND** ciprofloxacin MIC ≥0.125 and/or nalidixic acid MIC ≥32
Campylobacter	Pan-resistance
	Resistance to gentamicin (≥8)
	Not susceptible to florfenicol (≥8)