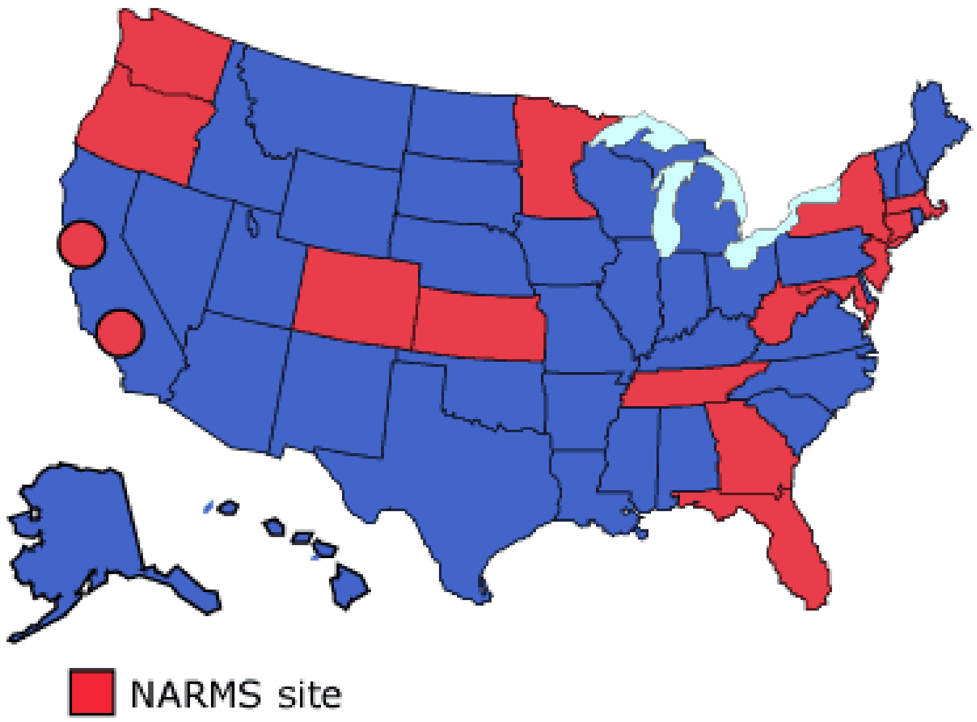
1998 Annual Report

CDC's Emerging Infections Program
National Antimicrobial Resistance Monitoring System: Enteric Bacteria



Centers for Disease Control and Prevention
National Center for Infectious Diseases
Division of Bacterial and Mycotic Diseases
Foodborne and Diarrheal Diseases Branch

Table of Contents

Click on any link to open page in a new window.
This Table of Contents page will remain open.

Report Summary

Tables

Figures

National Antimicrobial Resistance Monitoring System 1998 Annual Report

Table of Contents

Summary

Back to top

In 1998, there were 1476 *Salmonella* isolates, 315 *E. coli* O157:H7 isolates, and 382 *Campylobacter* isolates from humans submitted to the National Antimicrobial Resistance Monitoring System:Enteric Bacteria (NARMS). Twenty-seven percent of *Salmonella* isolates were resistant to one or more antimicrobial agents. Among *Salmonella* Typhimurium isolates, 53% were resistant to one or more antimicrobial agents. Thirty-two percent of *Salmonella* Typhimurium isolates had the multi-drug resistant pattern characteristic of DT104. One *Salmonella* isolate was resistant to ciprofloxacin. The percentage of *Salmonella* isolates with ciprofloxacin minimum inhibitory concentrations (MICs) >0.25 increased from 0.4% in l996 to 0.7% in l998. Among *E. coli* O157:H7 isolates, 7.3% were resistant to one or more antimicrobial agents. Among *Campylobacter* isolates, 55.0% were resistant to one or more antimicrobial agents; 13.3% were resistant to ciprofloxacin.

Methods

Back to top

NARMS was launched in l996, within the framework of CDC's Emerging Infections Program's Epidemiology and Laboratory Capacity Program and the Foodborne Disease Active Surveillance Network (FoodNet) as a collaboration between CDC, Food and Drug Administration-Center for Veterinary Medicine (FDA), United States Department of Agriculture- Food Safety and Inspection Service and Agricultural Research Service (USDA), and 14 state and local health departments to prospectively monitor the antimicrobial resistance of human non-typhoid *Salmonella* and *Escherichia* *coli* O157:H7 isolates. In 1998, there were 16 NARMS health department partners (CA, CO, CT, FL, GA, KS, Los Angeles County, MD, MN, MA, NJ, New York City, New York State, OR, WA, and WV), representing approximately 97 million persons (37% of the United States population). In 1998, seven states (CA, CT, GA, MD, MN, NY, and OR) also monitored antimicrobial resistance among human *Campylobacter* isolates (Table 1, Figure 1).

NARMS participating public health laboratories select every tenth *Salmonella* and every fifth *E. coli* O157:H7 isolate received at their laboratory, and forward the isolates to CDC for susceptibility testing. At CDC, a semi-automated system (Sensititre, Trek Diagnostics, Westlake, OH) is used to determine the MICs for 17 antimicrobial agents: amikacin, ampicillin, amoxicillin-clavulanic acid, apramycin, ceftiofur, ceftriaxone, cephalothin, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline, trimethoprim-sulfamethoxazole, and ticarcillin (Table 2). Public health laboratories from seven states also select and forward the first *Campylobacter* isolate received each week to CDC for susceptibility testing. For *Campylobacter*, the E-test system (AB BIODISK, Solna, Sweden) is used to determine the MICs for 8 antimicrobial agents: azithromycin, chloramphenicol, ciprofloxacin, clindamycin, erythromycin, gentamicin, nalidixic acid, and tetracycline (Table 2). After confirmation to genus level, identification of *Campylobacter* to species level is performed using dark field motility, oxidase test, and hippurate test, and for hippurate-negative *Campylobacter* isolates, polymerase chain reaction.

For all three pathogens in this report, MIC results are dichotomized, and isolates with intermediate susceptibility are categorized as sensitive. Breakpoints are determined using, when available, National Committee for Clinical Laboratory Standards (NCCLS). In l998, a validation of MIC results obtained by the CDC Sensititre system and the USDA Sensititre system was performed by both laboratories. Twelve samples from each laboratory were tested in both laboratories for MICs to all 17 antimicrobial agents; results from both systems were analyzed for consistency.

Results

Salmonella

Back to top

A total of 1476 *Salmonella* isolates were received at CDC in 1998; 1466/1476 (99.3%) were viable upon receipt and tested for antimicrobial susceptibility. The antimicrobial agents with the highest prevalence of resistance were tetracycline, sulfamethoxazole, streptomycin, and ampicillin; 295/1466 (20.1%) were resistant to tetracycline, 283/1466 (19.3%) isolates were resistant to sulfamethoxazole, 273/1466 (18.6%) were resistant to streptomycin, and 241/1466 (16.4%) were resistant to ampicillin (Table 3, Figure 2). Correlation between ampicillin resistance and ticarcillin resistance was very high; 234/241 (97.1%) of isolates resistant to ampicillin were resistant to ticarcillin. All ticarcillin-resistant *Salmonella* isolates were also resistant to ampicillin. One (0.1%) isolate (S. Schwarzengrund) was resistant to ciprofloxacin; twenty (1.4 %) isolates were resistant to nalidixic acid. Ten (0.7%) isolates were resistant to ceftriaxone. No isolates tested were resistant to amikacin (Table 3, Figure 2). MICs of all antimicrobial agents for *Salmonella* are shown in Figure 3.

Frequency of resistance among different serotypes of *Salmonella* is shown in Table 4. Among *Salmonella* isolates, 397/1466 (27.1%) were resistant to one or more agents, and 346/1466 (23.6%) were resistant to two or more agents. Among serotypes with >22 isolates tested, the serotypes with the greatest resistance were Hadar, Typhimurium, Heidelberg, and Agona. Among *Salmonella* isolates tested, 245/1466 (16.7%) were serotype Enteritidis and 380/1466 (25.9%) were serotype Typhimurium (includes serotype Typhimurium var. Copenhagen) (Table 4). Among *S*. Enteritidis isolates, 30/245 (12.2%) were resistant to one or more antimicrobial agents. Among *S*. Typhimurium isolates, 200/380 (52.6%) were resistant to one or more antimicrobial agents (Table 4). Resistance to each antimicrobial agent among specific serotypes of *Salmonella* is shown in Figure 4.

In recent years, a multidrug-resistant strain of *S.* Typhimurium (DT104) has been identified. Among 380 *S.* Typhimurium isolates tested, 120 (31.6%) were resistant to the five antimicrobial agents, ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline (ACSSuT), to which *S*. Typhimurium DT104 is commonly resistant (Table 5, Figure 6). Of the 120 *S.* Typhimurium isolates with the ACSSuT resistance pattern, 17 (14.2%) were also resistant to kanamycin, 8 (6.7%) were also resistant to cephalothin, 8 (6.7%) were also resistant to amoxicillin-clavulanic acid, 5 (4.2%) were also resistant to ceftiofur, and 4 (3.3%) were also resistant to ceftriaxone (Table 6). *S.* Typhimurium with the ACSSuT resistance pattern were somewhat more frequently isolated from blood (5/120, 4.2%) than were other *S.* Typhimurium isolates (9/260, 3.5%) (Table 7).

A second penta-resistant pattern, resistance to ampicillin, kanamycin, streptomycin, sulfamethoxazole, and tetracycline (AKSSuT), has also emerged among *Salmonella* Typhimurium. These strains are not DT104 by phage typing. Among 380 *Salmonella* Typhimurium isolates tested, 47/380 (12.4%) had the AKSSuT resistance pattern (Table 5). Of the 47 *S*. Typhimurium isolates with the AKSSuT resistance pattern, 17 (36.2%) were also resistant to chloramphenicol, 9 (19.1%) were also resistant to cephalothin, and 4 (8.5%) were also resistant to amoxicillin-clavulanic acid (Table 6). S. Typhimurium with the AKSSuT resistance pattern were more commonly isolated from blood (4/47, 8.5%) than were other *S*. Typhimurium isolates (9/260 or 3.5%) (Table 7).

Salmonella isolates with the ACSSuT or AKSSuT resistance pattern were also often additionally resistant to other antimicrobial agents, as shown in Table 8.

One *Salmonella* isolate (0.1%) was resistant to ciprofloxacin. The percentage of *Salmonella* isolates with ciprofloxacin MICs >0.25 increased from 0.4% (5/1326) in 1996 to 0.7% (10/1465) in 1998 (Figure 3). Serotypes of *Salmonella* isolates with reduced susceptibility or resistance to ciprofloxacin included *S.* Enteritidis (7/21 or 33.3%) and *S*. Typhimurium (3/21 or 14.3%)(Table 9). The percentage of *Salmonella* isolates resistant to nalidixic acid (MIC >32) increased from 0.4% (5/1326) in 1996 to 1.4%

(20/1466) in 1998 (Figure 3). Serotypes of *Salmonella* isolates with resistance to nalidixic acid included *S.* Enteritidis (12/35 or 34.3%) and *S.* Typhimurium (6/35 or 17.1%) (Table 10).

E. coli O157:H7

Back to top

A total of 315 *E. coli* O157:H7 isolates were received at CDC in 1997; 313/315 (99.4%) were tested for antimicrobial sensitivity. Among *E. coli* O157:H7 isolates, 23/313 (7.3%) were resistant to one or more antimicrobial agents and 19/313 (6%) were resistant to two or more agents. The most common resistance among *E. coli* O157:H7 isolates was to sulfamethoxazole (18/313 or 5.8%) or tetracycline (14/313 or 4.5%) (Table 11). None of the *E. coli* O157:H7 isolates tested were resistant to amikacin, amoxicillin/clavulanic acid, apramycin, ceftiofur, ceftriaxone, cephalothin, ciprofloxacin, gentamicin, or nalidixic acid (Table 11, Figure 7). The MICs for *E. coli* O157:H7 are shown in Figure 8.

Campylobacter

Back to top

A total of 382 *Campylobacter* isolates were collected in 1998 and forwarded to CDC; 346/382 (91.0%) were viable upon receipt and tested for antimicrobial susceptibility (Table 1, Figure 1). Among tested isolates, 332/346 (96%) were *C. jejuni*, 9/346 (2.6%) were *C. coli*, 2 were *C. upsaliensis*, 1 was *C. lari*, and 2 were undetermined. Among *Campylobacter jejuni* isolates, 181/332 (54.5%) were resistant to one or more antimicrobial agents, and 52/332 (15.6%) were resistant to two or more agents. The most common resistance among *Campylobacter jejuni* isolates was to tetracycline (46.4%) followed by nalidixic acid (15.1%), and ciprofloxacin (13.3%) (Table 12, Figure 9). The MICs for *Campylobacter jejuni* are shown in Figure 10. Among *Campylobacter coli* isolates, 5/9 (56%) were resistant to one or more antimicrobial agents, and 3/9 (33%) were resistant to two or more agents. The most common resistance among *Campylobacter coli* isolates was to nalidixic acid (55.6%) , followed by tetracycline (44.4%), chloramphenicol (22.2%), and ciprofloxacin (11.1%) (Table 12).

Sensititre Validation Study Overall

Back to top

355/408 (86%) of MIC results obtained in CDC and USDA laboratories were identical. Of the 53 (14%) results which differed, 52/53 (98%) differed by one dilution. In the 53 instances of disagreement, CDC had the higher MIC 17 times. The disagreements involved gentamicin (3/17), apramycin (3/17), cephalothin (2/17), streptomycin (2/17), tetracycline (2/17), ciprofloxacin (2/17), ticarcillin (1/17), amoxicillin-clavulanic acid (1/17), and trimethoprim-sulfamethoxazole (1/17). The one instance with >1 dilution disagreement involved ticarcillin (3 dilutions higher). Overall, there was a 99% agreement rate with respect to interpretation of Sensititre results obtained by CDC and USDA laboratories.

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 5, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report
Working Group

Centers for Disease Control and Prevention

Nina Marano, Shannon Rossiter, Karen Stamey, John Hatmaker,Richard Bishop, Tim Barrett, Joy Wells, Fred Angulo, Foodborne and Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases; National Center for Infectious Diseases

US Food and Drug Administration

Kathy Hollinger, Marcia Headrick, Roger Jones, Linda Tollefson, Office of Surveillance and Compliance, Division of Voluntary Compliance and Hearings Development, Center for Veterinary Medicine

US Dept of Agriculture

Paula Fedorka-Cray, Richard Russell Research Center, Agricultural Research Service Ken Peterson, Emerging Pathogens and Zoonotic Diseases Division, Food Safety and Inspection Service Nora Windland, Dave Dargatz, Centers for Epidemiology and Animal Health, Animal and Plant Health Inspection Service

Participating Local and State Health Departments

California Department of Health Services
Sharon Abbott, Paul Kimsey, Sue Shallow, Duc Vugia

Colorado Department of Public Health and Environment
Mike Rau, Robert Quillan, Richard Hoffman

Connecticut Department of Public Health and Addiction Services
Bob Howard, Don Mayo, Terry Fiorentino

Florida Department of Health
Judy Taylor, Jody Baldy, Richard Hopkins

Georgia Division of Public Health

Marsha Ray, Mahin Park, Suzanne Segler, Elizabeth Franco, Paul Blake

Kansas Department of Health and Environment
Robert Flaheart, June Sexton, Roger Carlson, Gianfranco Pezzino

Los Angeles County Department of Health Services
Liga Kilman, Elizabeth Cordero, Debra Brown, Laurene Mascola

Massachusetts Department of Public Health
Joseph Peppie, Alfred DeMaria

Maryland Department of Health and Mental Hygiene
Yongyu Wang, Glenn Morris

Minnesota Department of Health
Wanda Boyer, Fe Leano, Julie Wicklund, John Besser, Craig Hedberg

New Jersey Department of Health
Keith Pilot, Sylvia Matiuck, John Brook

New York City Department of Health
Alice Agasan, Wydenia Perry, Marci Layton

New York State Department of Health
Tim Root, Shelley Zansky, Dale Morse

Oregon Department of Human Resources
Steve Mauvais, Maureen Cassidy, Theresa McGivern, Beletsachew Shiferaw, Paul Cieslak

Washington Public Health Laboratories
Jay Lewis, Donna Green, Jon Counts

West Virginia Department of Health and Human Resources
Doug McElfresh, Loretta Haddy

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333

updated August 6, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report
Publications and Presentations

Publications

1. Glynn MK, Bopp C, Dewitt W, Dabney P, Moktar M, Angulo F. Emergence of multidrug resistant *Salmonella Enterica* serotype Typhimurium DT104 infections in the United States. *New England Journal of Medicine* 1998; 338 (19): 1333-1338.

2. Tollefson L, Angulo FJ, Fedorka-Cray PJ. National surveillance for antibiotic resistance in zoonotic enteric pathogens. *Veterinary Clinics of North America: Food Animal Practice* 1998: 14(1):141-150.

3. Threlfall EJ, Angulo FJ, Wall PG. Ciprofloxacin-resistant *Salmonella typhimurium* DT104. *Veterinary Record* 1998;142:255-256.

Abstracts

1. Angulo F, Marano N, Mackinson C, Wang Y, Sokolow R, DeBess E, Koehler J, Benson J, Hill B, McDonald C. Isolation of quinupristin-dalfopristin-resistant *Enterococcus faecium* from human stool specimens and retail chicken products in the United States. Interscience Conference on Antimicrobial Agents and Chemotherapy. 1999 September; San Francisco, California

2. Marano N, Benson J, Koehler J, Mackinson C, Wang Y, Madden J, DeBess E, Hill B Archibald L, Boel J, Soerensen T, Wegener H, Angulo F. Presence of high-level gentamicin resistant (HLGR) *enterococci* in humans and retail chicken products in the U.S., but not Denmark. Interscience Conference on Antimicrobial Agents and Chemotherapy. 1999 September; San Francisco, California

Presentations

1. Tollefson L, Fedorka-Cray P, Marano N, Angulo FJ and the NARMS Working Group. The US national antimicrobial resistance monitoring system for Enteric Bacteria. WHO Informational Meeting on Antimicrobial Resistance Surveillance in Foodborne Pathogens. 1998 March; Geneva, Switzerland

2. Marano N, Stamey K, Hatmaker J, Barrett T, Angulo FJ and the NARMS Working Group. The national antimicrobial resistance monitoring system (NARMS): trends in antimicrobial resistance. Emerging Antibiotic Resistance in Food Borne Enteric Pathogens Conference; 1998 August; Athens,

Georgia.

3. Angulo FJ, Tauxe RV, Cohen ML. Public health impact of the emergence of antibiotic resistance in foodborne pathogens. Annual Meeting of the Institute of Food Technologists; 1998 June; Atlanta, Georgia.

4. Angulo FJ. Human health consequences of antimicrobial use in food animals. Annual Meeting of the American Feed Industry Association; 1998 March; Kansas City, Missouri.

5. Angulo FJ, Tauxe RV, Cohen ML. Significance and sources of antimicrobial-resistant *Salmonella*. The role of veterinary therapeutics in bacterial resistance development: animal and public health perspectives. American Academy of Veterinary Pharmacology and Therapeutics; 1998 Jan; College Park, Maryland.

Poster Presentations

1. Marano N, Stamey K, Barrett TJ, Tollefson L, Angulo FJ, and the NARMS: Enteric Bacteria Working Group. Emerging resistance among U.S. *Salmonella* strains to quinolones and extended-spectrum cephalosporins, 1996 - 1998. American Society for Microbiology General Meeting.1999 June; Chicago, Illinois

2. Ribot EM, Angulo FJ, Barrett TJ. PCR amplification and characterization of intergron- associated antimicrobial resistance genes from various strains of *Salmonella*. 98th General Meeting of the American Society for Microbiology; 1998 May, Atlanta, Georgia.

3. Zirnstein G, Bopp C, Dabney P, Voetsch D, Swaminathan B, Hatmaker J, Miller M, Tollefsen L, Angulo F, and the NARMS Working Group. The national antimicrobial resistance monitoring system. International Conference on Emerging Infectious Diseases, l998 March, Atlanta, Georgia.

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 6, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria 1998 Annual Report

Table 1. Population size and number of isolates received, by site

Site	Pop. Size No. (%)	*Salmonella* No. (%)	*E. coli* No. (%)	*Campylobacter* No. (%)
California (1)	2,146,096 (2.2)	49 (3.3)	6 (1.9)	48 (12.5)
Colorado	3,970,971 (4.1)	72 (4.9)	23 (7.3)	
Connecticut	3,274,069 (3.4)	60 (4.1)	13 (4.1)	51 (13.4)
Florida	14,915,980 (15.4)	66 (4.5)	9 (2.9)	
Georgia	7,642,207 (7.9)	172 (11.7)	48 (15.2)	110 (28.8)
Kansas	2,629,067 (2.7)	31 (2.1)	3 (1.0)	
Los Angeles (2)	9,213,533 (9.5)	135 (9.1)	5 (1.6)	
Massachusetts	6,147,132 (6.3)	150 (10.2)	35 (11.1)	
Maryland	5,134,808 (5.3)	54 (3.7)	7 (2.2)	27 (7.1)
Minnesota	4,725,419 (4.9)	71 (4.8)	56 (17.8)	59 (15.4)
New Jersey	8,115,011 (8.4)	156 (10.6)	21 (6.7)	
New York City (3)	7,420,166 (7.7)	183 (12.4)	3 (1.0)	
New York State (excluding NYC)	10,755,135 (11.1)	147 (10.0)	33 (10.5)	36 (9.4)
Oregon	3,281,974 (3.4)	37 (2.5)	22 (7.0)	51 (13.4)
Washington	5,689,263 (5.9)	67 (4.5)	25 (7.9)	
West Virginia	1,811,156 (1.8)	26 (1.8)	6 (1.9)	
Totals	**96,871,987*(100.0)**	**1476 (100.0)**	**315 (100.0)**	**382 (100.0)**

* 1997 post census estimate
(1) San Francisco and Alameda Counties
(2) Los Angeles County
(3) Five boroughs of New York City (Bronx, Brooklyn, New York, Queens, Richmond)

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System:Enteric Bacteria
1998 Annual Report

Table 2. Antimicrobial agents used for susceptibility testing for *Salmonella*, *E. coli* O157:H7, and *Campylobacter* isolates

Antimicrobial Agent	Antimicrobial Agent Concentration Ranges (ug/ml)	Breakpoints (R) (I) (S)	Code
Amikacin	4 - 32	≥64 32 ≤16	Ak
Amoxicillin-Clav. Acid	0.5/0.25 - 32/16	≥32 16 ≤8	Cv
Ampicillin	2 - 64	≥32 16 ≤8	A
Apramycin**	2 - 16	≥32 16 ≤8	Ap
Azithromycin*	0.016 - 256	≥2 0.5-1 ≤0.025	Az
Ceftiofur**	0.5 - 16	≥8 4 ≤2	Cf
Ceftriaxone	0.25 - 16	≥64 32 ≤8	Cx
Cephalothin	1 - 32	≥32 16 ≤8	Ce
Chloramphenicol Chloramphenicol*	4 - 32 0.125 - 256	≥32 16 ≤8	C
Ciprofloxacin Ciprofloxacin*	0.015 - 2 0.016 - 32	≥4 2 ≤1	Cp
Clindamycin*	0.032 - 256	≥4 1-2 ≤0.5	Cl
Gentamicin Gentamicin*	0.25 - 16 0.025 - 16	≥16 8 ≤4	G
Erythromycin*	0.047 - 256	≥8 1-4 ≤0.5	E
Kanamycin	16 - 64	≥64 32 ≤16	K
Nalidixic Acid Nalidixic Acid*	4 - 64 0.047 - 256	≥32 ≤16	Na
Streptomycin**	32 - 256	≥64 ≤32	S
Sulfamethoxazole	128 - 512	≥512 ≤256	Su
Tetracycline Tetracycline*	4 - 64 0.023 - 32	≥16 8 ≤4	T
Ticarcillin	2 - 128	≥128 32 ≤16	Ti
Trimeth.-Sulfa.	0.12/2.4 - 4/76	≥4/76 ≤2/38	Tm

*** *Campylobacter* antimicrobial agents and concentration ranges used**
**** No NCCLS interpretive standards for this antimicrobial agent (veterinary use only)**

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria 1998 Annual Report

Table 3: Antibiotic Susceptibility of *Salmonella* isolates

N=1466

Antibiotic	Number resistant N %
Amikacin	0 0
Amox/Clav acid	24 1.6
Ampicillin	241 16.4
Apramycin	1 0.07
Ceftiofur	14 1.0
Ceftriaxone	10 0.7
Cephalothin	33 2.3
Chloramphenicol	145 9.9
Ciprofloxacin	1 0.07
Gentamicin	42 2.9
Kanamycin	84 5.7
Nalidixic acid	20 1.4
Streptomycin	273 18.6
Sulfamethoxazole	283 19.3
Tetracycline	295 20.1
Trimeth/Sulfa	34 2.3

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria
1998 Annual Report

Table 4. Frequency of *Salmonella* Serotypes/Frequency of multiresistance among serotypes

Serotype	Total		Number resistant to >1 antimicrobial		Number resistant to >2 anti-microbials	
	N	%	N	%	N	%
Typhimurium	380	25.9	200	52.6	194	51.0
Enteritidis	245	16.7	30	12.2	22	8.9
Heidelberg	103	7.0	44	42.7	39	37.8
Newport	79	5.4	4	5.1	2	2.5
Javiana	54	3.7	2	3.7	2	3.7
Agona	39	2.7	16	41.0	12	30.8
Montevideo	33	2.3	3	9.0	2	6.1
Muenchen	30	2.0	3	10.0	2	6.7
Hadar	26	1.8	26	100	25	96.0
Thompson	24	1.6	0	0	0	0
Braenderup	23	1.6	0	0	0	0
Infantis	22	1.5	2	9.0	1	4.5
Other serotypes	408	27.8	67	16.4	45	11.0
Total	1466	100	397	27.1	346	23.6

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System:Enteric Bacteria
1998 Annual Report

Table 5: Percentage of *S*. Typhimurium with ACSSuT or AKSSuT resistance pattern, by site

Site	Total # Typhimurium/ NARMS		ACSSuT/ Typhimurium		ACSSuT+K/ Typhimurium		AKSSuT/ Typhimurium	
	N	%	N	%	N	%	N	%
CA	8	2.5	3	37.5	0	0	2	25.0
CO	20	5.2	8	40.0	1	5.0	1	5.0
CT	18	4.7	8	44.4	1	5.6	1	5.6
FL	7	1.0	4	57.1	1	14.3	2	28.6
GA	50	13.2	11	22.0	1	2.0	6	12.9
KS	11	2.9	2	18.2	0	0	1	9.1
LA	22	5.8	6	27.3	0	0	3	13.6
MA	50	13.2	10	20.0	2	4.0	9	18.0
MD	16	4.2	9	56.3	1	6.3	2	12.5
MN	29	7.6	3	10.3	2	6.9	4	13.8
NJ	48	12.6	18	37.5	2	4.2	4	8.3
NYS	48	12.6	12	25.0	0	0	0	0
NYC	9	2.4	7	77.8	2	22.2	9	100
OR	16	4.2	5	31.3	0	0	0	0
WA	22	5.8	13	59.1	3	13.6	3	13.6
WV	6	1.6	1	16.7	0	0	0	0
Total	**380**	**100**	**120**	**31.6**	**16**	**4.2**	**47**	**12.4**

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria
1998 Annual Report

Table 6. Additional antimicrobial resistance for *S*. Typhimurium isolates with ACSSuT or AKSSuT patterns

Antimicrobial	ACSSuT (N=120) % Resistant	AKSSuT (N=47) % Resistant
Amoxicillin/ Clav	6.7	8.5
Ceftiofur	4.2	6.4
Ceftriaxone	3.3	0
Cephalothin	6.7	19.1
Chloramphenicol	-----	36.2
Gentamicin	2.5	6.4
Kanamycin	14.2	-----
Nalidixic acid	1.7	0
Trimeth/Sulfa	5.0	8.5

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria
1998 Annual Report

Table 7: Clinical source of *Salmonella* isolates

Isolate	Blood		Stool		Other		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
***S.* Typhimurium** *S.* Typhimurium w/ ACSSuT	5	4.2	111	92.5	2	1.7	2	1.7	120	100
S. Typhimurium w/ AKSSuT	4	8.5	40	85.0	3	6.5	0	0	47	100
Other *S.* Typhimurium	9	3.5	241	92.7	6	2.3	4	1.5	260	100
***S.* Enteritidis**	23	9.4	203	82.8	13	5.3	6	2.4	245	100
***S.* Heidelberg**	13	12.6	82	79.6	7	6.8	1	1.0	103	100
Other *Salmonella*	43	5.8	644	87.3	46	6.2	5	0.7	738	100
Total*	**93**	**6.3**	**1281**	**87.4**	**76**	**5.2**	**16**	**1.1**	**1466**	**100**

***Total** = due to overlap among *S*. Typhimurium isolates with ACSSUT and/or AKSSuT, 'Total' columns will not add up

---

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System:Enteric Bacteria 1998 Annual Report

Table 8. Multi-resistant antimicrobial resistance patterns of *Salmonella* isolates

(N=1466)

Multidrug resistant patterns	Number of ntibiotics in pattern (not incl. inter. susc.)	Number of isolates with pattern N	%	Serotype of isolates with multi-drug resistant pattern N
S T	2	18/1466	1.2	Hadar 14
				Enteritidis 3
				Typhimurium 1
Su T	2	15/1466	2.3	Agona 7
				Schwarzengrund 4
				Muenchen 1
				Oranienburg 1
				Heidelberg 1
				Typhimurium 1
Su T and Intermediate for G	2	1/1466	0.1	Infantis 1
A Ti	2	8/1466	0.6	Enteritidis 5
				Drypool 1
				Reading 1
				Typhimurium 1
A Ti and Intermediate for Cv	2	5/1466	0.3	Heidelberg 4
				Enteritidis 1
S Su	2	7/1466	0.5	Typhimurium 5
				Heidelberg 1
				Cholera-suis 1
Su Tm	2	3/1466	0.2	Enteritidis 1

				Typhimurium 1
				Unknown 1
G Su	2	2/1466	0.1	Heidelberg 1
				Typhimurium 1
Cf Ce and Intermediate for C	2	1/1466	0.1	Adelaide 1
Na Su	2	1/1466	0.1	Enteritidis 1
Cp Na	2	1/1466	0.1	Schwarzengrund 1
Cv Ce	2	1/1466	0.1	Typhimurium 1
G S Su	3	12/1466	0.8	Heidelberg 6
				Agona 2
				Typhimurium 2
				Enteritidis 1
				Unknown 1
K S T	3	10/1466	0.7	Heidelberg 10
A T Ti	3	8/1466	0.6	Enteritidis 6
				St. Paul 1
				Javiana 1
A T Ti and Intermediate for Ce	3	3/1466	0.2	Enteritidis 2
				Reading 1
S Su T	3	8/1466	0.6	Stanley 2
				Agona 1
				Derby 1
				Heidelberg 1
				Muenchen 1
				Schwarzengrund 1
				Typhimurium 1
Su T Tm	3	5/1466	0.3	Typhimurium 3
				St. Paul 1
				Enteritidis 1
S Su Tm	3	2/1466	0.1	St Paul 1

				Typhimurium 1
Na S T	3	1/1466	1/1466 0.1	Unknown 1
K Su T	3	1/1466	1/1466 0.1	Agona 1
Cv Ce T and Intermediate for C	3	1/1466	1/1466 0.1	Stanleyville 1
K Na T	3	1/1466	1/1466 0.1	Enteritidis 1
A S Ti	3	1/1466	0.1	Typhimurium 1
G S Su	3	12/1466	0.8	Heidelberg 6
				Agona 2
				Typhimurium 2
				Enteritidis 1
				Unknown 1
K S Su T	4	6/1466	0.4	Typhmurium 4
				St. Paul 1
				Unknown 1
A S T Ti	4	3/1466	0.2	Hadar 2
				Typhimurium 1
A S T Ti and Intermediate for CE	4	2/1466	0.1	Hadar 1
				Indiana 1
A S T Ti and Intermediate for Cv and Ce	4	1/1466	0.1	Indiana 1
G S Su T	4	2/1466	0.1	Typhimurium 2
Cv A Ce Ti	4	1/1466	0.1	Heidelberg 1
A Ce T Ti and Intermediate for Cv	4	1/1466	0.1	Hadar 1
A G Su Ti and intermediate for Ce	4	1/1466	0.1	Heidelberg 1
Cv A Cf Ce and Intermediate for Cx	4	1/1466	0.1	Typhimurium 1
C Su T Tm	4	1/1466	0.1	Brandenburg 1
Na Su T Tm	4	1/1466	0.1	Virchow 1

A Ce S T Ti and Intermediate for Cv	5	3/1466	0.2	Hadar 3
A G S Su Ti and Intermediate for Cv and Ce	5	3/1466	0.2	Heidelberg 3
A K S Su T	5	2/1466	0.1	Typhimurium 2
A K Su T Ti	5	2/1466	0.1	Typhimurium 1
				Dublin 1
A S Su Ti Tm	5	1/1466	0.1	Unknown 1
A S Su T Ti	5	1/1466	0.1	Typhimurium 1
C S Su T Tm	5	1/1466	0.1	Heidelberg 1
C Na Su T Tm	5	1/1466	0.1	Virchow 1
Cv A G S Su	5	1/1466	0.1	Johannesburg 1
G K S Su T	5	1/1466	0.1	Heidelberg 1
A C S T Ti and intermediate for Cv	5	1/1466	0.1	Typhimurium 1
A C Su T Ti	5	1/1466	0.1	St. Paul 1
A K S Su Ti	5	1/1466	0.1	Typhimurium 1
A K S T Ti and Intermediate for Ce	5	1/1466	0.1	Heidelberg 1
A Az Cf Cx Su and Intermediate for Cv and Ti	5	1/1466	0.1	Typhimurium 1
C Na Su T Tm	5	1/1466	0.1	Virchow 1
A Na S T Ti and Intermediate for Cv and Ce	5	1/1466	0.1	Hadar 1
A K S Su Ti and Intermediate for Cv	5	1/1466	0.1	Typhimurium 1
A C S Su T Ti and Intermediate for CV	6	96/1466	6.5	Typhimurium 92
				Agona 1
				Derby 1
				Hadar 1
				Paratyphi B 1
A K S Su T Ti	6	21/1466	1.4	Typhimurium 20
				Heidelberg 1

A C S Su T Ti	6	6/1466	0.4	Typhimurium 5
				St. Paul 1
A Ce G S Su Ti	6	3/1466	0.2	Heidelberg 3
A K S Su T Ti and Intermediate for Ce	6	3/1466	0.2	Typhimurium 3
A K S Su T Ti and Intermediate for Cv	6	3/1466	0.2	Typhimurium 3
Cv A Cf Cx Ce S	6	1/1466	0.1	Typhimurium 1
A G K S Su Ti and Intermediate for Ce	6	1/1466	0.1	Montevideo 1
A K S Su T Ti and Intermediate for Cv and Ce	6	1/1466	0.1	Typhimurium 1
A G K Na S Ti and Intermediate for Cv and Ce	6	1/1466	0.1	Berta 1
A G S Su T Ti and Intermediate for Cv and Ce	6	1/1466	0.1	Heidelberg 1
Cv A S Su Ti Tm and Intermediate for G and K	6	1/1466	0.1	Typhimurium 1
A C K S Su T Ti and Intermediate for Cv	7	10/1466	0.7	Typhimurium 10
A C Na S Su T Ti and Intermediate for Cv	7	2/1466	0.1	Typhimurium 2
A C G S Su T Ti and Intermediate for Cv	7	2/1466	0.1	Typhimurium 2
Cv A C S Su T Ti	7	2/1466	0.1	Typhimurium 2
Cv A C S Su T Ti and Intermediate for Ce	7	1/1466	0.1	Typhimurium 1
A Cf C S Su T Ti and Intermediate for Cv and Ce	7	1/1466	0.1	Typhimurium 1
Cv A C Su T Ti Tm	7	1/1466	0.1	Typhimurium 1
A G K S Su T Ti	7	1/1466	0.1	Typhimurium 1
A C S Su T Ti Tm and Intermediate for Cv	7	1/1466	0.1	Typhimurium 1

A C Na Su T Ti Tm	7	1/1466	0.1	Irumu 1
A Ce K S Su T Ti	7	1/1466	0.1	Typhimurium 1
A C G K Su T Ti Tm	8	3/1466	0.2	Typhimurium 3
Cv A Ce G S Su T Ti and Intermediate for K	8	1/1466	0.1	Hadar 1
Cv A C S Su T Ti Tm	8	1/1466	0.1	Typhimurium 1
Cv A G K S Su Ti Tm and Intermediate for Ce	8	1/1466	0.1	Typhimurium 1
Cv A Cf Ce C S Sy Ti and Intermediate for G and K	8	1/1466	0.1	Chester 1
A Ce C K S Su T Ti Tm and Intermediate for Cv	9	4/1466	0.3	Typhimurium 4
Cv A Cf Cx Ce C S Su T and Intermediate for Ti	9	2/1466	0.1	Newport 1 Typhimurium 1
Cv A Cf Cx Ce S Su Ti Tm	9	1/1466	0.1	Cubana 1
A Ce C G K S Su Ti Tm and Intermediate for Cv	9	1/1466	0.1	Newport 1
Cv A Ce G K S Su T Ti	9	1/1466	0.1	St. Paul 1
Cv Cf Ce G K S Su Ti Tm	9	1/1466	0.1	Heidelberg 1
A Ap C G S Su T Ti Tm and Intermediate for Ce	9	1/1466	0.1	Stanley 1
Cv A Ce G K S Su T Ti	9	1/1466	1/1466 0.1	Typhimurium 1
	10	0	0	
Cv,A Cf Cx Ce C K S Su T Ti	11	2/1466	0.1	Typhimurium 2
Cv A Cf Cx Ce C G K S,Su T Ti	12	1/1466	0.1	Typhimurium 2

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria
1998 Annual Report

Table 9. Serotypes of *Salmonella* with reduced susceptibility or resistant to ciprofloxacin 1996-1998 (N=21)

Serotype	Frequency	(%)
Enteritidis	7	33.3
Typhimurium	3	14.3
Berta	2	9.5
Virchow	2	9.5
Emek	1	4.8
Hadar	1	4.8
Heidelberg	1	4.8
Paratyphi A	1	4.8
Reading	1	4.8
Schwarzengrund	1	4.8
St. Paul	1	4.8

Table 10. Serotypes of *Salmonella* resistant to nalidixic acid 1996-1998 (N=35)

Serotype	Frequency	(%)
Enteritidis	12	34.3
Typhimurium	6	17.1
Virchow	5	14.3
Berta	2	5.7
Emek	1	2.9
Hadar	1	2.9
Heidelberg	1	2.9
Infantis	1	2.9

Irumu	1	2.9
Muenchen	1	2.9
Paratyphi A	1	2.9
Schwarzengrund	1	2.9
St. Paul	1	2.9
Uganda	1	2.9

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria
1998 Annual Report

Table 11. Antibiotic Susceptibility of *E. coli* O157:H7 isolates

N=313

Antibiotic	Number resistant	
	N	%
Amikacin	0	0
Amox/Clav acid	0	0
Ampicillin	8	2.6
Apramycin	0	0
Ceftiofur	0	0
Ceftriaxone	0	0
Cephalothin	0	0
Chloramphenicol	1	0.3
Ciprofloxacin	0	0
Gentamicin	0	0
Kanamycin	1	0.3
Nalidixic acid	0	0
Streptomycin	6	1.9
Sulfamethoxazole	18	5.8
Tetracycline	14	4.5
Trimeth/Sulfa	2	0.6

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System: Enteric Bacteria 1998 Annual Report

Table 12. Antimicrobial susceptibility of *Campylobacter* isolates

All *Campylobacter* isolates (N=346)

Antimicrobial Agent	Susc. (%)	Inter. (%)	Resist. (%)
Azithromycin	1.5	96.5	2.0
Chloramphenicol	91.0	7.5	1.5
Ciprofloxacin	85.8	0.6	13.6
Clindamycin	87.8	10.4	1.7
Erythromycin	32.6	64.2	3.2
Gentamicin	99.7	0.3	0
Nalidixic Acid	82.0	0.9	17.1
Tetracycline	57.2	0.6	42.2

Campylobacter jejuni isolates (N=332)

Antimicrobial Agent	Susc. (%)	Inter. (%)	Resist. (%)
Azithromycin	1.2	97.0	1.8
Chloramphenicol	92.7	6.7	0.6
Ciprofloxacin	86.4	0.3	13.3
Clindamycin	90.1	9.0	0.9
Erythromycin	15.5	81.8	2.7
Gentamicin	99.7	0.3	0
Nalidixic Acid	84.2	0.7	15.1
Tetracycline	52.1	1.5	46.4

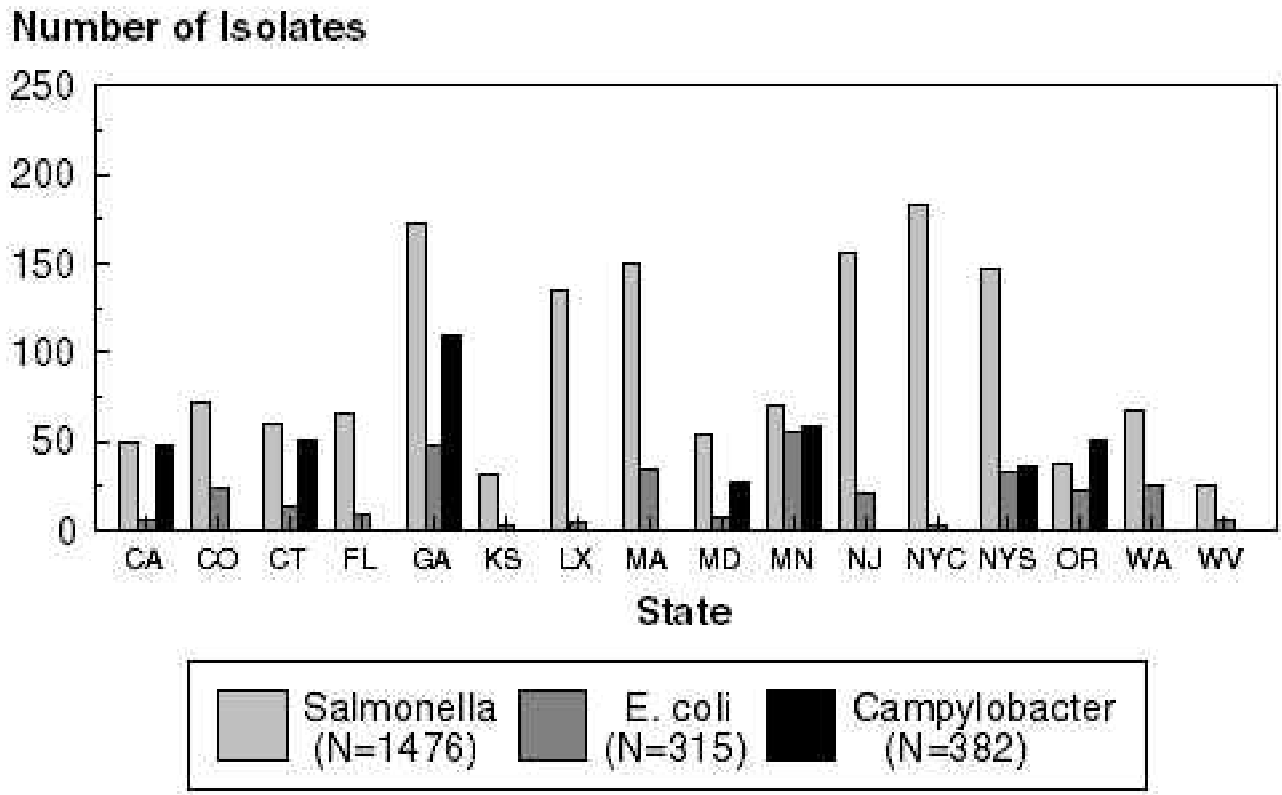
Campylobacter coli isolates (N=9)

Antimicrobial Agent	Susc. (%)	Inter. (%)	Resist. (%)
Azithromycin	0	88.9	11.1
Chloramphenicol	55.6	22.2	22.2
Ciprofloxacin	88.9	0	11.1
Clindamycin	44.3	44.5	11.1
Erythromycin	22.2	66.7	11.1
Gentamicin	100	0	0
Nalidixic Acid	33.3	11.1	55.6
Tetracycline	55.6	0	44.4

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial and Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta, GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

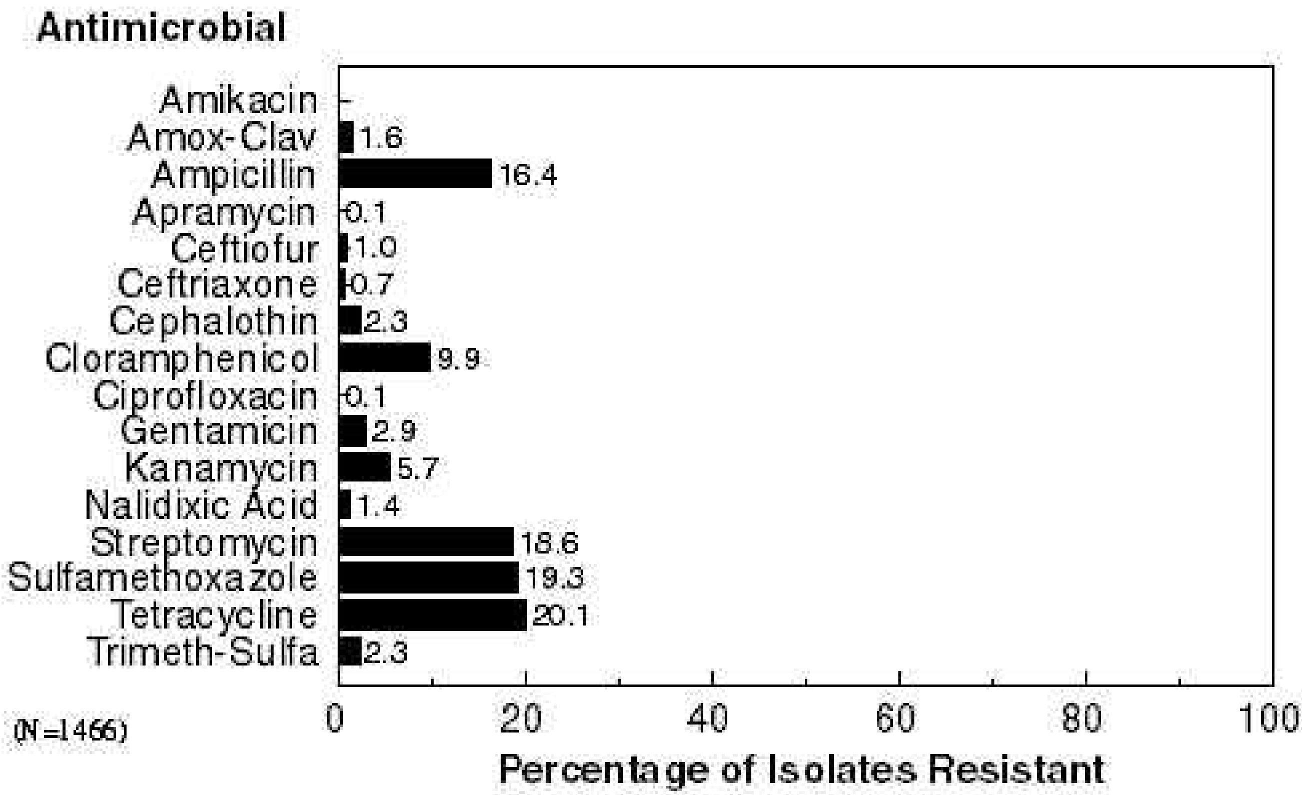
Figure 1: Number of isolates submitted, by site



Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

Figure 2: Resistance among *Salmonella* isolates for all sites

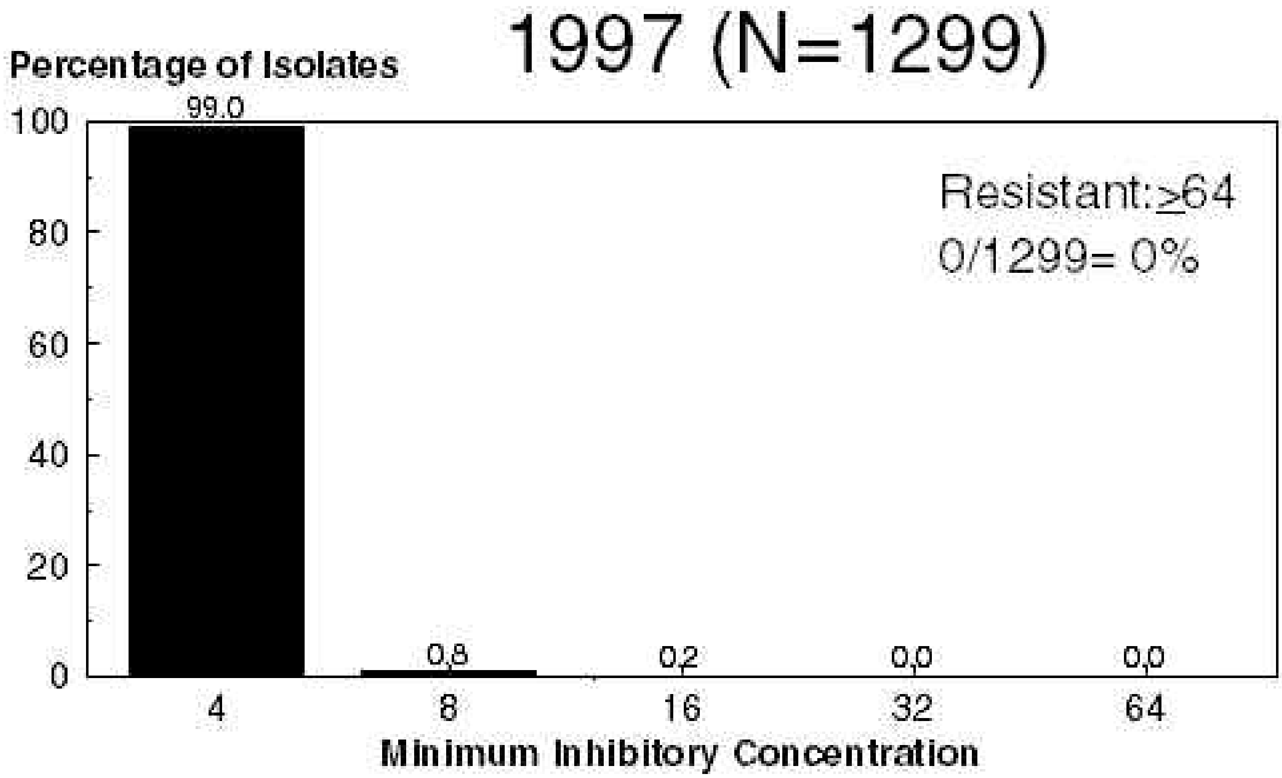


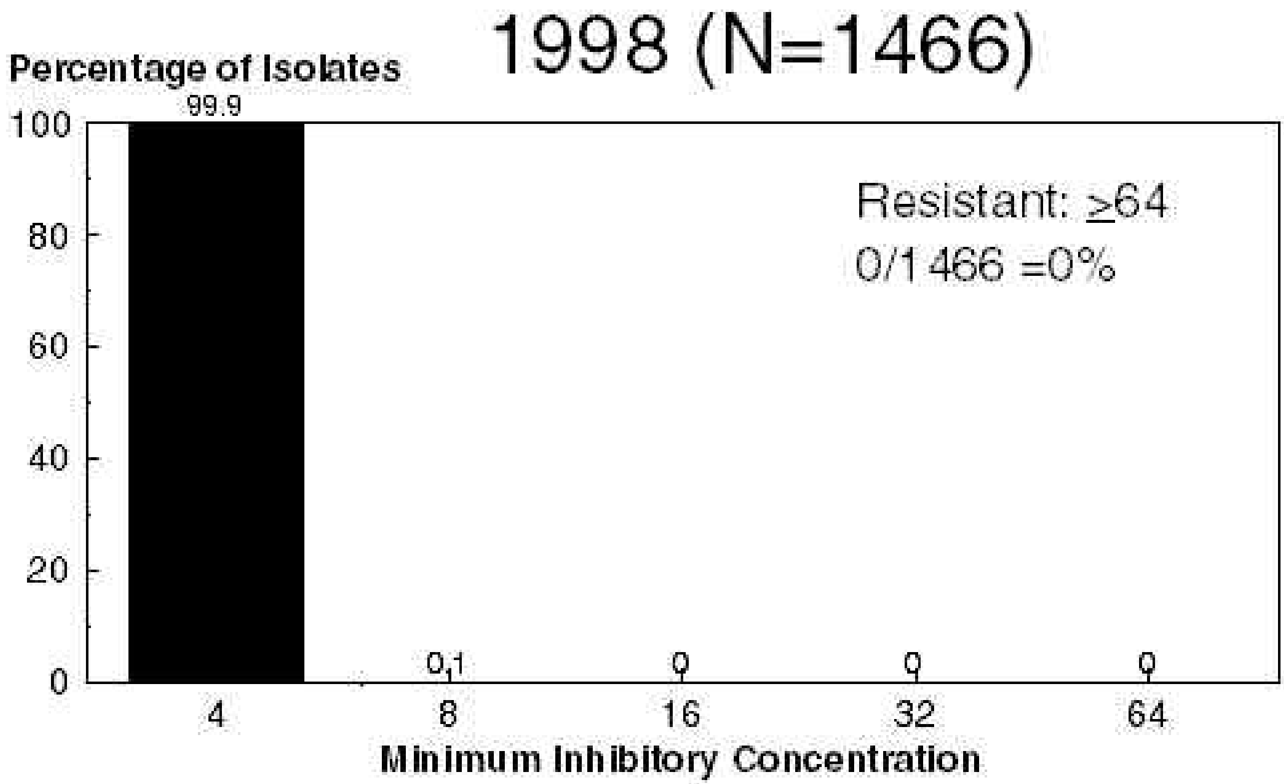
Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

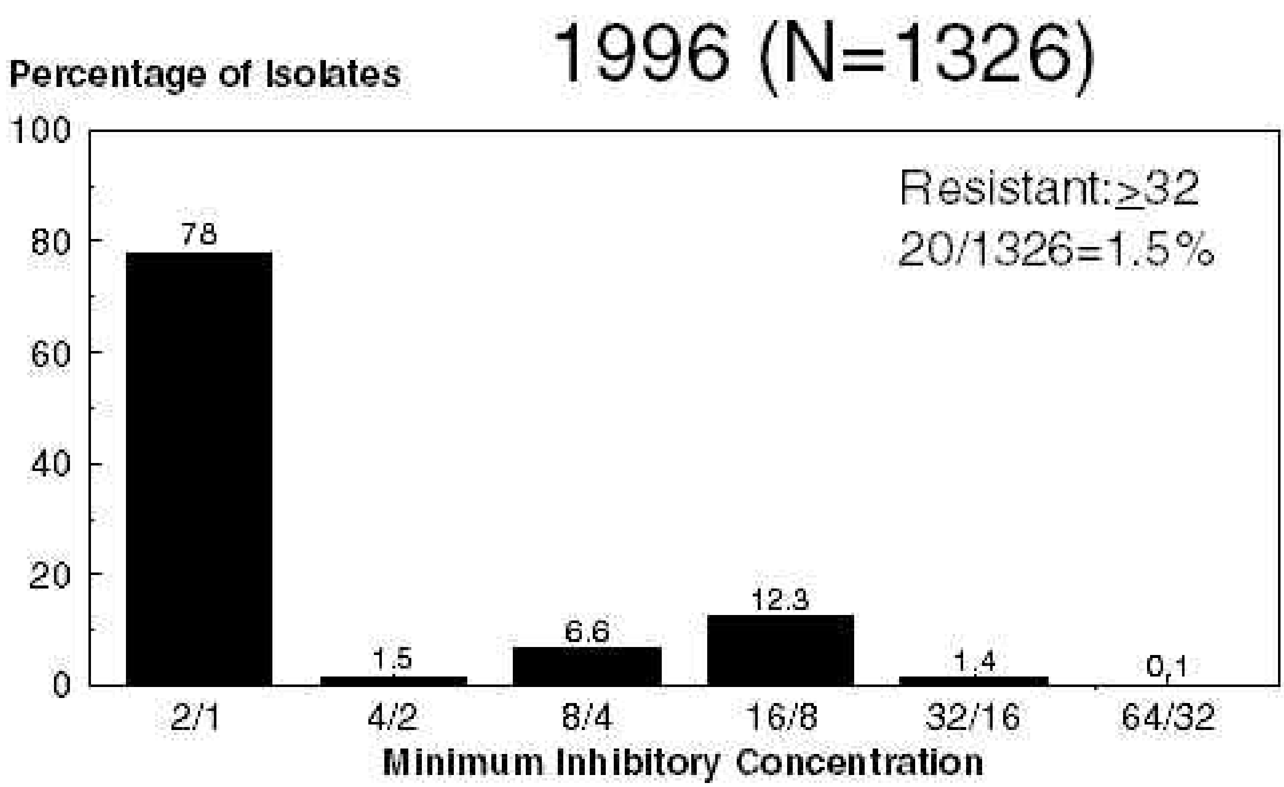
Figure 3: *Salmonella* MICs, by antimicrobial agent

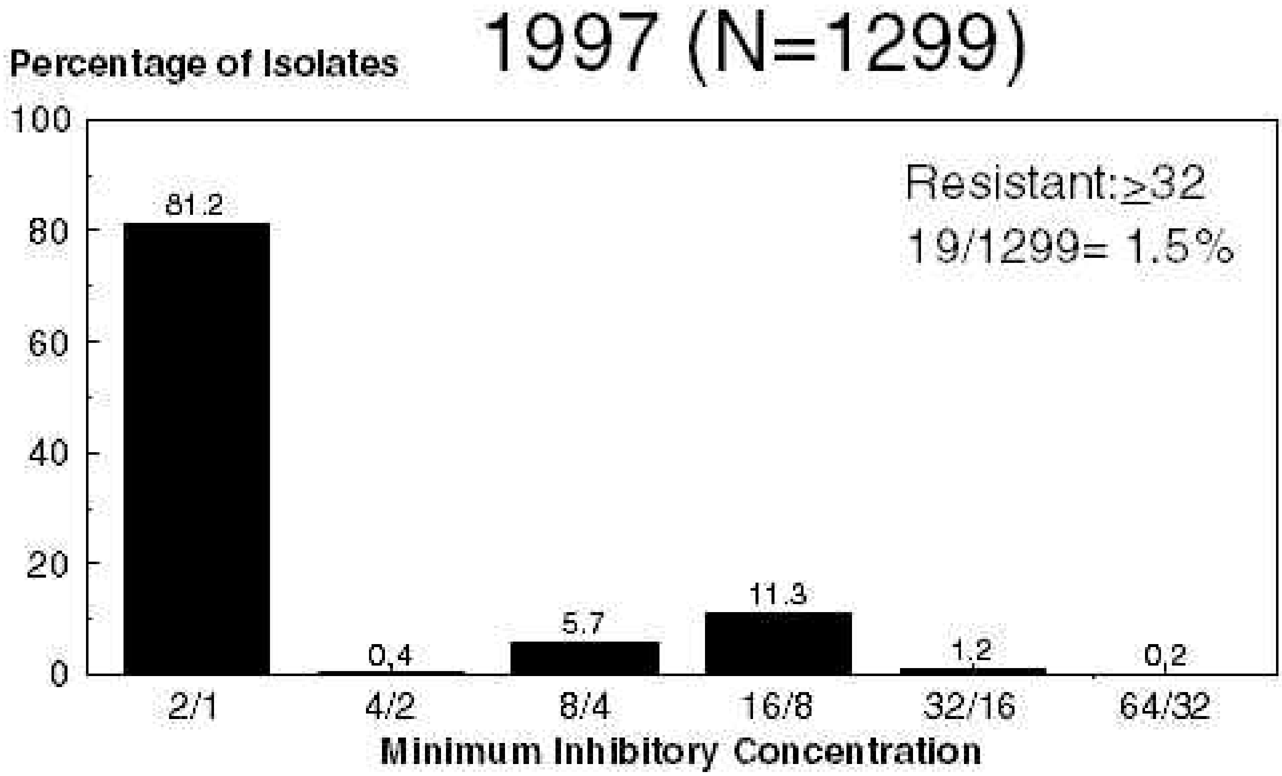
Comparison of *Salmonella* Amikacin MICs 1997-1998

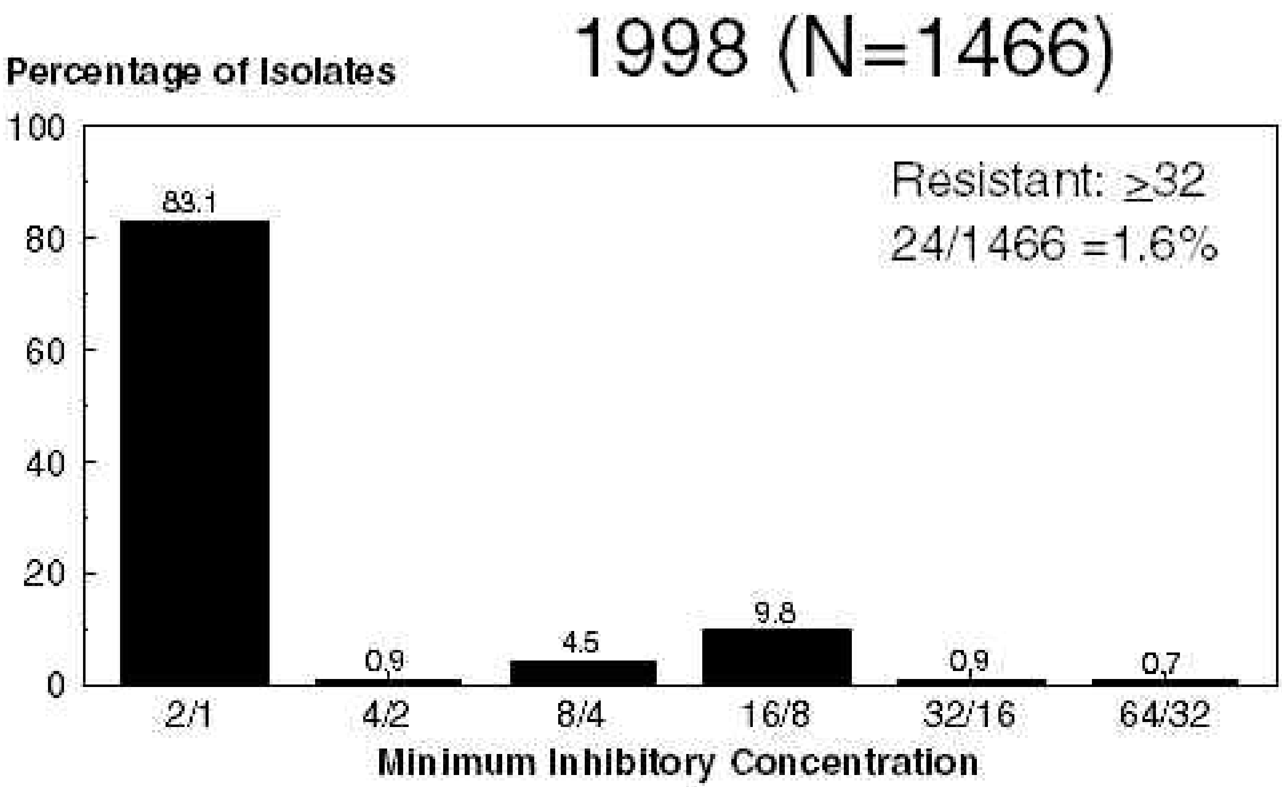




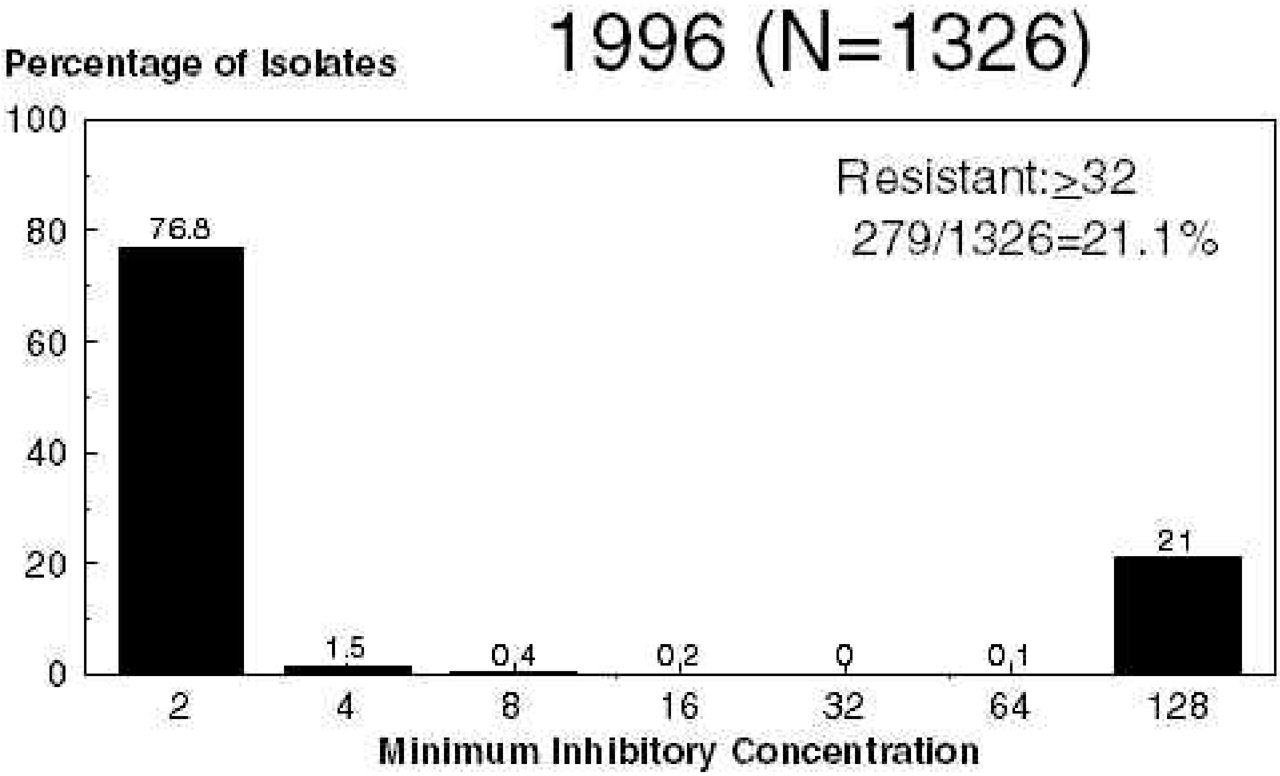
Comparison of *Salmonella* Amoxicillin-Clavulanic acid MICs 1996-1998

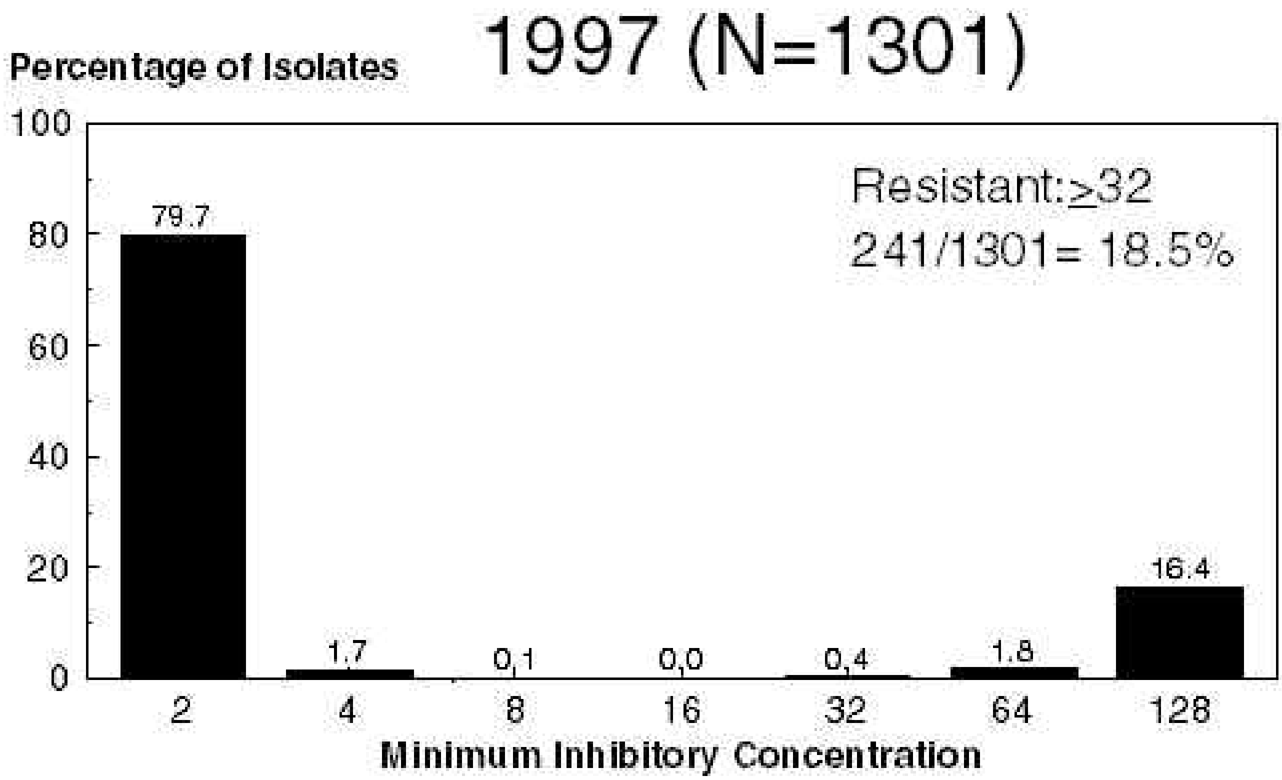


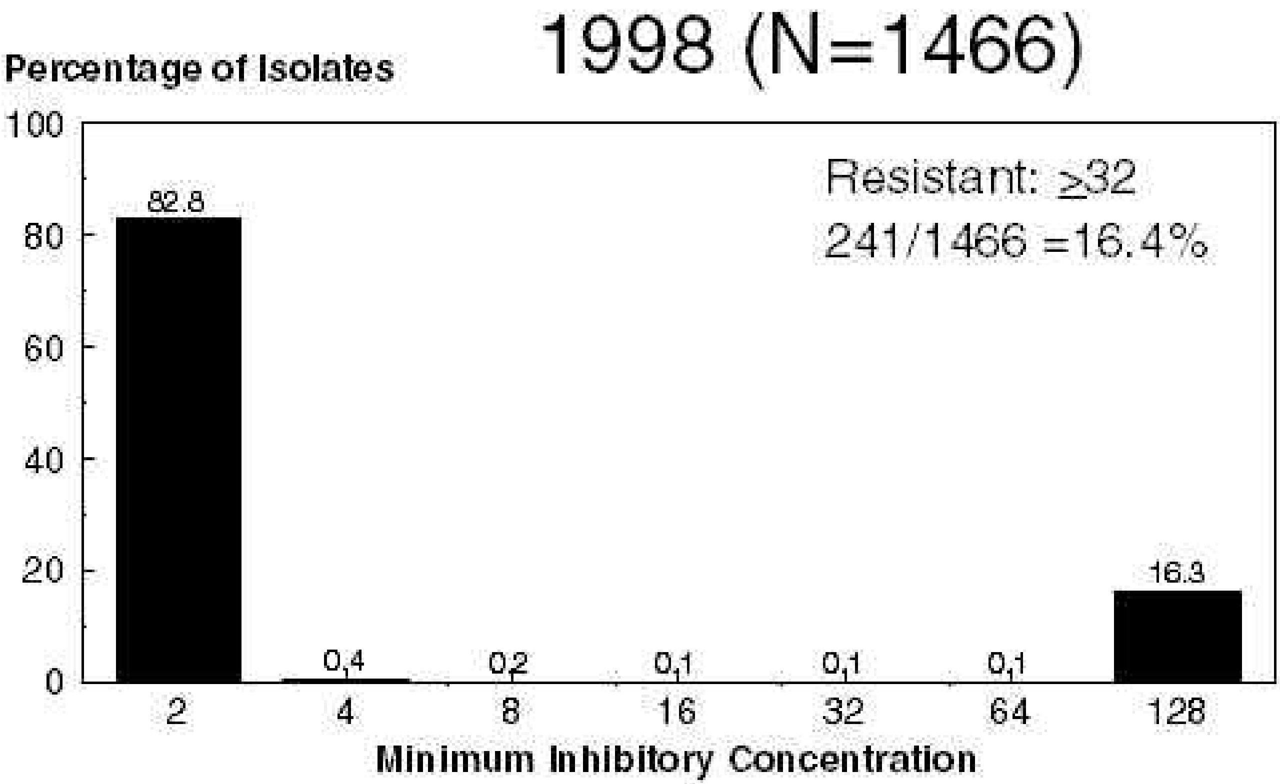




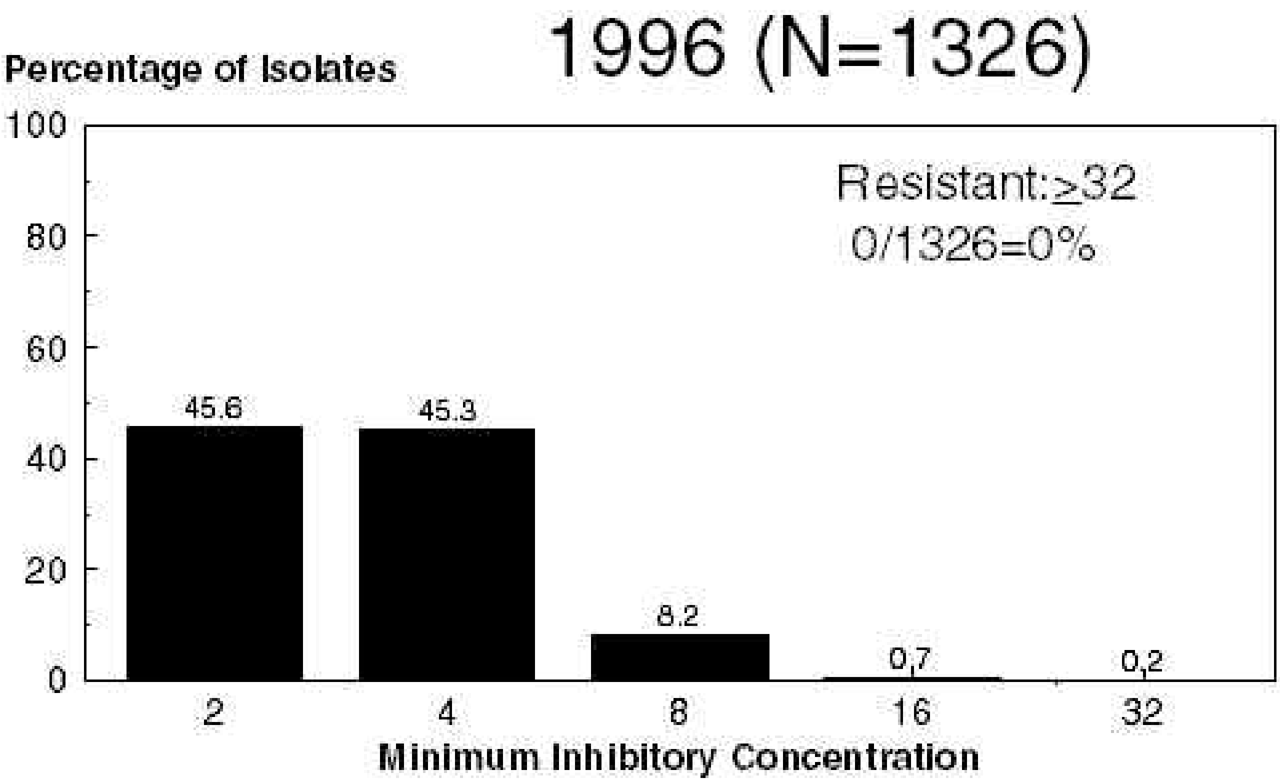
Comparison of *Salmonella* Ampicillin MICs 1996-1998

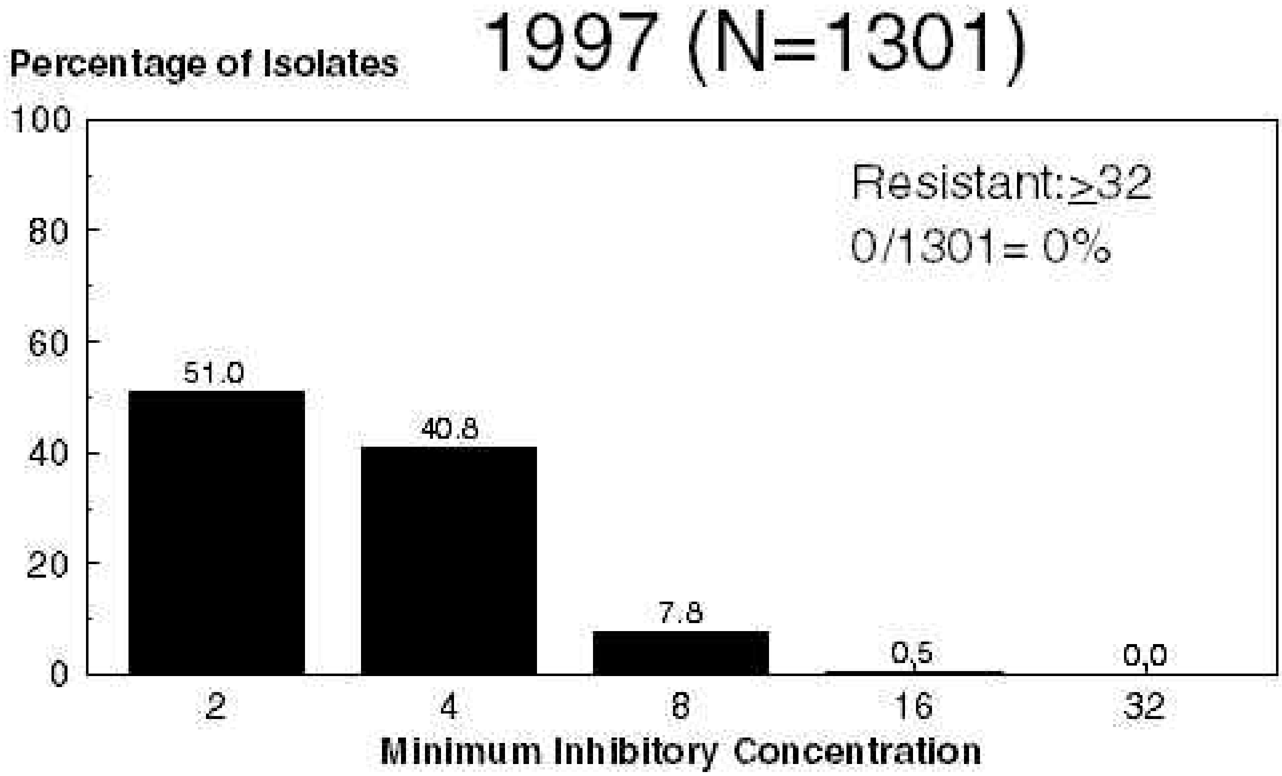

1996 (N=1326)
Percentage of Isolates
Resistant:≥32
279/1326=21.1%
76.8
1.5
0.4
0.2
0
0.1
21
100
80
60
40
20
0
2
4
8
16
32
64
128
Minimum Inhibitory Concentration

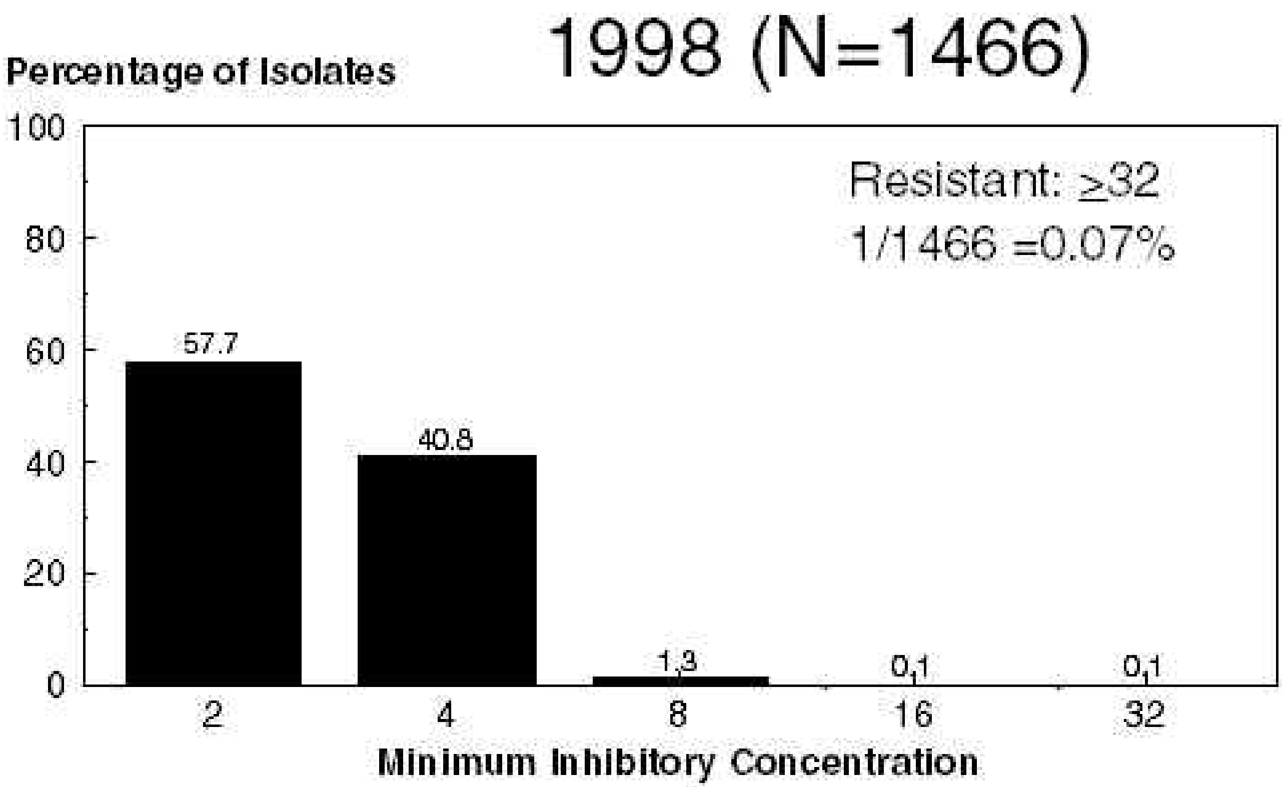

1997 (N=1301)
Percentage of Isolates
Resistant:≥32
241/1301= 18.5%
79.7
1.7
0.1
0.0
0.4
1.8
16.4
100
80
60
40
20
0
2
4
8
16
32
64
128
Minimum Inhibitory Concentration



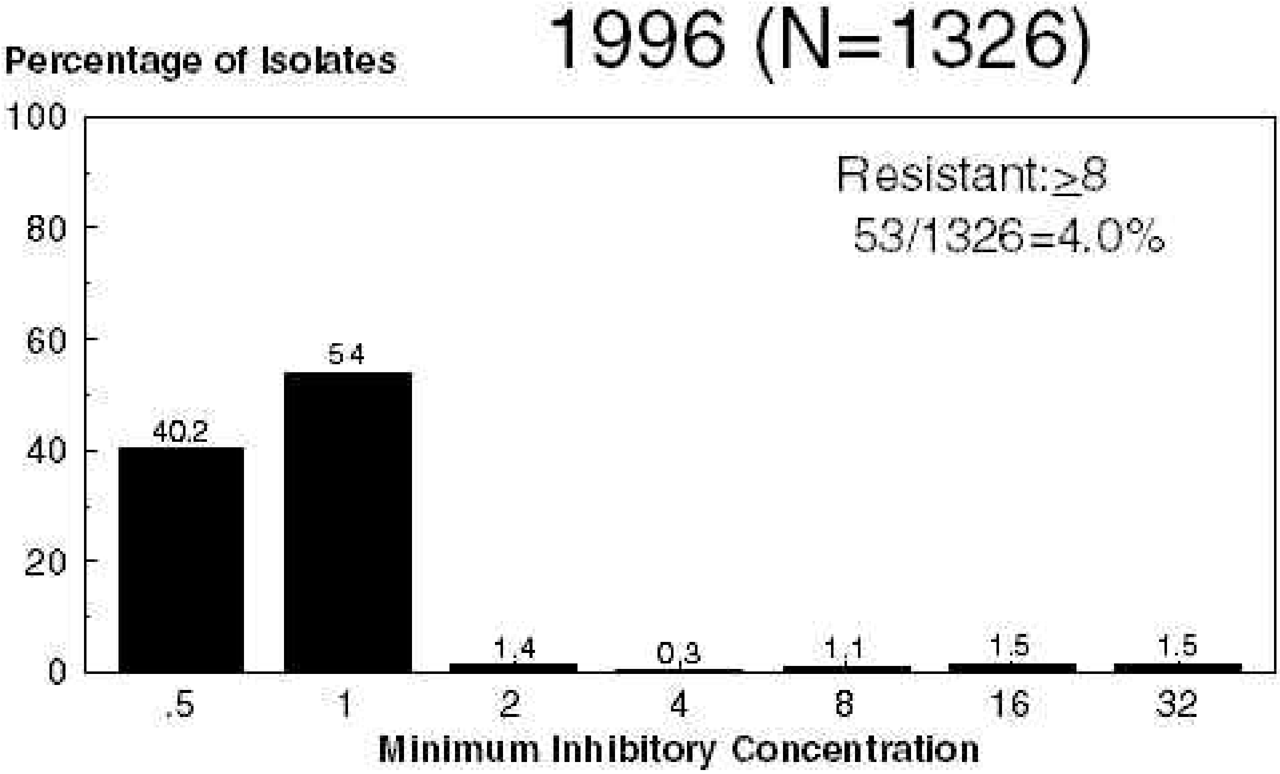
Comparison of *Salmonella* Apramycin MICs 1996-1998

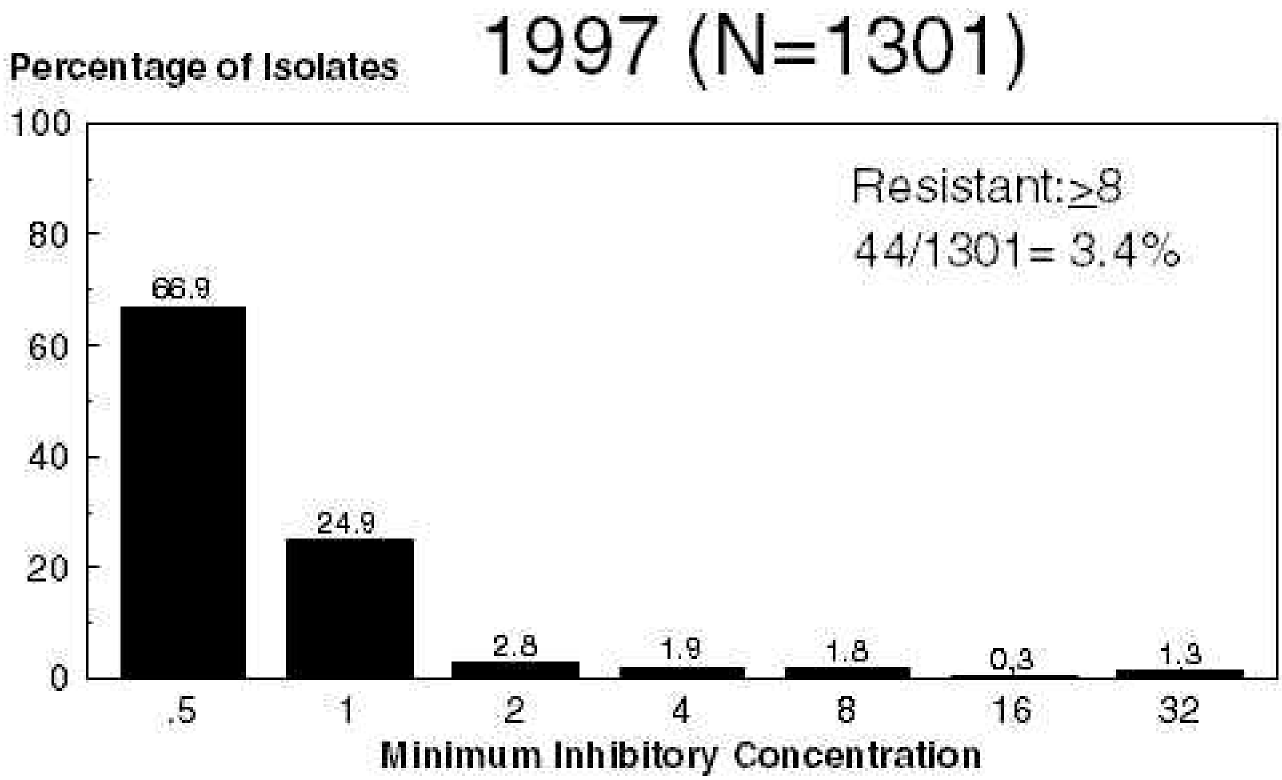


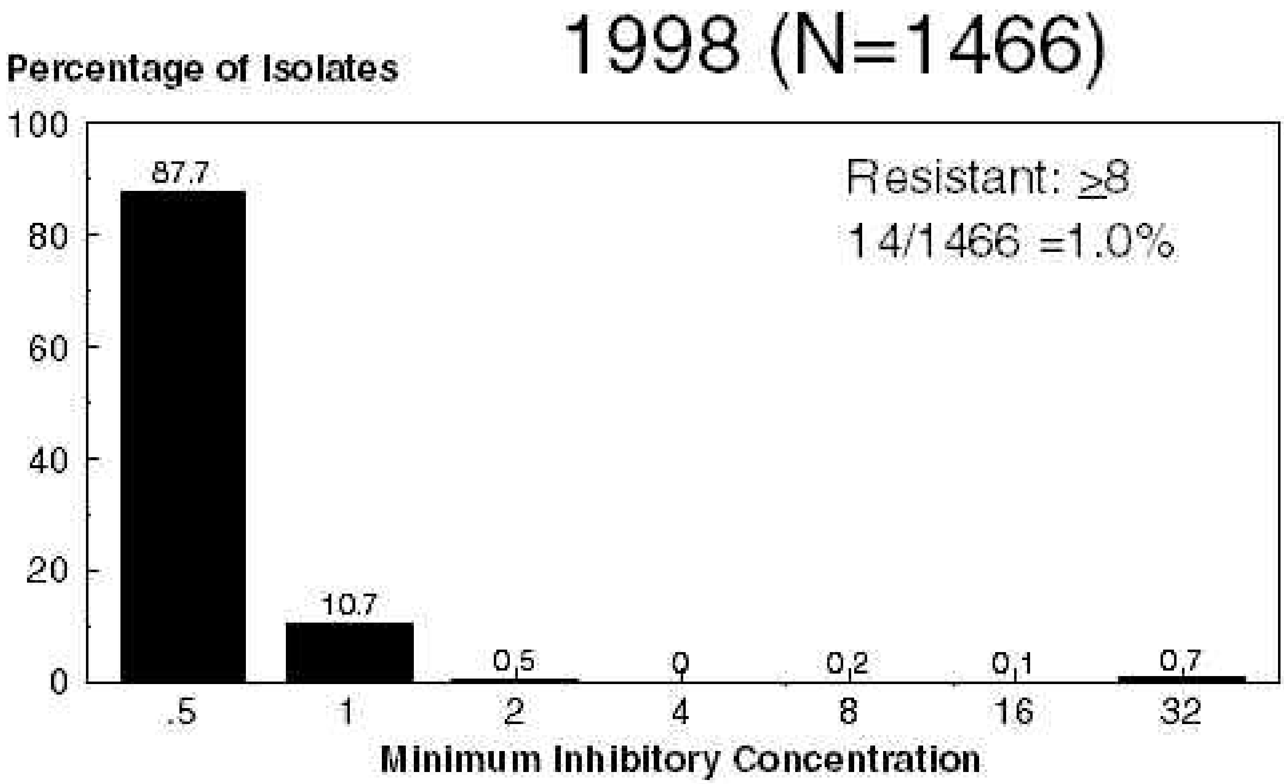




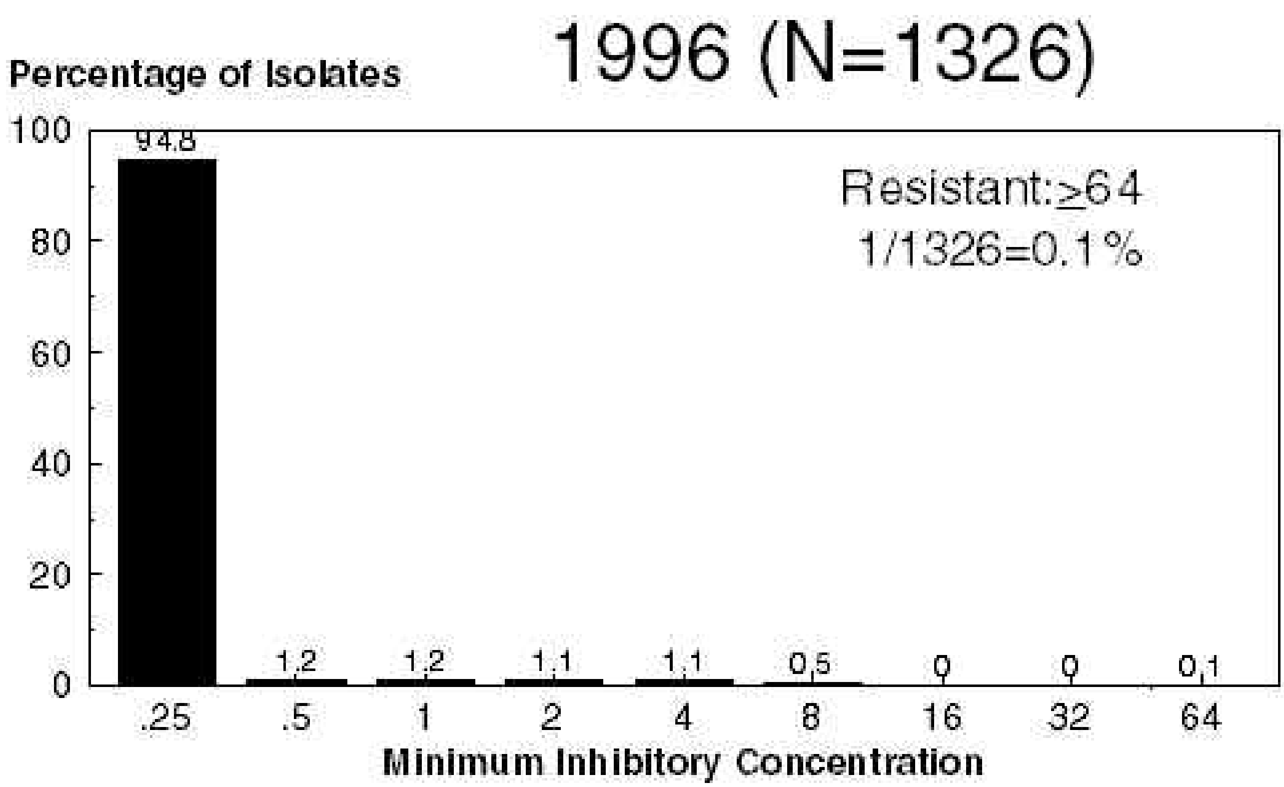
Comparison of *Salmonella* Ceftiofur MICs 1996-1998

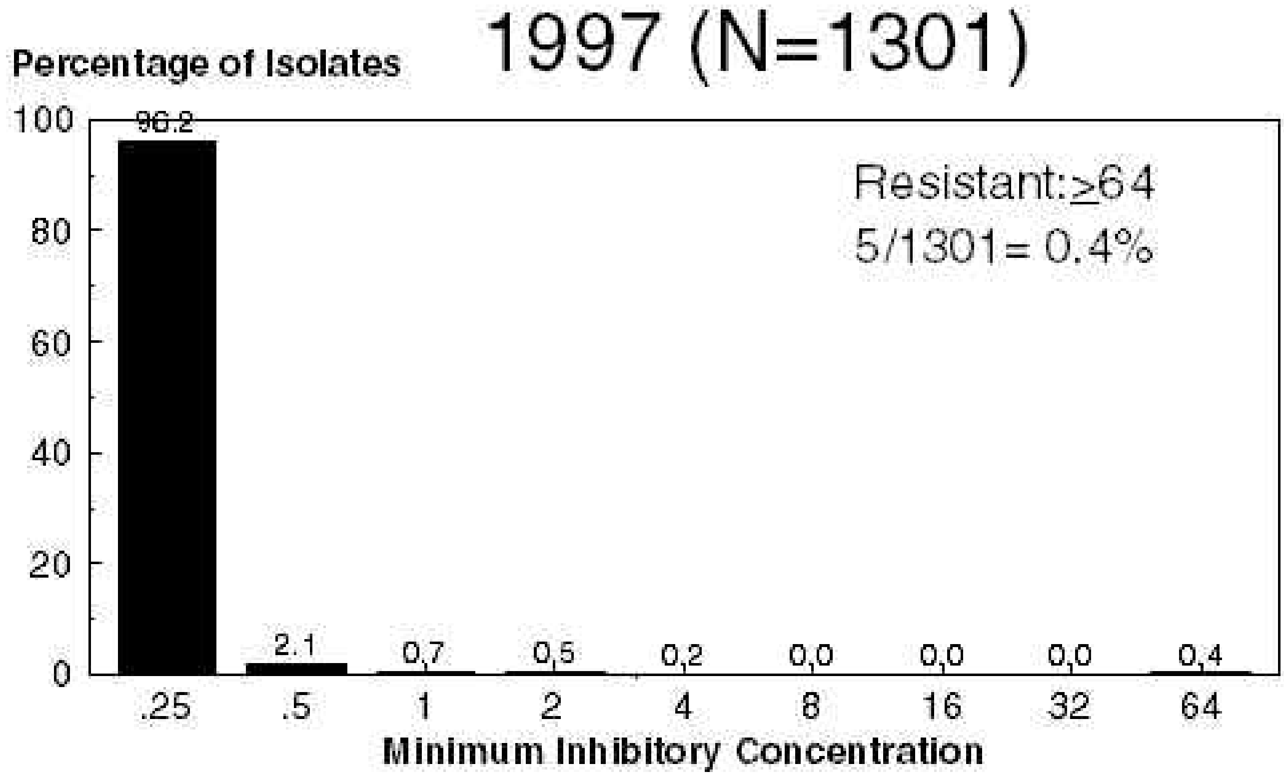

1996 (N=1326)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥8
53/1326=4.0%
40.2
54
1.4
0.3
1.1
1.5
1.5
.5
1
2
4
8
16
32
Minimum Inhibitory Concentration

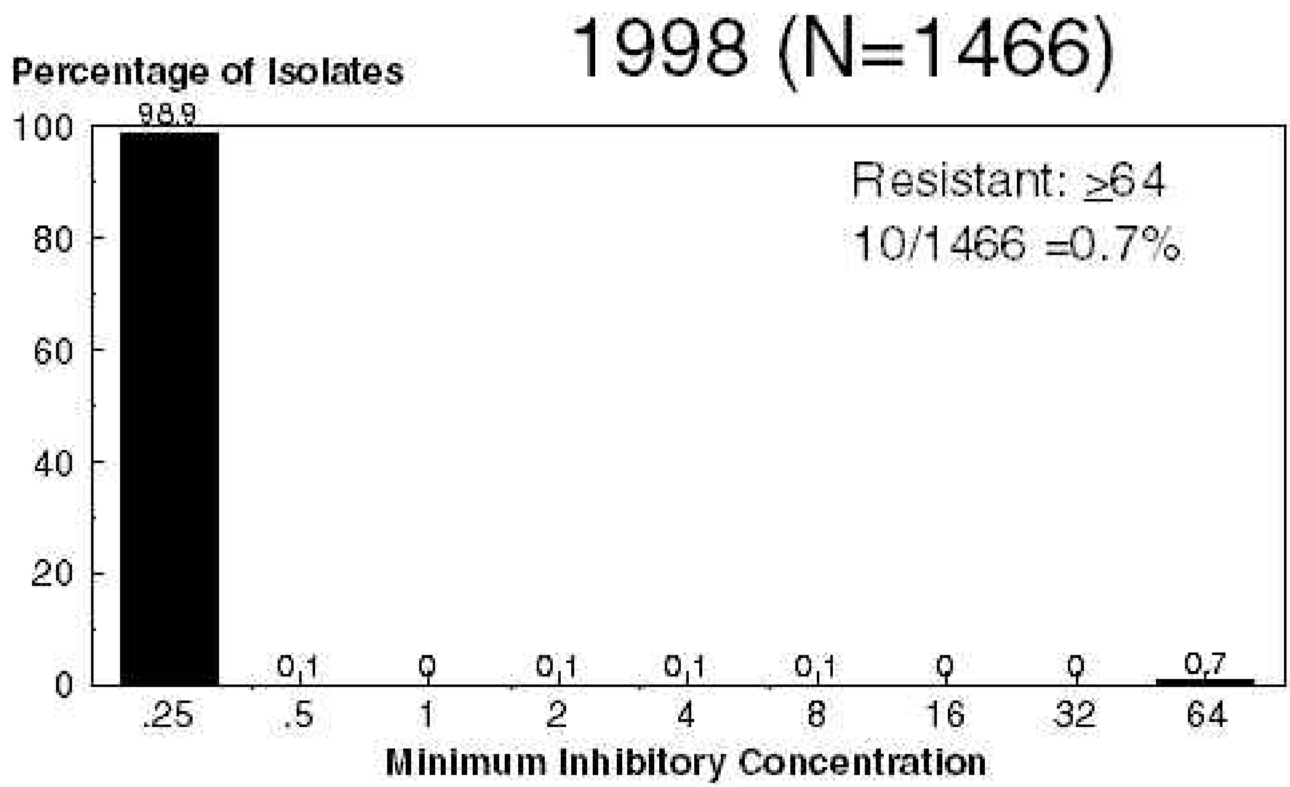

1997 (N=1301)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥8
44/1301= 3.4%
66.9
24.9
2.8
1.9
1.8
0.3
1.3
.5
1
2
4
8
16
32
Minimum Inhibitory Concentration



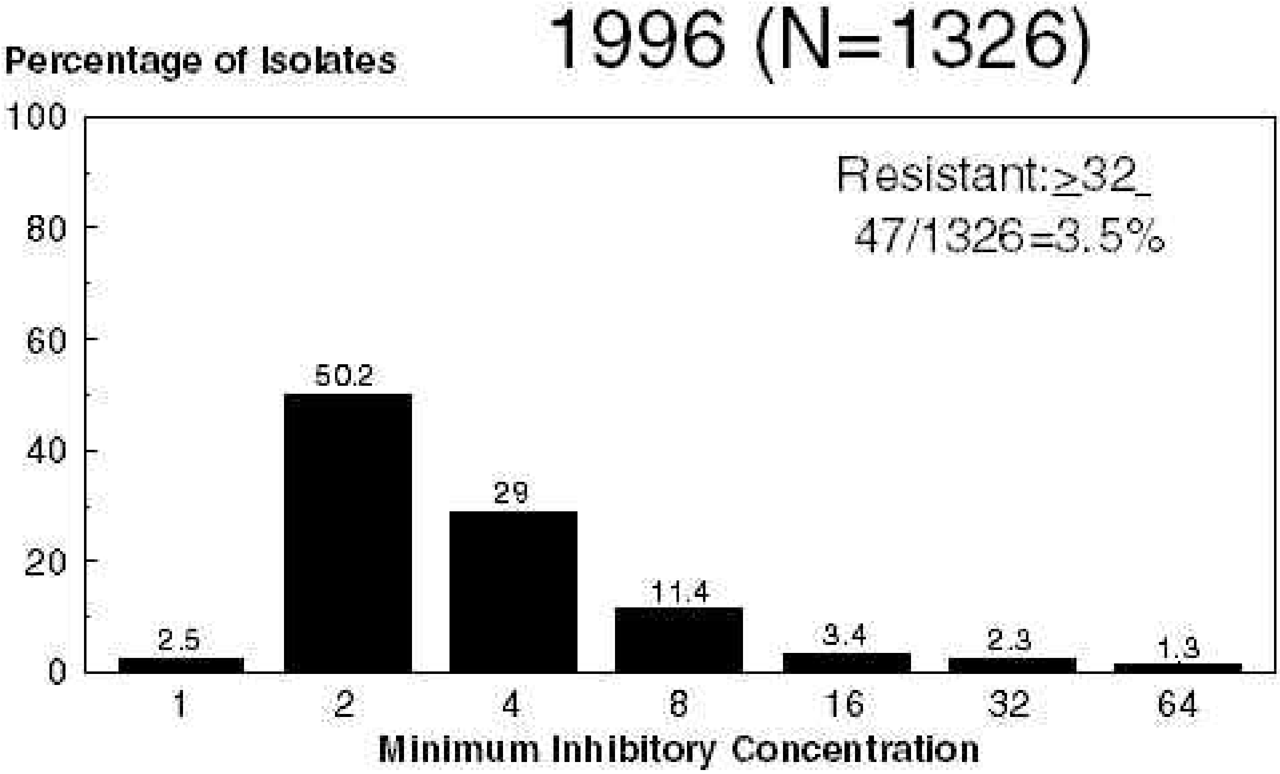
Comparison of *Salmonella* Ceftriaxone MICs 1996-1998

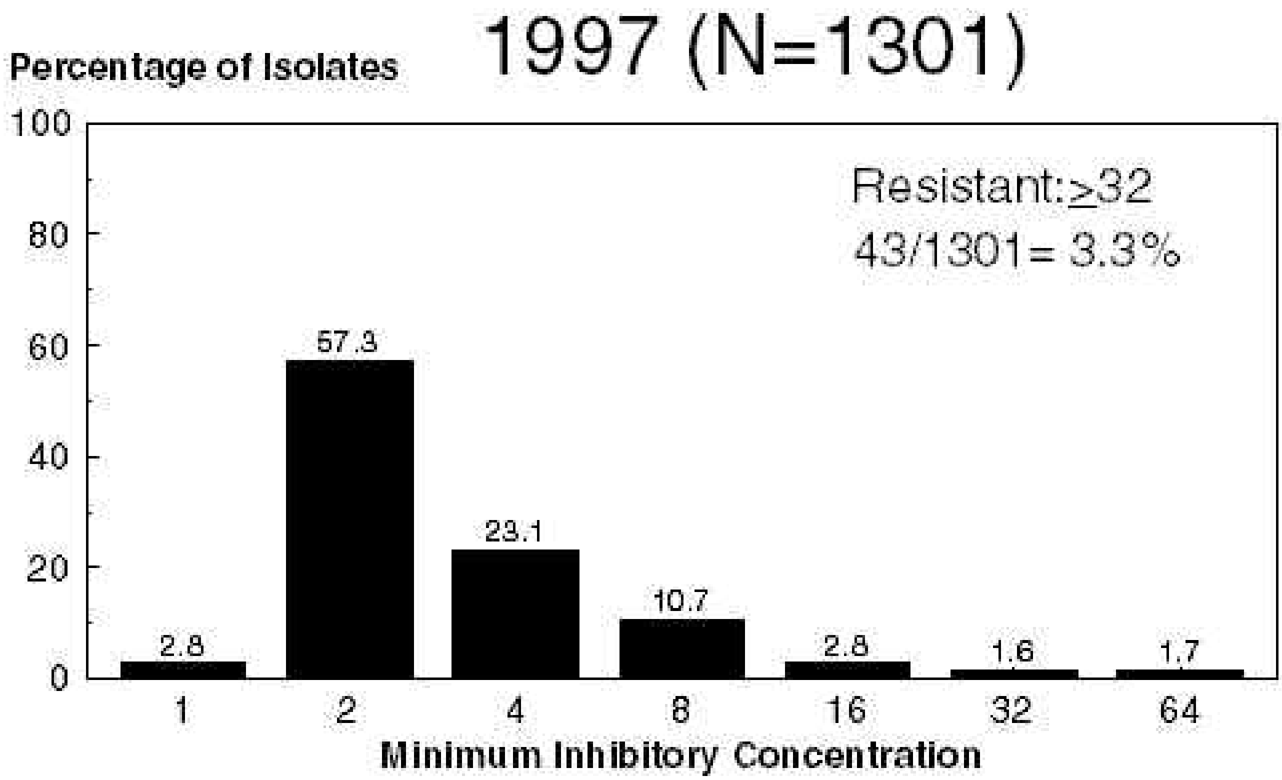


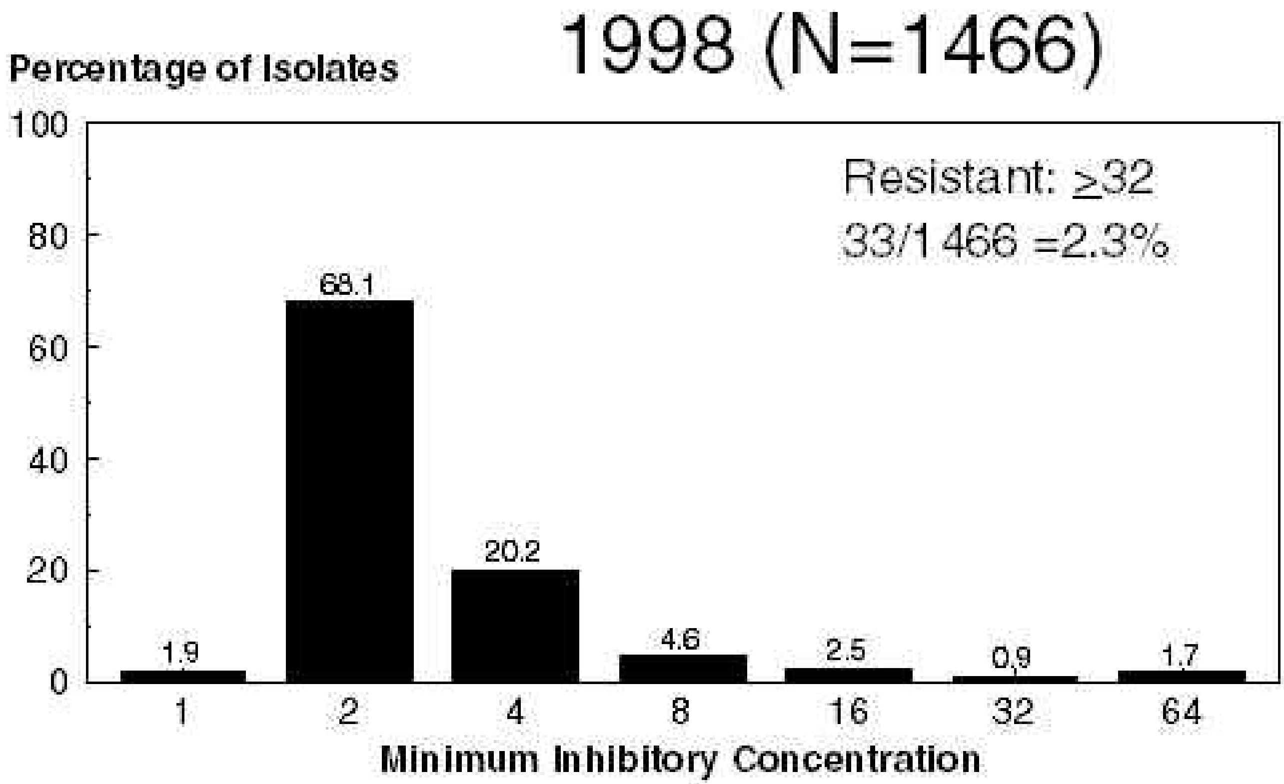




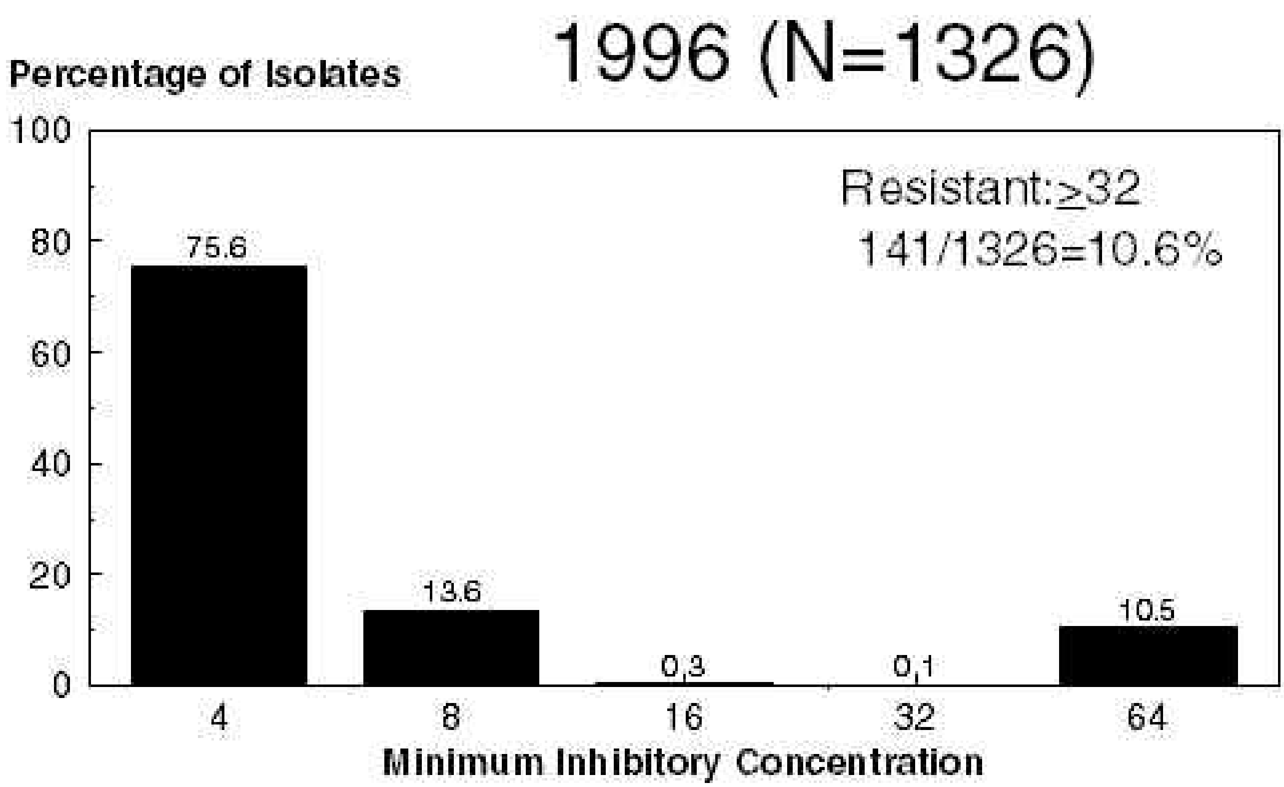
Comparison of *Salmonella* Cephalothin MICs 1996-1998

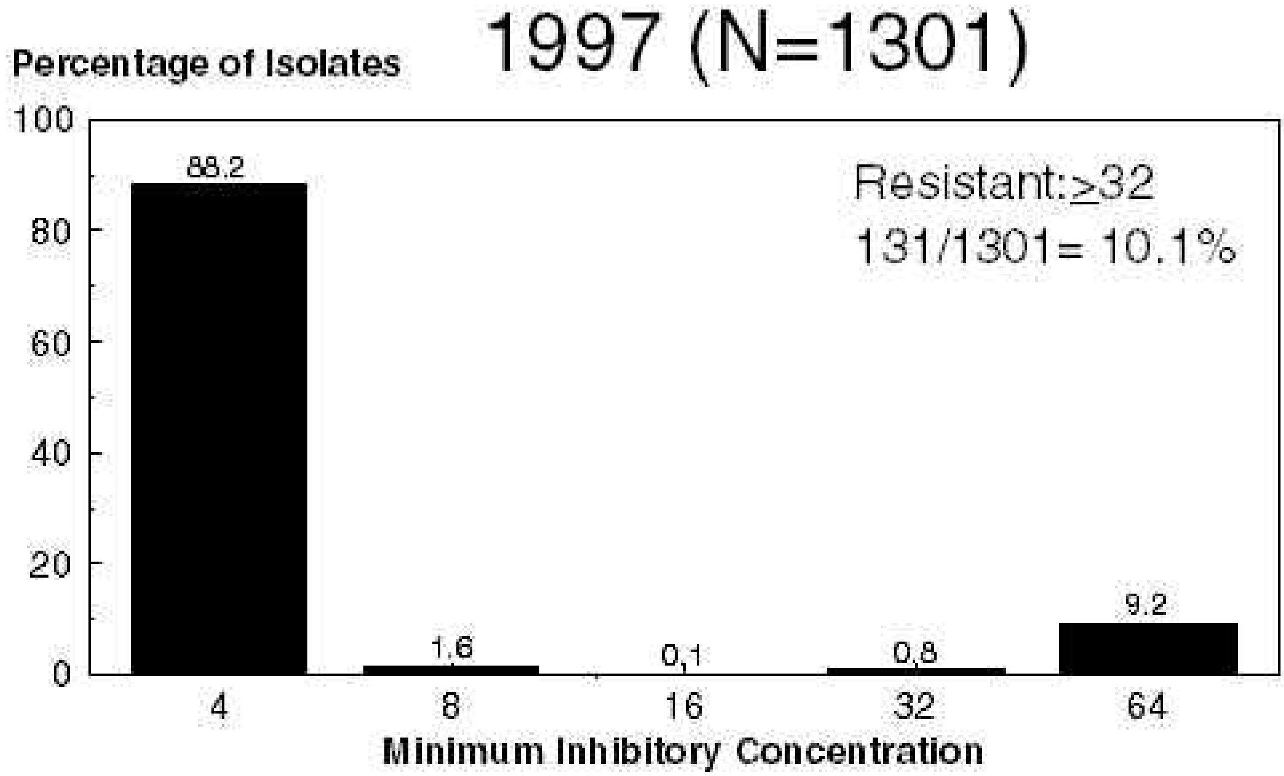

1996 (N=1326)
Percentage of Isolates
Resistant:≥32_
47/1326=3.5%
50.2
29
11.4
2.5
3.4
2.3
1.3
100
80
60
40
20
0
1
2
4
8
16
32
64
Minimum Inhibitory Concentration

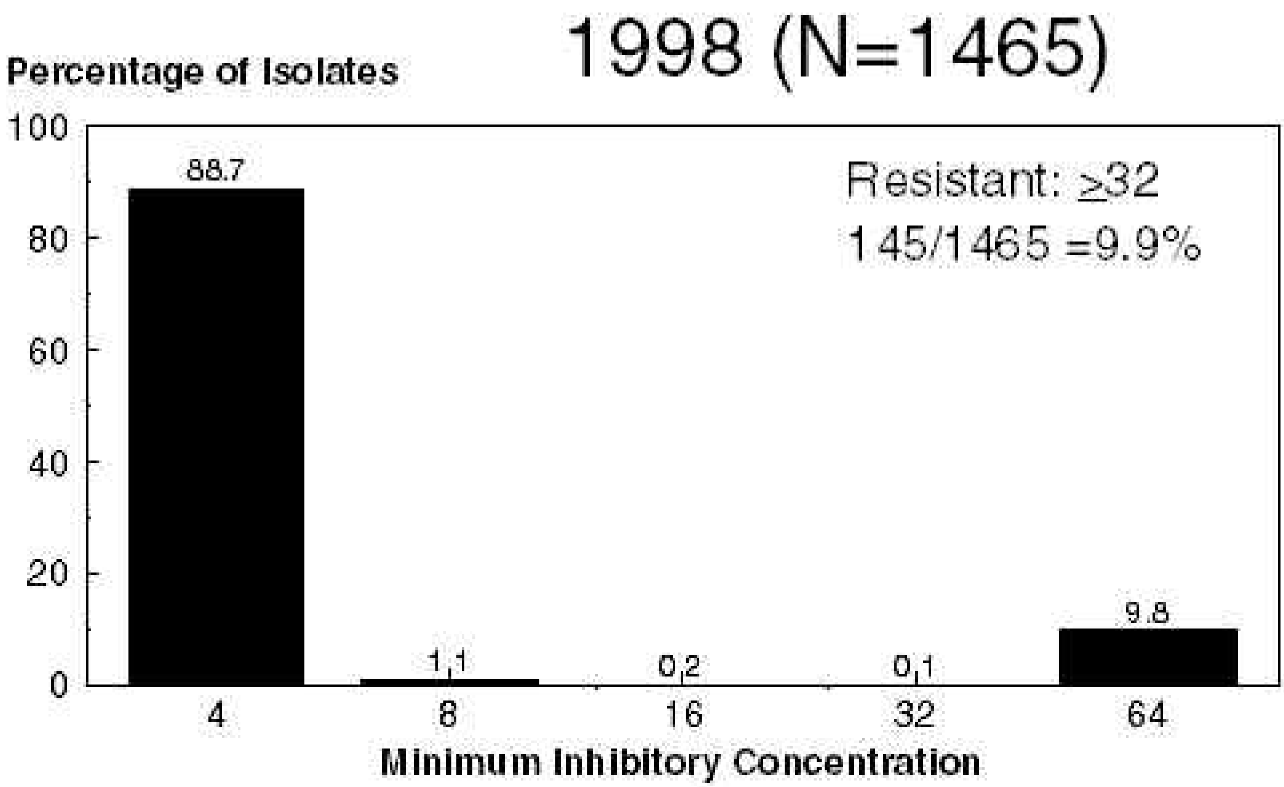

1997 (N=1301)
Percentage of Isolates
Resistant:≥32
43/1301= 3.3%
57.3
23.1
10.7
2.8
2.8
1.6
1.7
100
80
60
40
20
0
1
2
4
8
16
32
64
Minimum Inhibitory Concentration



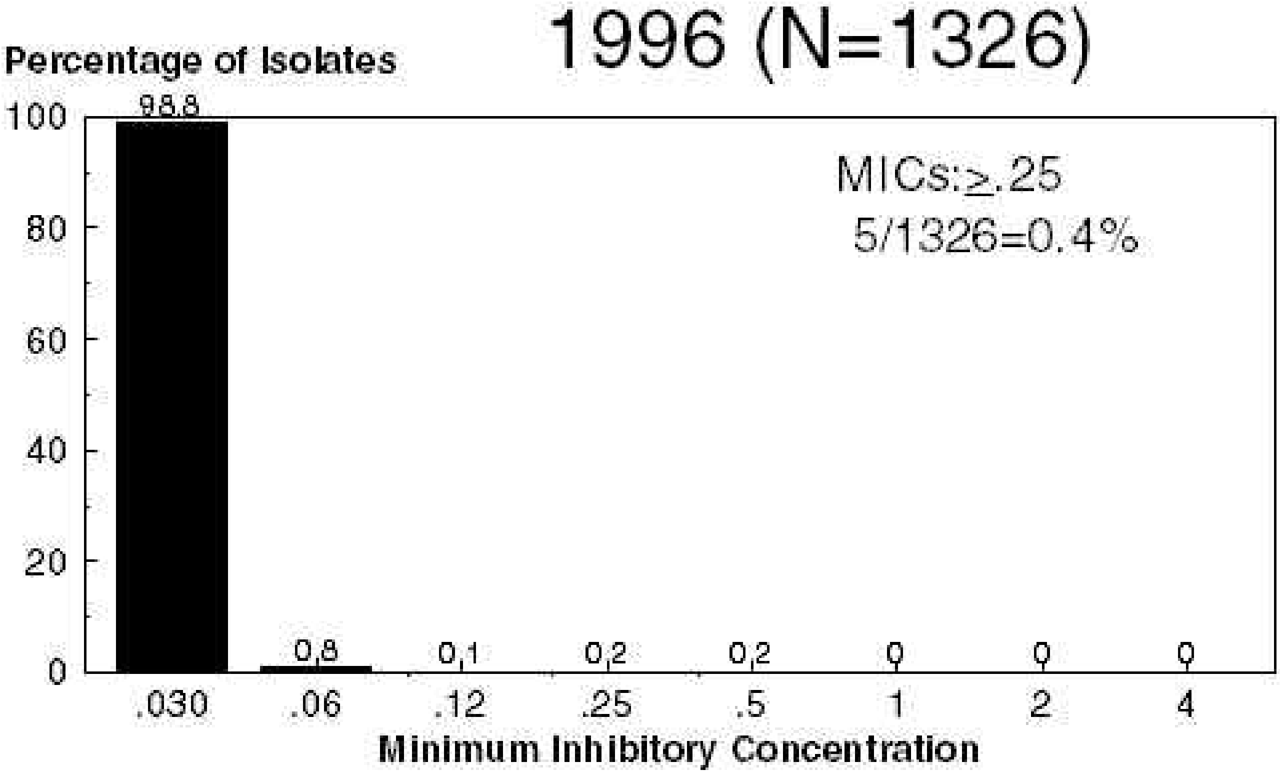
Comparison of *Salmonella* Chloramphenicol MICs 1996-1998

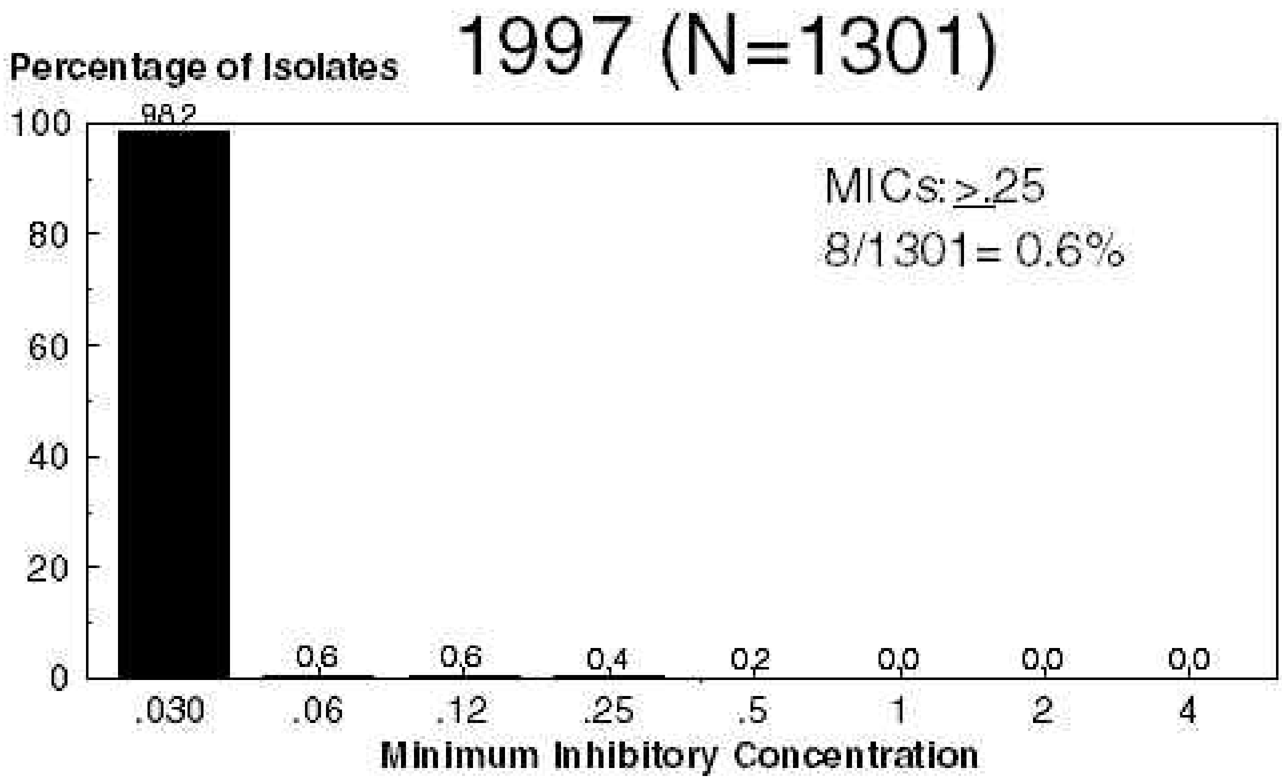


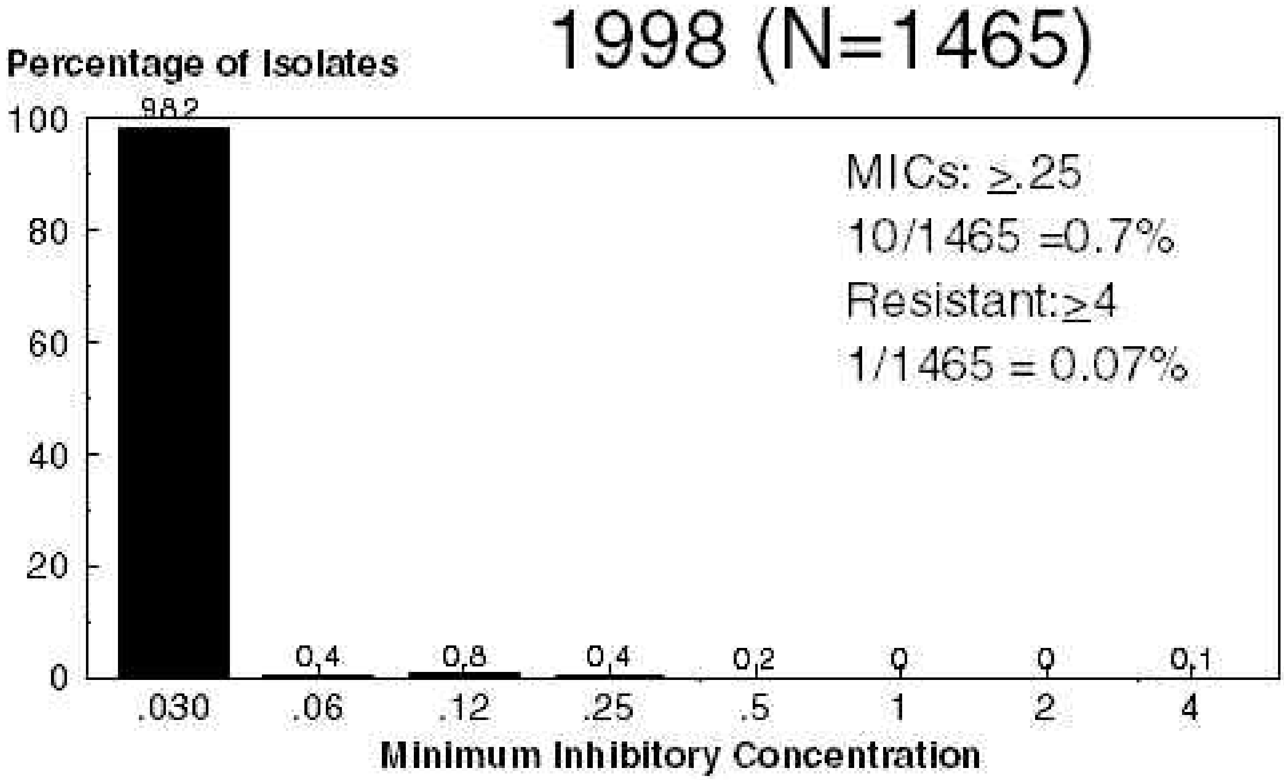




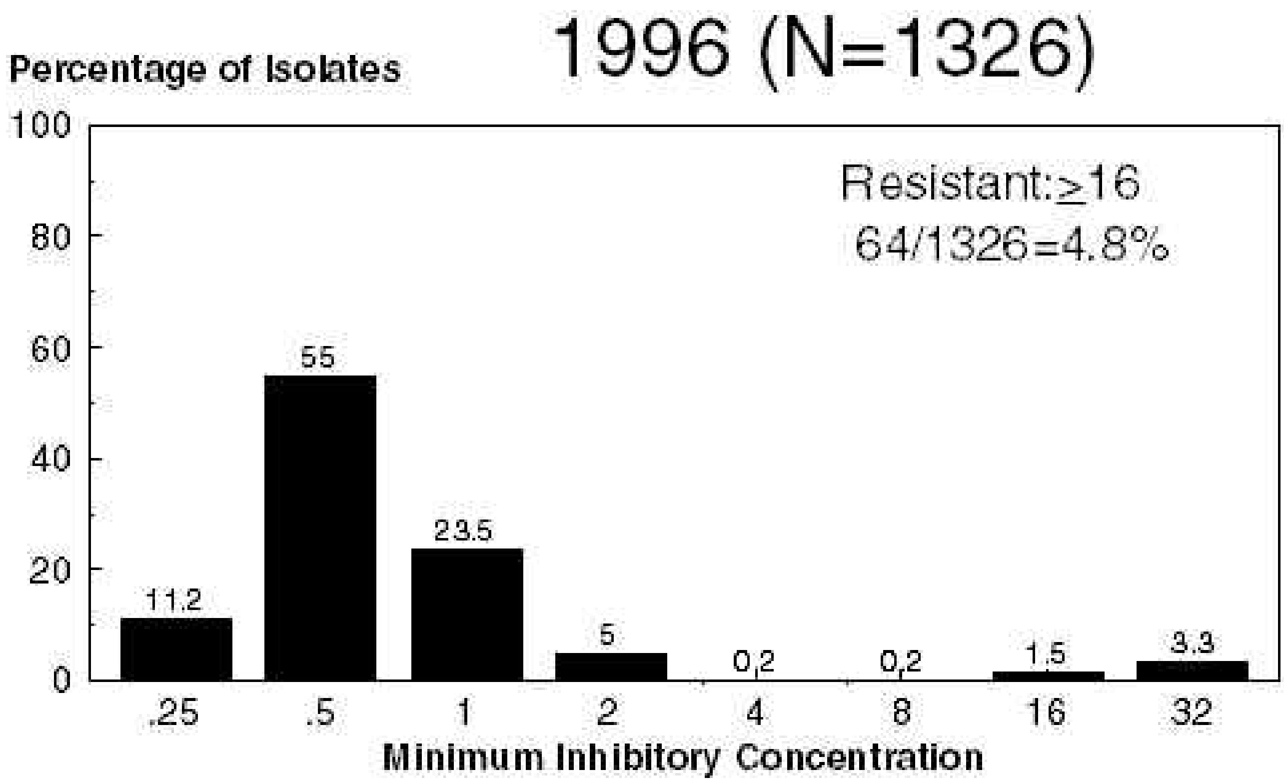
Comparison of *Salmonella* Ciprofloxacin MICs 1996-1998

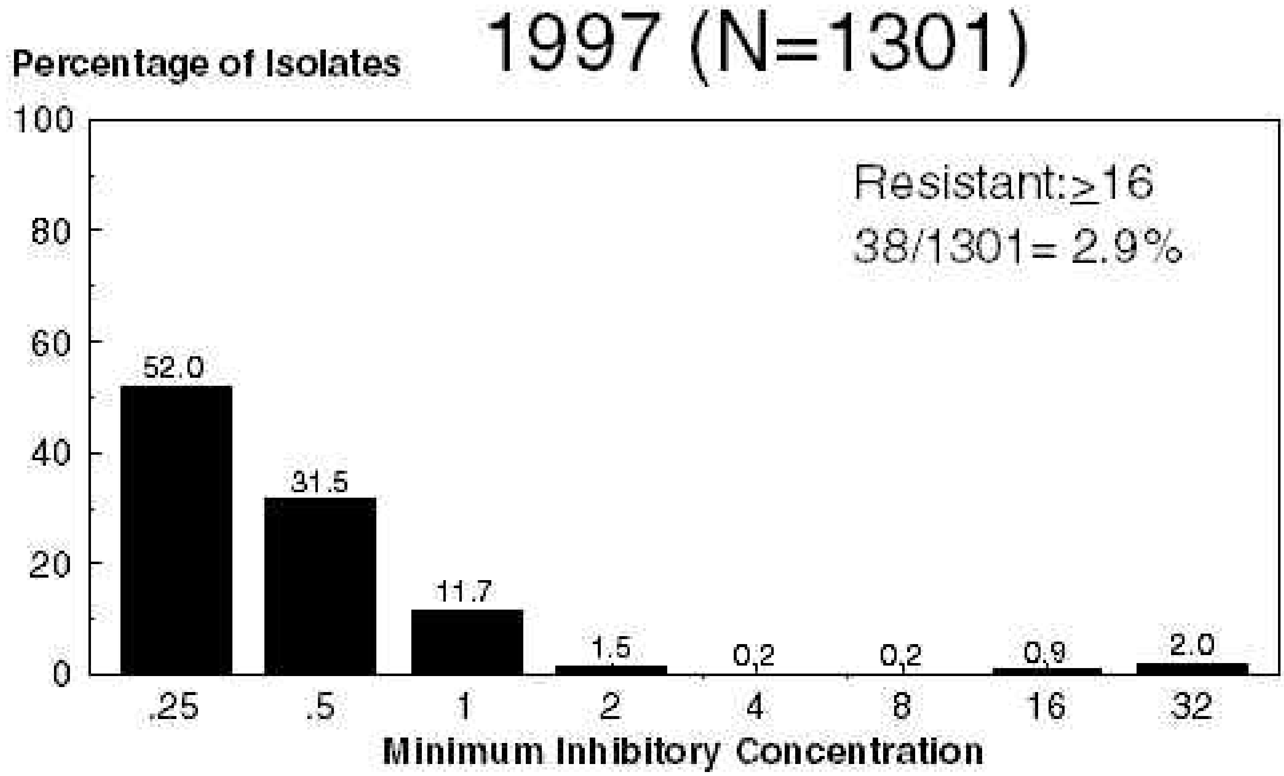

1996 (N=1326)
Percentage of Isolates
100
80
60
40
20
0
98.8
0.8
0.1
0.2
0.2
0
0
0
.030
.06
.12
.25
.5
1
2
4
Minimum Inhibitory Concentration
MICs:≥.25
5/1326=0.4%

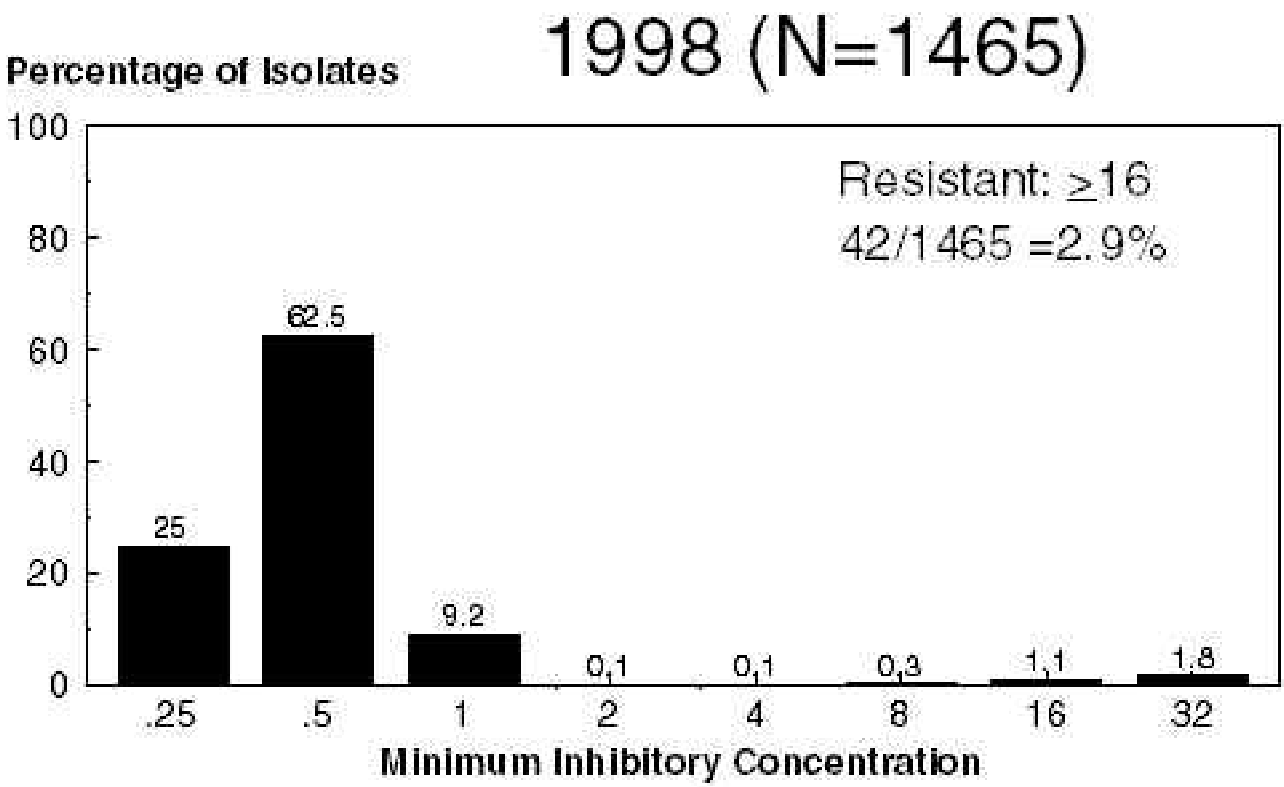

1997 (N=1301)
Percentage of Isolates
100
80
60
40
20
0
98.2
0.6
0.6
0.4
0.2
0.0
0.0
0.0
.030
.06
.12
.25
.5
1
2
4
Minimum Inhibitory Concentration
MICs:≥.25
8/1301= 0.6%



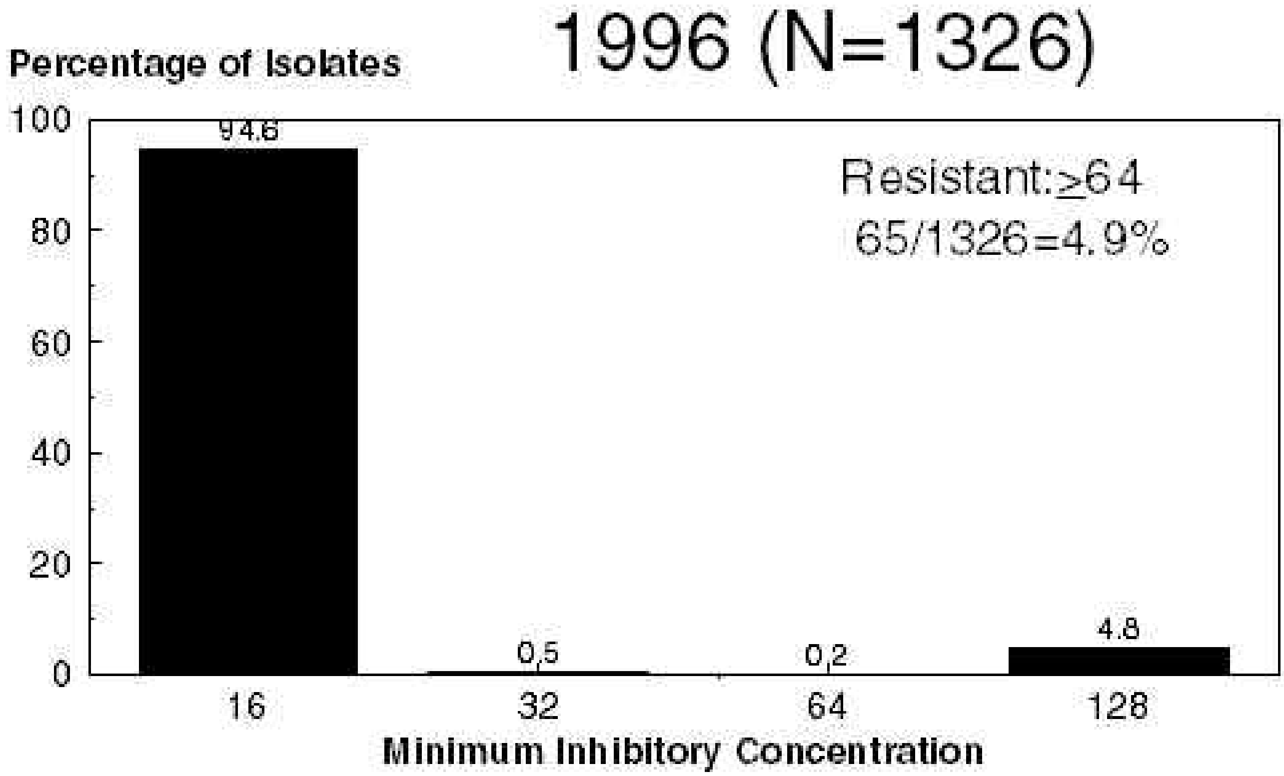
Comparison of *Salmonella* Gentamicin MICs 1996-1998

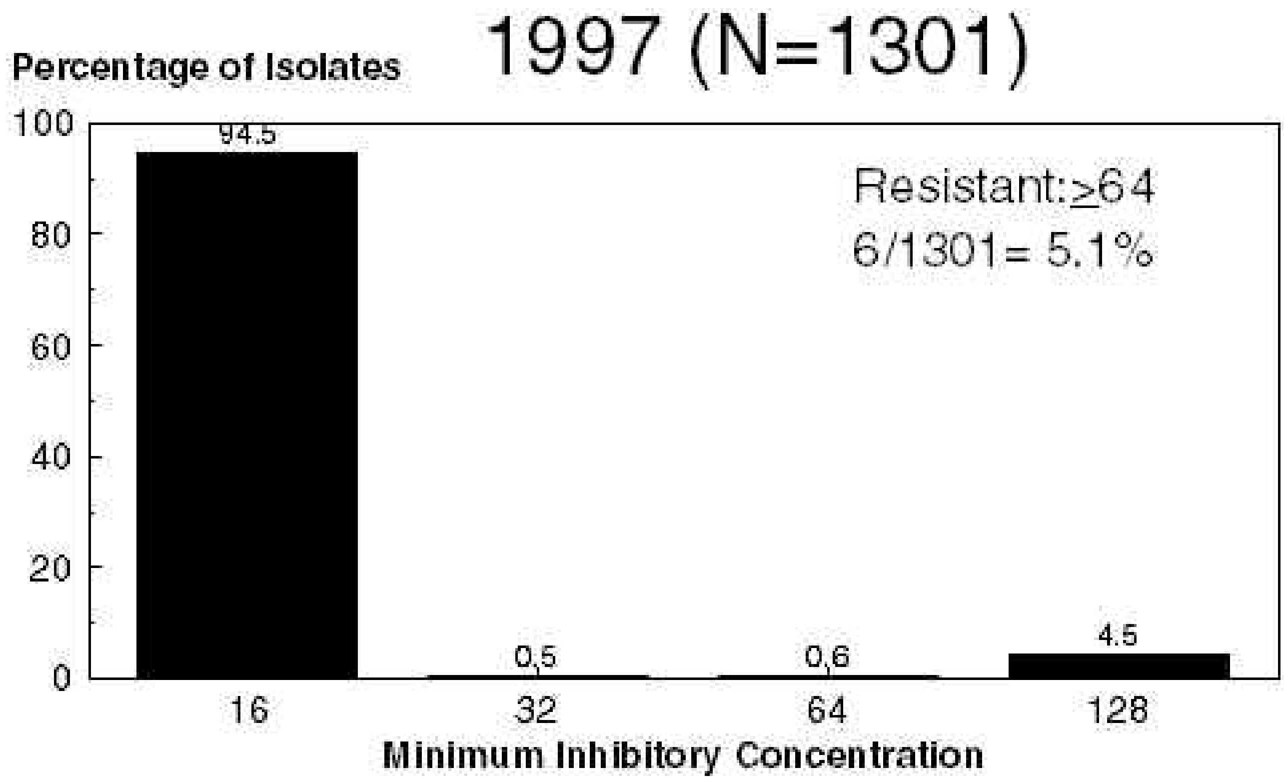


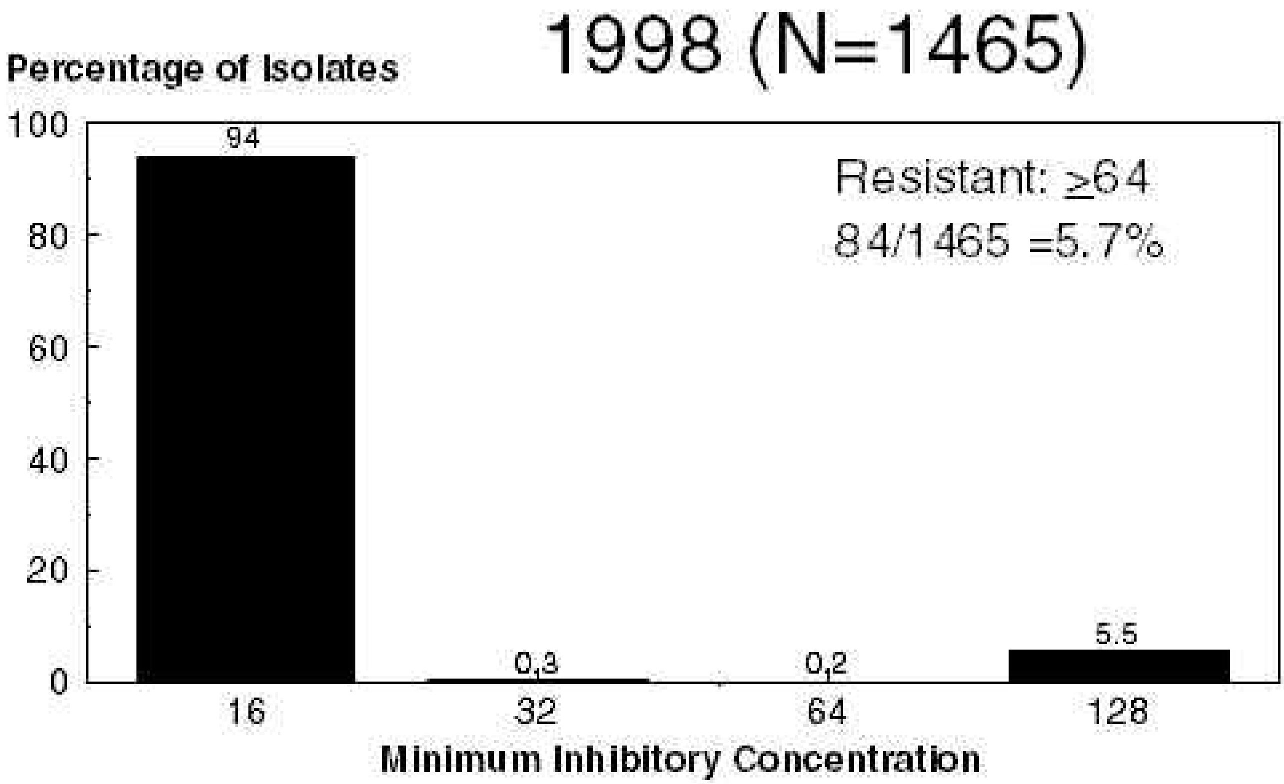




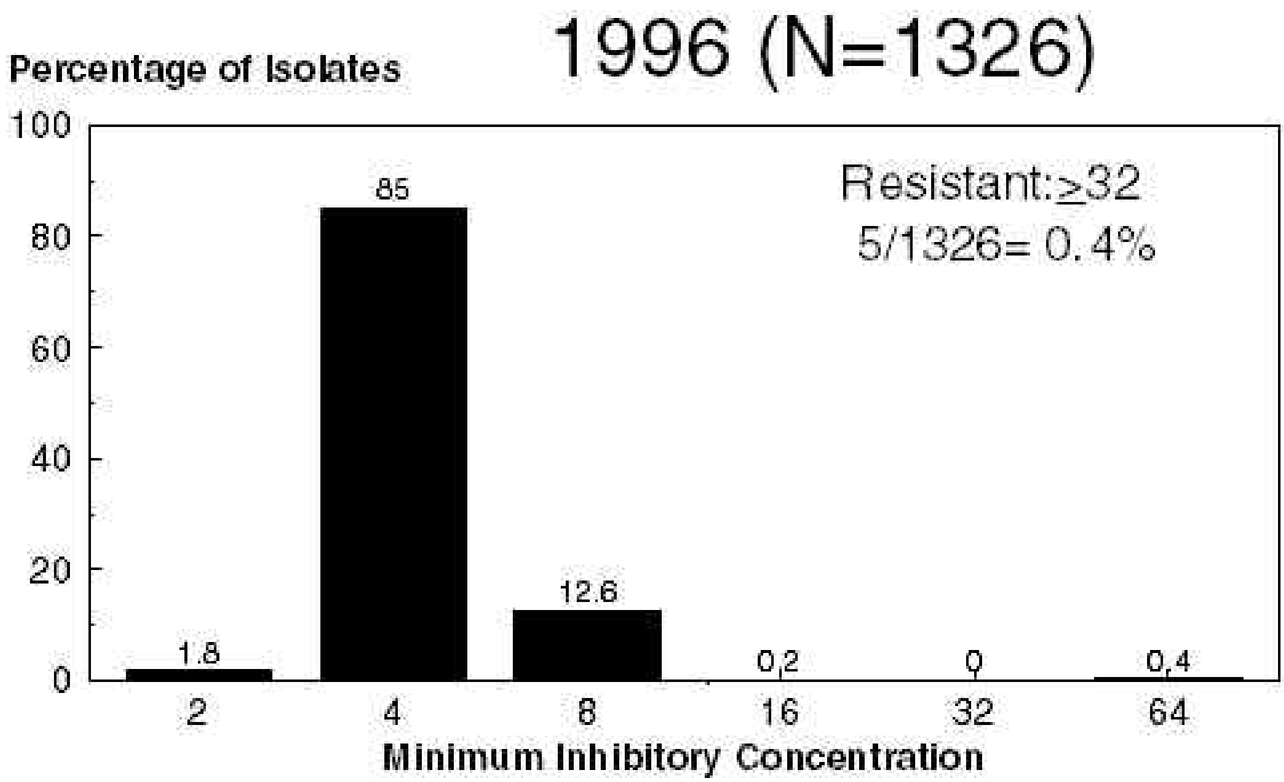
Comparison of *Salmonella* Kanamycin MICs 1996-1998

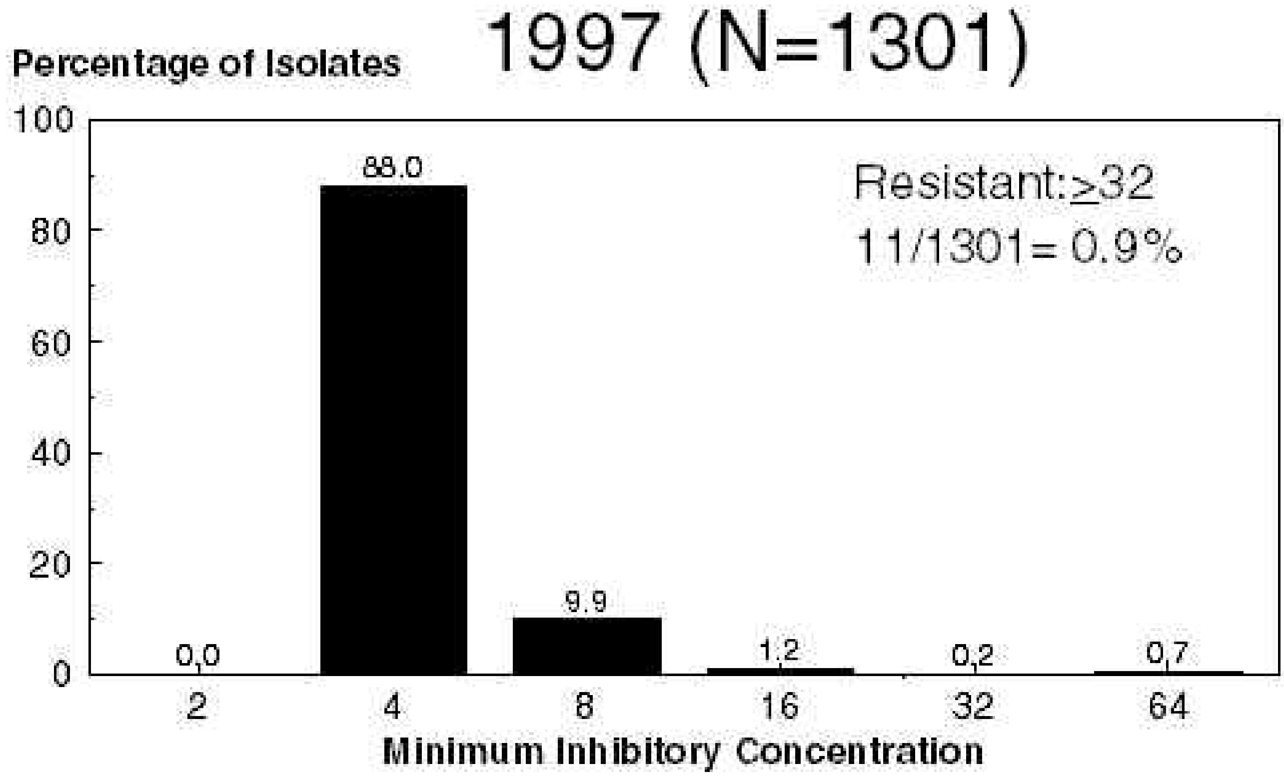

1996 (N=1326)
Percentage of Isolates
100
80
60
40
20
0
94.6
0.5
0.2
4.8
Resistant:≥64
65/1326=4.9%
16
32
64
128
Minimum Inhibitory Concentration

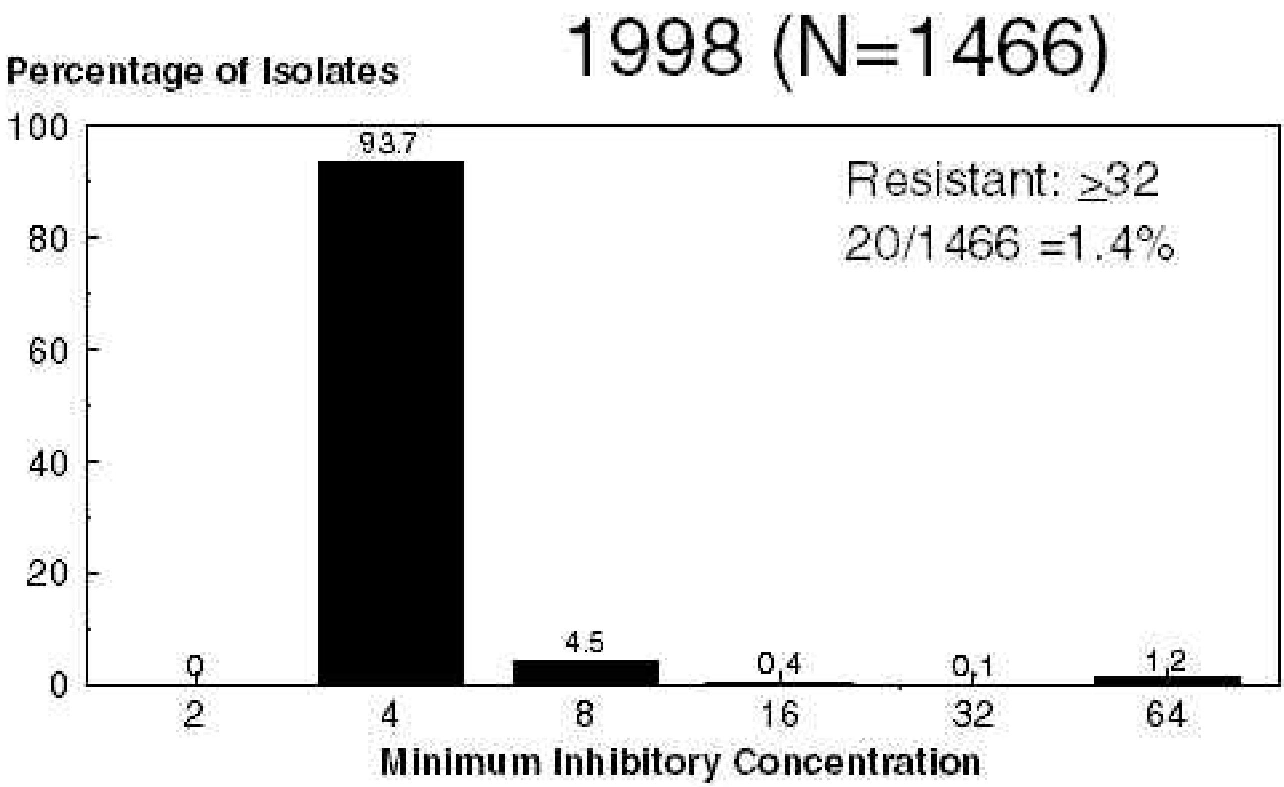

1997 (N=1301)
Percentage of Isolates
100
80
60
40
20
0
94.5
0.5
0.6
4.5
Resistant:≥64
6/1301= 5.1%
16
32
64
128
Minimum Inhibitory Concentration



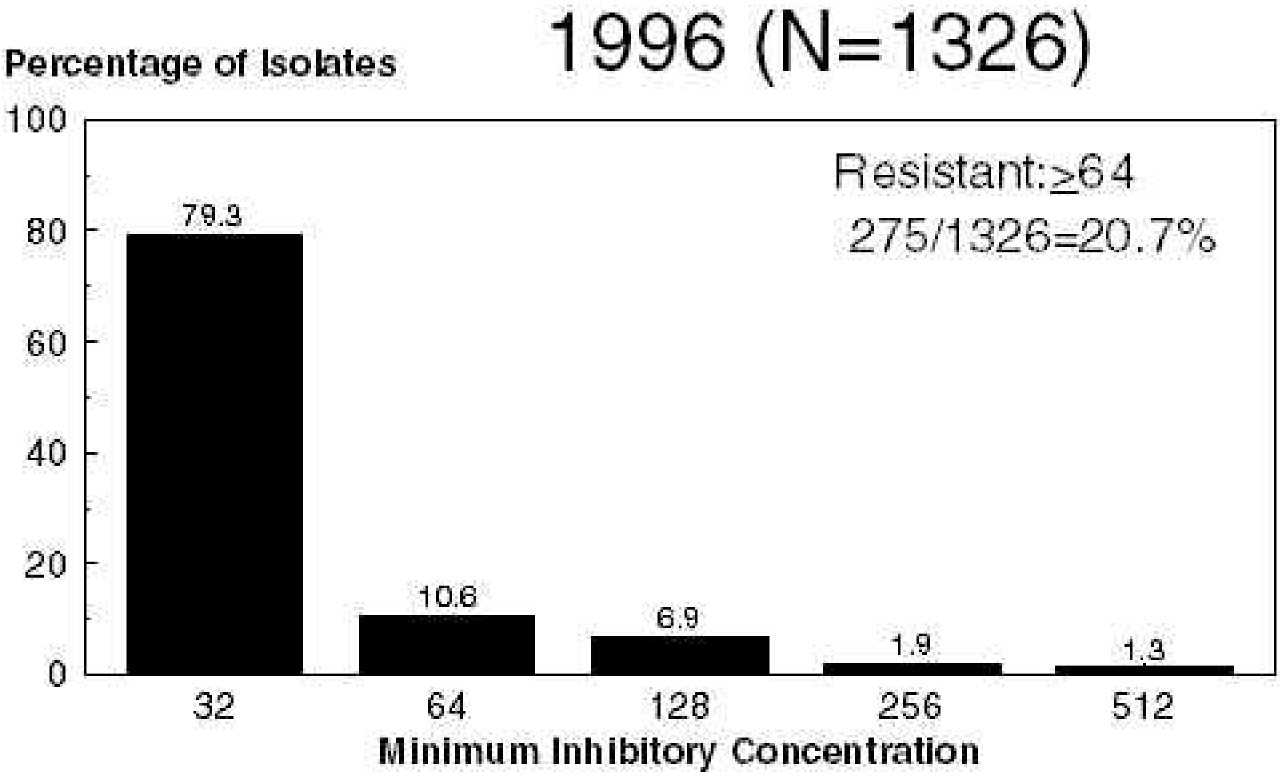
Comparison of *Salmonella* Nalidixic Acid MICs 1996-1998

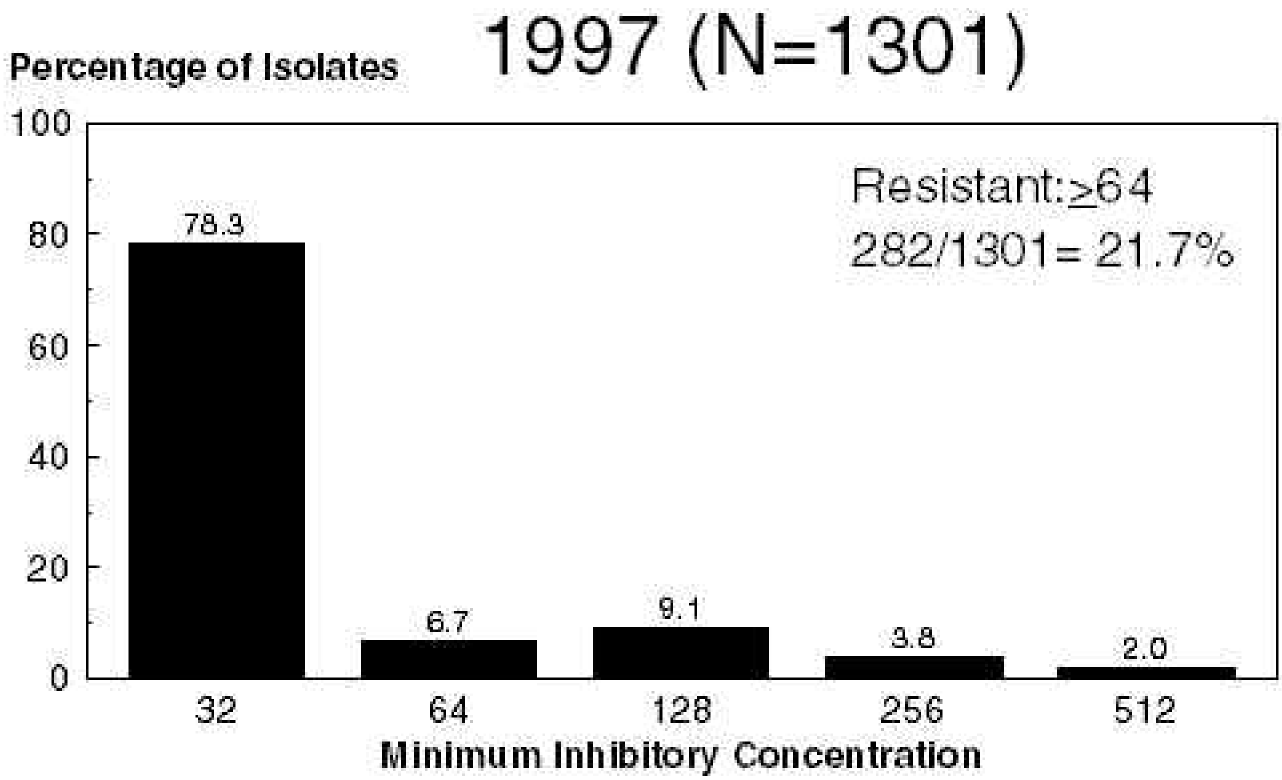


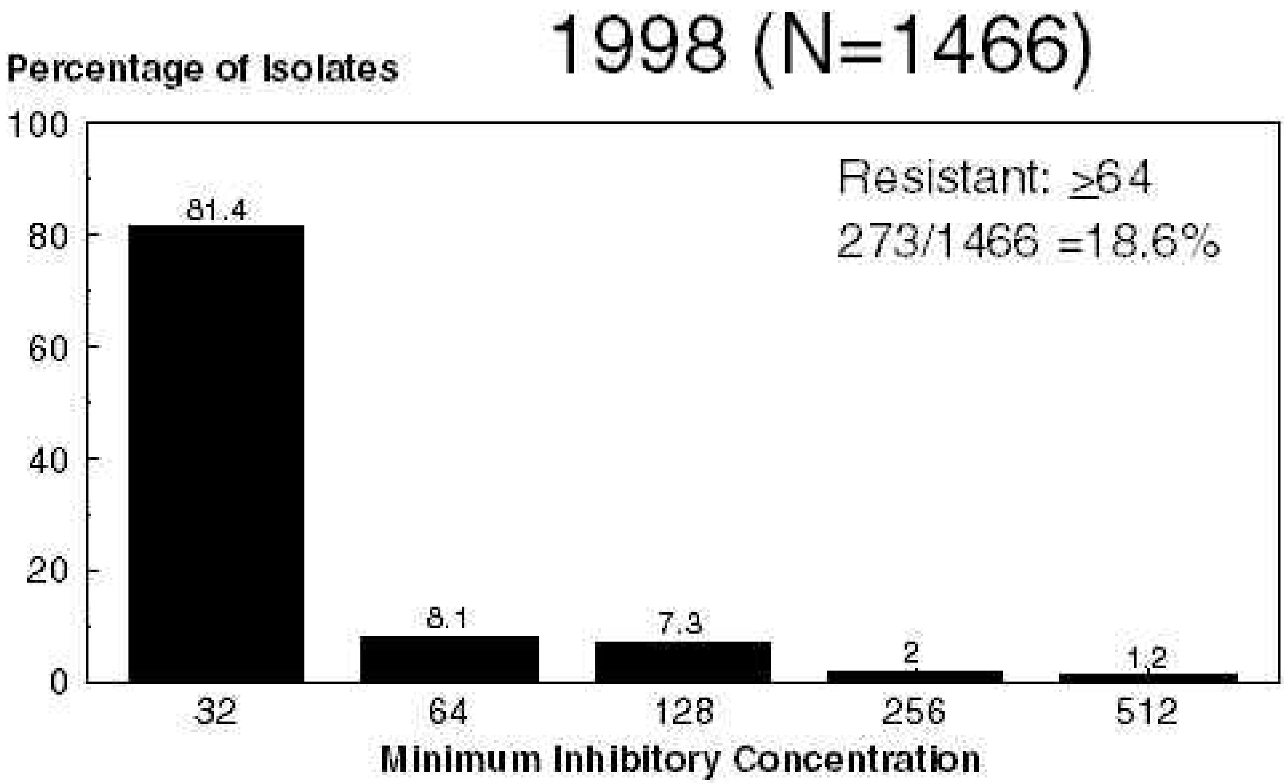




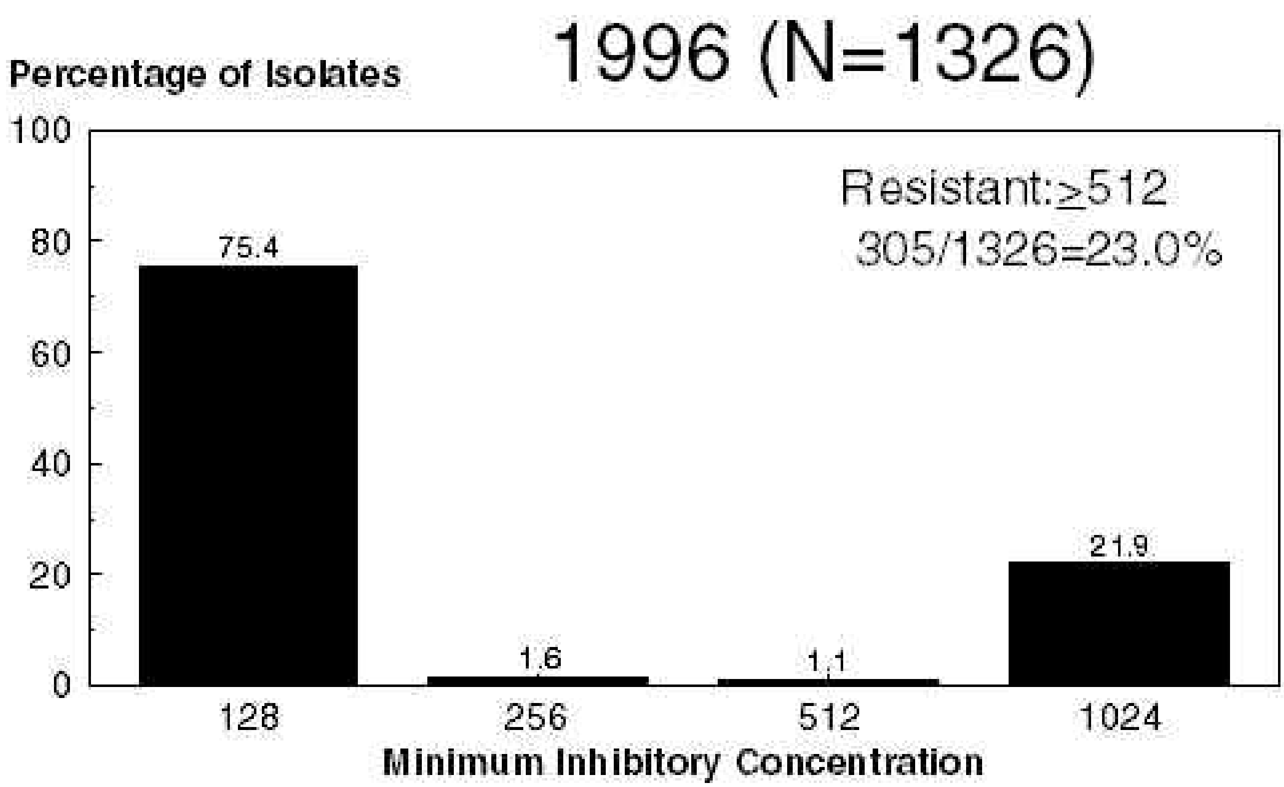
Comparison of *Salmonella* Streptomycin MICs 1996-1998

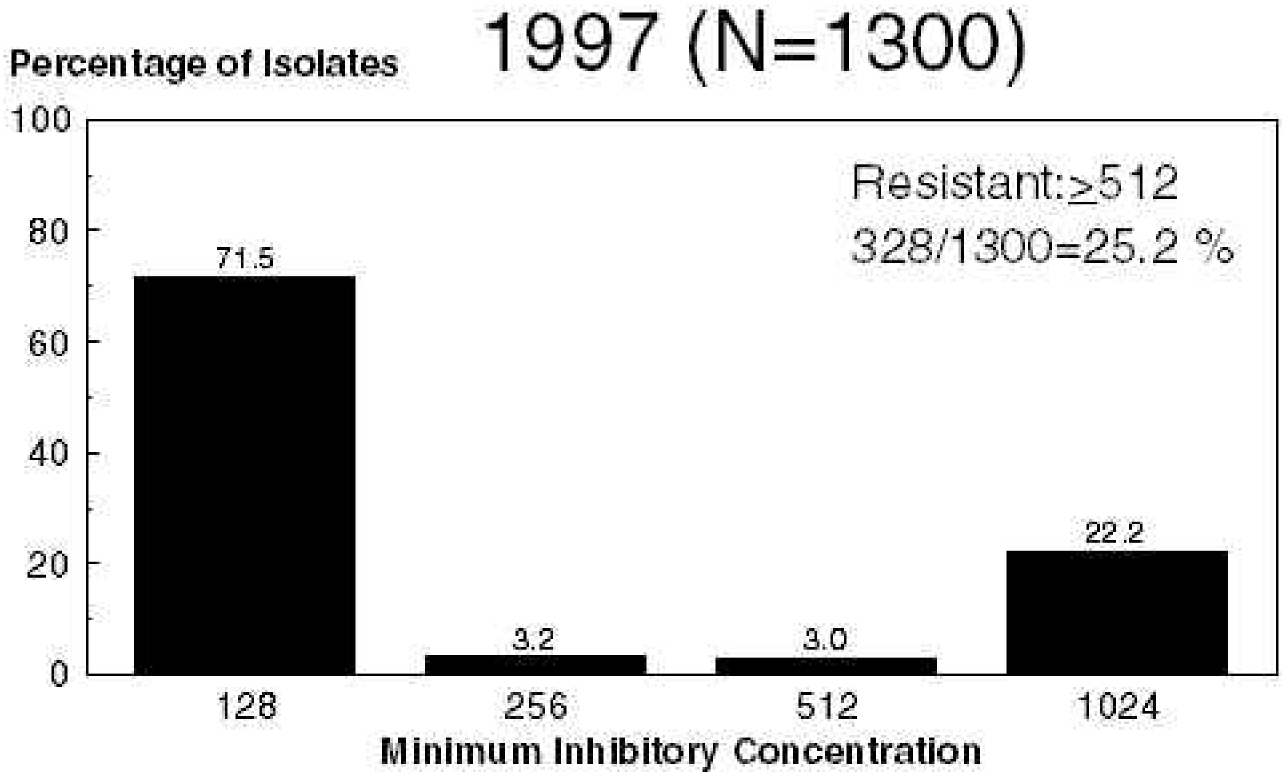

1996 (N=1326)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥64
275/1326=20.7%
79.3
10.6
6.9
1.9
1.3
32
64
128
256
512
Minimum Inhibitory Concentration

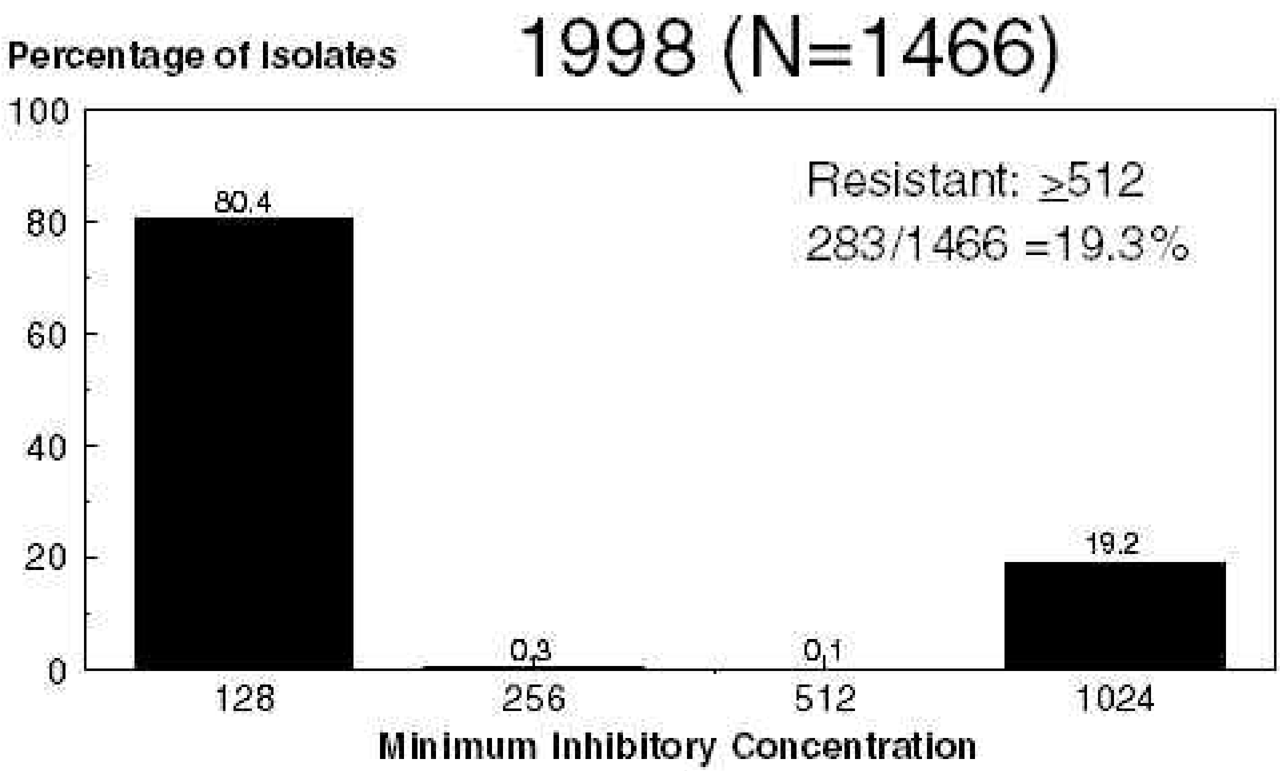

1997 (N=1301)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥64
282/1301= 21.7%
78.3
6.7
9.1
3.8
2.0
32
64
128
256
512
Minimum Inhibitory Concentration



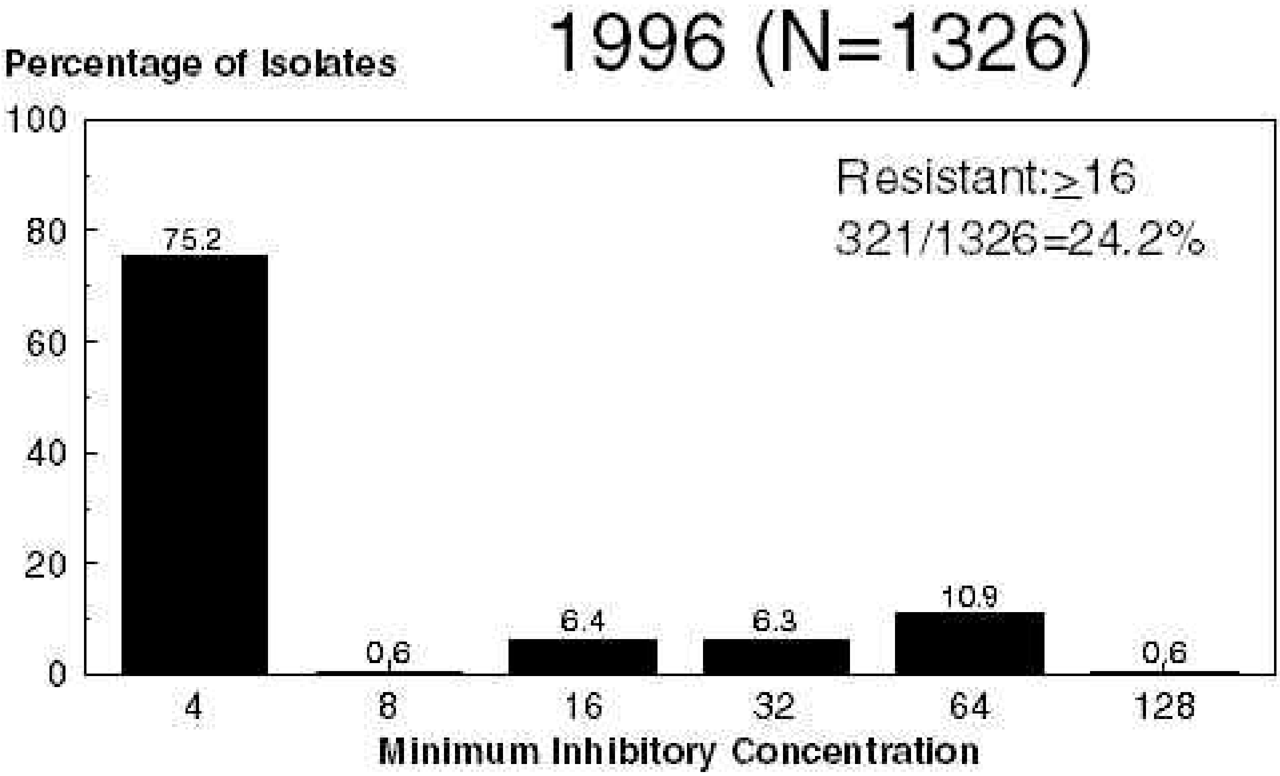
Comparison of *Salmonella* Sulfamethoxazole MICs 1996-1998

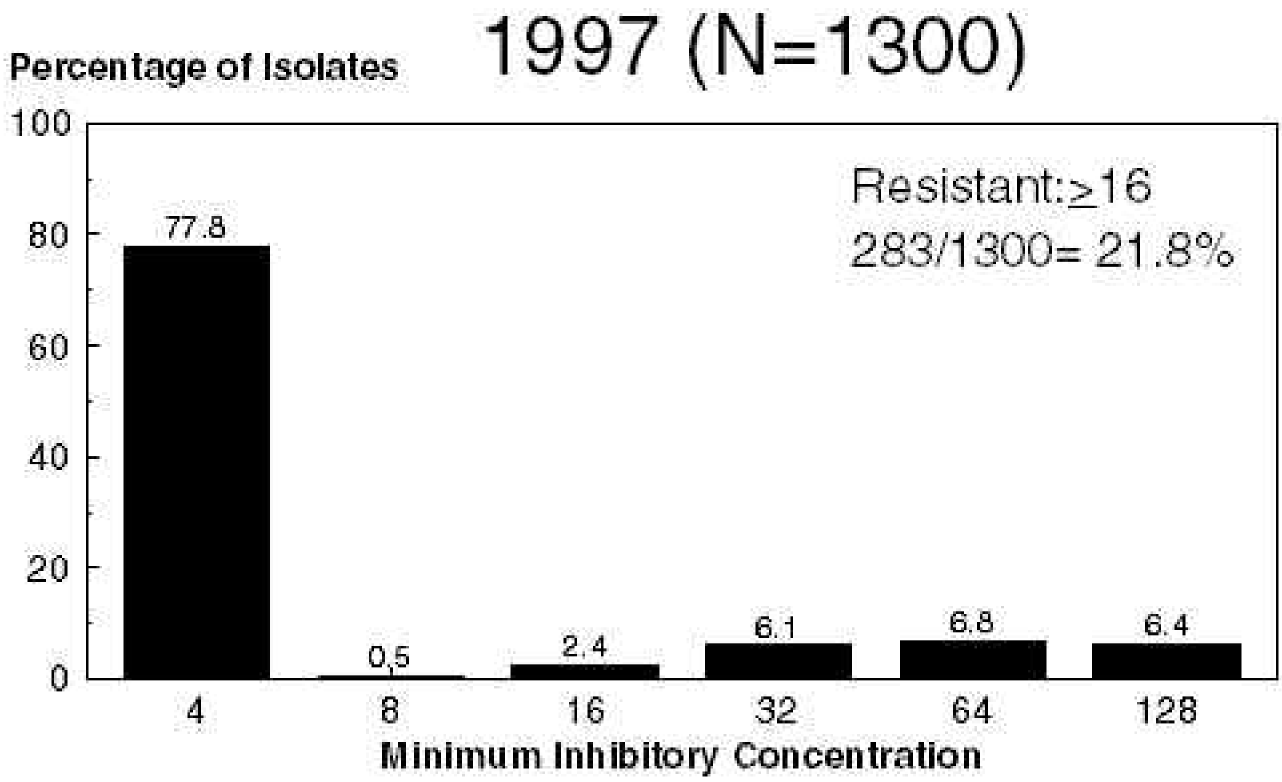


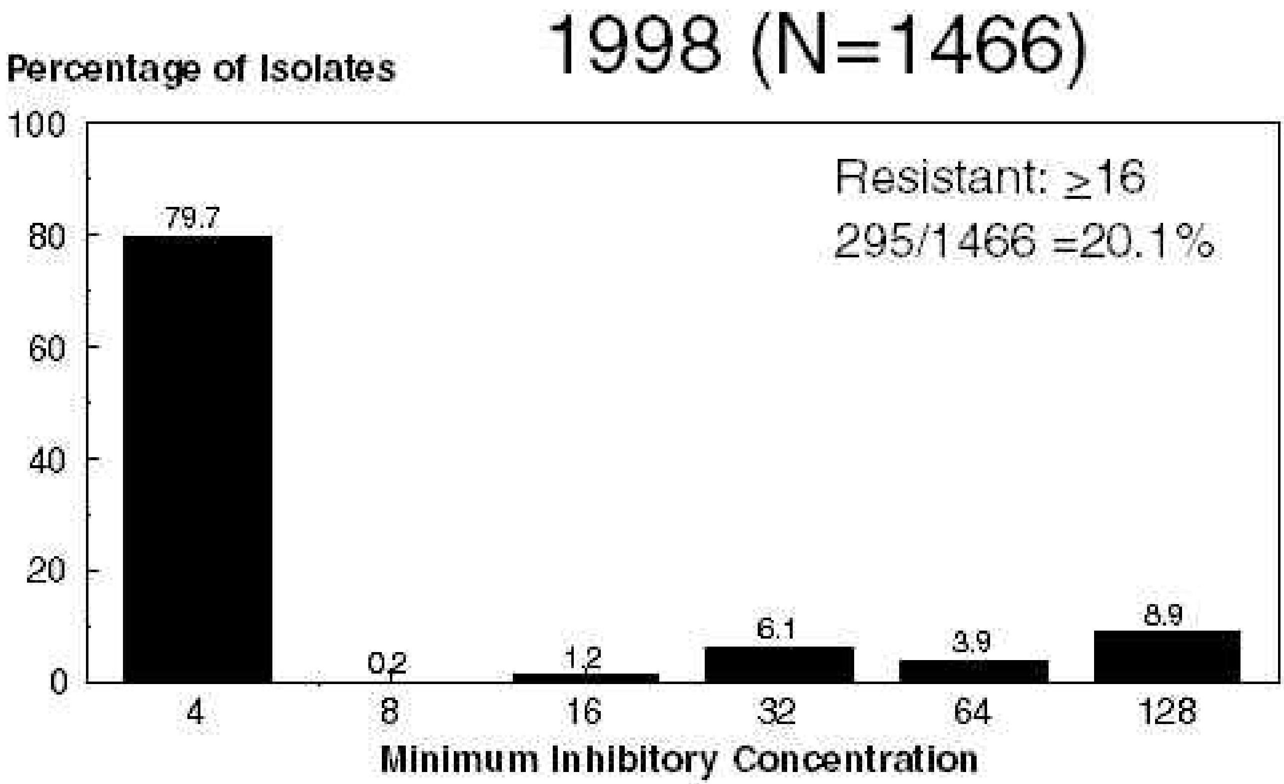




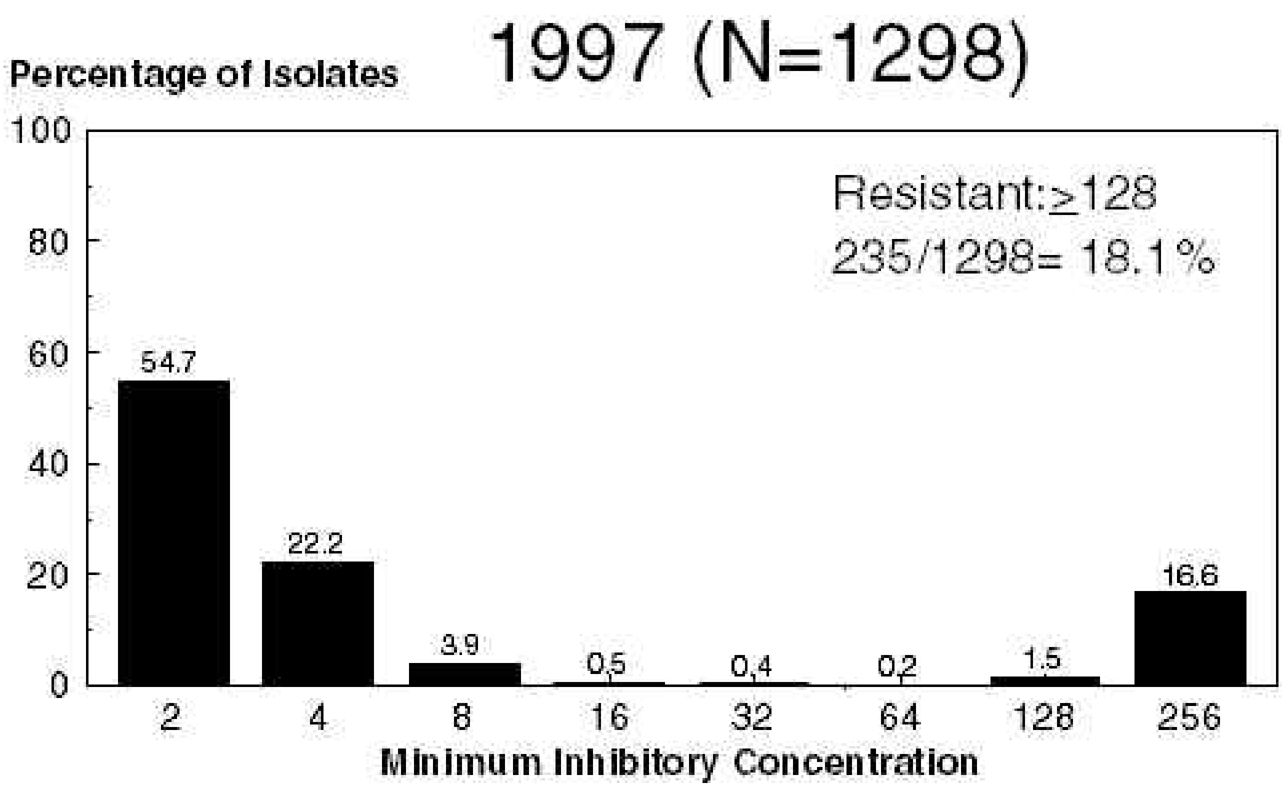
Comparison of *Salmonella* Tetracycline MICs 1996-1998

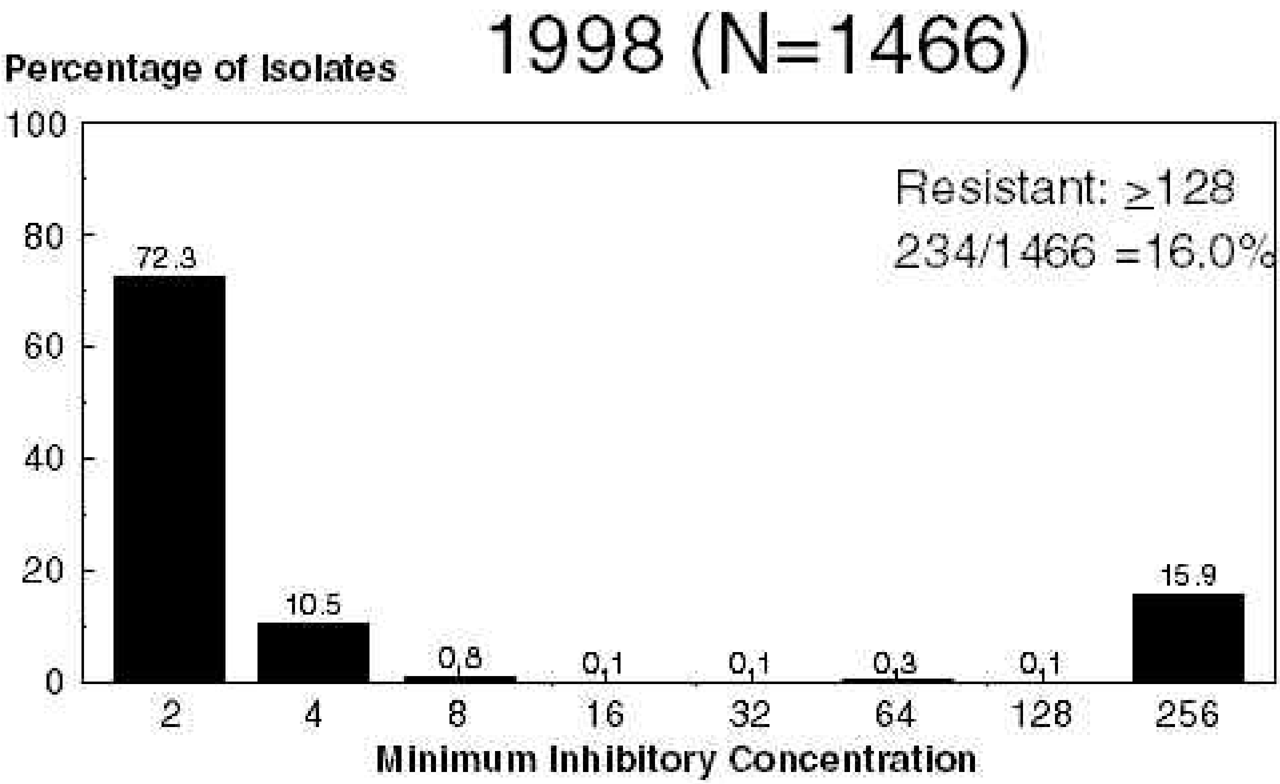

1996 (N=1326)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥16
321/1326=24.2%
75.2
0.6
6.4
6.3
10.9
0.6
4
8
16
32
64
128
Minimum Inhibitory Concentration


1997 (N=1300)
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥16
283/1300= 21.8%
77.8
0.5
2.4
6.1
6.8
6.4
4
8
16
32
64
128
Minimum Inhibitory Concentration

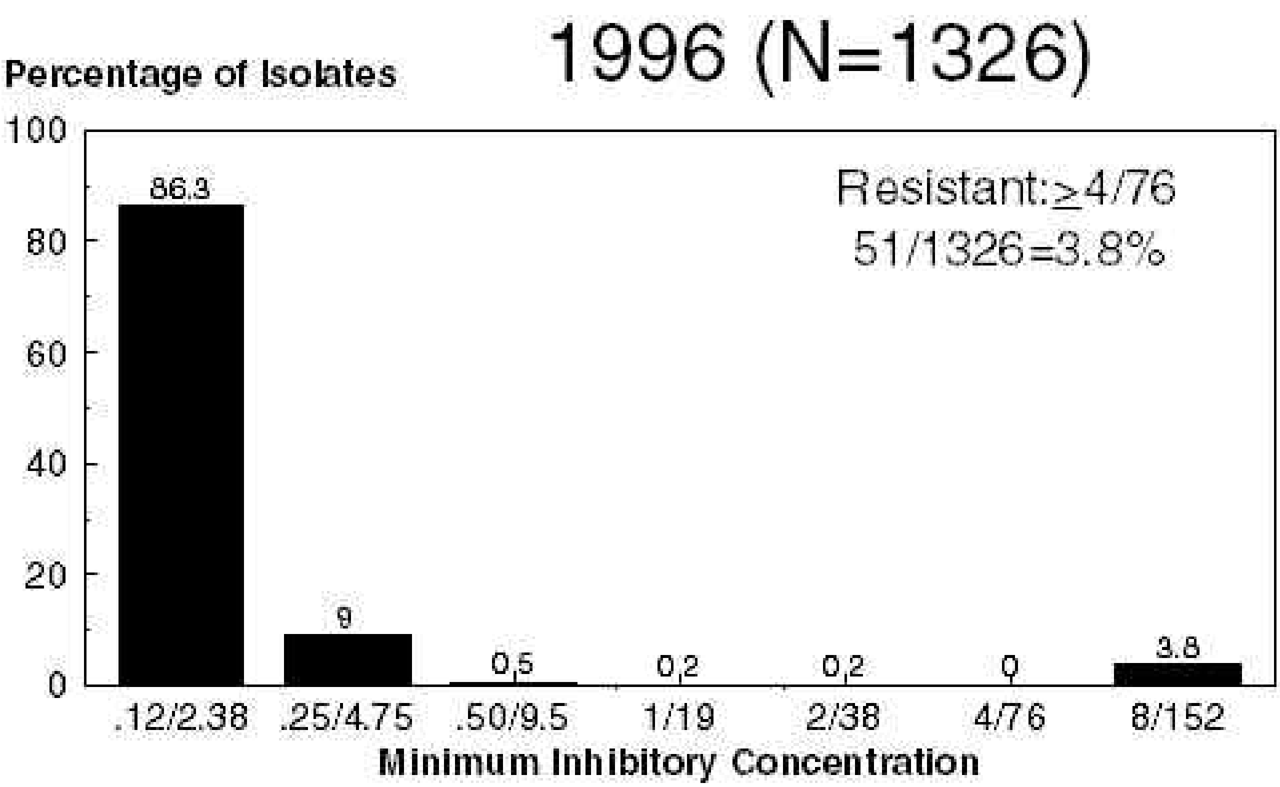


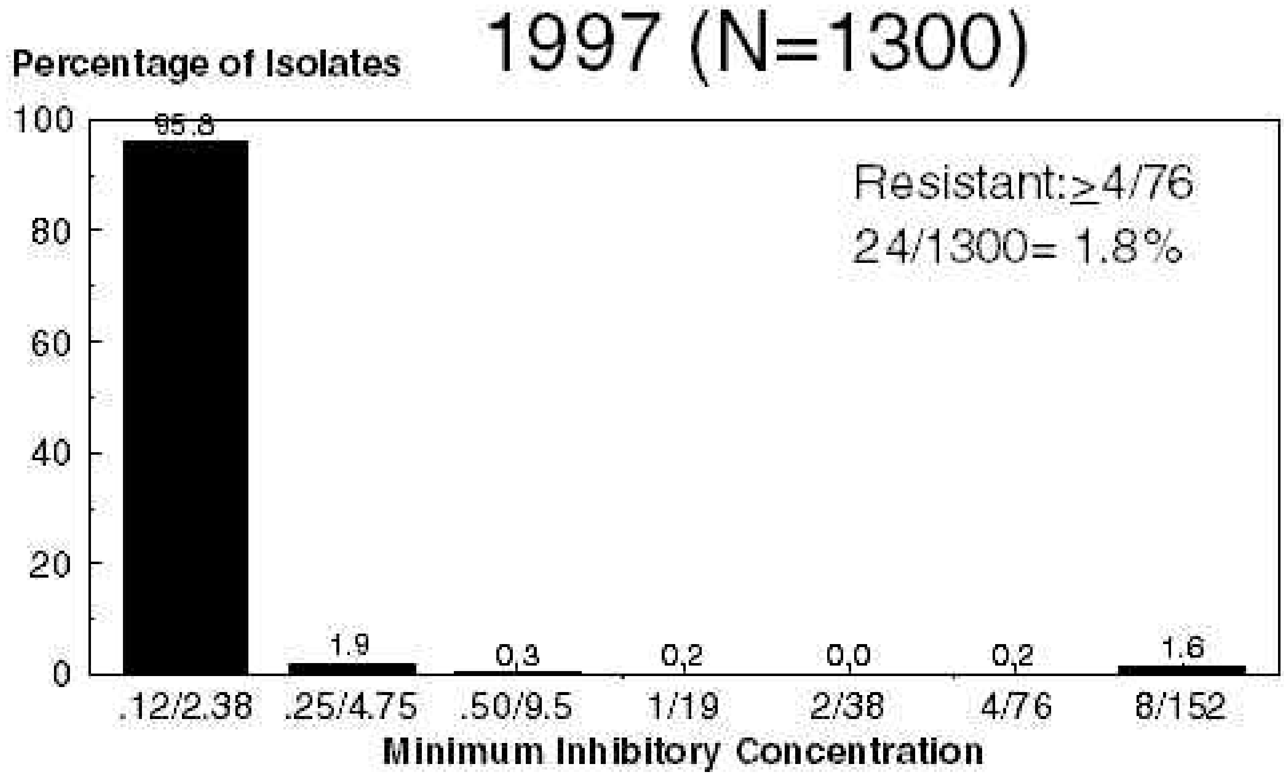
Comparison of *Salmonella* Ticarcillin MICs 1997-1998

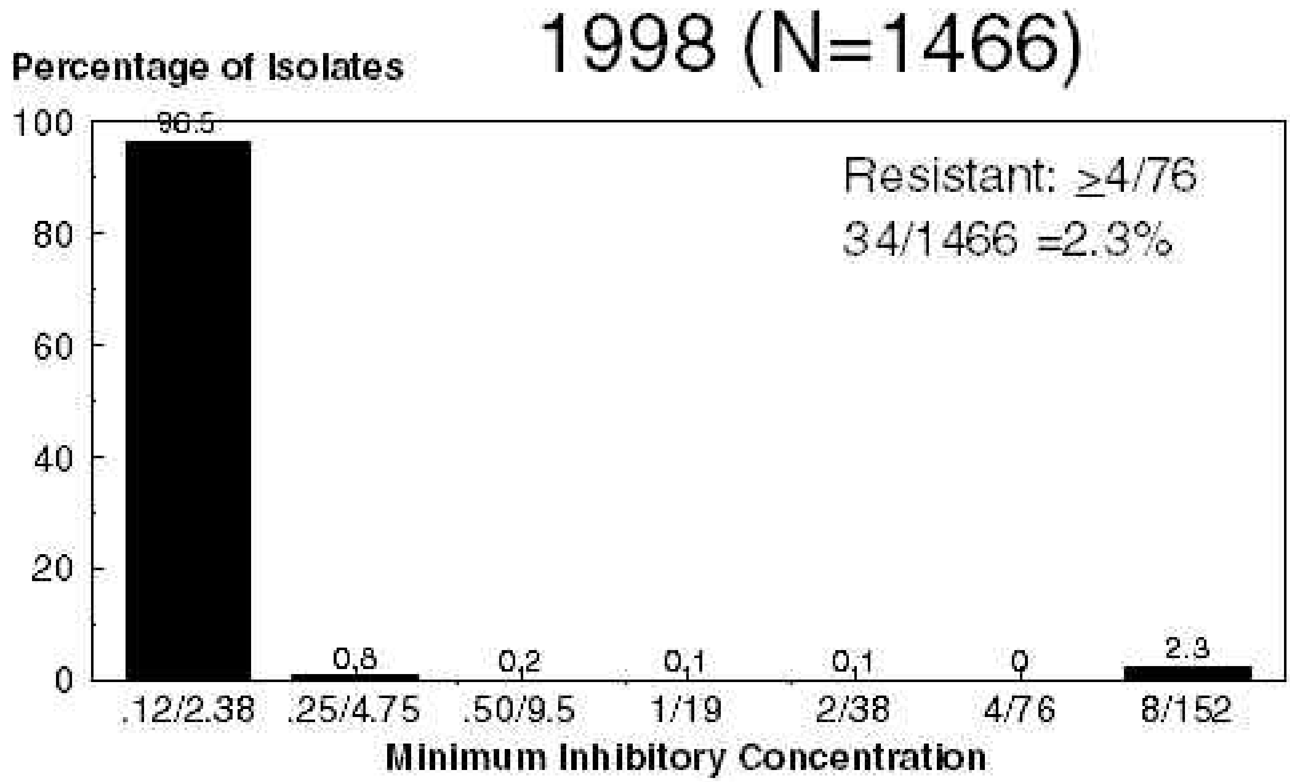




Comparison of *Salmonella* Trimethoprim-Sulfamethoxazole MICs 1996-1998



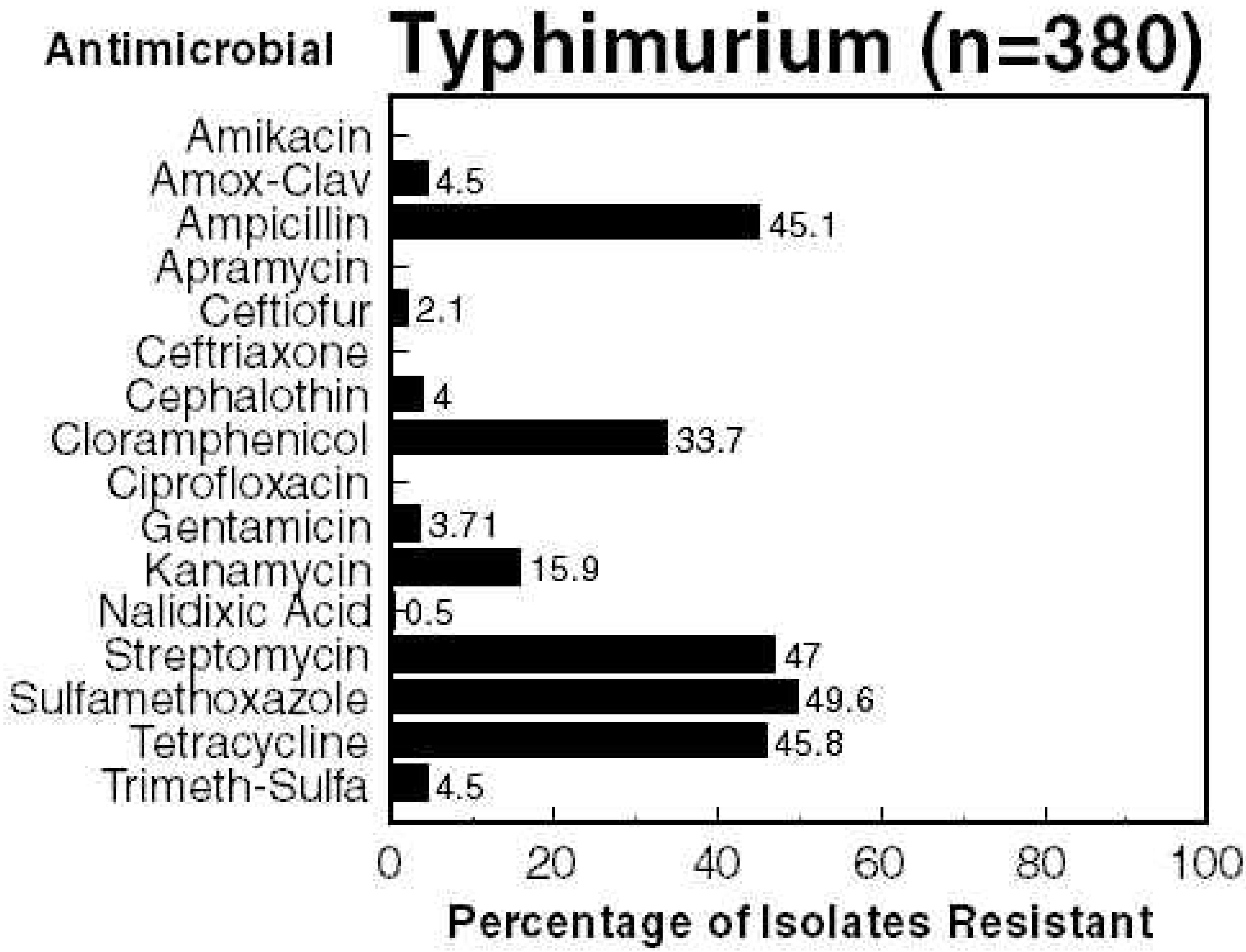

1997 (N=1300)
Percentage of Isolates
100
80
60
40
20
0
95.8
1.9
0.3
0.2
0.0
0.2
1.6
Resistant:≥4/76
24/1300= 1.8%
.12/2.38
.25/4.75
.50/9.5
1/19
2/38
4/76
8/152
Minimum Inhibitory Concentration

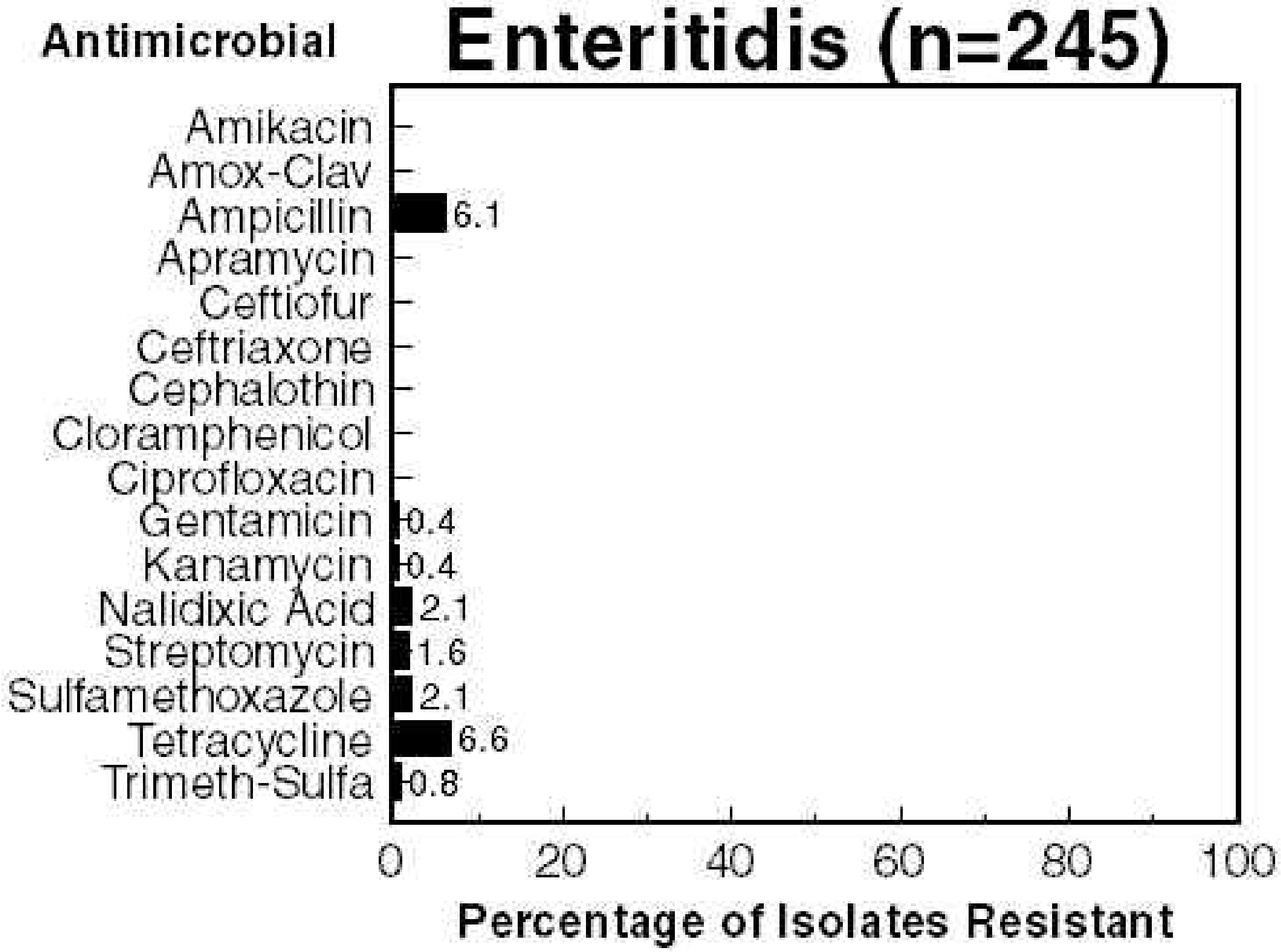

1998 (N=1466)
Percentage of Isolates
100
80
60
40
20
0
96.5
0.8
0.2
0.1
0.1
0
2.3
Resistant: ≥4/76
34/1466 =2.3%
.12/2.38
.25/4.75
.50/9.5
1/19
2/38
4/76
8/152
Minimum Inhibitory Concentration

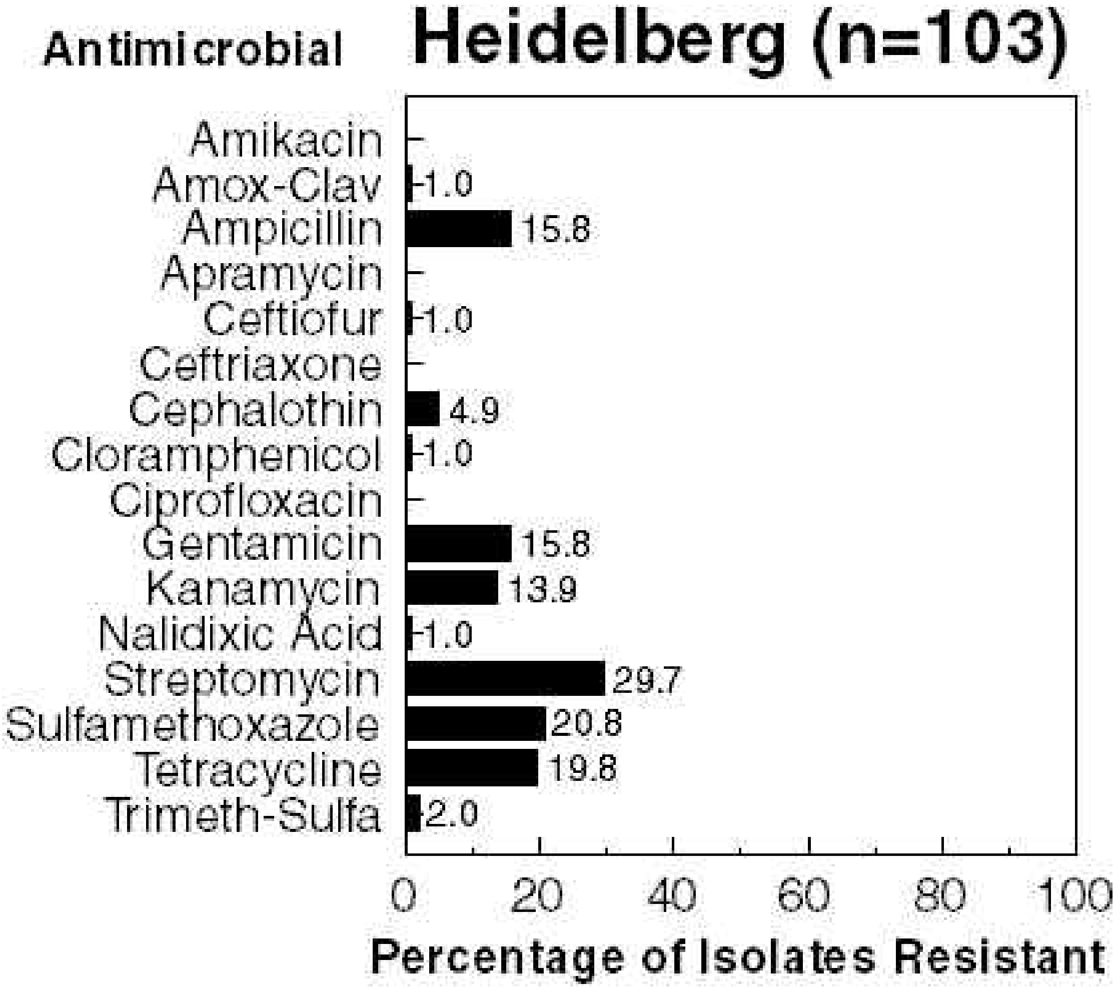
MS A-38
Atlanta GA 30333
updated August 9, 1999

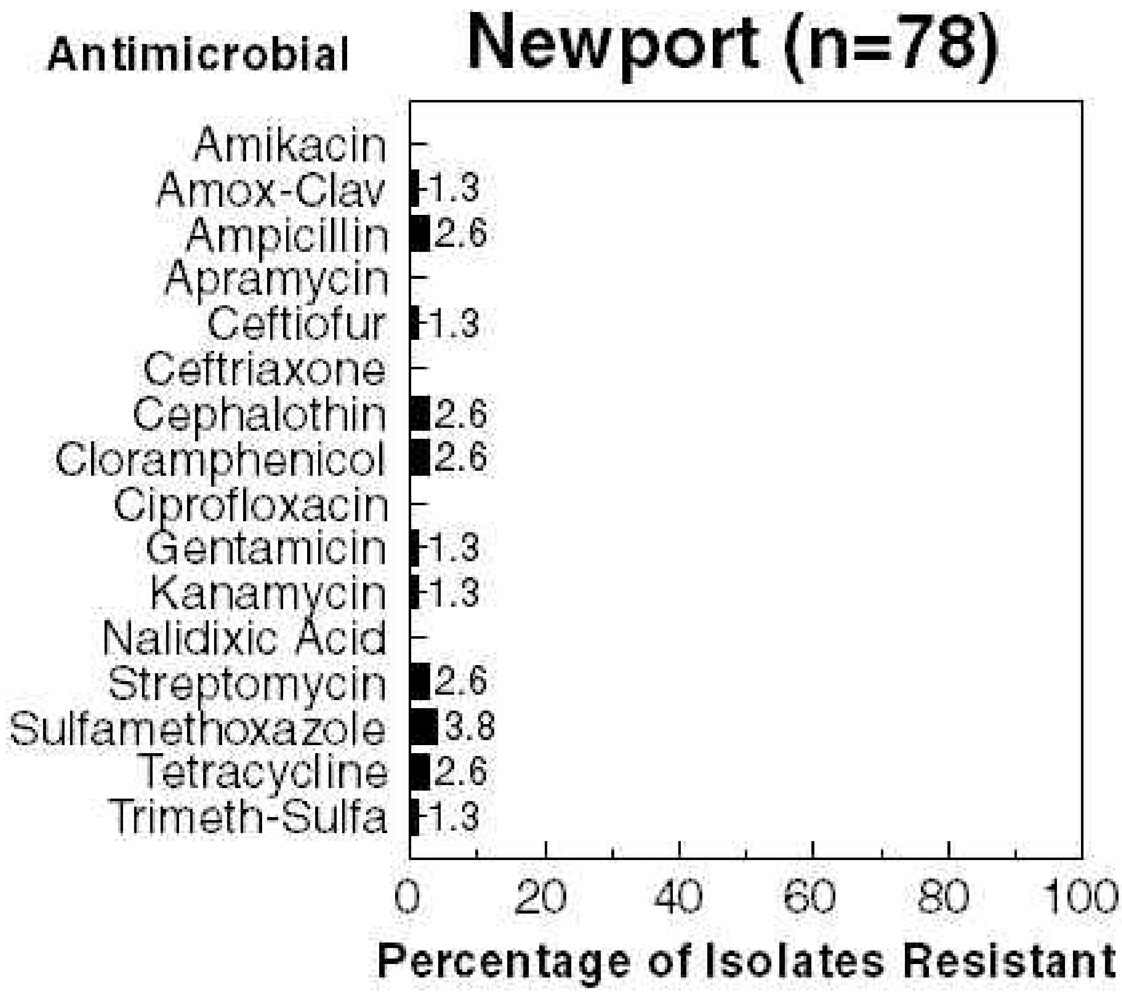
National Antimicrobial Resistance Monitoring System
1998 Annual Report

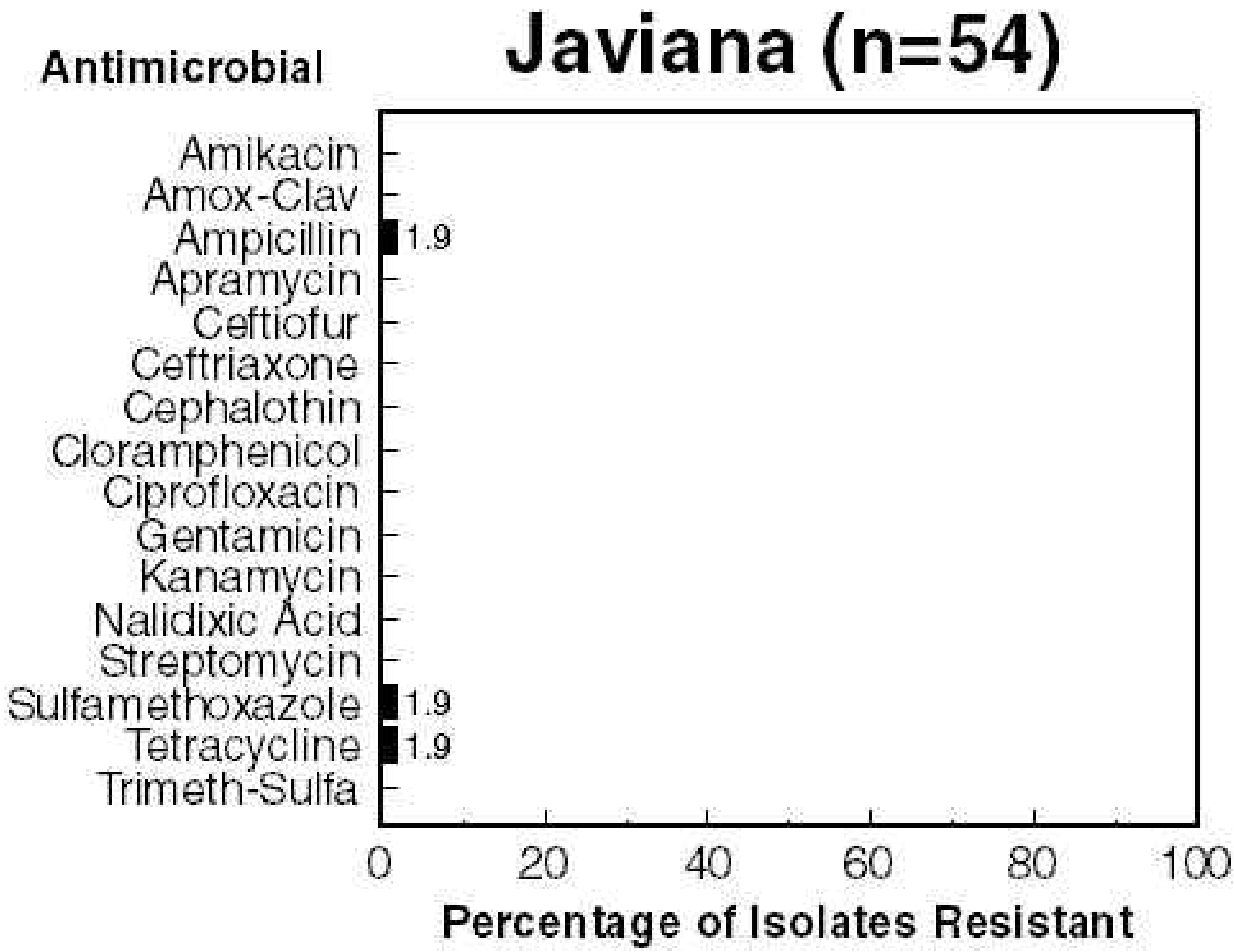
Figure 4: Resistance among *Salmonella* serotypes for all sites

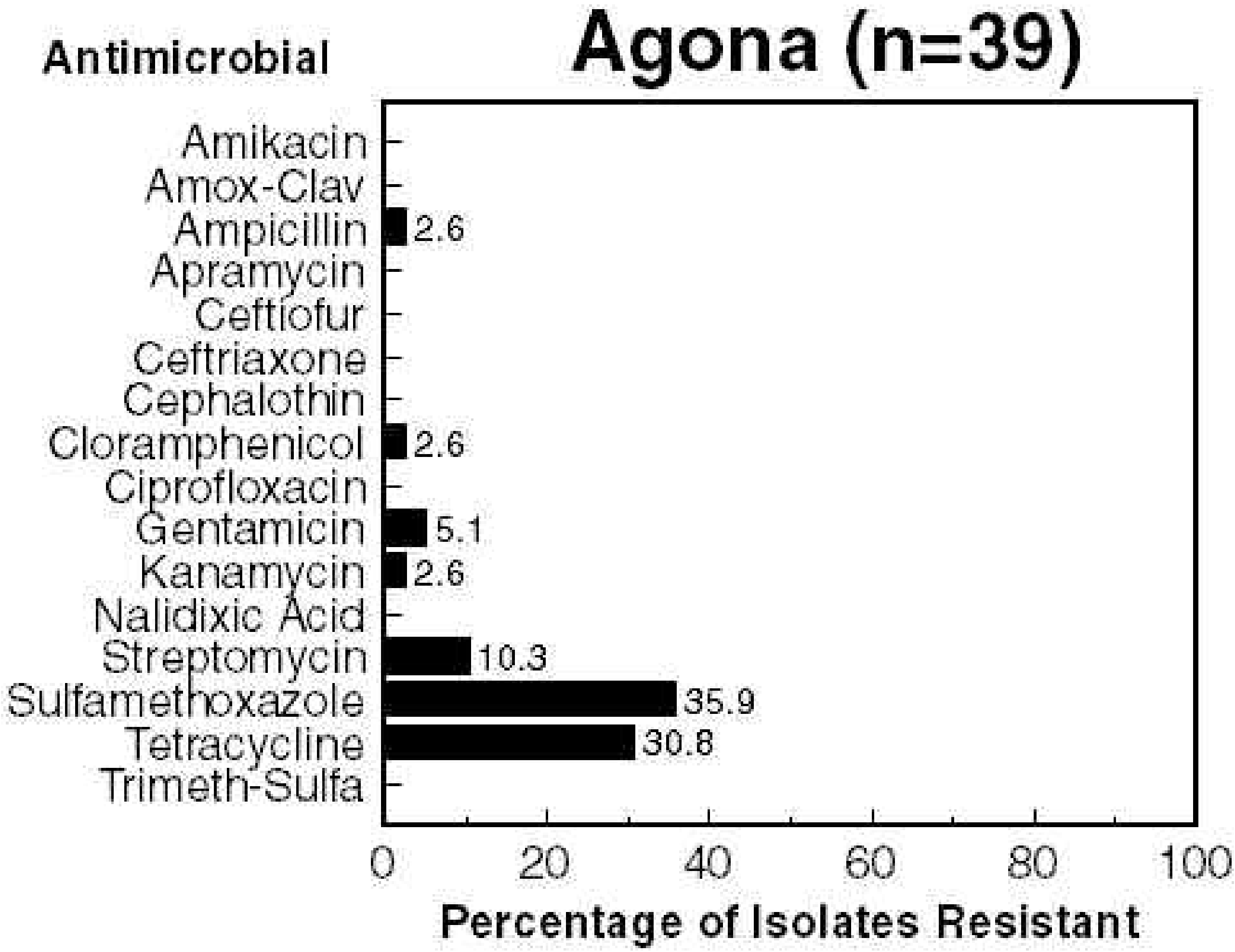


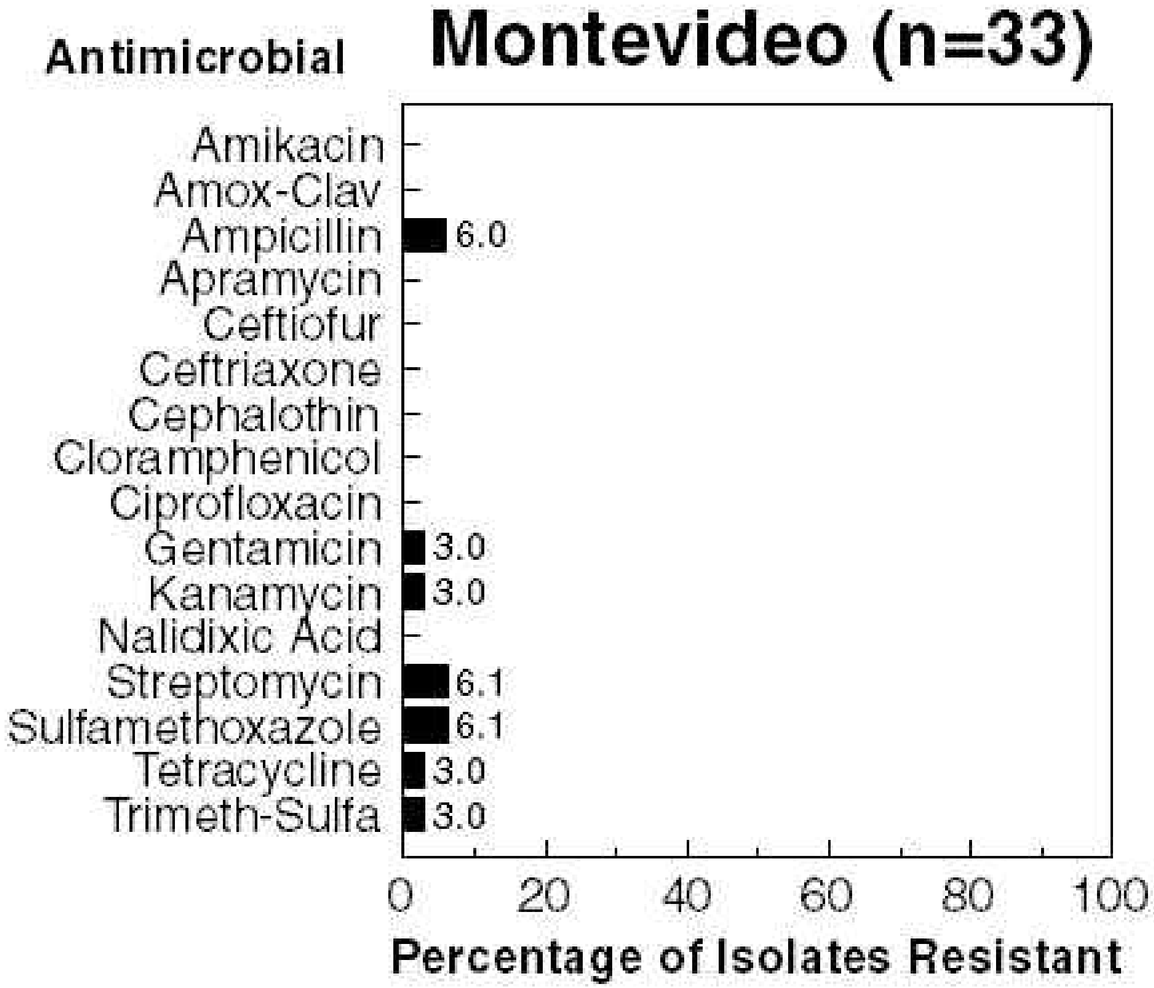

Antimicrobial
Enteritidis (n=245)
Amikacin
Amox-Clav
Ampicillin
6.1
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
0.4
Kanamycin
0.4
Nalidixic Acid
2.1
Streptomycin
1.6
Sulfamethoxazole
2.1
Tetracycline
6.6
Trimeth-Sulfa
0.8
0
20
40
60
80
100
Percentage of Isolates Resistant

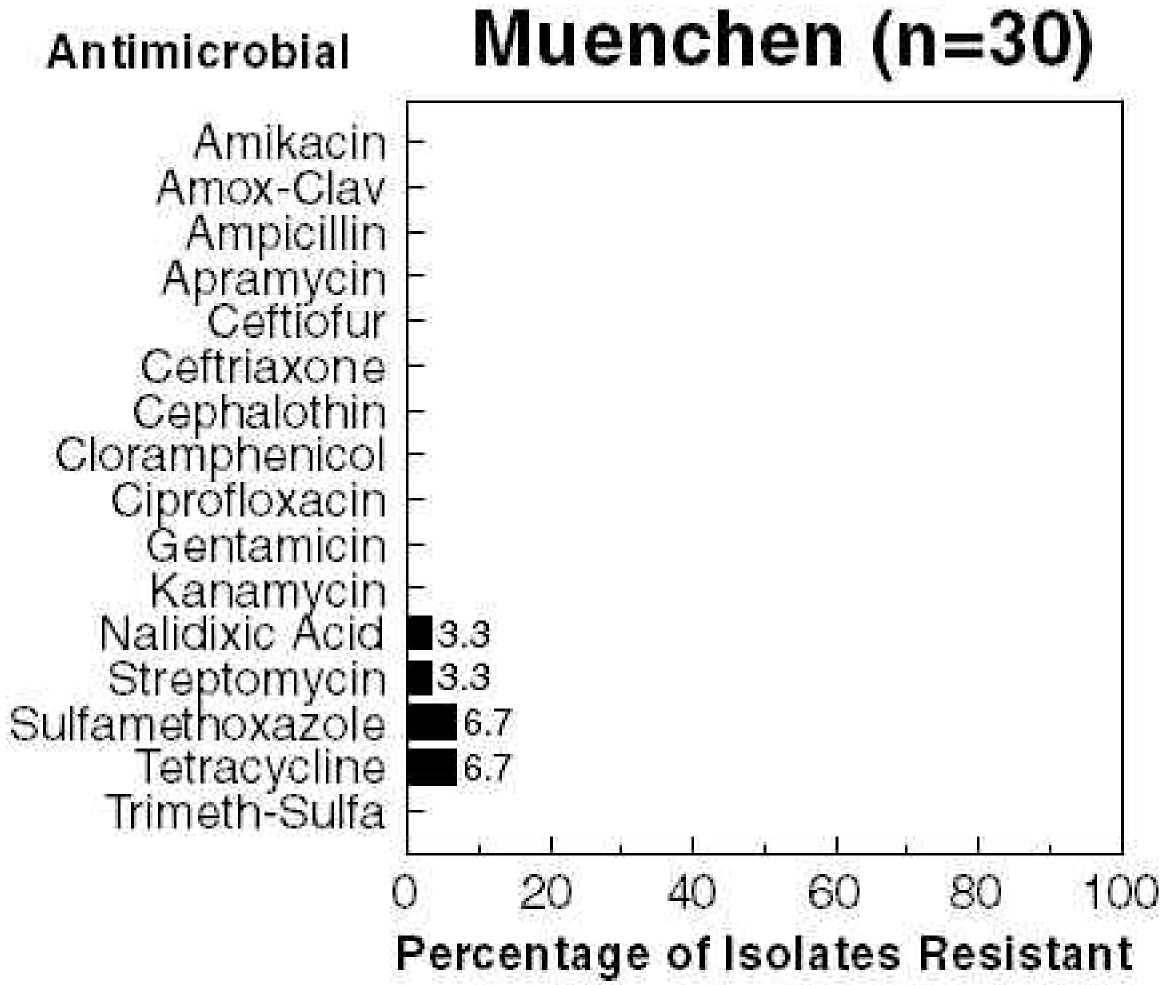

Antimicrobial
Heidelberg (n=103)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
1.0
15.8
1.0
4.9
1.0
15.8
13.9
1.0
29.7
20.8
19.8
2.0
0
20
40
60
80
100
Percentage of Isolates Resistant

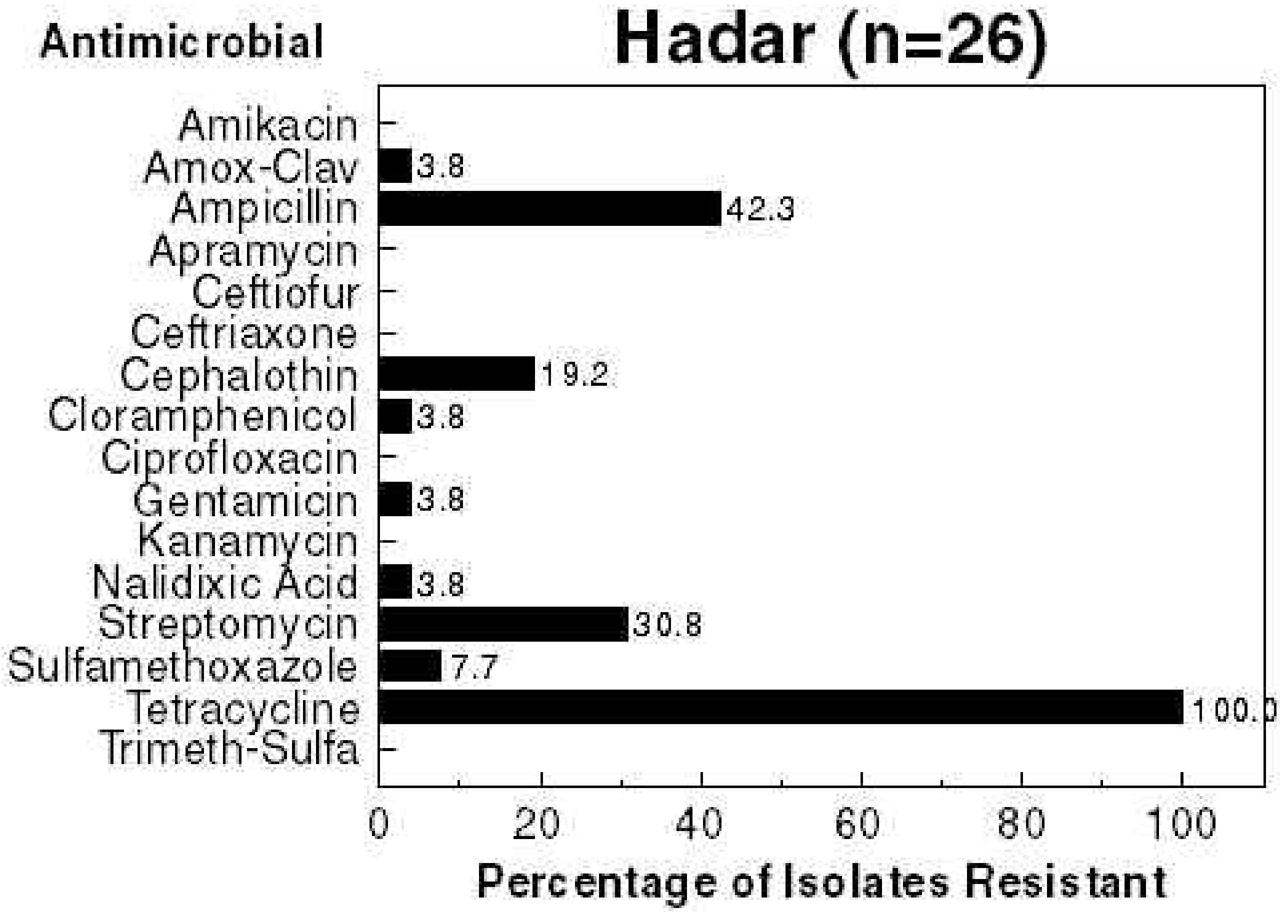

Antimicrobial
Newport (n=78)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
1.3
2.6
1.3
2.6
2.6
1.3
1.3
2.6
3.8
2.6
1.3
0
20
40
60
80
100
Percentage of Isolates Resistant

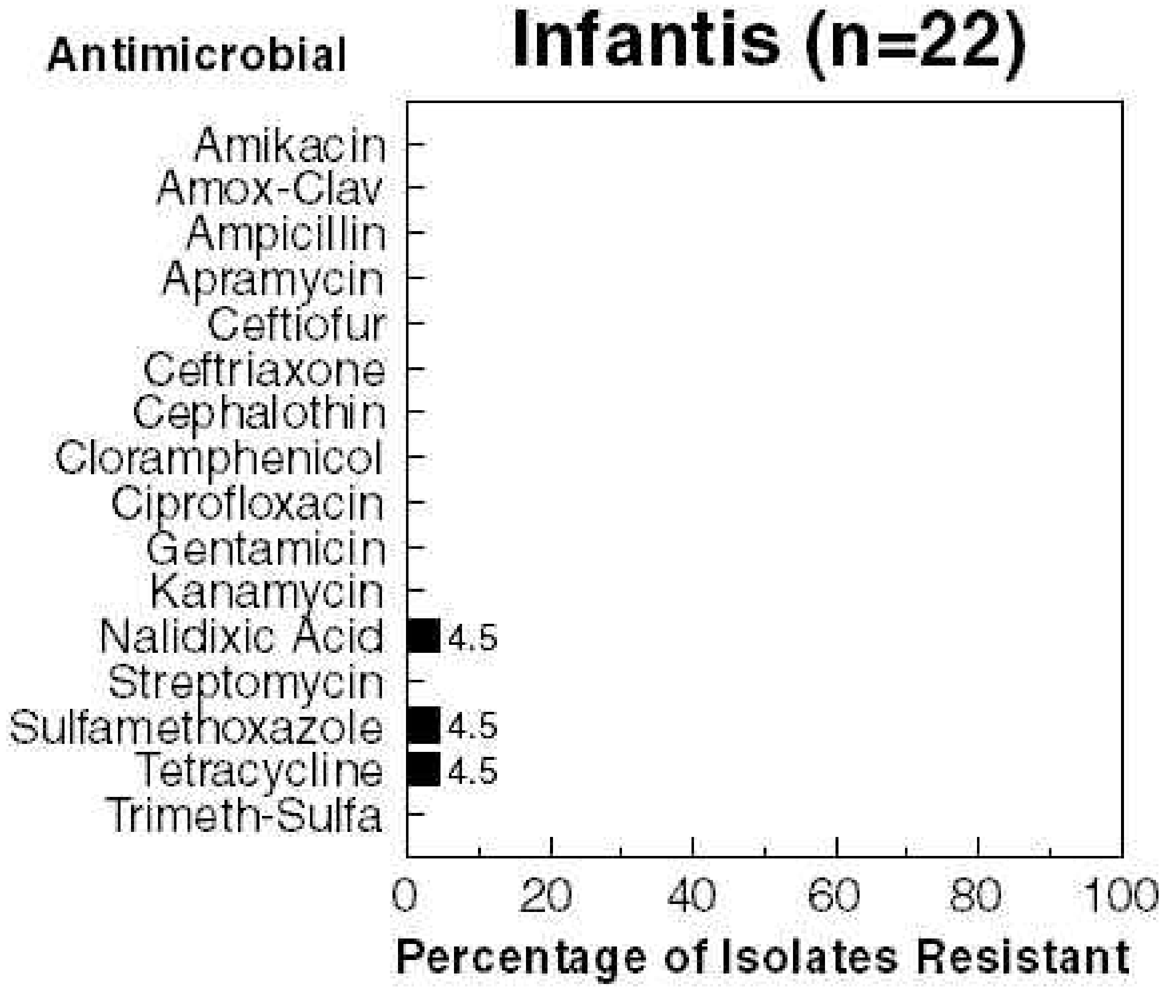

Javiana (n=54)
Antimicrobial
Amikacin
Amox-Clav
Ampicillin
1.9
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
1.9
Tetracycline
1.9
Trimeth-Sulfa
0
20
40
60
80
100
Percentage of Isolates Resistant


Antimicrobial
Agona (n=39)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
2.6
2.6
5.1
2.6
10.3
35.9
30.8
0
20
40
60
80
100
Percentage of Isolates Resistant


Antimicrobial
Montevideo (n=33)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
6.0
3.0
3.0
6.1
6.1
3.0
3.0
0
20
40
60
80
100
Percentage of Isolates Resistant


Antimicrobial
Muenchen (n=30)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
3.3
3.3
6.7
6.7
0
20
40
60
80
100
Percentage of Isolates Resistant

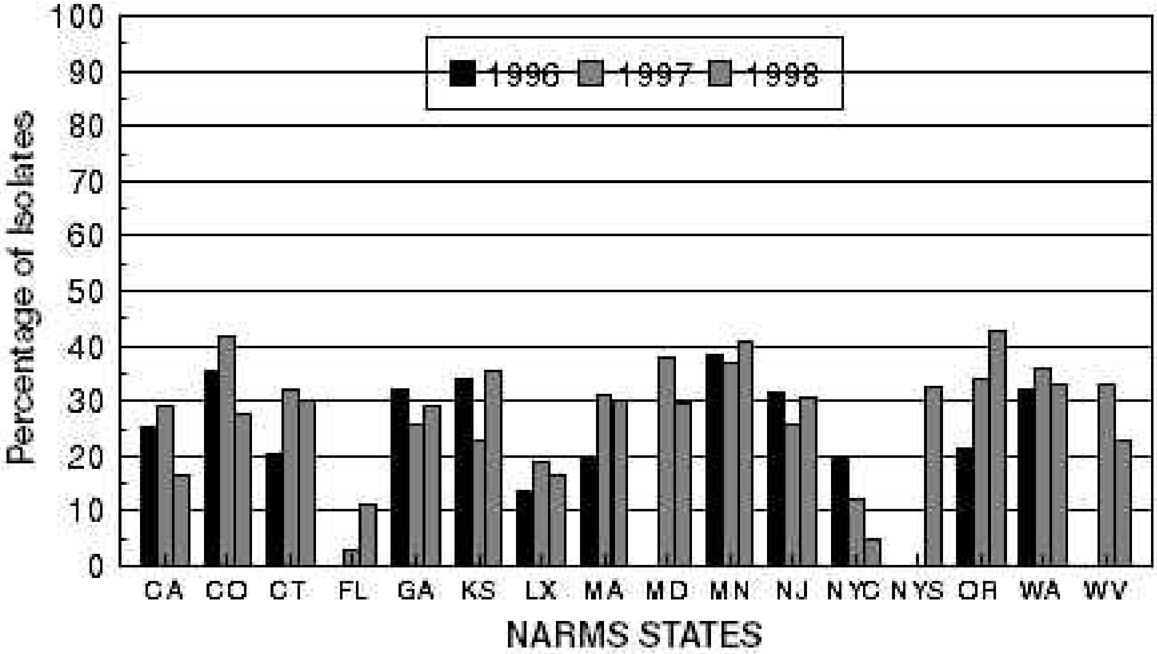

Antimicrobial
Hadar (n=26)
Amikacin
Amox-Clav
Ampicillin
Apramycin
Ceftiofur
Ceftriaxone
Cephalothin
Cloramphenicol
Ciprofloxacin
Gentamicin
Kanamycin
Nalidixic Acid
Streptomycin
Sulfamethoxazole
Tetracycline
Trimeth-Sulfa
3.8
42.3
19.2
3.8
3.8
3.8
30.8
7.7
100.0
0
20
40
60
80
100
Percentage of Isolates Resistant



Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

Figure 5: Percentage of *Salmonella* isolates identified as Typhimurium by site, 1996-1998

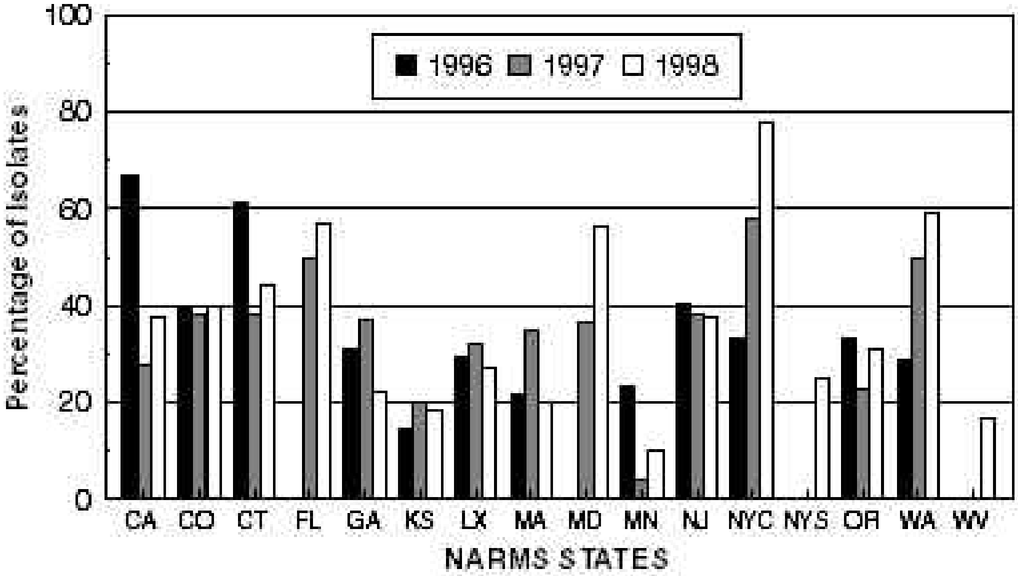


Total serotyped at state 1996=1239 Total Typhimurium received=306/1239=24.7%
Total serotyped at state 1997=1221 Total Typhimurium received=326/1221=26.7%
Total serotyped at state 1998=1430 Total Typhimurium received=380/1430=26.6%

Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

Figure 6: Percentage of *Salmonella* isolates with ACSSuT pattern by site, 1996-1998



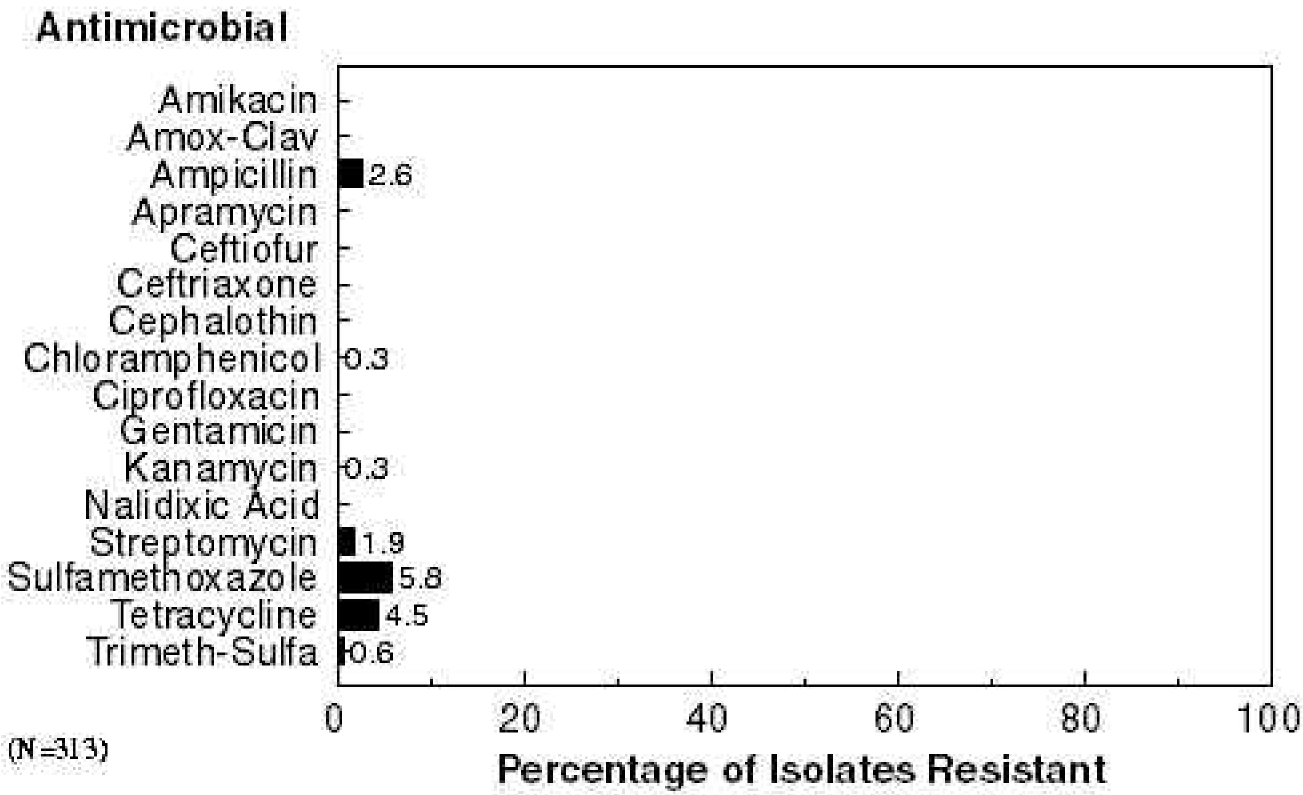
Percent of all 1996 Typhimurium with ACSSuT pattern: 103/306 =33.6%
Percent of all 1997 Typhimurium with ACSSuT pattern: 115/326 =35.3%
Percent of all 1998 Typhimurium with ACSSuT pattern: 120/380=31.6%

[Centers for Disease Control and Prevention]
[National Center for Infectious Diseases] | [Division of Bacterial & Mycotic Diseases]
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333

updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

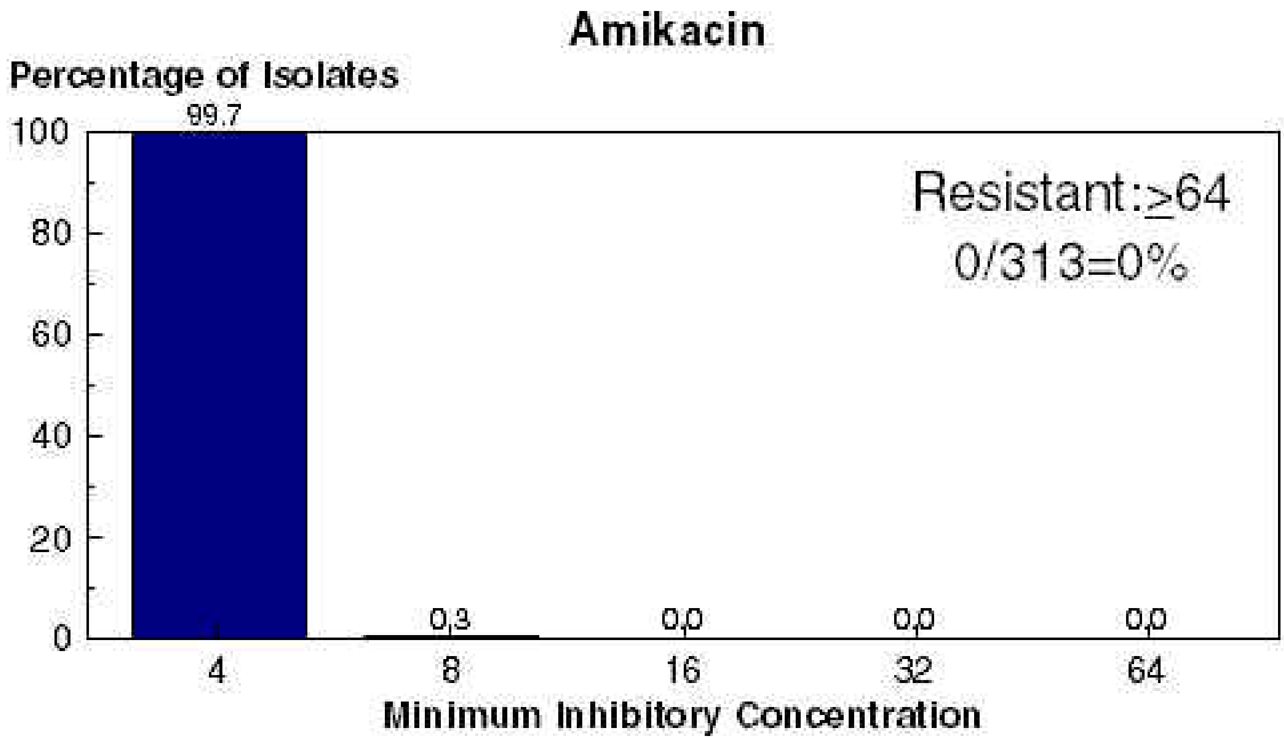
Figure 7: Resistance among *E. coli* O157:H7 isolates for all sites

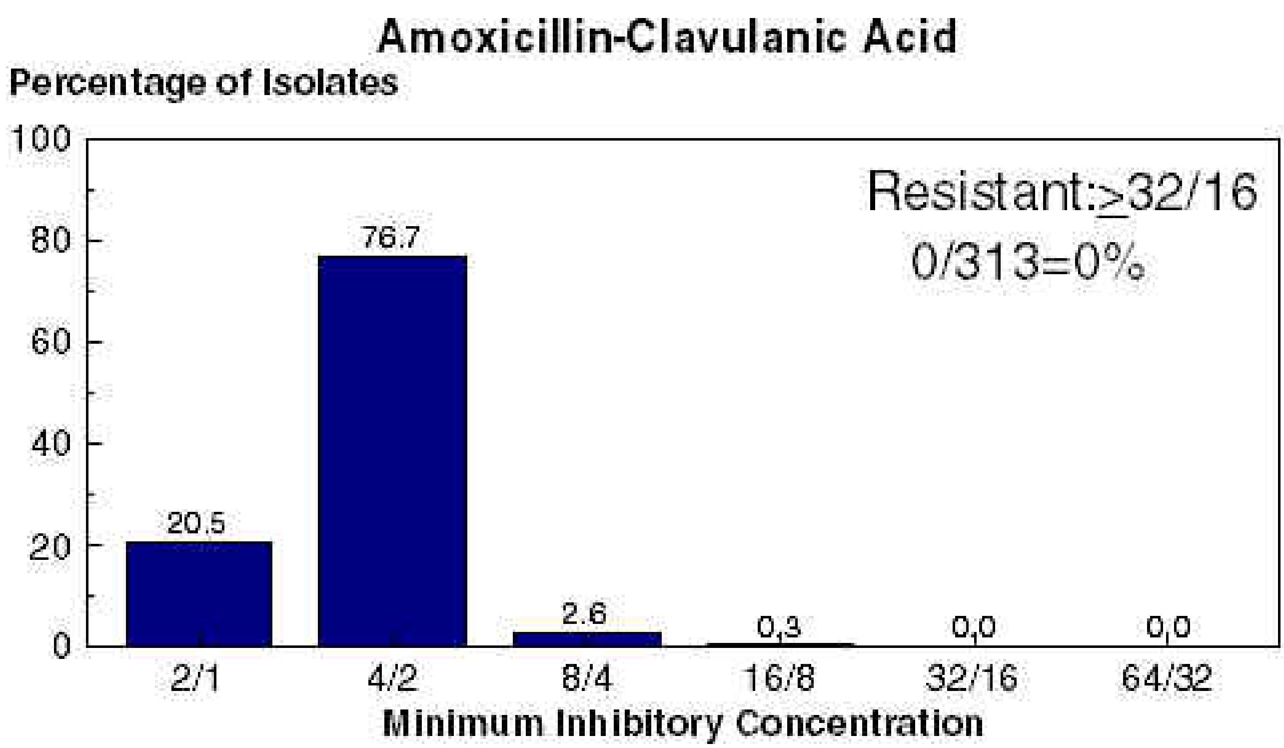


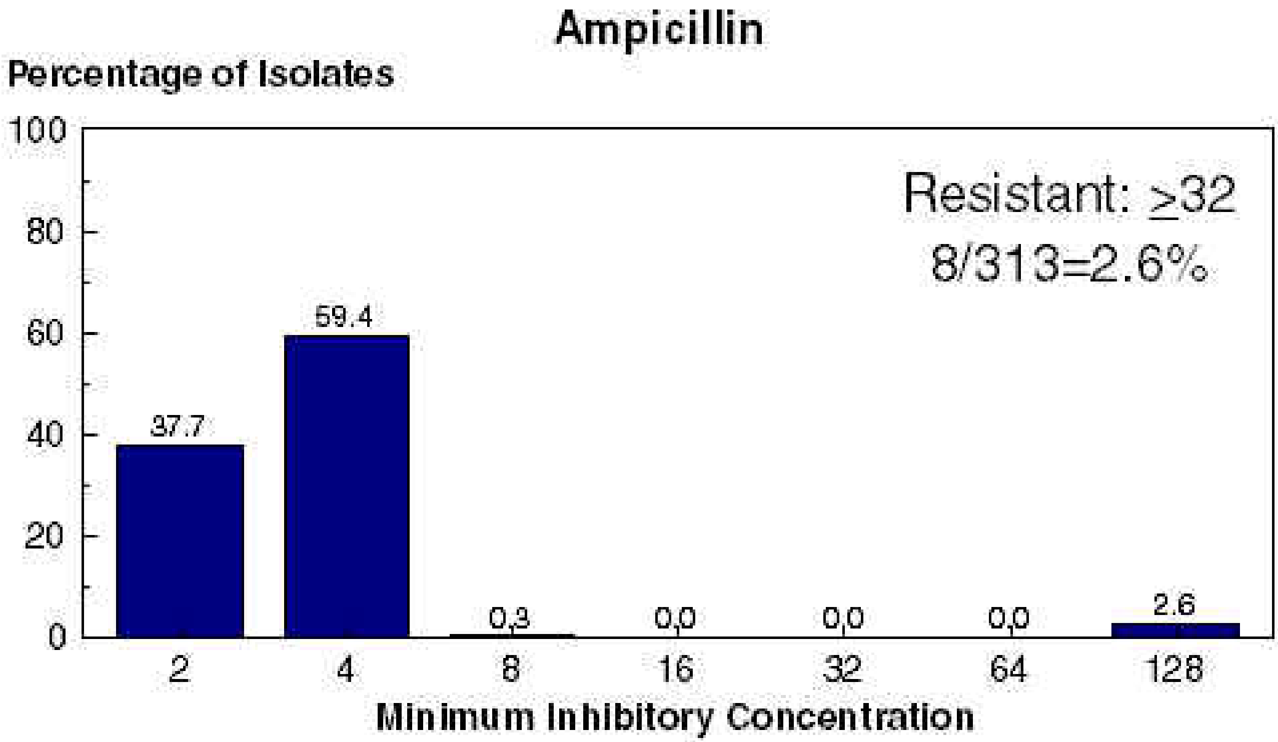
Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

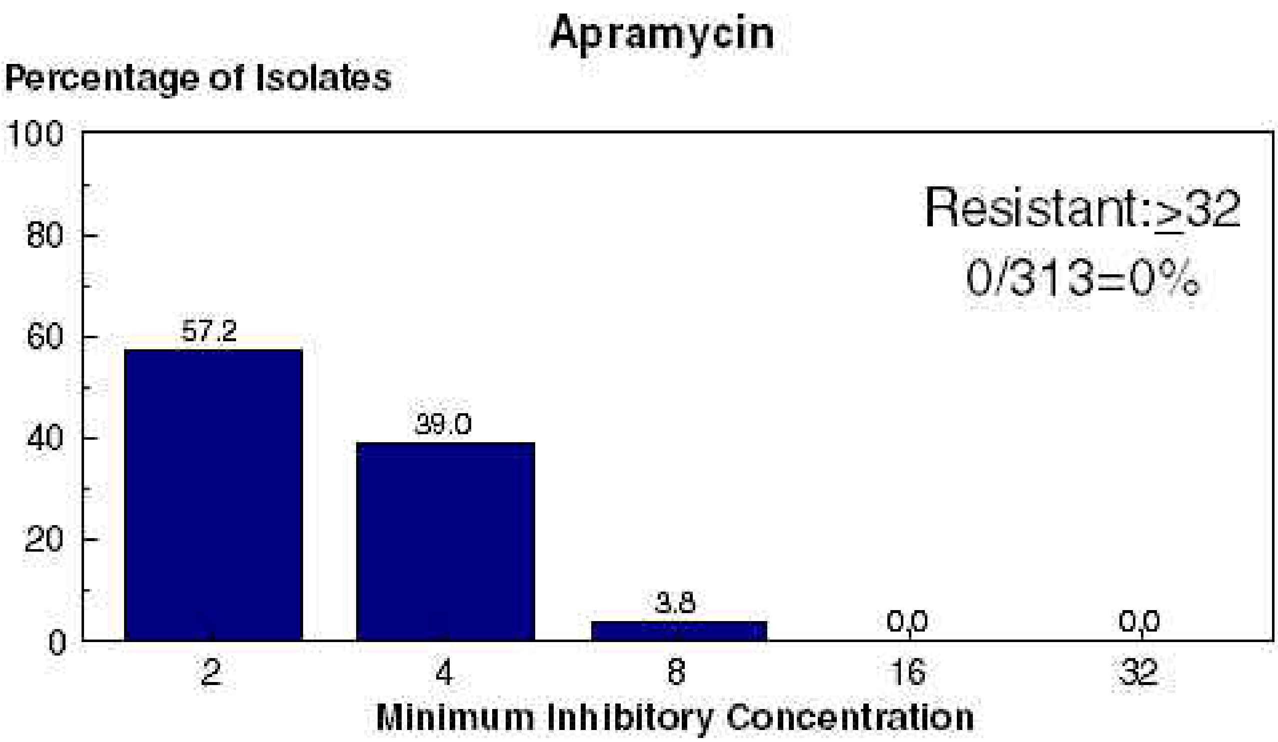
National Antimicrobial Resistance Monitoring System
1998 Annual Report

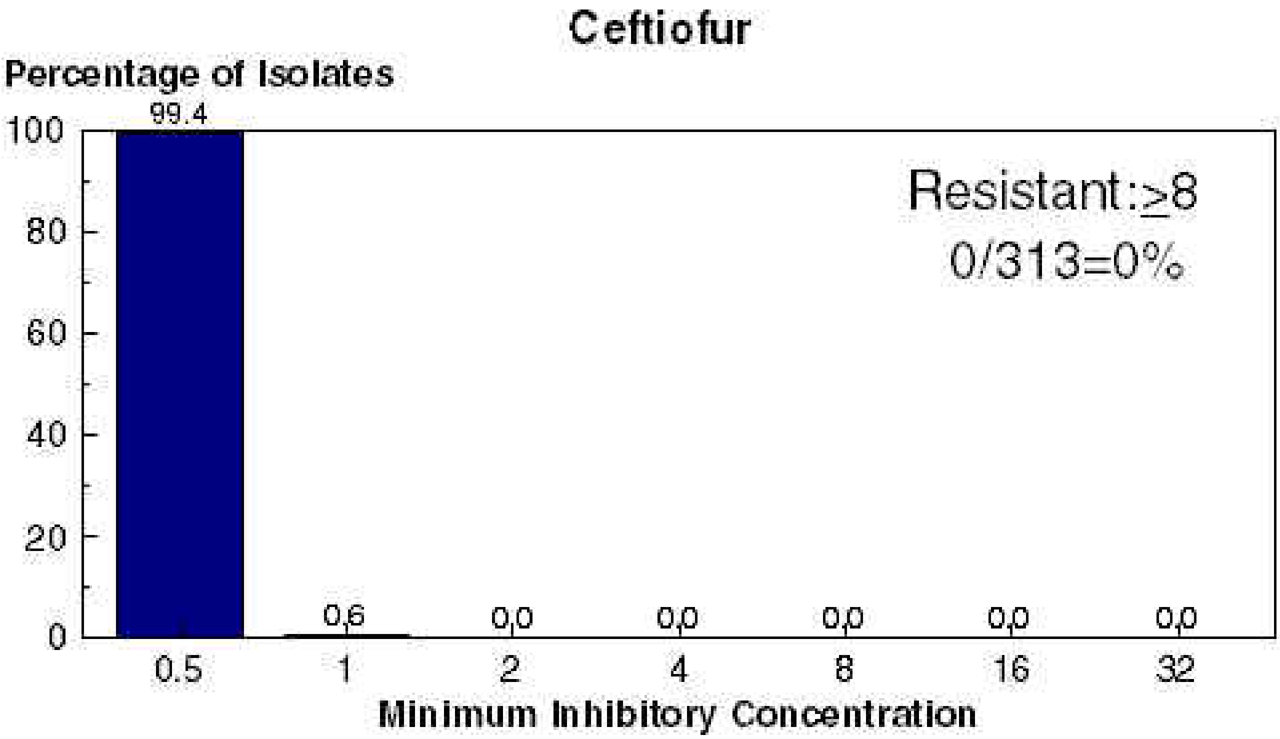
Figure 8: *E. coli* O157:H7 MICs, by antimicrobial agent

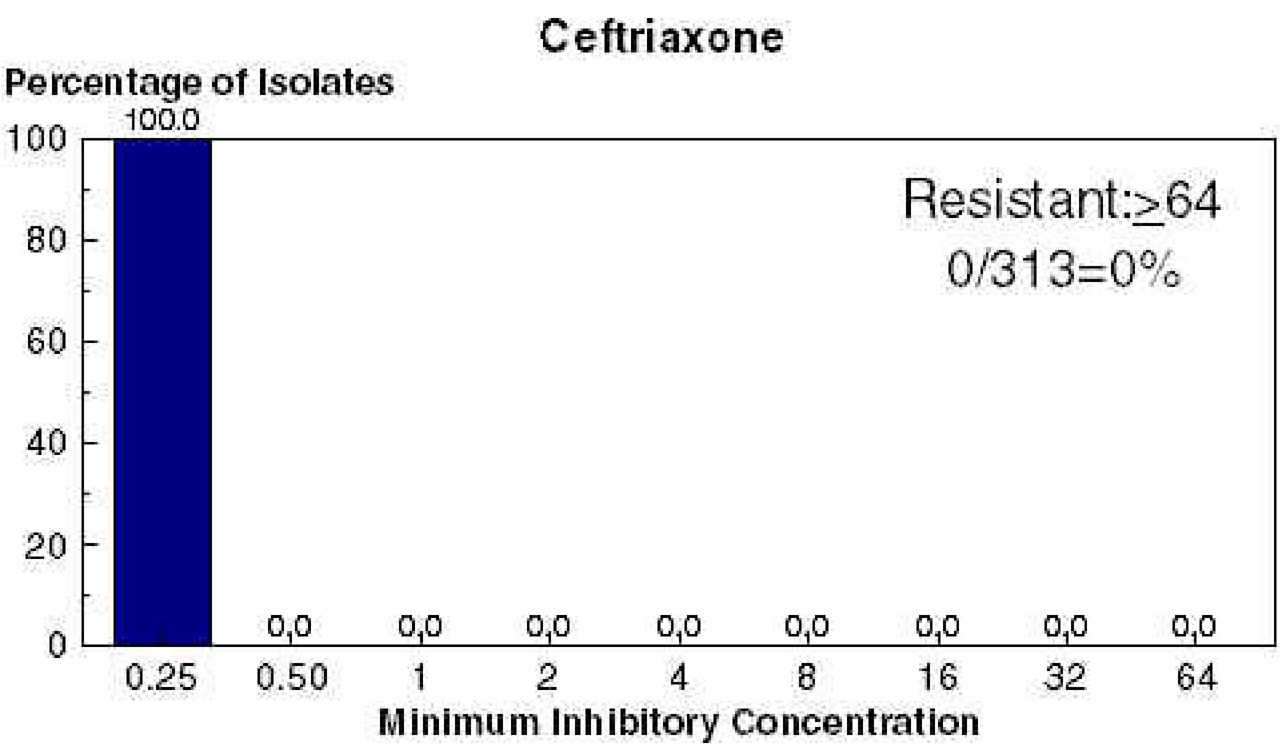


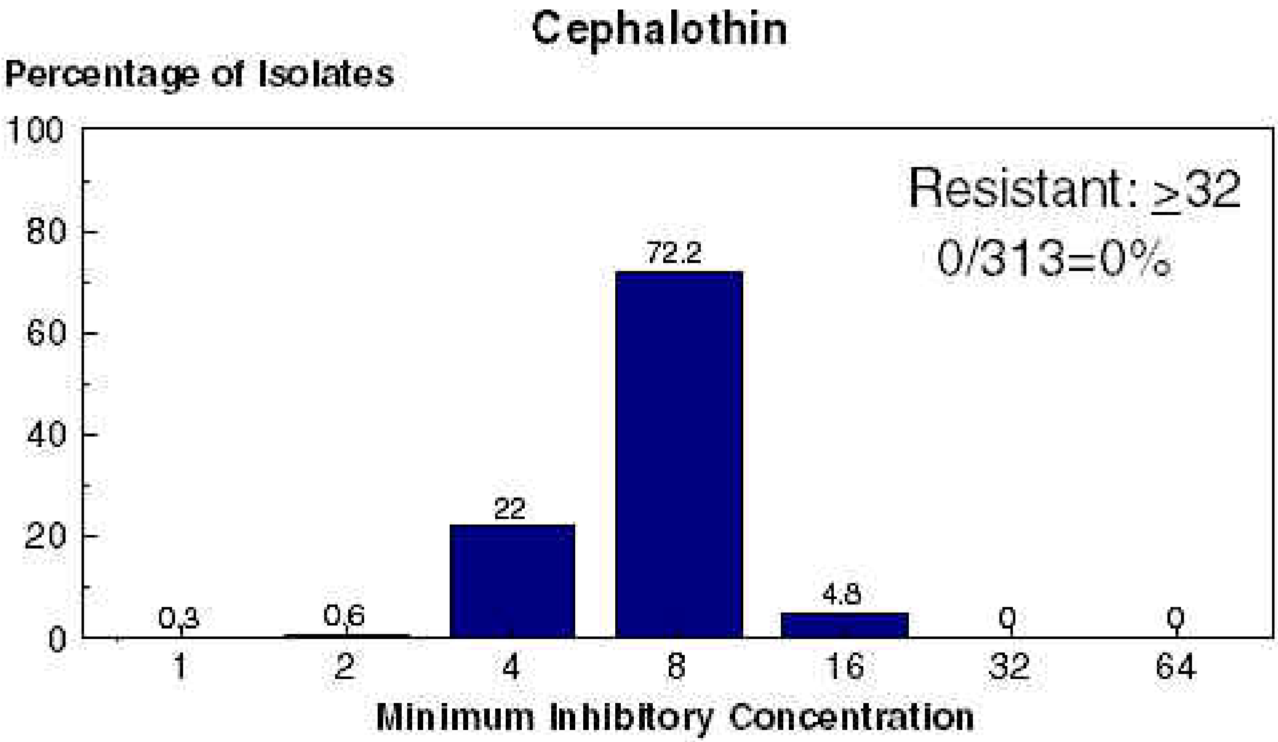


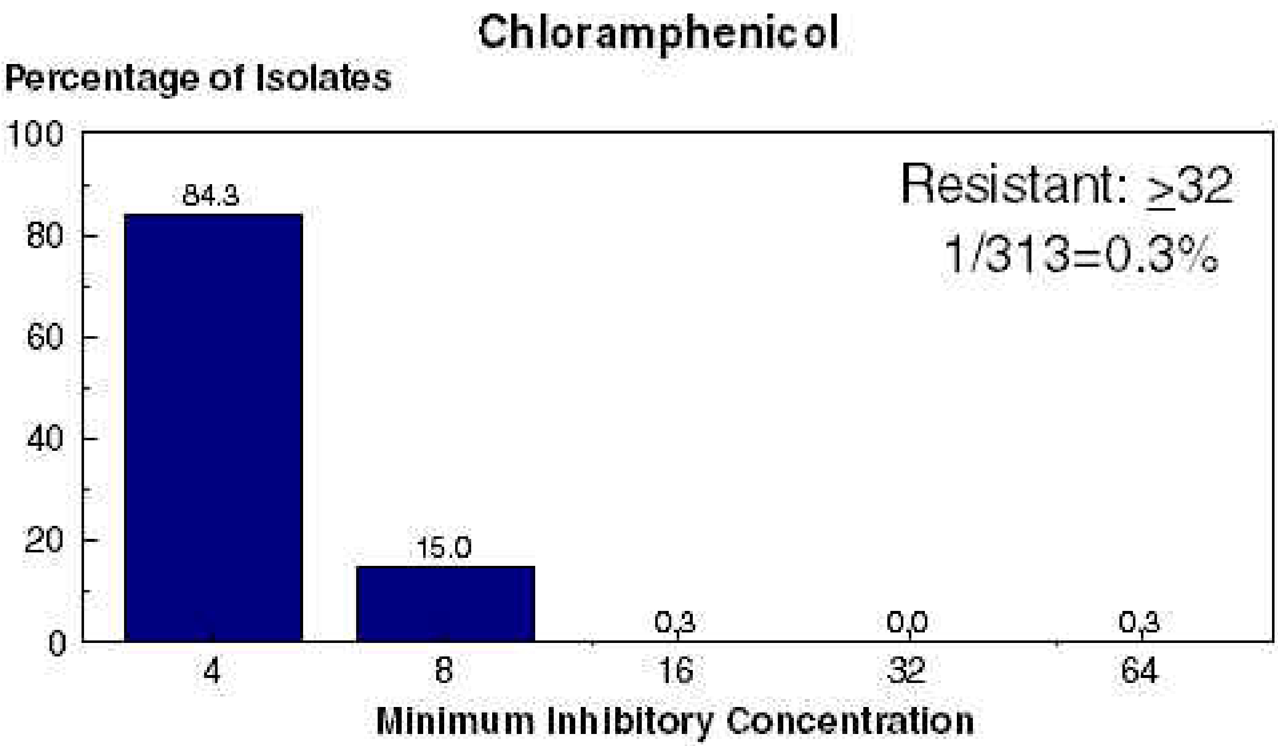

Ampicillin
Percentage of Isolates
100
80
60
40
20
0
Resistant: ≥32
8/313=2.6%
37.7
59.4
0.3
0.0
0.0
0.0
2.6
2
4
8
16
32
64
128
Minimum Inhibitory Concentration

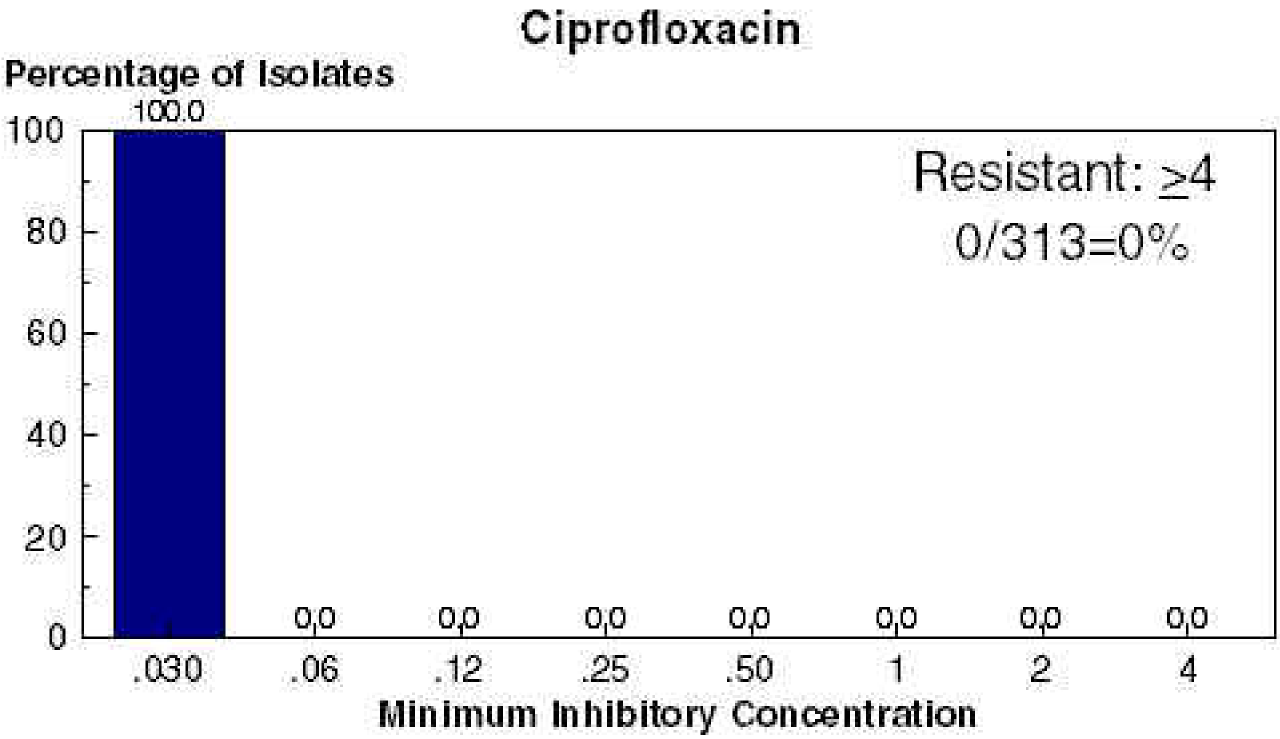

Apramycin
Percentage of Isolates
100
80
60
40
20
0
Resistant:≥32
0/313=0%
57.2
39.0
3.8
0.0
0.0
2
4
8
16
32
Minimum Inhibitory Concentration

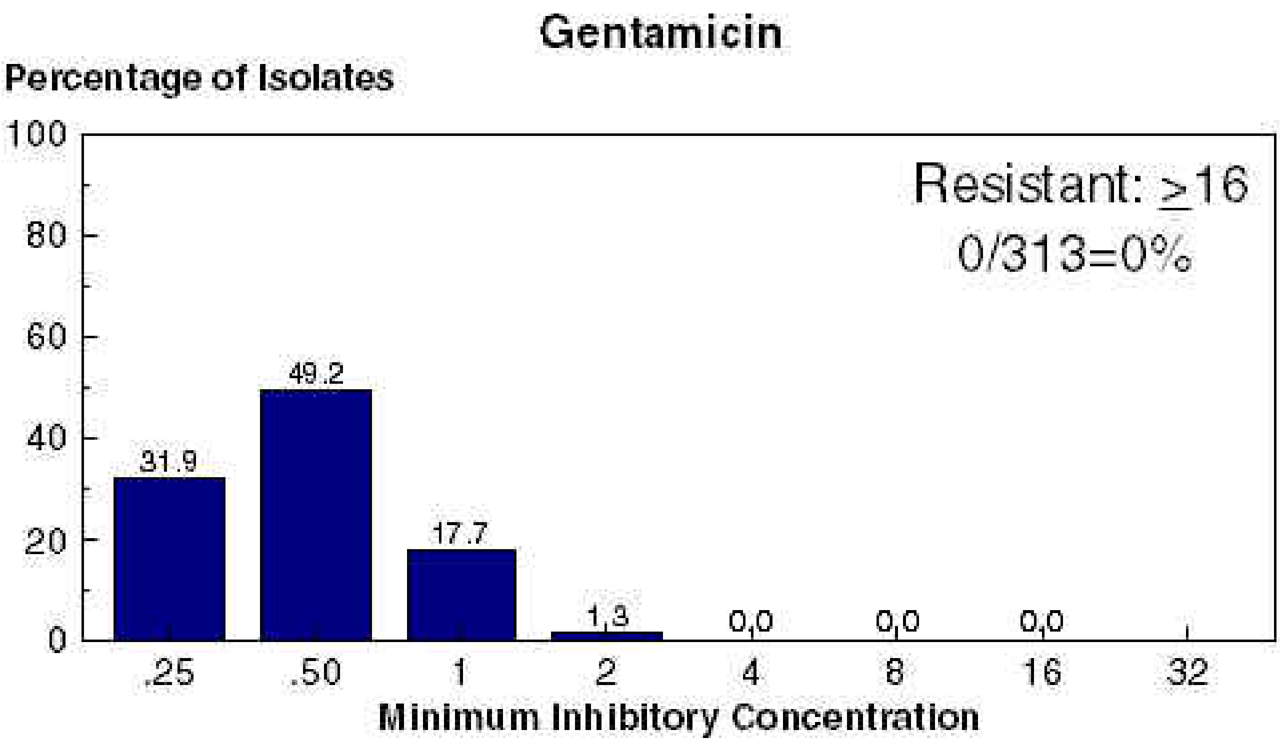

Ceftiofur
Percentage of Isolates
99.4
0.6
0.0
0.0
0.0
0.0
0.0
0
20
40
60
80
100
Resistant:>8
0/313=0%
0.5
1
2
4
8
16
32
Minimum Inhibitory Concentration

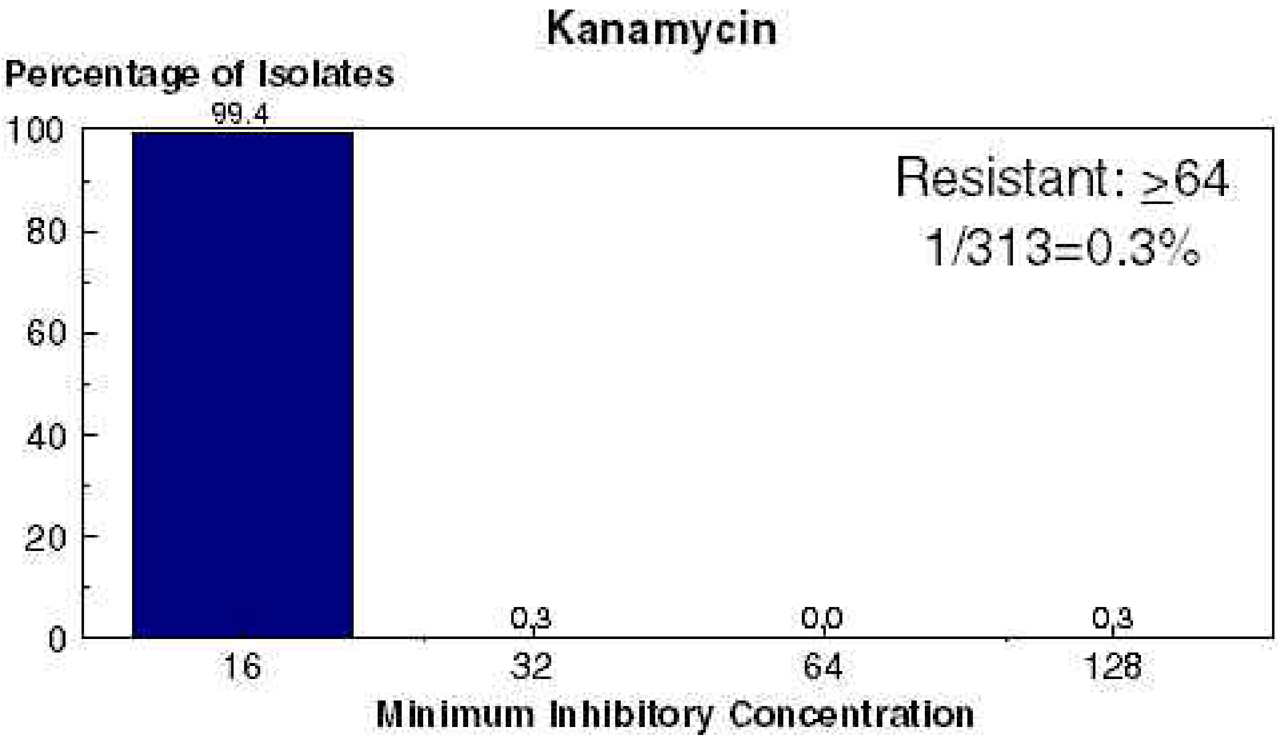

Ceftriaxone
Percentage of Isolates
100.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0
20
40
60
80
100
Resistant:>64
0/313=0%
0.25
0.50
1
2
4
8
16
32
64
Minimum Inhibitory Concentration

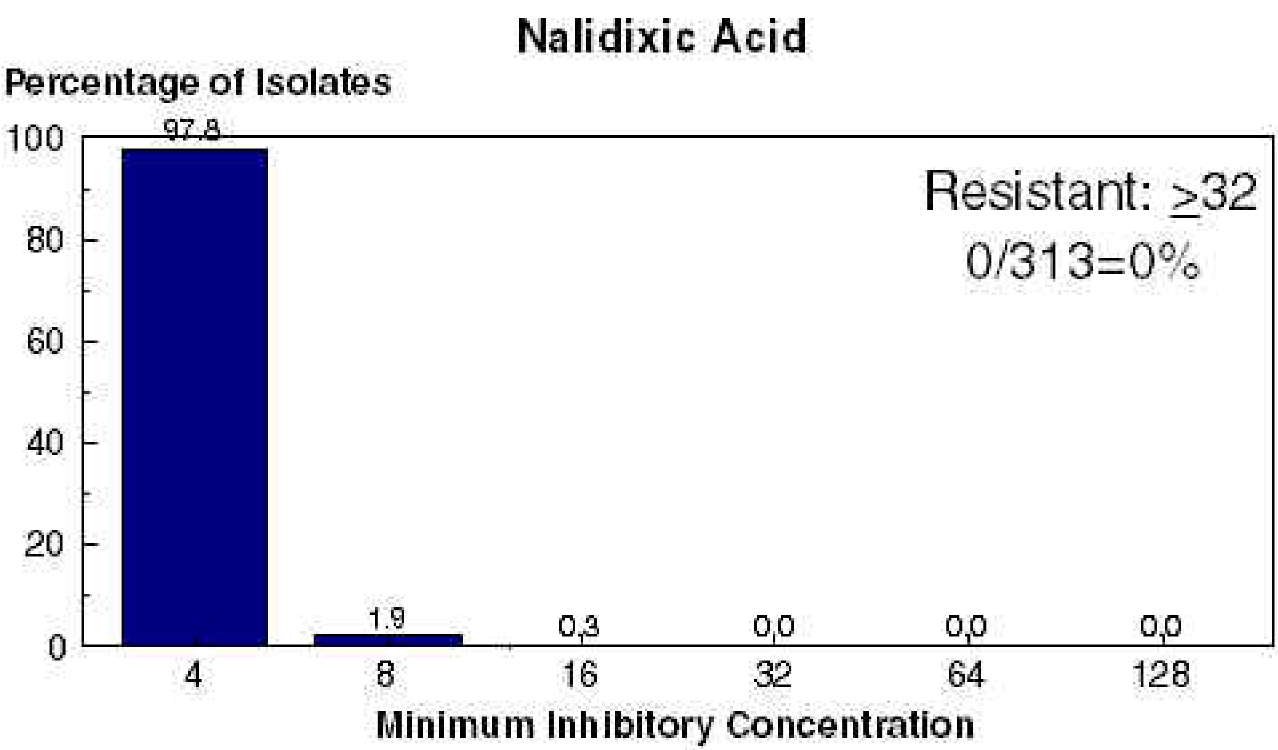

Cephalothin
Percentage of Isolates
100
80
60
40
20
0
Resistant: ≥32
0/313=0%
0.3
0.6
22
72.2
4.8
0
0
1
2
4
8
16
32
64
Minimum Inhibitory Concentration

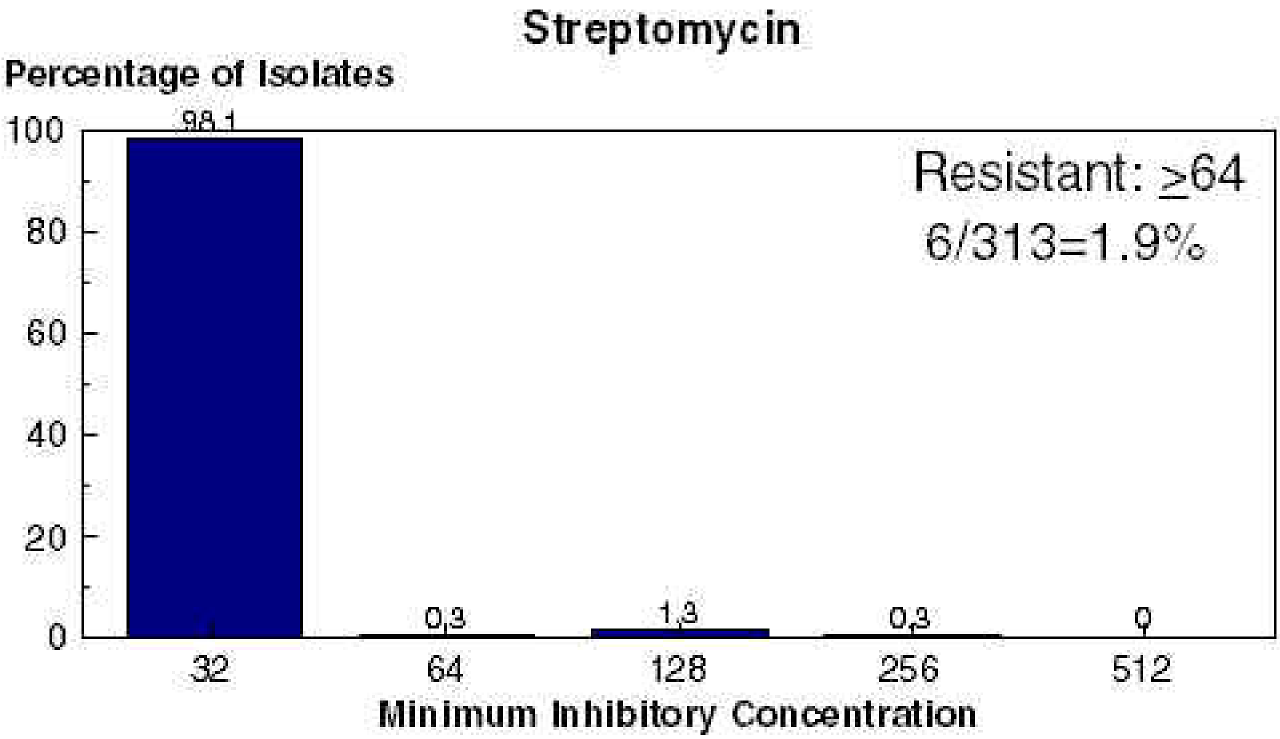

Chloramphenicol
Percentage of Isolates
100
80
60
40
20
0
Resistant: ≥32
1/313=0.3%
84.3
15.0
0.3
0.0
0.3
4
8
16
32
64
Minimum Inhibitory Concentration

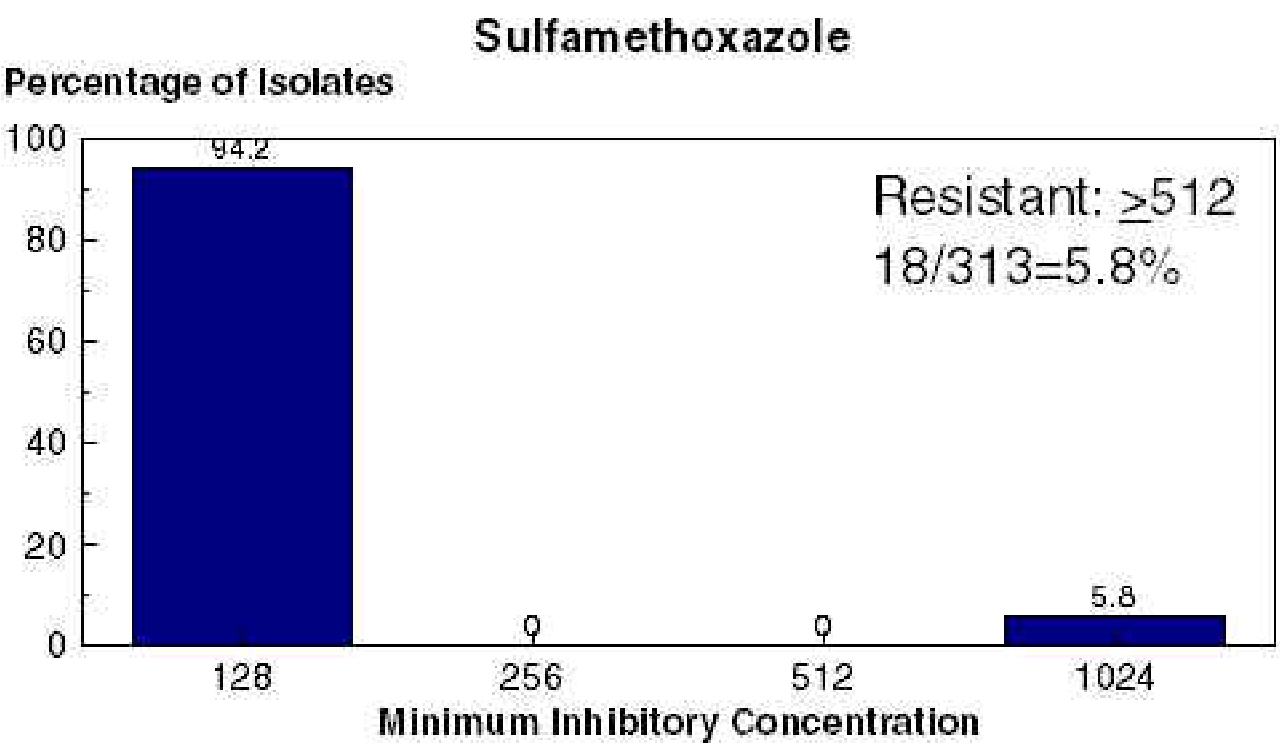

Ciprofloxacin
Percentage of Isolates
100.0
Resistant: >4
0/313=0%
0.0
0.0
0.0
0.0
0.0
0.0
0.0
.030
.06
.12
.25
.50
1
2
4
Minimum Inhibitory Concentration

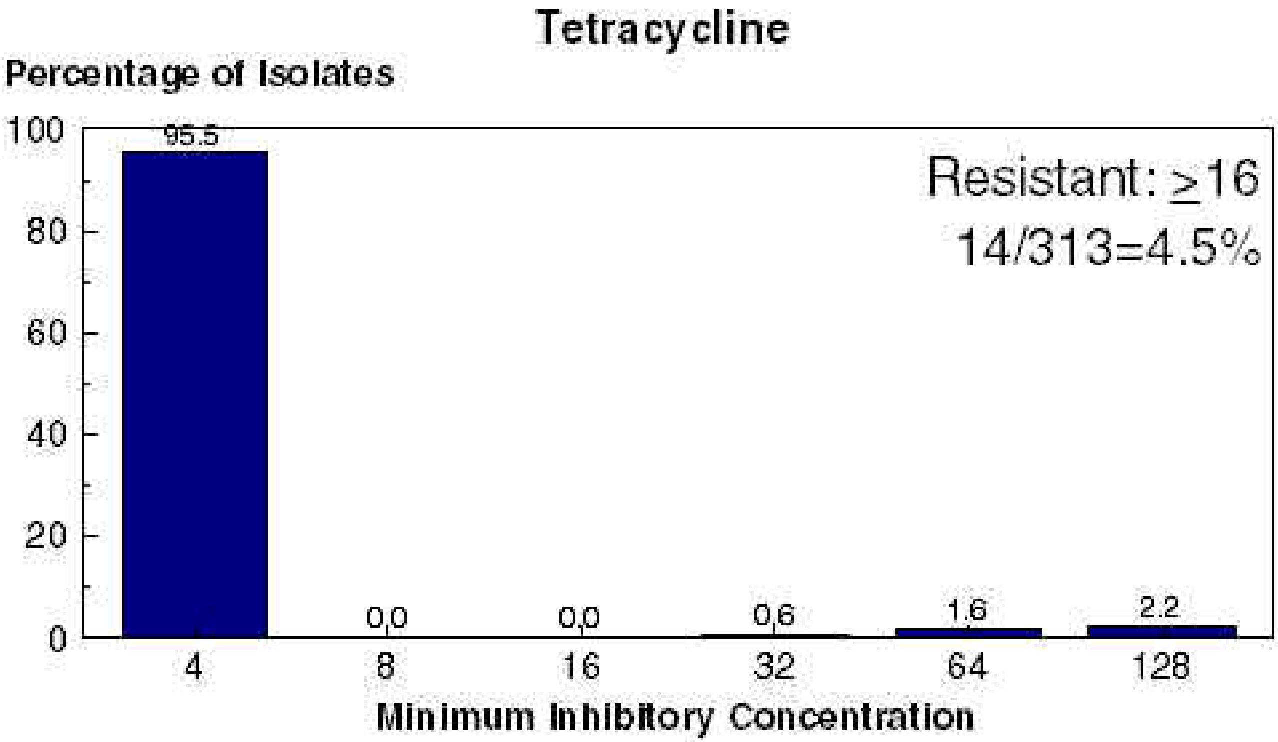

Gentamicin
Percentage of Isolates
Resistant: >16
0/313=0%
31.9
49.2
17.7
1.3
0.0
0.0
0.0
.25
.50
1
2
4
8
16
32
Minimum Inhibitory Concentration

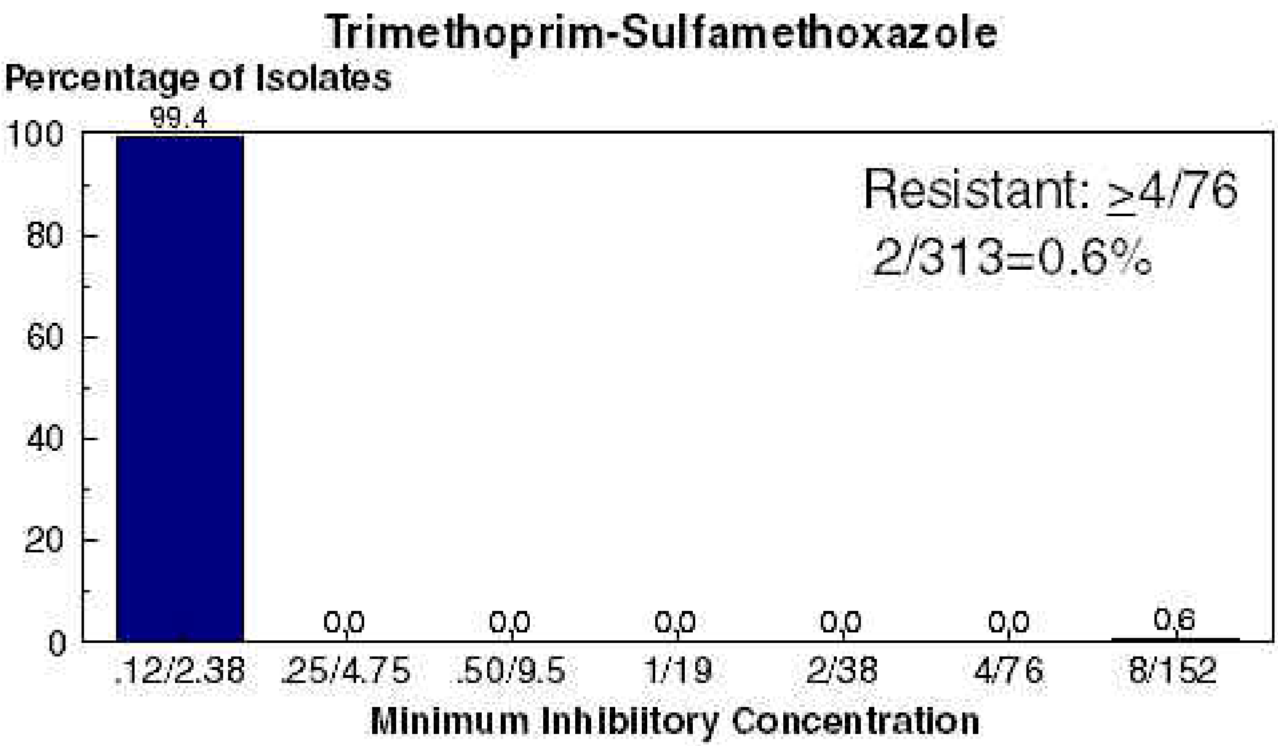

Kanamycin
Percentage of Isolates
99.4
100
80
60
40
20
0
Resistant: ≥64
1/313=0.3%
0.3
0.0
0.3
16
32
64
128
Minimum Inhibitory Concentration


Nalidixic Acid
Percentage of Isolates
97.8
100
80
60
40
20
0
Resistant: ≥32
0/313=0%
1.9
0.3
0.0
0.0
0.0
4
8
16
32
64
128
Minimum Inhibitory Concentration


Streptomycin
Percentage of Isolates
100
80
60
40
20
0
98.1
0.3
1.3
0.3
0
Resistant: ≥64
6/313=1.9%
32
64
128
256
512
Minimum Inhibitory Concentration


Sulfamethoxazole
Percentage of Isolates
100
80
60
40
20
0
94.2
0
0
5.8
Resistant: ≥512
18/313=5.8%
128
256
512
1024
Minimum Inhibitory Concentration

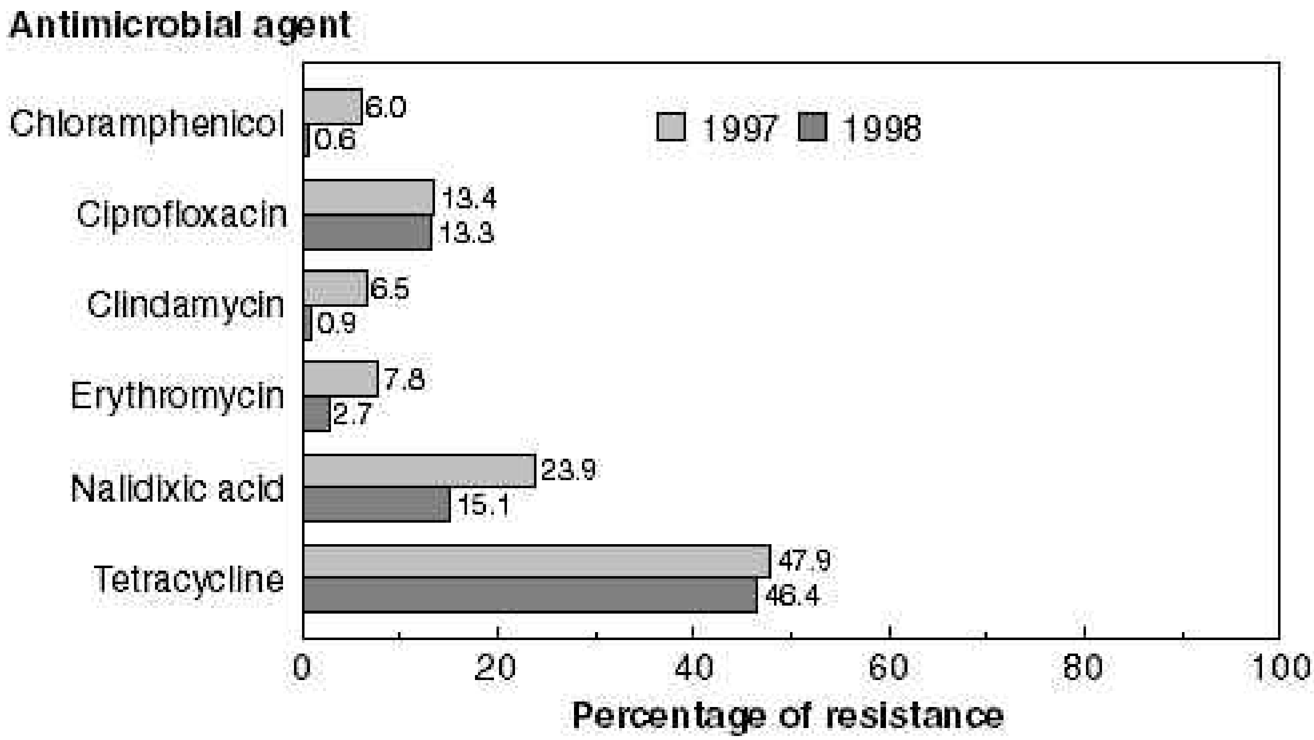




Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999

National Antimicrobial Resistance Monitoring System
1998 Annual Report

Figure 9: Resistance among *Campylobacter jejuni* isolates for all sites



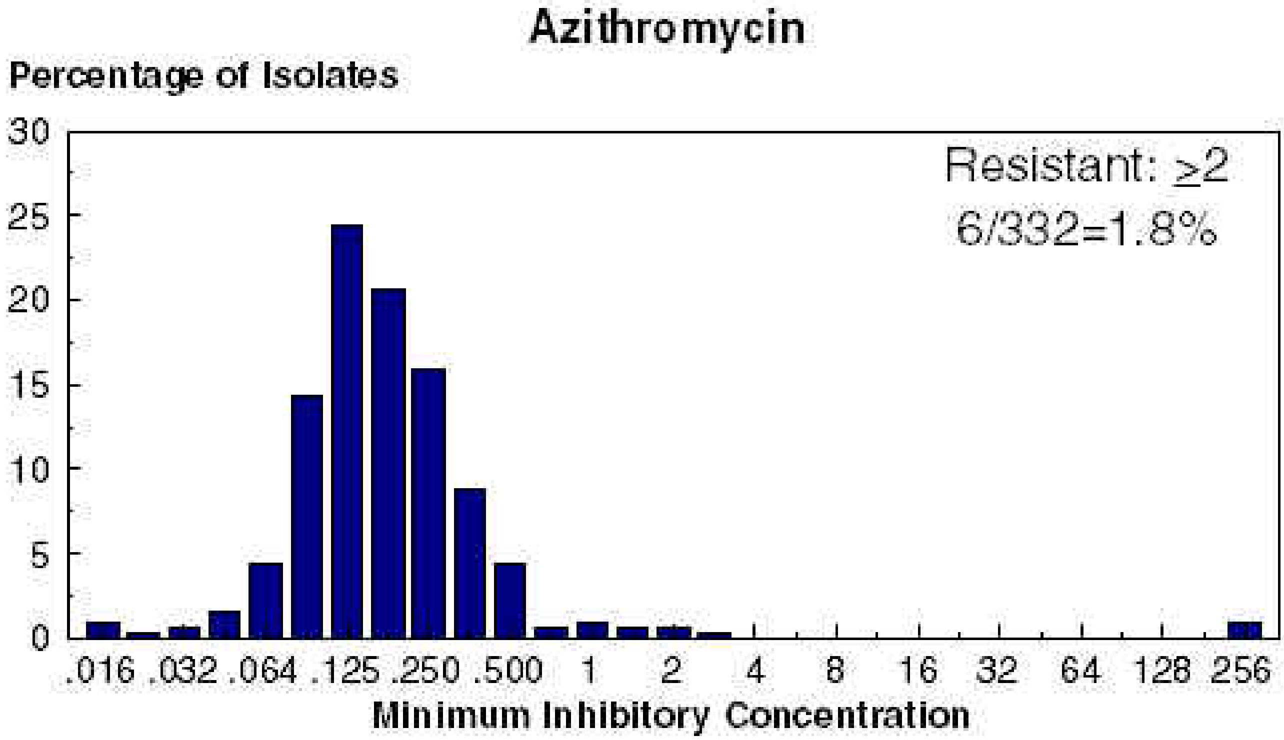
*agents tested in both years

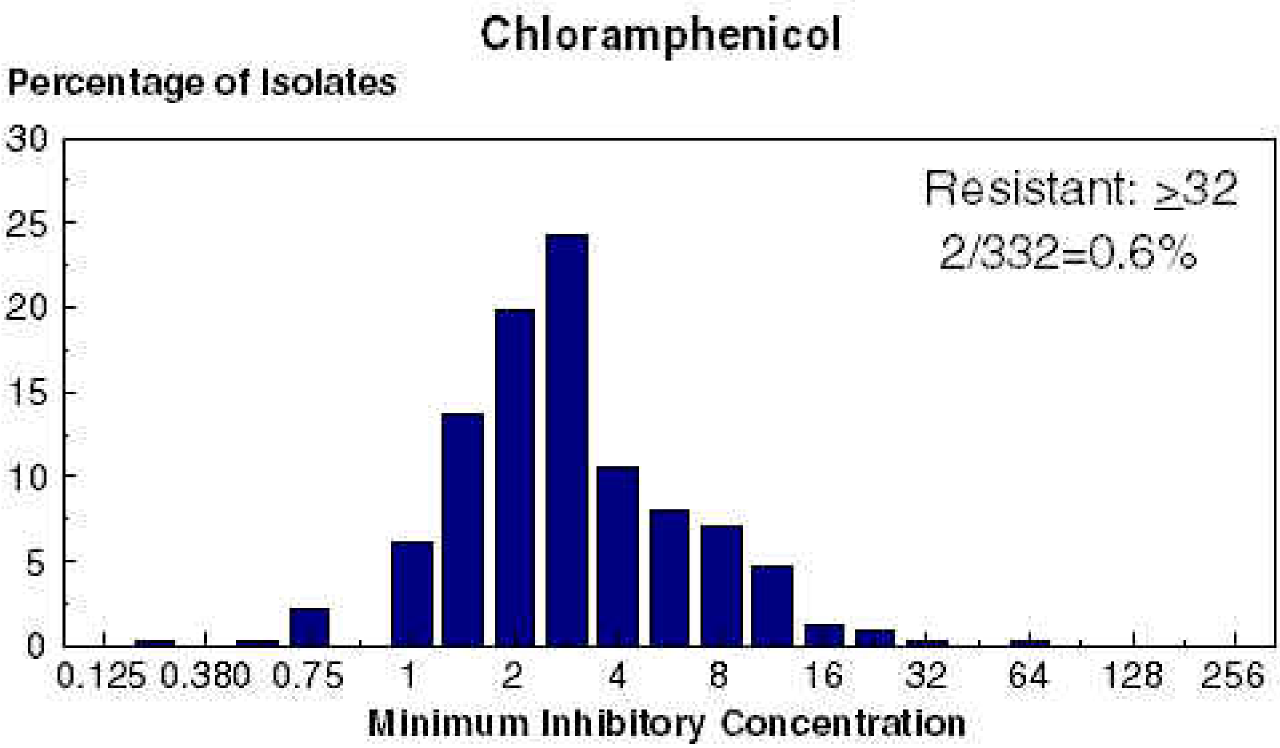
Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333

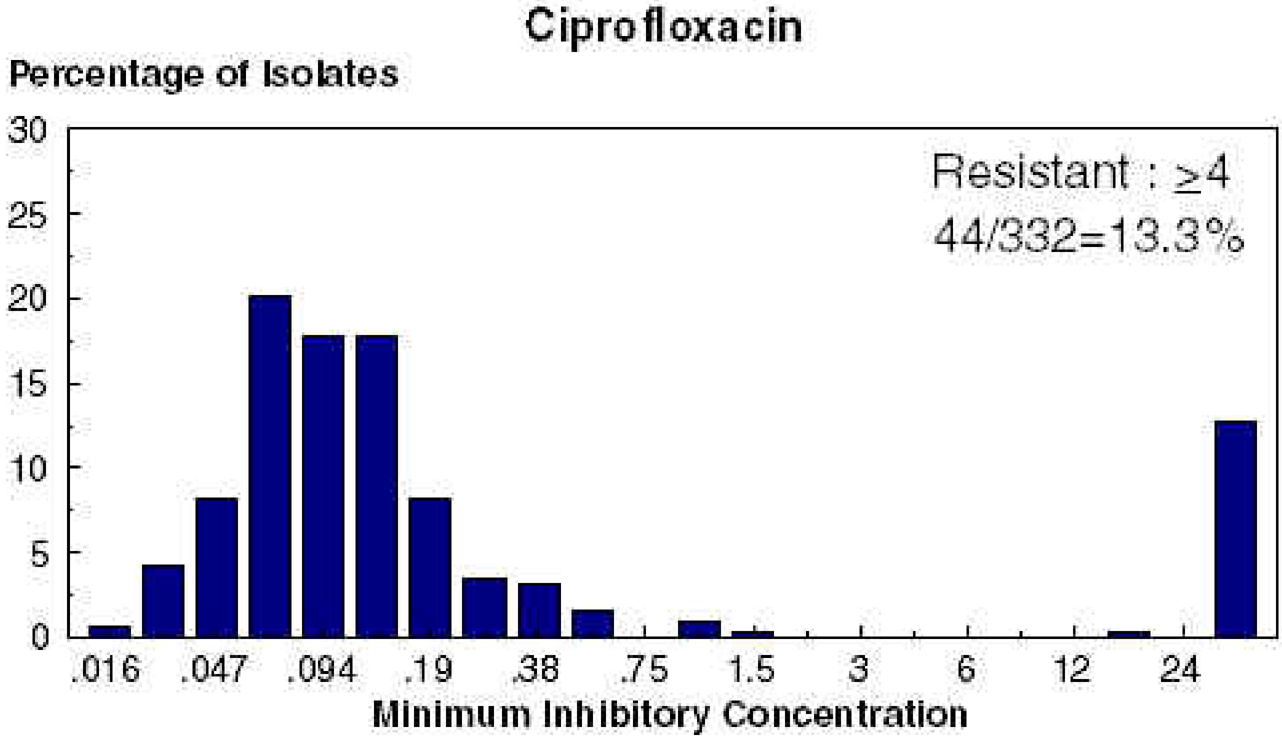
updated August 9, 1999

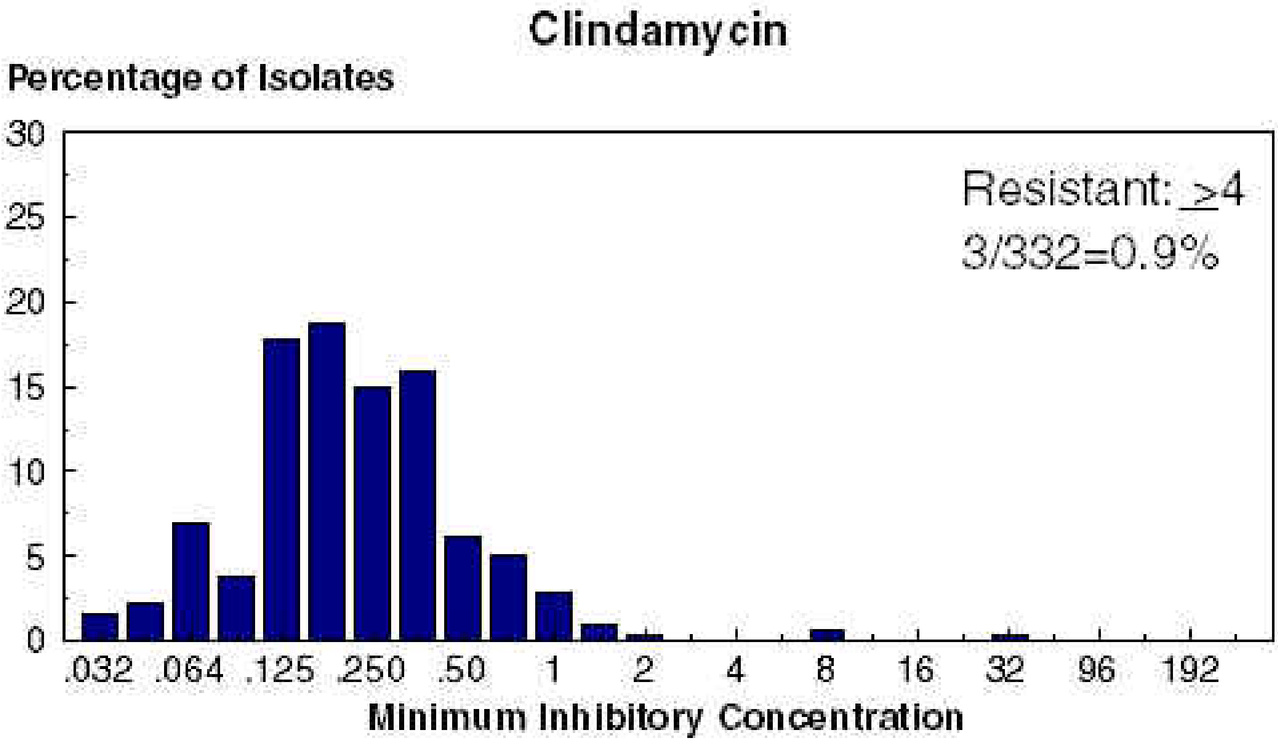
National Antimicrobial Resistance Monitoring System
1998 Annual Report

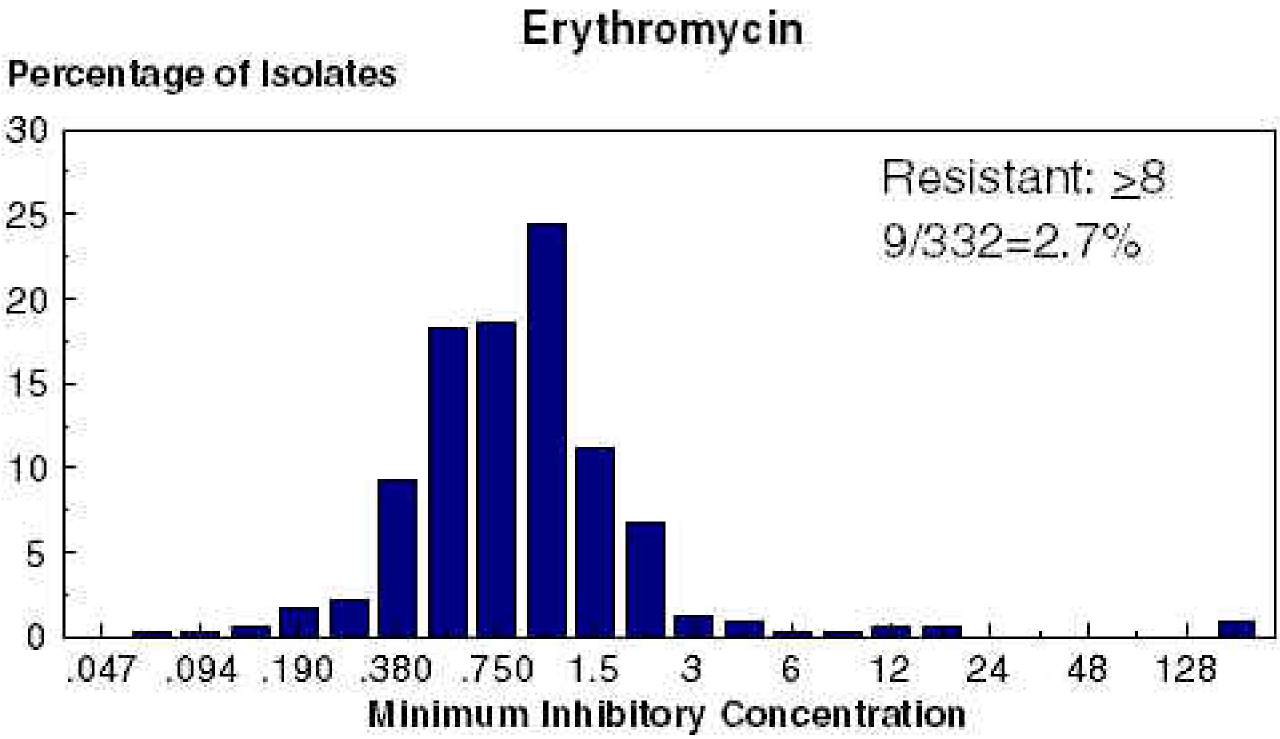
Figure 10: *Campylobacter jejuni* MICs, by antimicrobial agent

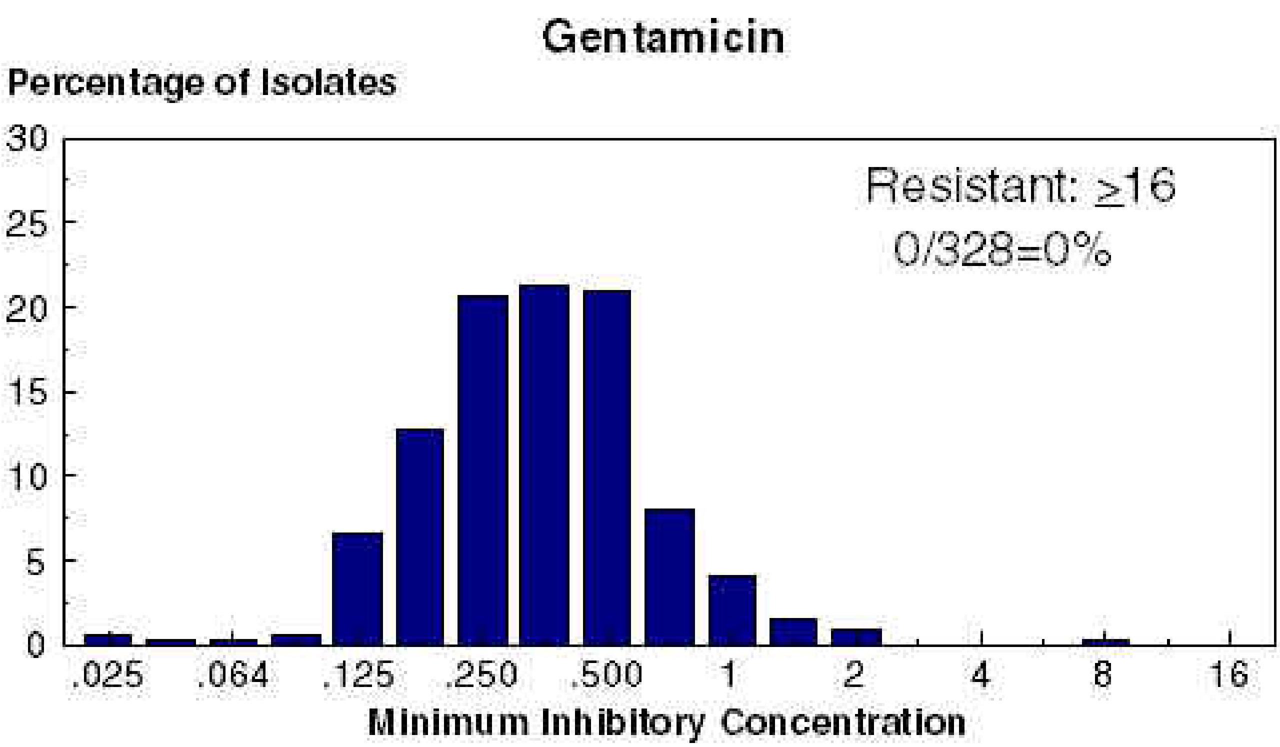


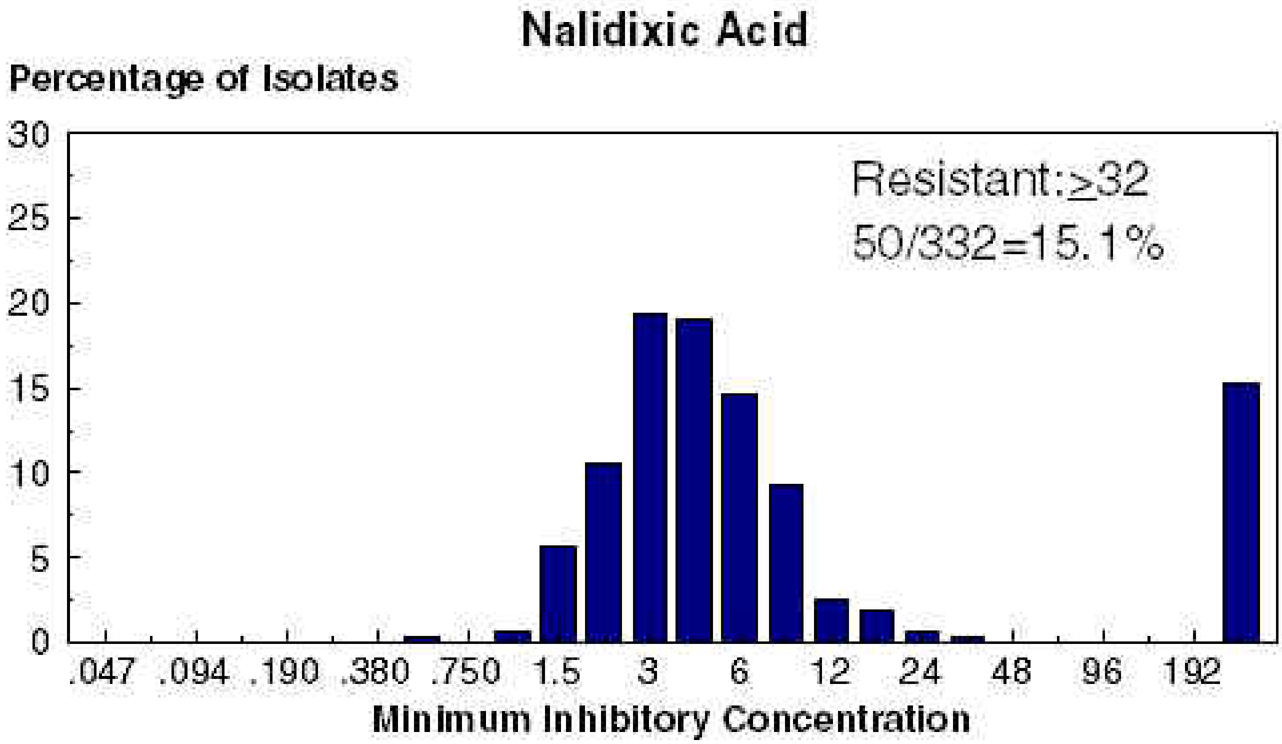


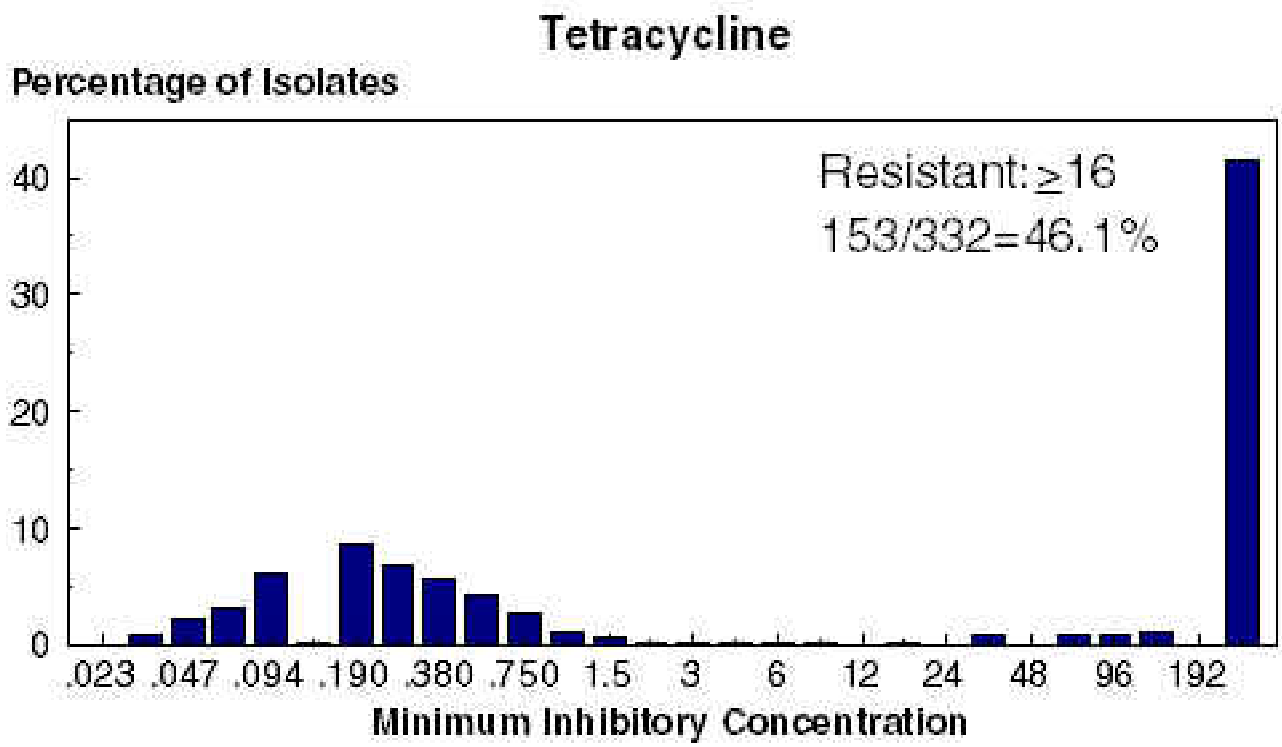

Ciprofloxacin
Percentage of Isolates
30
25
20
15
10
5
0
Resistant : ≥4
44/332=13.3%
.016
.047
.094
.19
.38
.75
1.5
3
6
12
24
Minimum Inhibitory Concentration


Clindamycin
Percentage of Isolates
30
25
20
15
10
5
0
Resistant: ≥4
3/332=0.9%
.032
.064
.125
.250
.50
1
2
4
8
16
32
96
192
Minimum Inhibitory Concentration


Erythromycin
Percentage of Isolates
30
25
20
15
10
5
0
Resistant: ≥8
9/332=2.7%
.047
.094
.190
.380
.750
1.5
3
6
12
24
48
128
Minimum Inhibitory Concentration


Gentamicin
Percentage of Isolates
30
25
20
15
10
5
0
Resistant: ≥16
0/328=0%
.025
.064
.125
.250
.500
1
2
4
8
16
Minimum Inhibitory Concentration





Centers for Disease Control and Prevention
National Center for Infectious Diseases | Division of Bacterial & Mycotic Diseases
1600 Clifton Rd NE
MS A-38
Atlanta GA 30333
updated August 9, 1999