Antimicrobial susceptibility of *Salmonella*, 2014

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 (PMACBL). Multidrug resistance is defined as resistance to ≥3 antibiotic classes.

Non-typhoidal Salmonella

In 2014, the antimicrobial susceptibility of a representative sample of 345 non-typhoidal *Salmonella* was tested. The sample comprised 205 isolates from human sources and 140 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 85.5% (79.5% of human isolates and 94.3% of food/animal/environmental isolates) fully susceptible to all 12 antimicrobials.

Three (1.5%) of the *Salmonella* from human sources tested in 2014 produced a β-lactamase that would confer resistance to 3rd-generation cephalosporins such as ceftriaxone. Two of these isolates produced a CMY-2-like PMACBL and the third isolate produced an ESBL. One of the cases with a PMACBL-producing *Salmonella* (*S.* Enteritidis phage type RDNC-Sep 14) had recently been in Bali, Indonesia.

Two (1.0%) *Salmonella* from human sources were ciprofloxacin resistant: one *S*. Hadar and one *S*. Kentucky isolate. Both cases had recently travelled in South East Asia. In addition, another 62 (18.0%) isolates had intermediate ciprofloxacin resistance: 39 (19.0%) from human sources and 23 (16.4%) from other sources (ie, food, animal and environmental sources). Patients infected with *Salmonella* strains that test as ciprofloxacin intermediate may fail fluoroquinolone treatment or have a delayed response to such treatment.

Salmonella from human sources were significantly ($P < 0.05$) more resistant to ampicillin, nalidixic acid, streptomycin and sulphonamides, and more multidrug resistant, than *Salmonella* from other 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, there were no significant differences in resistance to any of the antibiotics or in multidrug resistance.

Table 1. Antimicrobial resistance among non-typhoidal *Salmonella*, 2014

	Percent resistant			**P value for significance of any difference in resistance between human and other isolates[1]**
Antimicrobial	**All isolates n = 345**	**Human isolates n = 205**	**Food/animal/ environmental isolates n = 140**	
Ampicillin	7.0	9.8	2.9	0.013
Cephalothin[2]	1.7	2.4	0.7	0.407
Chloramphenicol	2.9	3.9	1.4	0.211
Ciprofloxacin	0.6	1.0	0.0	0.516
Co-amoxiclav	0.9	1.5	0.0	0.275
Co-trimoxazole	1.7	2.4	0.7	0.407
Gentamicin	0.9	0.5	1.4	0.569
Nalidixic acid	6.1	8.3	2.9	0.038
Streptomycin	5.2	7.3	2.1	0.034
Sulphonamides	4.6	6.8	1.4	0.019
Tetracycline	7.3	9.3	4.3	0.080
Trimethoprim	1.7	2.4	0.7	0.407
Multiresistant to ≥3 antimicrobials[3]	5.8	7.8	2.9	0.054

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

2 There were six cephalothin-resistant isolates. Two of these isolates produced a CMY-2-like plasmid-mediated AmpC β-lactamase and a third isolate produced extended-spectrum β-lactamase (ESBL). These three isolates were from human salmonellosis cases.

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. *Salmonella* isolates from people who had travelled were significantly ($P < 0.05$) more resistant to ampicillin, nalidixic acid, streptomycin and tetracycline, and more multidrug resistant.

Table 2. Antimicrobial resistance among non-typhoidal *Salmonella* from cases who had travelled overseas compared with non-travellers, 2014

	Percent resistant		P value for significance of any difference in resistance between travellers and non-travellers[1]
Antimicrobial	**Cases who had travelled overseas n = 38**	**Cases who had not travelled overseas n = 167**	
Ampicillin	26.3	6.0	<0.001
Cephalothin	2.6	2.4	1.000
Chloramphenicol	7.9	3.0	0.168
Ciprofloxacin	2.6	0.6	0.337
Co-amoxiclav	2.6	1.2	0.461
Co-trimoxazole	2.6	2.4	1.000
Gentamicin	0.0	0.6	1.000
Nalidixic acid	26.3	4.2	<0.001
Streptomycin	18.4	4.8	0.009
Sulphonamides	13.2	5.4	0.144
Tetracycline	21.1	6.6	0.011
Trimethoprim	2.6	2.4	1.000
Multiresistant to ≥3 antimicrobials[2]	18.4	5.4	0.014

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 2014, several isolates belonging to internationally recognised multidrug-resistant *Salmonella* clones were identified. These included:

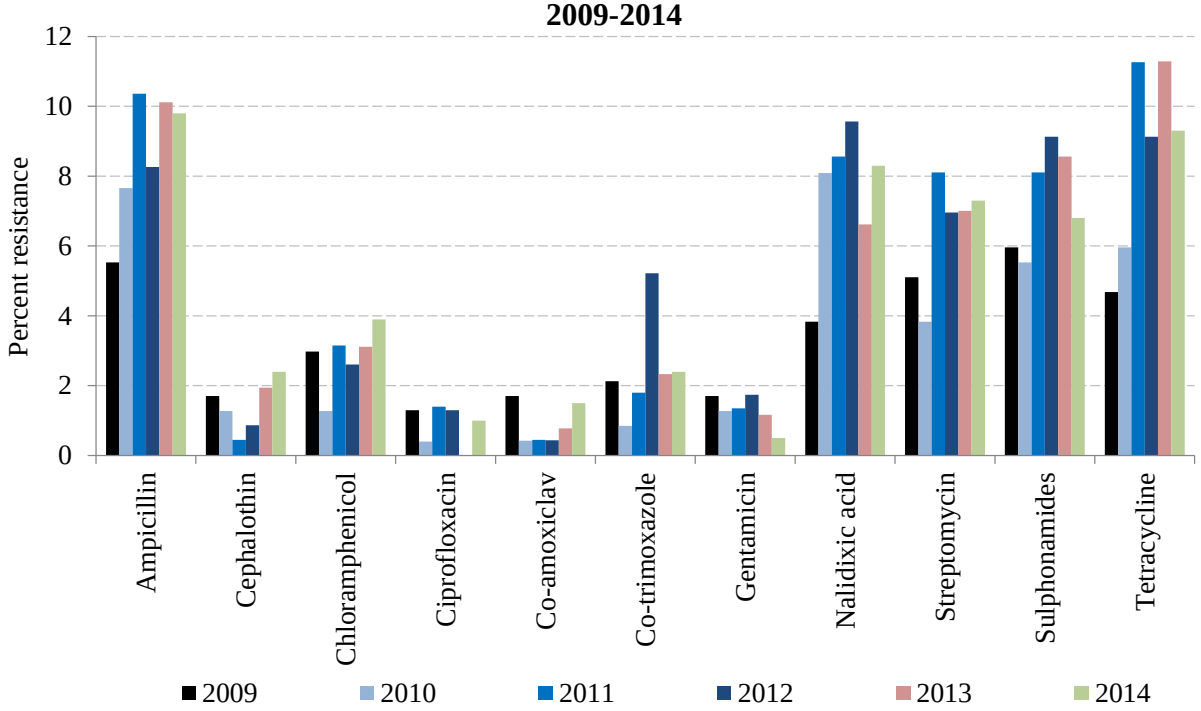
- 27 isolates of *S.* Typhimurium phage type DT193, 10 of which were from animal sources. Only three of the 27 isolates were multidrug resistant: one isolate from a person who had recently travelled to Cambodia, one equine isolate and one bovine isolate.
- 5 isolates of *S.* Typhimurium phage type DT120. All five isolates were from human cases. Only one isolate was multidrug resistant and was from a person who had recently travelled to Cambodia.
- 1 isolate of *S.* Typhimurium phage type U302 from a human case. This isolate was multidrug resistant.

No isolates of the other internationally recognised multidrug-resistant *S.* Typhimurium clones, that is, DT104 or DT12 were identified in 2014.

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 eleventh most common in New Zealand in 2014. Twenty-seven isolates of *S. enterica* serovar 4,[5],12:i:- were identified in New Zealand in 2014, and all were from human salmonellosis cases. Twenty-four of the 27 isolates (88.9%) were multidrug resistant with the resistance pattern typical of this serovar, that is, resistant to at least ampicillin, streptomycin, sulphonamides and tetracycline. Travel history was reported for 23 of the 27 cases, 22 of whom had recently travelled overseas with the country or region reported for 20 cases: Thailand (10 cases), Cambodia (3), Bali (2), Vietnam (1), China (1), South-East Asia – not otherwise specified (1), Asia – not otherwise specified (1), and Mexico (1).

Trends in resistance among *Salmonella* from human cases since 2009 are shown in Figure 1. There has been a significant (P <0.05) increase in tetracycline resistance over the last 6 years.

Figure 1. Resistance among non-typhoidal *Salmonella* from human cases, 2009-2014



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 2014, 43 *S.* Typhi, 7 *S.* Paratyphi A and 1 *S.* Paratyphi B isolates were referred to ESR. Resistance among these typhoidal *Salmonella* to each of the 12 antimicrobials tested is shown in Table 3.

Two of the *S.* Typhi isolates were multidrug resistant, and these isolates were from two members of the same family who had recently been in Zimbabwe. Six (14.0%) *S.* Typhi isolates were ciprofloxacin resistant and another 22 (51.2%) isolates had intermediate ciprofloxacin resistance. All patients with ciprofloxacin-resistant *S.* Typhi and 77.3% (17/22) with ciprofloxacin-intermediate *S.* Typhi had recently travelled to India.

Table 3. Antimicrobial resistance among *Salmonella* Typhi and *S*. Paratyphi, 2014

	Percent (number) resistant		
Antimicrobial[1]	***S*. Typhi n = 43**	***S*. Paratyphi A n = 7**	***S*. Paratyphi B[2] n = 1**
Ampicillin	4.7 (2)	0.0 (0)	0.0 (0)
Cephalothin	0.0 (0)	0.0 (0)	0.0 (0)
Chloramphenicol	4.7 (2)	0.0 (0)	0.0 (0)
Ciprofloxacin	14.0 (6)	0.0 (0)	0.0 (0)
Co-amoxiclav	0.0 (0)	0.0 (0)	0.0 (0)
Co-trimoxazole	4.7 (2)	0.0 (0)	0.0 (0)
Gentamicin	0.0 (0)	0.0 (0)	0.0 (0)
Nalidixic acid	62.8 (27)	57.1 (4)	0.0 (0)
Streptomycin	37.2 (16)	14.3 (1)	0.0 (0)
Sulphonamides	4.7 (2)	0.0 (0)	0.0 (0)
Tetracycline	0.0 (0)	0.0 (0)	0.0 (0)
Trimethoprim	4.7 (2)	0.0 (0)	0.0 (0)
Multiresistant to ≥3 antimicrobials[3]	4.7 (2)	0.0 (0)	0.0 (0)

1 The azithromycin susceptibility of typhoidal *Salmonella* isolates will be tested from 2015 onwards.

2 *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*.

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

[1] Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; twenty-fourth informational supplement. Wayne, PA, USA: CLSI; 2014. CLSI document M100-S24.