

Antimicrobial susceptibility of *Salmonella*, 2013

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 multidrug-resistant *Salmonella* clones is tested. These clones include *S. Typhimurium* phage types DT12, DT104, DT120, DT193 and U302, and *S. enterica* serovar 4,[5],12:i:-.

Susceptibility to 12 antimicrobials (Table 1) is determined by the Clinical and Laboratory Standards Institute's (CLSI'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. Multidrug resistance is defined as resistance to ≥ 3 antibiotic classes.

Non-typhoidal Salmonella

In 2013, the antimicrobial susceptibility of a representative sample of 439 non-typhoidal *Salmonella* was tested. The sample comprised 257 human and 182 food/animal/environmental isolates.

Resistance to each of the 12 antimicrobials tested and multidrug resistance is shown in Table 1. Antimicrobial resistance among *Salmonella* remains relatively low, with 86.8% (81.7% of human isolates and 94.0% of food/animal/environmental isolates) fully susceptible to all 12 antimicrobials.

In 2013, the CLSI interpretive standards for ciprofloxacin were changed again to a uniform set of breakpoints applicable to all *Salmonella*. Previously the interpretive standards for typhoidal *Salmonella* and extraintestinal non-typhoidal *Salmonella* infections differed from those for other *Salmonella*. With the application of the new standards, none of the non-typhoidal *Salmonella* tested in 2013 were categorised as ciprofloxacin resistant.

Five (1.9%) of the human *Salmonella* tested in 2013 produced ESBL. These five ESBL-producing *Salmonella* were different serotypes: *S. Infantis*, *S. Saintpaul*, *S. Stanley*, *S. Typhimurium* and *S. Weltevreden*. The ESBL-producing *S. Typhimurium* isolate co-produced a CMY-2-like plasmid-mediated AmpC β -lactamase. Three of the five cases with an ESBL-producing *Salmonella* (the cases with *S. Infantis*, *S. Saintpaul* and *S. Weltevreden*) were reported to have recently travelled overseas.

¹ Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; twenty-third informational supplement. Wayne, PA, USA: CLSI, 2013. CLSI document M100-S23.

Salmonella from human sources were significantly ($P < 0.05$) more resistant to ampicillin, cotrimoxazole, nalidixic acid, streptomycin, sulphonamides, tetracycline and trimethoprim, and more multidrug resistant, than *Salmonella* from other sources (ie, food, animal and environmental sources) (Table 1). When the comparison between *Salmonella* from human sources and other sources was confined to only human salmonellosis cases who had no reported recent overseas travel, resistance to ampicillin, nalidixic acid, tetracycline and multidrug resistance remained significantly higher among *Salmonella* from human sources.

Table 1. Antimicrobial resistance among non-typhoidal *Salmonella*, 2013

Antimicrobial	Percent resistant			P value for significance of any difference in resistance between human and other isolates ¹
	All isolates n = 439	Human isolates n = 257	Food/animal/ environmental isolates n = 182	
Ampicillin	5.9	10.1	0.0	<0.001
Cephalothin ²	1.1	2.0	0.0	0.080
Chloramphenicol	2.1	3.1	0.6	0.087
Ciprofloxacin	0.0	0.0	0.0	-
Co-amoxiclav	0.5	0.8	0.0	0.514
Co-trimoxazole	1.4	2.3	0.0	0.044
Gentamicin	0.7	1.2	0.0	0.270
Nalidixic acid	4.3	6.6	1.1	0.005
Streptomycin	5.0	7.0	2.2	0.023
Sulphonamides	6.4	8.6	3.3	0.026
Tetracycline	6.8	11.3	0.6	<0.001
Trimethoprim	1.4	2.3	0.0	0.044
Multiresistant to ≥3 antimicrobials ³	5.5	9.0	0.6	<0.001

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

2 There were five cephalothin-resistant isolates. All five isolates produced extended-spectrum β -lactamase (ESBL). These five ESBL-producing *Salmonella* were all isolated from human salmonellosis cases. One of the five ESBL-producing isolates co-produced a CMY-2-like plasmid-mediated AmpC β -lactamase.

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

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. Except for co-amoxiclav and ciprofloxacin, resistance to all antimicrobials and multidrug resistance was higher among *Salmonella* isolates from cases who had travelled, however, the differences were only significant ($P < 0.05$) for ampicillin, streptomycin, sulphonamides, tetracycline and multidrug resistance.

Table 2. Antimicrobial resistance among non-typhoidal *Salmonella* from cases who had travelled overseas compared with non-travellers, 2013

Antimicrobial	Percent resistant		P value for significance of any difference in resistance between travellers and non-travellers ¹
	Cases who had travelled overseas n = 28	Cases who had not travelled overseas n = 229	
Ampicillin	32.1	7.4	<0.001
Cephalothin	3.6	1.8	0.441
Chloramphenicol	3.6	3.1	1.000
Ciprofloxacin	0.0	0.0	-
Co-amoxiclav	0.0	0.9	1.000
Co-trimoxazole	7.1	1.8	0.130
Gentamicin	3.6	0.9	0.294
Nalidixic acid	14.3	5.7	0.099
Streptomycin	25.0	4.8	0.001
Sulphonamides	21.4	7.0	0.021
Tetracycline	42.9	7.4	<0.001
Trimethoprim	7.1	1.8	0.130
Multiresistant to ≥ 3 antimicrobials ²	28.6	6.6	0.001

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

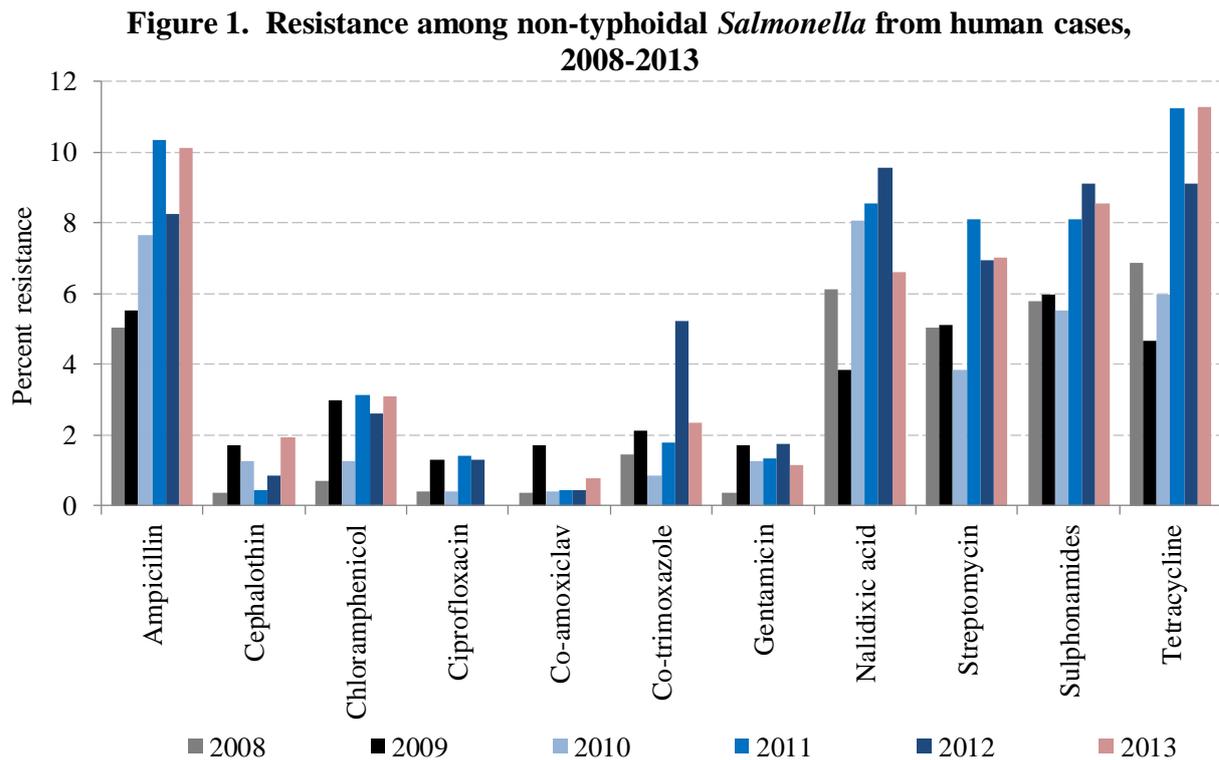
2 For estimates of multidrug resistance, ciprofloxacin and nalidixic acid resistance, and co-trimoxazole and trimethoprim resistance, was counted as one resistance.

In 2013, 14 isolates of the internationally recognised multidrug-resistant *S. Typhimurium* phage type DT193 and one isolate of *S. Typhimurium* phage type DT12 were identified. Four of the 14 DT193 isolates were from animal sources, including the one isolate that was multidrug resistant. The DT12 isolate was not multidrug resistant. No isolates of the other internationally recognised multidrug-resistant *S. Typhimurium* clones, that is, DT104, DT120 and U302, were identified in 2013.

S. enterica serovar 4,[5],12:i:- is a monophasic variant of *S. Typhimurium*, and isolates are typically multidrug resistant to ampicillin, streptomycin, sulphonamides and tetracycline. This serovar is now among the 10 most common *Salmonella* serovars isolated from humans in many countries in Europe, and was the seventh most common in New Zealand in 2013. Thirty-four isolates of *S. enterica* serovar 4,[5],12:i:- were identified in New Zealand in 2013, and all were from human salmonellosis cases. Twenty-four of the 34 isolates (70.6%) were multidrug resistant; 22 of which had the resistance pattern typical of this serovar, that

is, resistant to at least ampicillin, streptomycin, sulphonamides and tetracycline. Nineteen (55.9%) of the patients with this *Salmonella* serovar were reported to have recently travelled overseas, with the country or region recorded for 17 cases: Thailand (8 cases), Cambodia (2), Philippines (2), South-East Asia – not otherwise specified (2), Tonga (2), and Japan (1).

Trends in resistance among *Salmonella* from human cases since 2008 are shown in Figure 1. There have been significant ($P < 0.05$) increases in resistance to ampicillin and tetracycline over the last 6 years.



Trimethoprim resistance not shown as the rates of co-trimoxazole and trimethoprim resistance are almost invariably the same. The ciprofloxacin resistance rates for all years shown are based on the CLSI interpretive standards revised in 2013.

Typhoidal Salmonella

In 2013, 50 *S. Typhi* and 14 *S. Paratyphi A* isolates were referred to ESR. Resistance among these typhoidal *Salmonella* to each of the 12 antimicrobials tested is shown in Table 3.

One of the *S. Typhi* isolates was multidrug resistant, and this isolate was from a patient reported to have recently travelled to Pakistan. Four patients had ciprofloxacin-resistant *S. Typhi*. These four ciprofloxacin-resistant isolates were, as expected, also nalidixic acid-resistant, and there were a further five nalidixic acid-resistant, ciprofloxacin-susceptible *S. Typhi* isolates. All nine patients with ciprofloxacin and/or nalidixic acid-resistant *S. Typhi* were reported to have recently travelled to the Indian subcontinent.

As has been observed in previous years, a large proportion (50%, 7/14) of the *S. Paratyphi A* isolates were nalidixic acid resistant. Two of these nalidixic acid-resistant isolates were also ciprofloxacin resistant. All nalidixic acid-resistant and ciprofloxacin-resistant *S. Paratyphi A* were from patients reported to have recently travelled to the Indian subcontinent.

Table 3. Antimicrobial resistance among *Salmonella Typhi* and *S. Paratyphi*, 2013

Antimicrobial	Percent (number) resistant	
	<i>S. Typhi</i> n = 50	<i>S. Paratyphi A</i> ¹ n = 14
Ampicillin	2.0 (1)	0.0 (0)
Cephalothin	0.0 (0)	0.0 (0)
Chloramphenicol	2.0 (1)	0.0 (0)
Ciprofloxacin	8.0 (4)	14.3 (2)
Co-amoxiclav	0.0 (0)	0.0 (0)
Co-trimoxazole	2.0 (1)	0.0 (0)
Gentamicin	0.0 (0)	0.0 (0)
Nalidixic acid	18.0 (9)	50.0 (7)
Streptomycin	80.0 (40)	14.3 (2)
Sulphonamides	2.0 (1)	0.0 (0)
Tetracycline	2.0 (1)	0.0 (0)
Trimethoprim	2.0 (1)	0.0 (0)
Multiresistant to ≥3 antimicrobials ²	2.0 (1)	0.0 (0)

- 1 No *S. Paratyphi B* were referred in 2013. *S. Paratyphi B* var Java isolates are not included with the *S. Paratyphi B* isolates, as they are no longer considered to belong to the typhoidal *Salmonella*.
- 2 For estimates of multidrug resistance, ciprofloxacin and nalidixic acid resistance, and co-trimoxazole and trimethoprim resistance, was counted as one resistance.