Antimicrobial susceptibility of *Salmonella*, 2009

Hospital and community laboratories are requested to refer all *Salmonella* isolated from human salmonellosis cases to ESR for serotyping and the laboratory-based surveillance of this disease. *Salmonella* from other sources, including food, animal and environmental sources, are also referred to ESR for typing. The antimicrobial susceptibility of a sample (approximately 20%) of non-typhoidal *Salmonella* isolates and all typhoidal isolates is routinely tested at ESR. In addition, the susceptibility of all isolates belonging to internationally recognised multiresistant *S.* Typhimurium clones is tested. These clones include *S.* Typhimurium phage types DT104, U302, DT12, DT120 and DT193.

Susceptibility to 12 antimicrobials (Table 1) is determined by the Clinical and Laboratory Standards Institute's disc diffusion method.[1] All cephalothin-resistant isolates are further tested for the production of extended-spectrum β-lactamase (ESBL) and plasmid-mediated AmpC β-lactamase.

Non-typhoidal Salmonella

In 2009, the susceptibility of a representative sample of 415 non-typhoidal *Salmonella* was tested. The sample comprised 235 human and 180 animal/environmental isolates.

Resistance to each of the 12 antimicrobials tested and multiresistance is shown in Table 1. Antimicrobial resistance among *Salmonella* remains relatively low, with 92.1% (91.1% of human isolates and 93.3% of animal/environmental isolates) fully susceptible to all 12 antimicrobials.

Salmonella from human sources were significantly ($P < 0.05$) more resistant to ampicillin, chloramphenicol and nalidixic acid than *Salmonella* from other sources (ie, animal and environmental sources) (Table 1). These significant differences in resistance remained when the comparison between *Salmonella* from human sources and other sources was confined to just human salmonellosis cases who had no reported recent overseas travel.

Three (1.3%) of the 235 *Salmonella* from human sources produced ESBL and one (0.4%) human isolate produced plasmid-mediated AmpC β-lactamase. The three ESBL-producing *Salmonella* were different serotypes, but all three had the same type of ESBL: CTX-M-15. This is the most common ESBL type found among Enterobacteriaceae in New Zealand. The plasmid-mediated AmpC β-lactamase was a CIT type which is one of the two most common plasmid-mediated AmpC β-lactamase types found in this country.

Fluoroquinolone (ciprofloxacin)-susceptible strains of *Salmonella* that are resistant to the older-generation quinolone nalidixic acid may be associated with clinical failure or delayed response when fluoroquinolones are used to treat extra-intestinal salmonella infections. While only 0.9% of human isolates of non-typhoidal *Salmonella* tested in 2009 were ciprofloxacin resistant, an additional 3.0% were nalidixic acid resistant and therefore could fail fluoroquinolone treatment if causing an extra-intestinal infection.

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[1] Clinical and Laboratory Standards Institute. Performance standards for antimicrobial disks; approved standard - tenth edition. Wayne, PA, USA: CLSI; 2009. CLSI document M2-A10.

Table 1. Antimicrobial resistance among non-typhoidal *Salmonella*, 2009

	Percent resistance			P value for significance of any difference in resistance between human and other isolates[1]
Antimicrobial	**All isolates n = 415**	**Human isolates n = 235**	**Animal and environmental isolates n = 180**	
Ampicillin	3.1	5.5	0	0.0013
Cephalothin[2]	1.0	1.7	0	0.1364
Chloramphenicol	1.7	3.0	0	0.0206
Ciprofloxacin	0.5	0.9	0	0.5076
Co-amoxiclav	1.0	1.7	0	0.1364
Co-trimoxazole	1.2	2.1	0	0.0720
Gentamicin	1.0	1.7	0	0.1364
Nalidixic acid	2.2	3.8	0	0.0061
Streptomycin	5.1	5.1	5.0	0.9609
Sulphonamides	5.3	6.0	4.4	0.4954
Tetracycline	4.1	4.7	3.3	0.4925
Trimethoprim	1.2	2.1	0.0	0.0720
Multiresistant to ≥3 antimicrobials[3]	4.3	5.5	2.8	0.1722

1 Chi-square test or Fisher's Exact test as appropriate.

2 There were a total of four cephalothin-resistant isolates and these isolates were tested for the production of extended-spectrum β-lactamase (ESBL) and plasmid-mediated AmpC β-lactamase. Three of the cephalothin-resistant isolates were ESBL producers and the fourth had plasmid-mediated AmpC β-lactamase.

3 For estimates of multiresistance, ciprofloxacin and nalidixic acid resistance, and co-trimoxazole and trimethoprim resistance, was counted as one resistance.

There was no clear association of multidrug resistance with any particular serotypes. In 2009 there was one isolate of the internationally-recognised multiresistant *S.* Typhimurium phage type DT104, 11 of U302, three of DT12, and one of DT120. All isolates of these types were from human cases except for five of the U302 isolates and one of the DT12 isolates. No travel history was recorded for any of the human cases. However, most (81.3%) of the isolates of these types, and all those from animals, were not multiresistant.

Table 2 shows a comparison of resistance among isolates from salmonellosis cases reported to have travelled overseas with isolates from cases for whom no recent overseas travel was reported. Multiresistance and resistance to ampicillin, cephalothin, co-amoxiclav, sulphonamides and tetracycline was significantly higher ($P < 0.05$) among *Salmonella* from cases who had travelled.

Table 2. Antimicrobial resistance among non-typhoidal *Salmonella* from cases who had travelled overseas compared with non-travellers, 2009

	Percent resistance		P value for significance of any difference in resistance between travellers and non-travellers[1]
Antimicrobial	**Cases who had travelled overseas n = 22**	**Cases who had not travelled overseas n = 213**	
Ampicillin	18.2	4.2	0.0236
Cephalothin[2]	13.6	0.5	0.0027
Chloramphenicol	4.6	2.8	0.5022
Ciprofloxacin	0.0	0.9	1.0000
Co-amoxiclav	9.1	0.9	0.0448
Co-trimoxazole	4.6	1.9	0.3910
Gentamicin	4.6	1.4	0.3269
Nalidixic acid	9.1	3.3	0.2014
Streptomycin	13.6	4.2	0.0899
Sulphonamides	18.2	4.7	0.0310
Tetracycline	22.7	2.8	0.0014
Trimethoprim	4.6	1.9	0.3910
Multiresistant to ≥3 antimicrobials[3]	18.2	4.2	0.0236

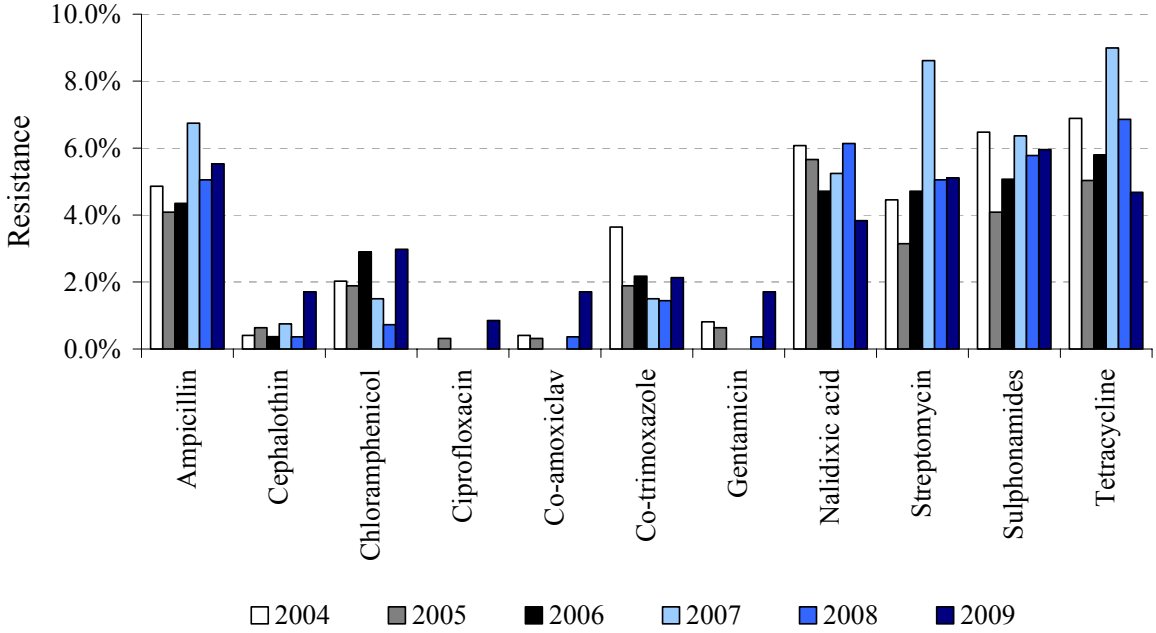
1 Chi-square test or Fisher's Exact test as appropriate.

2 Three of the four cephalothin-resistant isolates were from cases who were reported to have travelled overseas. Among the isolates from these three cases, two produced extended-spectrum β-lactamase (ESBL) and the other produced plasmid-mediated AmpC β-lactamase.

3 For estimates of multiresistance, ciprofloxacin and nalidixic acid resistance, and co-trimoxazole and trimethoprim resistance, was counted as one resistance.

Trends in resistance among *Salmonella* from human cases since 2004 are shown in Figure 1. There have been no significant (P <0.05) changes in resistance to any of the antibiotics during the last 6 years.

Figure 1. Resistance among non-typhoidal *Salmonella* from human cases, 2004-2009



Trimethoprim resistance not included as the rates of co-trimoxazole and trimethoprim resistance are almost invariably the same.

Typhoidal Salmonella

In 2009, 30 *S.* Typhi and 8 *S.* Paratyphi A isolates were referred to ESR. There were no *S.* Paratyphi B identified in 2009. Resistance to each of the 12 antimicrobials tested is shown in Table 3. None of the *S.* Typhi isolates were multiresistant. As has been noted in earlier years, there was a clear association between nalidixic acid resistance and *S.* Typhi acquired in Asia, particularly India. In contrast, both streptomycin-resistant *S.* Typhi isolates, from patients for whom a travel history was reported, were from patients who had been in Samoa.

Table 3. Antimicrobial resistance among *Salmonella* Typhi and *S.* Paratyphi, 2009

	Percent resistance	
Antimicrobial	***S.* Typhi n = 30**	***S.* Paratyphi A n = 8**
Ampicillin	0	0.0
Cephalothin	0	0.0
Chloramphenicol	0	0.0
Ciprofloxacin	0	0.0
Co-amoxiclav	0	0.0
Co-trimoxazole	0	0.0
Gentamicin	0	0.0
Nalidixic acid	40.0	87.5
Streptomycin	16.7	0.0
Sulphonamides	0	0.0
Tetracycline	0	0.0
Trimethoprim	0	0.0
Multiresistant to ≥3 antimicrobials	0	0.0