Chapter 6

ANTIMICROBIAL SENSITIVITY IN SALMONELLAS 2008

Salmonella isolates received for serotyping at VLA Weybridge and Lasswade are tested for their *in vitro* sensitivity to 16 antimicrobials. All of these isolates originate from animals, their feed or their environment in England and Wales. The choice of antimicrobials, which is reviewed periodically, is designed to comprise a representative core set. Most of the antimicrobials have been used in veterinary practice for many years, but some of the more recently licensed products, and some of limited usage in animals in Great Britain, together with some which are used exclusively in human medicine have been chosen.

In 2001, the 30µg cefuroxime disc that had been used in previous years, was replaced with a 30µg ceftazidime disc and in 2004 the 30µg cefoperazone and 25µg colistin discs were replaced with 30µg cefotaxime and 1 µg ciprofloxacin discs respectively. These changes were made to enhance the detection of resistance to third generation cephalosporins and fluoroquinolones.

In 2007, the interpretative criterion was changed for ciprofloxacin from the historical VLA veterinary breakpoint of resistant $\leq$ 13mm used in previous years, to the BSAC breakpoint of resistant or intermediate $\leq$ 19mm (this breakpoint was that recommended by BSAC on 1/1/2007, see www.bsac.org.uk). Trends in ciprofloxacin resistance should therefore be interpreted taking into account this change to the breakpoint. Similarly in 2007, the interpretative criterion for ceftazidime was changed to resistant $\leq$ 27mm, amikacin to resistant $\leq$ 18mm and cefotaxime to resistant $\leq$ 29mm.

In 2008 the streptomycin 25µg disc was replaced with a 10µg disc and the chloramphenicol 10µg disc was replaced with a 30µg disc. These changes were made to comply with the latest BSAC recommendations. Zone size versus MIC studies at VLA also showed that use of a streptomycin 10µg disc gave much better separation of the resistant and susceptible populations. Zone size criteria which were changed in 2008 comprised ceftazidime, resistant $\leq$ 29mm (formerly R $\leq$ 27mm), sulphamethoxazole/ trimethoprim resistant $\leq$ 15mm (formerly R $\leq$ 13mm), amoxicillin/ clavulanate resistant $\leq$ 14mm (formerly R $\leq$ 13mm), chloramphenicol resistant $\leq$ 20mm (formerly R $\leq$ 13mm) and gentamicin resistant $\leq$ 19mm (formerly R $\leq$ 13mm). All tests are performed using a disc diffusion technique on Oxoid “Isosensitest” agar using the antibiotic discs listed below:

	Antimicrobial	Concentration (µg per ml)	Code	Zone Size (R≤x mm)
1	Nalidixic acid	(30 µg)	NA	13
2	Tetracycline	(10 µg)	T	13
3	Neomycin	(10 µg)	N	13
4	Ampicillin	(10 µg)	AM	13
5	Furazolidone	(15 µg)	FR	13
6	Ceftazidime	(30 µg)	CAZ	29
7	Sulphamethoxazole/ trimethoprim	(25 µg)	TM	15
8	Chloramphenicol	(30 µg)	C	20
9	Amikacin	(30 µg)	AK	18
10	Amoxicillin/clavulanic acid	(30 µg)	AMC	14
11	Gentamicin	(10 µg)	CN	19
12	Streptomycin	(10 µg)	S	13
13	Sulphonamide compounds	(300 µg)	SU	13
14	Cefotaxime	(30 µg)	CTX	29
15	Apramycin	(15 µg)	APR	13
16	Ciprofloxacin	(1 µg)	CIP	19

Prior to 1996, all *Salmonella* isolates received were tested for antimicrobial susceptibility, but since then only the first isolate from each incident has usually been tested. The number of cultures received from a farm or integrated company varies enormously, especially in the case of those received from poultry premises. Some poultry companies have a continuous monitoring programme and large numbers of isolates may be received from a particular company. In these circumstances the numbers of a particular serotype and its antimicrobial susceptibility may not reflect its prevalence in the animal population as a whole but rather the intensity of the monitoring programme on a farm or group of farms. Therefore, to better indicate the prevalence of resistance, only the first isolate from each incident has usually been tested since the start of 1996. This chapter contains data from routine surveillance and other surveillance projects.

SALMONELLA DUBLIN

Of the 404 *Salmonella* Dublin cultures tested during 2008, 96% were susceptible to all 16 antimicrobial drugs (Table 79). The percentage of *S.* Dublin isolates sensitive to all 16 antimicrobials has shown only slight fluctuations over the period 2000 - 2008 and the majority of isolates remain susceptible; this has been the situation since surveillance began in 1971. Most *S.* Dublin isolates originate from cattle. Resistance to ampicillin, which had been observed for the first time for several years in

a very low number of bovine isolates in 2000, was not recorded in 2001 or 2002 but re-appeared in 2003 - 2008. Resistance to furazolidone, which had also not been detected for several years in *S*. Dublin, was detected for the first time in recent years in 2002 and again in 2003, was not identified in 2004 – 2007, but re-appeared in 2008. Isolates resistant to trimethoprim/sulphonamides were not detected in 2007 or 2008. Resistance to streptomycin increased in 2008, with 3.2% of cultures resistant. There was no resistance in 2008 reported to any of the antimicrobials in the panel of 16 which were tested but which are not shown in Table 79.

Many of these fluctuations in the prevalence of resistance are probably related to the clonal spread of particular strains as a result of husbandry and animal movement factors, which has a greater influence than variations in the selective pressure exerted by use of particular antimicrobials.

SALMONELLA TYPHIMURIUM

The number of cultures of *Salmonella* Typhimurium examined in 2008 was 709. The eight most frequent definitive or undefined phage types subjected to susceptibility testing at VLA are given in Figure 48. 24.1% of *S*. Typhimurium isolates were the related definitive types (DT) 104, DT104b or undefined type (U)302 (Table 80). The percentage of the eight most common definitive and undefined types of *Salmonella* Typhimurium sensitive to all 16 antimicrobial agents in 2008 is given in Figure 49. 19.6% of all *Salmonella* Typhimurium isolates were sensitive to all of the antimicrobials tested (Table 80), which is an increase from the figure of 11.4% observed in 2007. The generally high level of resistance of *Salmonella* Typhimurium isolates is partly a reflection of the contribution of DT104 and its variants DT104b and U302, only 8.2% of which were sensitive to all the antimicrobials tested in 2008. Although, the proportion of *Salmonella* Typhimurium isolates comprising DT104 and its variants has declined significantly in recent years, the phage types which are currently prevalent are also frequently resistant.

S. Typhimurium U288 and DT193 from pigs comprise 15% (106) and 22% (153) of the total of *S*. Typhimurium isolates; only 2.8% of the U288 and 1.3% of the DT193 isolates from pigs were fully susceptible in 2008. Am,S,Su,T was the most common resistance pattern in DT 193 isolates from pigs (85 isolates), followed by Am,C,S,Su,T,Tm (30 isolates). The most frequent resistance pattern in U288 isolates from pigs was Am,C,S,Su,T,Tm (72 isolates).

The typical pentavalent resistance pattern Am,C,S,Su,T was the commonest pattern seen in *S*. Typhimurium DT104 and 104b isolates

recovered from cattle, occurring in 87% of 46 isolates examined. In 2006 this resistance pattern with additional trimethoprim resistance was observed, but no similar resistance patterns were recorded in 2007 or 2008 in cattle. There were two *S*. Typhimurium DT104b isolates recovered from turkeys in 2008 and both showed the typical Am,C,S,SU,T pentavalent resistance pattern. There were no *Salmonella* Typhimurium isolates resistant to ceftazidime, cefotaxime or amikacin recovered in 2008.

In 2008, 8.0 % (11/138) of DT104 and 104b isolates were resistant to nalidixic acid and 2.9% (4/138) were resistant to sulphamethoxazole/ trimethoprim. In 2007, 10.4 % (13/125) of DT104 and 104b isolates were resistant to nalidixic acid and 8.8% resistant to sulphamethoxazole/ trimethoprim. This can be compared to the figures for 2006, when 16.1% of DT104 and 104b isolates were resistant to nalidixic acid and 18.3% resistant to sulphamethoxazole/ trimethoprim. Nalidixic acid resistance in *S.* Typhimurium DT104 by species of origin is listed in Table 81 for the main food-producing species. Table 82 gives the equivalent figures for trimethoprim/ sulphamethoxazole resistance by species of origin in *S.* Typhimurium DT104 for the period 2003 - 2008.

A marked increase in resistance to sulphamethoxazole/trimethoprim in all definitive types of *S*. Typhimurium from levels of around 16-24% in 1996-2001 to 44.1% in 2002, 37.5% in 2003, 32.7% in 2004, 36.1% in 2005, 39.8% in 2006 and 57.9% in 2007 has been observed and discussed in previous reports. In 2008, the prevalence of resistance to sulphamethoxazole/trimethoprim was 26.4%. The contribution from DT 104 to this overall figure is shown in Table 82. In relation to other phage types of *S*. Typhimurium it was predominantly isolates from pigs that accounted for these fluctuations in sulphamethoxazole/trimethoprim resistance (Table 83); a high percentage of many definitive types of *S*. Typhimurium isolated from pigs are resistant to sulphamethoxazole/ trimethoprim.

The definitive and undefined types of *S*. Typhimurium resistant to sulphamethoxazole/trimethoprim and recovered from pigs in 2008 include DT193 and U288. The total numbers of isolates of these types and the percentage resistant to trimethoprim/sulphonamides are shown in Table 84.

Resistance to neomycin was detected in a single *S*. Typhimurium DT104b isolate, six isolates of DT193, a single isolate of DT2 and three isolates of U288. All of these isolates were recovered from pigs apart from the isolate of *S*. Typhimurium DT2, which was from birds other than poultry. The findings are similar to those observed in 2006 and 2007 when the main contribution to the overall levels of neomycin resistance

seen in *Salmonella* Typhimurium was also associated with isolates of DT193 and U288 of porcine origin.

Furazolidone resistance was not observed in isolates of *S*. Typhimurium in 2008.

Multiple antibiotic resistance (i.e. resistance to four or more unrelated antimicrobial agents in the panel of 16) was detected in DTs 104, 104b, 193 and U302 from cattle; in DTs 104, 104b and U302 from poultry (i.e. chickens and/ or turkeys); in DT 104 from sheep and in DTs 104, 104b, 120, 193, 193a, U288 and U302 from pigs. Of the 34 different definitive and undefined types detected, 17 (namely 1, 8, 12a, 13variant, 30, 40, 41, 41b, 41 variant, 46, 93, 96, 99, 101 variant, 111, 177 and U276) were fully susceptible to all of the antimicrobials in the test panel.

SEROTYPES OTHER THAN SALMONELLA *DUBLIN* AND SALMONELLA *TYPHIMURIUM*

Of the 2474 isolates of serotypes other than *S*. Dublin and *S*. Typhimurium tested, 67.3% were sensitive to all the antimicrobials in the panel (Table 85), a slight increase from the figure recorded in 2007, when 63.4% were fully sensitive. 238 (9.6%) of these isolates were *S.* Enteritidis, of which 94 were *S.* Enteritidis PT4 and of these *S.* Enteritidis PT4 isolates, 97% were sensitive to all of the antimicrobials in the test panel, with two isolates resistant to streptomycin and sulphonamide compounds and one with an S,Su,Tm resistance pattern. The tendency of *S*. Enteritidis to be fully sensitive is largely responsibly for this overall increase in sensitivity. *S.* Enteritidis PT1 is a phage type which has previously been commonly resistant to nalidixic acid, although all of the five isolates of this phage type which were tested in 2008 were susceptible to nalidixic acid.

Levels of resistance to furazolidone and neomycin were higher than those observed in 2001 and earlier, maintaining the trend observed over the period 2002 - 2007, although levels observed in 2007 - 2008 were lower than in 2006. Neomycin resistant isolates originated mainly from ducks (where of 294 isolates 11.5% were resistant), with lower numbers from chickens (406 isolates, 1.5% resistant), turkeys (121 isolates, 13.2% resistant) and pigs (825 isolates, 1.7% resistant).

In 2008, all furazolidone-resistant Salmonellas other than *S.* Dublin and *S.* Typhimurium originated from poultry (chickens and ducks). In 2008, 9.5%, of 295 isolates from ducks were resistant to furazolidone whilst 1.2% of 406 isolates from chickens were resistant. The majority of the isolates resistant to furazolidone or neomycin were *Salmonella* Indiana and originated from ducks. This is discussed further below.

INDIVIDUAL ANTIMICROBIALS

Of the 3587 isolates tested in 2008, 2192 (61%) were sensitive to all of the antimicrobials tested (Table 86). In 2007, 52% were sensitive to all of the antimicrobials tested whereas in 2006, 54% were sensitive to all of the antimicrobials tested; the figure was 63% for 2005. The main contribution to tetracycline resistance in 2008 came from *Salmonella* isolates originating from pigs. The prevalence of resistance to neomycin in all *Salmonella* serotypes was 2% in 2008, 4% in 2007, 6% in 2006, 3% in 2005 and 6% in 2004. Levels of resistance to furazolidone remained at 0.3% in 1999 and 2000, though increased slightly to 0.5% in 2001 and increased further in 2002 when levels of 3% were recorded. Over the period 2003 - 2006, 4 - 6% of all isolates were resistant to furazolidone. The prevalence of furazolidone resistance was 2% in 2007 and 1% in 2008. The observed increase in furazolidone resistance was considered to reflect increased surveillance of *Salmonella* isolates from ducks rather than a genuine increase in resistance to this antimicrobial, since *Salmonella* Indiana is a frequent *Salmonella* isolate from ducks and shows clonal resistance to furazolidone. Numbers of *Salmonella* isolates received from ducks have increased over this period as surveillance of this species has increased. Examination of records from previous years shows that furazolidone-resistant *Salmonella* Indiana has been present in poultry in England and Wales for many years. *Salmonella* Indiana isolates from ducks are also commonly resistant to neomycin. Such resistance is likely to reflect historic usage of these antimicrobials and long-term persistence in the duck industry.

Resistance to apramycin in all *Salmonella* serotypes was 0.4% in 2008, similar to the figure of 0.5% observed in 2007. 0.5% of *Salmonella* isolates from all species were resistant to gentamicin in 2008. No resistance was detected to amikacin.

In 2008, 2% of all *Salmonella* isolates were resistant to nalidixic acid – similar to the figure of 3% of all *Salmonella* isolates resistant to nalidixic acid recorded in 2007. This can be compared with 2% of all *Salmonella* isolates which were resistant to nalidixic acid in 2002, 3% in 2001, 5% in 2000 and 1999, 7% in 1998 and 7% in 1997. The highest prevalence of resistance to nalidixic acid was observed in *Salmonella* isolates from turkeys and from avian species other than poultry, such as game birds. Ciprofloxacin resistance was also detected in *Salmonella* isolates from turkeys and avian species other than poultry. The ciprofloxacin-resistant isolates detected in 2008 originated from cattle (n=1; *S.* Typhimurium RDNC), avian species other than poultry (*S.* Binza (n=4) and *S.* Typhimurium DT193 (n=1)), pigs (n=3; 6,7:c:-, *S*. Kedougou and *S*. Typhimurium DT193) and turkeys (n=10; all *S*. Newport, primarily related

to imported birds). In addition, from animal species which are not otherwise mentioned, ciprofloxacin resistance was detected in single isolates of *S.* Hadar and *S.* Nima from lizards.

Table 86 shows that 9% of *Salmonella* isolates from environmental samples were resistant to ciprofloxacin, but susceptible to nalidixic acid. These ciprofloxacin-resistant isolates were all recovered in 2008 from environmental sites linked to a foal from which *S.* Typhimurium DT104 was recovered in 2007. The environmental *S.* Typhimurium isolates recovered in 2008 were not typable using phages. The isolate from the foal had the resistance pattern SSuTCip, as did the six environmental isolates. The ciprofloxacin MIC was 0.38mg/l for the isolate from the foal and 0.5 - 0.75mg/l for the environmental isolates. The isolates were all found to carry the *qnrB* gene, which confers transferable fluoroquinolone resistance. This, to the best of our knowledge, is the first detection of *qnrB* in livestock in England and Wales.

A single isolate of *S*. Kedougou which was resistant to both cefotaxime and ceftazidime was recovered from a breeding pig herd. The isolate had the resistance pattern A,Su,Tm,Caz,Ctx. Synergy in disc tests between cephalosporins and clavulanate indicated that the isolate was probably an extended-spectrum beta-lactamase producer. This was confirmed genetically and the isolate shown to carry to the ESBL CTX-M-1. This is the first reported isolation of a *Salmonella* from livestock in England and Wales carrying an ESBL. *Salmonella* Kedougou is a rare cause of salmonellosis in man in the UK and the ESBL enzyme CTX-M-1 is not one of the common ESBLs occurring in human bacteria in the UK. Colleagues at the Health Protection Agency have confirmed that there have been no reported human cases of infection with *Salmonella* Kedougou resistant to third generation cephalosporins (personal communication). Ceftiofur was used on the affected farm to control and treat *Streptococcus suis* infection in piglets.

Table 79: *Salmonella* Dublin: antimicrobial sensitivity monitoring 2000 - 2008

Year	No of cultures	Percentage sensitive to all 16 anti-microbials*	Percentage of cultures resistant to:								
			S	C	SU	T	N	AM	FR	TM	NA
2000	863	98.7	0.7	0.6	0.7	0.5	-	0.1	-	0.2	0.2
2001	467	98.3	0.2	0.6	1.3	-	-	-	-	0.2	0.2
2002	687	97.5	0.3	0.4	0.7	0.6	0.4	-	0.6	0.9	-
2003	949	96.4	1.4	1.3	1.2	0.8	0.2	0.6	0.4	0.4	0.2
2004	516	97.9	1.0	0.8	1.2	0.4	-	0.2	-	0.8	0.2
2005	365	98.1	1.1	0.3	0.3	0.3	-	0.8	-	-	-
2006	468	96.4	0.4	0.6	1.3	0.6	0.2	0.9	-	0.2	1.5
2007	381	98.7	0.8	-	-	0.2	-	0.2	-	-	-
2008	404	96.0	3.2	0.3	0.3	0.5	-	0.3	0.3	-	0.3

* For a key to the antimicrobials used please see the table towards the beginning of this chapter

Table 80: *Salmonella* Typhimurium: antimicrobial sensitivity monitoring 2000 – 2008

Year	No of cultures	Percentage sensitive to all 16 anti-microbials*	Percentage of cultures resistant to:									
			S	SU	T	N	AM	FR	TM	C	APR	NA
2000	864 [a]	15.3	63.2	70.8	80.4	2.5	63.8	0.1	23.4	56.5	3.2	7.5
2001	519 [b]	20.6	57.8	71.7	75.5	2.9	66.7	0.4	24.3	55.9	2.3	11.9
2002	533 [c]	14.5	61.0	77.9	80.1	3.4	70.5	2.6	44.1	62.1	2.4	7.1
2003	613 [d]	19.6	61.7	73.1	74.2	6.2	68.5	0.7	37.5	58.9	3.8	13.5
2004	468 [e]	26.7	55.8	63.7	65.6	4.5	58.5	0.6	32.7	49.4	1.5	10.0
2005	552 [f]	24.1	60.0	71.6	71.0	1.3	67.2	4.2	36.1	53.1	0.7	8.9
2006	1136 [g]	24.2	54.2	70.2	69.2	5.1	65.9	1.0	39.8	57.0	1.0	6.9
2007	1057 [h]	11.4	70.6	85.3	81.6	4.5	78.4	0.6	57.9	58.8	1.5	4.5
2008	709 [i]	19.6	65.7	70.7	73.8	1.6	66.2	-	26.4	43.0	1.0	3.5

* For a key to the antimicrobials used please see the table towards the beginning of this chapter

[a] 460 (53.2%) of these strains were DT104 and its variants
[b] 274 (52.8%) of these strains were DT104 and its variants
[c] 239 (44.8%) of these strains were DT104 and its variants
[d] 73 (44.5%) of these strains were DT104 and its variants
[e] 126 (53.8%) of these strains were DT104 and its variants
[f] 144 (26.1%) of these strains were DT104 and its variants
[g] 316 (27.8%) of these strains were DT104 and its variants
[h] 181 (17.1%) of these strains were DT104 and its variants
[i] 171 (24.1%) of these strains were DT104 and its variants

Table 81: Nalidixic acid resistance in *Salmonella* Typhimurium DT104 from domestic livestock. Number of cultures tested (percentage resistant to nalidixic acid) 2000 - 2008

Year	Livestock species					
	Cattle	Sheep	Pigs	Chickens	Turkeys	Ducks
2000	223 (10.8)	21 (0)	51 (2.0)	7 (14.3)	7 (0)	1 (0)
2001	115 (15.7)	8 (12.5)	19 (21.1)	22 (0)	25 (60)	0 (0)
2002	67 (7.5)	5 (40)	36 (5.6)	32 (0)	17 (11.8)	0 (0)
2003	100 (20)	6 (0)	27 (11.1)	12 (8.3)	41 (63.4)	0 (0)
2004	44 (0)	2 (0)	10 (10.0)	6 (0)	39 (74.4)	0 (0)
2005	40 (12.5)	8 (0)	2 (0)	6 (33.3)	32 (96.9)	0 (0)
2006	112 (0)	12 (0)	20 (0)	6 (50)	57 (71.9)	0 (0)
2007	33 (3)	7 (0)	22 (0)	5 (0)	11 (100)	0 (0)
2008	29 (3.4)	5 (0)	34 (0)	6 (0)	0 (0)	0 (0)

Table 82: Trimethoprim/ sulphonamide resistance in *Salmonella* Typhimurium DT104 from domestic livestock in 2003 - 2008. Number of cultures tested (percentage resistant to trimethoprim/sulphonamide)

Year	Livestock species					
	Cattle	Sheep	Pigs	Chickens	Turkeys	Ducks
2003	100 (33)	6 (0)	27 (15)	12 (33)	41 (7.3)	0 (0)
2004	44 (34)	2 (50)	10 (10)	6 (0)	39 (0)	0 (0)
2005	40 (17.5)	8 (37.5)	2 (0)	6 (33.3)	32 (0)	0 (0)
2006	112 (22.3)	12 (41.7)	20 (15)	6 (16.7)	57 (8.8)	0 (0)
2007	33 (0)	7 (0)	22 (4.5)	5 (0)	11 (0)	0 (0)
2008	29 (0)	5 (0)	34 (5.9)	6 (0)	0 (0)	0 (0)

Table 83: Trimethoprim/sulphonamide resistance in *Salmonella* Typhimurium (all phage types) from domestic livestock in 2004 - 2008. Number of cultures tested (percentage resistant to trimethoprim/sulphonamide)

Year	Livestock species					
	Cattle	Sheep	Pigs	Chickens	Turkeys	Ducks
2004	90 (30)	7 (57)	146 (72)	11 (0)	55 (2)	7 (0)
2005	71 (14)	13 (31)	317 (56)	10 (20)	37 (3)	13 (0)
2006	174 (20)	18 (28)	555 (69)	13 (15)	86 (7)	35 (14)
2007	86 (5)	10 (0)	792 (75)	10 (0)	24 (0)	3 (0)
2008	76 (0)	6 (0)	404 (42)	39 (0)	20 (0)	8 (0)

Table 84: Trends in Trimethoprim/sulphonamide resistance in certain types of *Salmonella* Typhimurium from pigs over the period 2002- 2008. Number of cultures tested (percentage resistant to trimethoprim/sulphonamide)

Year	Definitive type or undefined type			
	DT193	DT208	U288	U308a
2002	47 (85)	14 (100)	51 (94)	59 (95)
2003	38 (92)	7 (43)	72 (90)	0 (0)
2004	19 (79)	1 (100)	71 (97)	3 (0)
2005	134 (43)	0 (0)	107 (96)	0 (0)
2006	103 (72)	16 (25)	229 (96)	0 (0)
2007	239 (65)	7 (14)	374 (97)	0 (0)
2008	153 (35)	28 (29)	106 (95)	0 (0)

Table 85: *Salmonella* other than *Salmonella* Dublin and *Salmonella* Typhimurium: antimicrobial susceptibility monitoring 2000 - 2008

Year	No of cultures	Percentage sensitive to all 16 antimicrobials*	Percentage of cultures resistant to:									
			S	SU	T	N	AM	FR	TM	C	APR	NA
2000	2877	70.7	5.0	18.0	9.5	0.9	4.8	0.5	13.7	3.5	0.1	5.5
2001	1814	69.8	8.1	20.0	10.0	1.0	5.7	0.6	12.1	6.4	0.2	1.4
2002	2167	60.3	11.2	24.0	13.7	5.2	6.5	3.7	19.5	8.0	0.3	1.9
2003	3652	67.7	10.0	19.0	15.7	6.2	4.4	8.7	12.4	4.5	0.1	2.2
2004	2942	67.3	11.6	19.1	17.5	7.2	2.2	7.8	14.0	1.3	0.3	2.1
2005	2683	65.6	10.9	23.7	23.6	4.2	4.6	6.2	12.3	2.5	0.1	2.2
2006	2727	58.7	15.8	25.1	28.8	6.9	7.2	5.7	14.2	3.2	0.2	4.0
2007	2248	63.4	12.8	22.2	28.8	4.0	7.7	3.5	11.9	2.2	0.2	3.4
2008	2474	67.3	14.0	17.5	23.7	3.2	5.0	1.3	8.1	1.8	0.3	1.8

* For a key to the antimicrobials used please see the table towards the beginning of this chapter

Table 86: All salmonellas: antimicrobial sensitivity 2008

Year	No of isolates	Percentage sensitive to all 16 antimicrobials*	Percentage of isolates resistant to:														
			NA	CIP	S	N	APR	CN	SU	TM	AM	AMC	CAZ	CTX	FR	T	C
Cattle	625	82	1.0	0.2	16.0	-	-	-	13.0	0.2	12.0	-	-	-	0.2	14.0	9.0
Sheep	139	92	0.7	-	7.0	-	-	-	4.0	-	4.0	-	-	-	-	4.0	4.0
Pigs	1231	34	0.9	0.2	38.0	2.0	0.7	0.7	47.0	26.0	31.0	-	0.08	0.08	-	57.0	17.0
Chickens	452	76	0.9	-	10.0	1.0	-	-	10.0	4.0	4.0	-	-	-	1.0	14.0	5.0
Turkeys	141	18	13.0	7.0	51.0	11.0	-	-	76.0	7.0	21.0	-	-	-		71.0	11.0
Ducks	303	78	0.7	-	12.0	11.0	-	-	5.0	3.0	3.0	0.3	-	-	9.0	13.0	1.0
Geese	1	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horses	60	77	2.0	-	13.0	-	-	-	15.0	7.0	13.0	-	-	-	-	20.0	3.0
Other non-avian species	306	73	3.0	1.0	18.0	3.0	0.7	1.0	16.0	7.0	13.0	0.3	-	-	-	18.0	8.0
Other avian species	80	48	20.0	6.0	28.0	1.0	5.0	6.0	28.0	5.0	24.0	-	-	-	-	30.0	11.0
Feed	179	90	-	-	5.0	-	-	-	7.0	4.0	2.0	-	-	-	-	8.0	-
Environment	70	81	-	9.0	14.0	-	-	-	13.0	1.0	4.0	-	-	-	-	11.0	1.0
Total	3587	61	2.0	0.08	23.0	2.0	0.4	0.5	26.0	11.0	17.0	0.6	0.03	0.03	1.0	31.0	10.0

* For a key to the antimicrobials used please see the table towards the beginning of this chapter

No isolates were resistant to amikacin

Fig 48: Number of isolates of *Salmonella* Typhimurium of the eight most frequent definitive or undefined types subjected to susceptibility testing in 2008

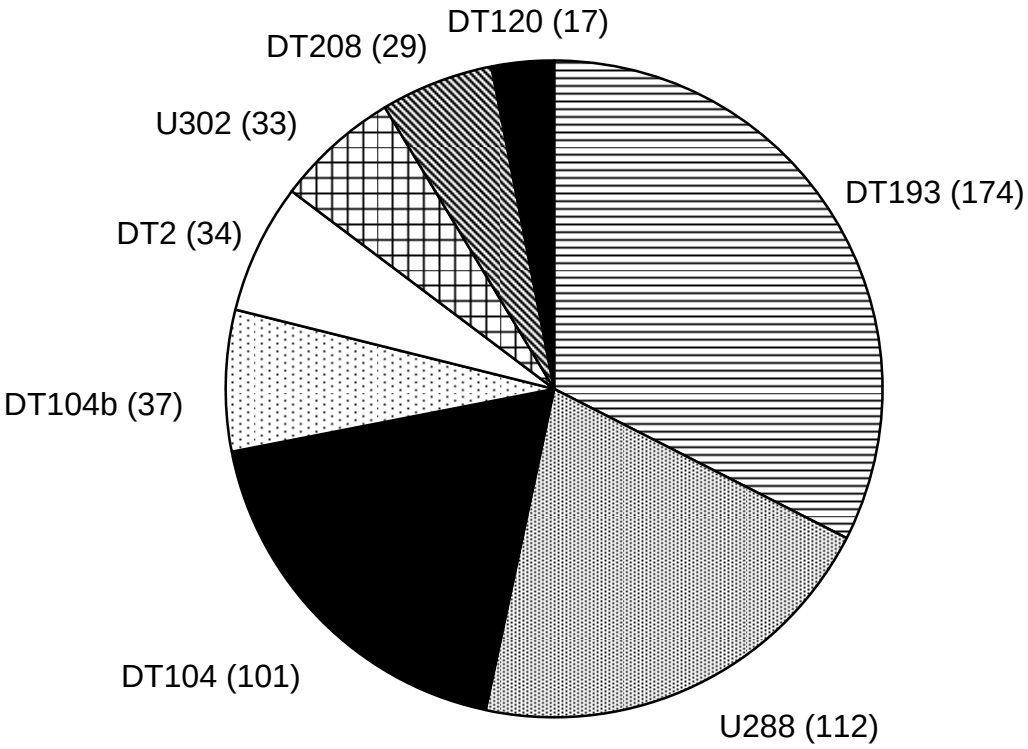

Fig 49: Percentage of the eight most common definitive and undefined types of *Salmonella* Typhimurium sensitive to 16 antimicrobial agents in 2008