Antimicrobial susceptibility of *Salmonella*, 2008

A representative sample of 554 non-typhoidal *Salmonella*, chosen from isolates routinely referred to ESR for serotyping in 2008, was tested for antimicrobial susceptibility. The sample comprised 277 human and 277 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 90.1% (86.6% of human isolates and 93.5% of animal/environmental isolates) fully susceptible to all 12 antimicrobials.

Salmonella from human sources were significantly (P <0.05) more multiresistant and resistant to ampicillin, nalidixic acid and tetracycline than *Salmonella* from other sources (ie, animal and environmental sources) (Table 1). 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, co-trimoxazole and trimethoprim resistance was also significantly higher among human isolates. This result is consistent with the fact that co-trimoxazole and trimethoprim resistance was recorded only among isolates from human cases who had not travelled overseas (Table 2).

Table 1. Antimicrobial resistance among non-typhoidal Salmonella, 2008

	Percent resistance			**P value for significance of any difference in resistance between human and other isolates[1]**
Antimicrobial	**All isolates n = 554**	**Human isolates n = 277**	**Animal and environmental isolates n = 277**	
Ampicillin	2.9	5.1	0.7	0.0023
Cephalothin[2]	0.5	0.4	0.7	1.0000
Chloramphenicol	0.5	0.7	0.4	1.0000
Ciprofloxacin	0.0	0.0	0.0	-
Co-amoxiclav	0.5	0.4	0.7	1.0000
Co-trimoxazole	0.7	1.4	0.0	0.1236
Gentamicin	0.2	0.4	0.0	1.0000
Nalidixic acid	3.1	6.1	0.0	<0.0001
Streptomycin	5.2	5.1	5.4	0.8487
Sulphonamides	4.2	5.8	2.5	0.0553
Tetracycline	4.3	6.9	1.8	0.0035
Trimethoprim	0.9	1.8	0.0	0.0614
Multiresistant to ≥3 antimicrobials[3]	4.0	5.8	2.2	0.0296

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

[2] Cephalothin-resistant isolates were tested for the production of extended-spectrum β-lactamase (ESBL) and plasmid-mediated AmpC β-lactamase. Plasmid-mediated AmpC β-lactamase was identified in one isolate. No ESBL producers were identified.

[3] For estimates of multiresistance, co-trimoxazole and trimethoprim resistance was counted as one resistance.

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 no non-typhoidal *Salmonella* tested in 2008 were ciprofloxacin resistant, 6.1% of human isolates were nalidixic acid resistant and therefore could fail fluoroquinolone treatment if causing an extra-intestinal infection.

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. Resistance to nalidixic acid, streptomycin 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, 2008

	Percent resistance		**P value for significance of any difference in resistance between travellers and non-travellers[1]**
Antimicrobial	**Cases who had travelled overseas n = 26**	**Cases who had not travelled overseas n = 251**	
Ampicillin	7.7	4.8	0.6285
Cephalothin	0.0	0.4	1.0000
Chloramphenicol	0.0	0.8	1.0000
Ciprofloxacin	0.0	0.0	-
Co-amoxiclav	0.0	0.4	1.0000
Co-trimoxazole	0.0	1.6	1.0000
Gentamicin	0.0	0.4	1.0000
Nalidixic acid	23.1	4.4	0.0023
Streptomycin	15.4	4.0	0.0320
Sulphonamides	15.4	4.8	0.0510
Tetracycline	19.2	5.6	0.0229
Trimethoprim	0.0	2.0	1.0000
Multiresistant to ≥3 antimicrobials[2]	15.4	4.8	0.0510

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

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

There was no clear association of multidrug resistance with any particular serotypes. The incidence of the international multiresistant *S.* Typhimurium DT104 clone continues to be low in New Zealand, with no cases identified in 2008 and a total of 29 isolates in the last 10 years. In 2008, ESR began monitoring other internationally recognised multiresistant *S.* Typhimurium clones: U302, DT12, DT120 and DT193. All isolates of these types referred to ESR were susceptibility tested. In 2008, there was one isolate of U302 and one of DT12. The U302 isolate was isolated from a case who had recently travelled to Mexico and it was resistant to all antibiotics tested except co-trimoxazole, trimethoprim and ciprofloxacin, although it had reduced susceptibility to ciprofloxacin. The isolate also produced a plasmid-mediated AmpC β-lactamase. The DT12 isolate was fully susceptible.

All *S.* Typhi, *S.* Paratyphi A and *S.* Paratyphi B isolates referred to ESR in 2008 were tested for susceptibility to the same 12 antimicrobials as the non-typhoidal *Salmonella* (Table 3).

Based on the travel history information available, there was a clear association between nalidixic acid resistance and *S.* Typhi acquired in India, with all patients with nalidixic acid-resistant strains reported to have been in India recently. In addition, for the first time in 2008, ciprofloxacin resistance was identified in an *S.* Typhi isolate. The isolate was from a patient who had been in India. The isolate was not multiresistant as, in addition to ciprofloxacin, it was only resistant to nalidixic acid.

Table 3. Antimicrobial resistance among Salmonella Typhi and S. Paratyphi, 2008

	Percent resistance		
Antimicrobial	***S*. Typhi n = 29**	***S*. Paratyphi A n = 13**	***S*. Paratyphi B[1] n = 2**
Ampicillin	6.9	0.0	0.0
Cephalothin	0	0.0	0.0
Chloramphenicol	6.9	0.0	0.0
Ciprofloxacin	3.5	0.0	0.0
Co-amoxiclav	0	0.0	0.0
Co-trimoxazole	6.9	0.0	0.0
Gentamicin	0	0.0	0.0
Nalidixic acid	24.1	92.3	0.0
Streptomycin	41.4	0.0	0.0
Sulphonamides	6.9	0.0	0.0
Tetracycline	3.5	0.0	0.0
Trimethoprim	6.9	0.0	0.0
Multiresistant to ≥3 antimicrobials[2]	6.9	0.0	0.0

[1] *S*. Paratyphi B var Java isolates are not included with the other *S*. Paratyphi B isolates, as they are no longer considered to belong to the 'typhoidal' *Salmonella*.

[2] For estimates of multiresistance, co-trimoxazole and trimethoprim resistance was counted as one resistance.