**Antimicrobial susceptibility of *Salmonella*, 2012**

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 *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. Multiresistance is defined as resistance to ≥3 antibiotic classes.

*Non-typhoidal Salmonella*

In 2012, the susceptibility of a representative sample of 433 non-typhoidal *Salmonella* was tested. The sample comprised 230 human and 203 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 88.2% (82.2% of human isolates and 95.1% of animal/environmental isolates) fully susceptible to all 12 antimicrobials. None of the *Salmonella* tested in 2012 produced ESBL or plasmid-mediated AmpC β-lactamase.

*Salmonella* from human sources were significantly ($P < 0.05$) more resistant to ampicillin, co-trimoxazole, nalidixic acid, streptomycin, sulphonamides, tetracycline and trimethoprim, and more multiresistant, 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 only human salmonellosis cases who had no reported recent overseas travel, resistance to co-trimoxazole, nalidixic acid, sulphonamides, tetracycline and trimethoprim, and multiresistance, remained significantly higher among *Salmonella* from human sources.

In 2012, the CLSI introduced additional ciprofloxacin interpretive standards specifically for typhoidal and extraintestinal non-typhoidal *Salmonella* infections. While none of the non-typhoidal *Salmonella* tested in 2012 would be categorised as ciprofloxacin resistant using the interpretive standards applied to intestinal infections (Table 1), three isolates from human sources (0.7% of all non-typhoidal *Salmonella* tested and 1.3% of human isolates) would be categorised as resistant using the standards applied to extraintestinal infections.

[1] Clinical and Laboratory Standards Institute. Performance standards for antimicrobial disks; approved standard – eleventh edition. Wayne, PA, USA: CLSI; 2012. CLSI document M02-A11.

**Table 1. Antimicrobial resistance among non-typhoidal *Salmonella*, 2012**

| | Percent resistance | | | P value for significance of any difference in resistance between human and other isolates[1] |
|---|---|---|---|---|
| **Antimicrobial** | **All isolates n = 433** | **Human isolates n = 230** | **Animal and environmental isolates n = 203** | |
| Ampicillin | 5.5 | 8.3 | 2.5 | 0.009 |
| Cephalothin[2] | 0.7 | 0.9 | 0.5 | 1.000 |
| Chloramphenicol | 1.6 | 2.6 | 0.5 | 0.127 |
| Ciprofloxacin[3] | 0.0 | 0.0 | 0.0 | - |
| Co-amoxiclav | 0.2 | 0.4 | 0.0 | 1.000 |
| Co-trimoxazole | 2.8 | 5.2 | 0.0 | 0.001 |
| Gentamicin | 0.9 | 1.7 | 0.0 | 0.126 |
| Nalidixic acid | 5.3 | 9.6 | 0.5 | <0.001 |
| Streptomycin | 4.6 | 7.0 | 2.0 | 0.014 |
| Sulphonamides | 5.5 | 9.1 | 1.5 | <0.001 |
| Tetracycline | 5.5 | 9.1 | 1.5 | <0.001 |
| Trimethoprim | 2.8 | 5.2 | 0.0 | 0.001 |
| Multiresistant to ≥3 antimicrobials[4] | 5.3 | 9.1 | 1.0 | <0.001 |

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

2 There were three cephalothin-resistant isolates. These three isolates were tested, and were negative, for the production of extended-spectrum β-lactamase and plasmid-mediated AmpC β-lactamase.

3 CLSI ciprofloxacin interpretive standards for non-typhoidal *Salmonella* from intestinal sources applied (ie, zone diameter ≥21 mm = susceptible; 16-20 mm = intermediate; ≤15 mm = resistant). Based on the interpretive standards for extraintestinal *Salmonella* infections, three (0.7%) isolates would be categorised as ciprofloxacin resistant. These three isolates were all from human sources.

4 For estimates of multiresistance, 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. Resistance to ampicillin, chloramphenicol, co-trimoxazole, gentamicin, nalidixic acid, streptomycin, sulphonamides, tetracycline and trimethoprim, and multiresistance, 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, 2012**

| | 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 = 208** | |
| Ampicillin | 45.5 | 4.3 | <0.001 |
| Cephalothin | 4.6 | 0.5 | 0.183 |
| Chloramphenicol | 27.3 | 0.0 | <0.001 |
| Ciprofloxacin[2] | 0.0 | 0.0 | - |
| Co-amoxiclav | 0.0 | 0.5 | 1.000 |
| Co-trimoxazole | 18.2 | 3.9 | 0.019 |
| Gentamicin | 13.6 | 0.50 | 0.003 |
| Nalidixic acid | 40.9 | 6.3 | <0.001 |
| Streptomycin | 22.7 | 5.3 | 0.011 |
| Sulphonamides | 36.4 | 6.3 | <0.001 |
| Tetracycline | 36.4 | 6.3 | <0.001 |
| Trimethoprim | 18.2 | 3.9 | 0.019 |
| Multiresistant to ≥3 antimicrobials[3] | 36.4 | 6.3 | <0.001 |

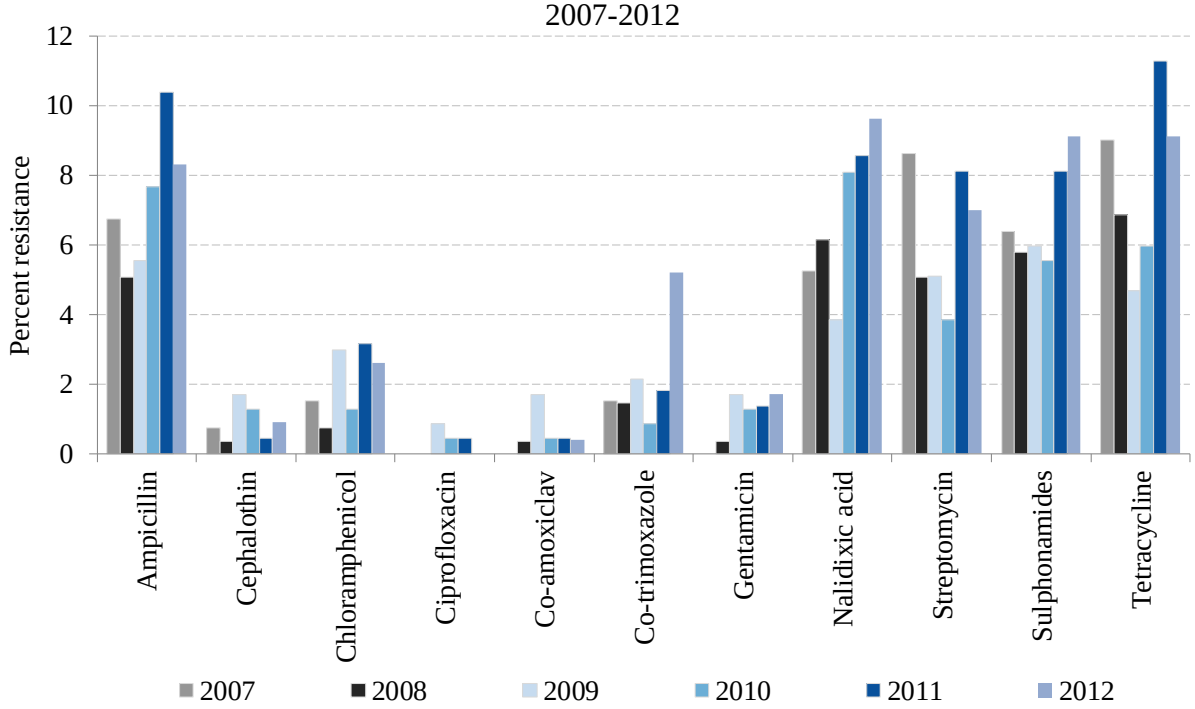
1 Chi-square test or Fisher's Exact test as appropriate.
2 CLSI ciprofloxacin interpretive standards for non-typhoidal *Salmonella* from intestinal sources applied (ie, zone diameter ≥21 mm = susceptible; 16-20 mm = intermediate; ≤15 mm = resistant).
3 For estimates of multiresistance, ciprofloxacin and nalidixic acid resistance, and co-trimoxazole and trimethoprim resistance, was counted as one resistance.

In 2012, 22 isolates of the internationally recognised multiresistant *S.* Typhimurium phage type DT193, three isolates of DT120 and one isolate of U302 were identified. However, none of the phage type DT193 isolates were multiresistant. Two of the phage type DT120 and the U302 isolate were multiresistant. These three multiresistant isolates were from human salmonellosis cases, two of whom were reported to have recently travelled overseas to Indonesia (DT120 case) and China (U302 case).

*S. enterica* serovar 4,[5],12:i:- is a monophasic variant of *S.* Typhimurium, and isolates are typically multiresistant 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. Thirty-eight isolates of *S. enterica* serovar 4,[5],12:i:- were identified in New Zealand in 2012, and all were from human salmonellosis cases. All 38 isolates were multiresistant; 35 of which had the resistance pattern typical of the serovar, that is, resistant to at least ampicillin, streptomycin, sulphonamides and tetracycline. Twelve of the patients with this *Salmonella* serovar were reported to have recently travelled overseas: Thailand (8 cases), China (2), Europe (1), and country not specified (1).

Trends in resistance among *Salmonella* from human cases since 2007 are shown in Figure 1. There have been significant ($P < 0.05$) increases in resistance to co-trimoxazole, gentamicin and nalidixic acid during the last 6 years.

Figure 1. Resistance among non-typhoidal *Salmonella* from human cases, 2007-2012




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

*Typhoidal Salmonella*

In 2012, 41 *S.* Typhi and 16 *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.

Two patients had multiresistant *S.* Typhi; both patients had recently travelled to India. In previous years, nalidixic acid resistance in *S.* Typhi has been associated with infections acquired in India and South East Asia, but not infections acquired in the Pacific Islands. However in 2012, among the 20 patients with nalidixic acid-resistant *S.* Typhi, six had recently travelled to Samoa and the remaining 14 had been in India.

As has been observed in previous years, most (75%) of the *S.* Paratyphi A isolates were nalidixic acid resistant.

**Table 3. Antimicrobial resistance among *Salmonella* Typhi and *S*. Paratyphi, 2012**

| | **Percent resistance** | |
|---|---|---|
| **Antimicrobial** | ***S*. Typhi n = 41** | ***S*. Paratyphi A[1] n = 16** |
| Ampicillin | 4.9 | 0.0 |
| Cephalothin | 0.0 | 0.0 |
| Chloramphenicol | 4.9 | 0.0 |
| Ciprofloxacin[2] | 0.0 | 0.0 |
| Co-amoxiclav | 0.0 | 0.0 |
| Co-trimoxazole | 4.9 | 0.0 |
| Gentamicin | 0.0 | 0.0 |
| Nalidixic acid | 48.8 | 75.0 |
| Streptomycin | 48.8 | 12.5 |
| Sulphonamides | 4.9 | 0.0 |
| Tetracycline | 0.0 | 0.0 |
| Trimethoprim | 4.9 | 0.0 |
| Multiresistant to ≥3 antimicrobials[3] | 6.3 | 0.0 |

1 No *S*. Paratyphi B were referred in 2012. *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 CLSI ciprofloxacin interpretive standards for typhoidal *Salmonella* applied (ie, zone diameter ≥31 mm = susceptible; 21-30 mm = intermediate; ≤20 mm = resistant).

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