Veterinary Medicines Directorate

Supplementary Material

UK-VARSS 2018

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S1.1: Further Details on the Methodology

The European Commission has requested the European Medicines Agency (EMA) to take the lead in collating data collected on the use of antibiotic agents in animals in the European Union. The EMA has therefore developed a harmonised approach for the collection and reporting of data based on national sales figures. This is designed to be comparable with usage data of human antibiotics, to the extent possible.

Published European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) reports are available from: https://www.ema.europa.eu/en/veterinary-regulatory/overview/antimicrobial-resistance/european-surveillance-veterinary-antimicrobial-consumption-esvac.

The ESVAC publications use a different method to calculate mg/kg (called milligram per Population Correction Unit (mg/PCU) for ESVAC purposes) compared to the approach previously used in the UK (reports prior to UK-VARSS 2015). Table S1.1.1 summarises these differences.

Table S1.1.1: Differences between the UK-VARSS and ESVAC methodology used in previous publications for the calculation of quantity of active ingredient of antibiotics sold

	UK-VARSS	ESVAC
Products included	↑ All authorised veterinary antibiotic products.	↓ Topical presentations are not included.
Calculation of active ingredient quantity	↓ Ingredients are converted to active moiety (the active molecule not including salts).	↑ Active ingredient weights relate directly to information held within the SPC.
Calculation of kg biomass	↑ Horses not included as food-producing animals.	↓ Horses included as food-producing animals.
Calculation of mg/kg	↓ Only takes into account products which are authorised for use in food-producing animals only. Horses are excluded. Takes into account all administration routes.	↑ All formulations (*for all species*) other than tablets included; it is considered that tablets are primarily used in the treatment of non-food-producing animals.
Conclusion	Likely underestimates mg/kg.	Likely overestimates mg/kg.

In order to harmonise national and European reporting, the ESVAC methodology has been adopted since the UK-VARSS 2015 report.

For further details on how mg/PCU is calculated please see: https://www.gov.uk/government/publications/understanding-the-mgpcu-calculation-used-for-antibiotic-monitoring-in-food-producing-animals.

The data reported in Chapter 1 of the main report are presented according to the Anatomical Therapeutic Chemical Classification System for veterinary medicinal products (ATCvet) as shown in Table S1.1.2 (World Health Organization, 2018).

Table S1.1.2: Categories and ATCvet codes of antibiotic veterinary medicinal products included in the data

Veterinary antibiotic category	ATCvet codes
Antibiotics for intestinal use	QA07AA; QA07AB
Antibiotics for intrauterine use	QG01AA; QG01AE; QG01BA; QG01BE; QG51AA; QG51AG
Antibiotics for systemic use	QJ01
Antibiotics for intramammary use	QJ51
Antibiotics for antiprotozoal use (solely sulphonamides)	QP51AG

Table S1.1.3 shows the sales for other antibiotic products, which include topical preparations and those for sensory organs, e.g. aerosols, creams, gels, shampoos and ear and eye medications. These are not included in the ESVAC calculation.

Table S1.1.3: Active ingredient (tonnes) of antibiotics sold for all animal species by 'other' routes of administration; 2014–2018

	Tonnes of active ingredient				
	2014	2015	2016	2017	2018
Other routes	2.4	2.0	2.4	2.4	2.5

S1.2: Population Correction Unit (PCU)

When assessing antibiotic sales it is important that the demographics of the animal population potentially exposed to treatment are also taken into account, (see Annex C of the main report – data limitations). This is achieved through use of the PCU, a technical unit of measurement (where 1 PCU = 1 kg of animal treated), which is calculated by multiplying a standardised average weight at time of treatment (see Table S1.2.3) with the associated annual animal/slaughter numbers. The calculation also takes into account animals exported from the UK for slaughter or imported to the UK for fattening. Full details on the methodology of calculation of the PCU can be found in the 2011 ESVAC report (data from 2005–2009): https://www.ema.europa.eu/en/veterinary-regulatory/overview/antimicrobial-resistance/european-surveillance-veterinary-antimicrobial-consumption-esvac.

Table S1.2.1 shows the UK PCU value for food-producing animal species and horses. The standard formula used for calculation of the PCU for poultry does not include population figures for egg producers (laying hens) so the poultry PCU is an underestimate (European Medicines Agency, 2011).

Table S1.2.1: PCU (1,000 tonnes) by food-producing animal species; 2014–2018

	PCU (1,000 tonnes)				
Animal species	**2014**	**2015**	**2016**	**2017**	**2018**
Sheep and goats	2824.9	2,795.6	2,845.3	2,910.4	2832.7
Cattle	1,731.3	1,743.0	1,792.3	1,785.2	1787.7
Poultry	1,041.7	1,082.4	1,150.9	1,185.3	1233.0
Pigs	744.6	769.7	788.9	766.4	781.0
Horses*	395.2	377.6	377.6	377.6	377.6
Fish	177.0	193.1	187.3	117.3	203.6
Total PCU	**6914.7**	**6961.4**	**7142.4**	**7202.1**	**7215.7**

* Horse population data are obtained from the British Equestrian Trade Association survey which is run every 5 years.

Table S1.2.2 shows the combined UK denominator value for cats and dogs (in kg) used for the dog and cat mg/kg calculations. Population data was sourced from the Pet Food Manufacturers Association[1] and mean adult cat and dog weights provided by the Small Animal Veterinary Surveillance Network (SAVSNET)[2]. Routinely recorded tabulated weight data were extracted from electronic health records provided by veterinary practices voluntarily participating in the SAVSNET project. Animals aged under 2 years, over 22.5 years and 27.5 years for dogs and cats respectively and/or with unrealistic weight measurements were excluded from the analysis. The mean weights were then calculated from the remaining data.

Table S1.2.2 Weights of dogs and cats (1,000 tonnes); 2014–2018

	Year				
Animal species	**2014**	**2015**	**2016**	**2017**	**2018**
Dogs					
Population (1,000s) heads	8,900	8,500	8,500	8,500	9,000
Mean weight (kg)	19.4	19.1	18.8	18.5	18.3
Total weight of dogs (1,000 tonnes)	172.8	162.3	159.8	157.1	164.9
Cats					
Population (1,000s) heads	7,900	7,400	7,500	8,000	8,000
Mean weight (kg)	4.4	4.4	4.4	4.5	4.5
Total weight of cats (1,000 tonnes)	34.8	32.8	32.6	35.7	35.7
Total combined weight of dogs and cats (1,000 tonnes)	**207.7**	**195.0**	**192.4**	**192.8**	**200.6**

[1] https://www.pfma.org.uk/statistics
[2] University of Liverpool, Small Animal Veterinary Surveillance Network (SAVSNET) project, personal communication, August 2019

Table S1.2.3: Average weight at time of treatment (kg) used to calculate the PCU for food-producing animals

Animal category	Average weight at treatment (kg)	Source
Cattle		
Slaughter cows	425	Montforts (1999)[1]
Slaughter heifers	200	EMA[2]
Slaughter bullocks and bulls	425	Montforts (1999)[1]
Slaughter calves and young cattle	140	Montforts (1999)[1]; EMA[2]
Imported/exported cattle for slaughter	425	Montforts (1999)[1]
Imported/exported cattle for fattening	140	Montforts (1999)[1]
Livestock dairy cows	425	Montforts (1999)[1]; EMA[2]
Pigs		
Slaughter pigs	65	Montforts (1999)[1]
Imported/exported pigs for slaughter	65	Montforts (1999)[1]
Imported/exported pigs for fattening	25	M. Goll (Eurostat, personal comm.)
Livestock sows	240	Montforts (1999)[1]
Poultry		
Slaughter broilers	1	Montforts (1999)[1]; EMA[2]
Slaughter turkeys	6.5	Montforts (1999)[1]; EMA[2]
Imported/exported poultry for slaughter[3]	1	Montforts (1999)[1]; EMA[2]
Sheep and goats		
Slaughter sheep and goats[4]	20	Montforts (1999)[1]
Imported/exported sheep and goats for slaughter[4]	20	Montforts (1999)[1]
Livestock sheep	75	Montforts (1999)[1]
Horses		
Living horses	400	Montforts (1999)[1]; EMA[2]
Fish[5]		

[1] Montforts, M. H. M. M. (1999). Environmental risk assessment for veterinary medicinal products. Part 1. Other than GMO-containing and immunological products. First update.

[2] European Medicines Agency (2016). Revised guideline on environmental impact assessment for veterinary medicinal products in support of the VICH guidelines GL6 and GL 38 (EMEA/CVMP/ERA/418282/2005-Rev.1- Corr.).

[3] Assume broilers.

[4] Assume lambs.

[5] Data from Eurostat is given in 1,000 tonnes slaughtered fish (as live weight).

S1.3: Antibiotic Active Ingredients Authorised for Use in Animals

Antibiotic class/ active ingredient	Authorised species	Administration route
Tetracyclines		
Chlortetracycline	Cattle, pigs, sheep, chickens, turkeys, ducks	Cutaneous spray, oral/water, premix
Doxycycline	Pigs, chickens, turkeys, *cats, dogs, pigeons*	Tablet, oral/water, premix
Oxytetracycline	Cattle, pigs, sheep, chickens, salmon, trout, *dogs, cats, horses*	Tablet, injectable, premix, oral/water, cutaneous spray
Tetracycline	Cattle, pigs, chickens	Tablet, oral
Trimethoprim/sulphonamides		
Sulfadiazine	Cattle, pigs, chickens, turkeys, *cats, dogs, horses*	Tablet, oral/water, injectable, premix, intramammary suspension
Sulfadimethoxine	*Pigeons*	Oral/water
Sulfadimidine	Cattle, pigs, sheep	Injectable
Sulfadoxine	Cattle, *horses*	Injectable
Sulfamethoxazole	Pigs, chickens	Oral/water
Trimethoprim	Cattle, pigs, chickens, turkeys, *cats, dogs, horses*	Tablet, oral/water, premix, intramammary suspension
Beta-lactams		
1st generation cephalosporins		
Cefalexin	Cattle, *cats, dogs*	Tablet, injectable, intramammary suspension
Cefalonium	Cattle	Intramammary suspension
Cefapirin	Cattle	Intramammary suspension, intrauterine suspension
*3rd generation cephalosporins**		
Cefoperazone	Cattle	Intramammary suspension
Cefovecin	Cats, *dogs*	Injectable
Ceftiofur	Cattle, pigs, *horses*	Injectable
*4th generation cephalosporins**		
Cefquinome	Cattle, pigs, *horses*	Injectable, intramammary suspension/ointment
Penicillins		
Amoxicillin	Cattle, pigs, sheep, chickens, turkeys, ducks, salmon, *cats, dogs, pigeons*	Injectable, tablet, oral/water, premix, intramammary suspension, top dressing
Ampicillin	Cattle, pigs, sheep, *cats, dogs*	Injectable, tablet, intramammary suspension
Benzylpenicillin	Cattle, pigs, sheep, chickens, *cats, dogs, horses*	Injectable, oral/water, intramammary suspension

Antibiotic class/ active ingredient	Authorised species	Administration route
Penicillins (cont.)		
Cloxacillin	Cattle, sheep, *cats, dogs, horses*	Intramammary suspension, eye ointment
Nafcillin	Cattle	Intramammary suspension
Phenoxymethylpenicillin	Pigs	Premix
Aminoglycosides		
Apramycin	Cattle, pigs, chickens	Premix, oral/water
Dihydrostreptomycin	Cattle, pigs, sheep, *cats, dogs, horses*	Injectable, intramammary suspension
Framycetin	Cattle, *cats, dogs*	Injectable, intramammary suspension, ear drops
Gentamicin	*Cats, dogs, horses, rabbits*	Injectable, eye drops, ear drops, gel
Kanamycin	Cattle	Intramammary suspension
Neomycin	Cattle, pigs, sheep*, cats, dogs, horses*	Injectable, oral/water, intramammary suspension, ear drops
Paromomycin	Cattle, pigs	Oral/water
Spectinomycin	Cattle, pigs, sheep, chickens	Injectable, premix, oral/water
Streptomycin	Cattle, sheep, *cats, dogs, horses*	Injectable, oral/water, intramammary suspension
Fluoroquinolones*		
Danofloxacin	Cattle, pigs	Injectable
Difloxacin	Cattle, chickens, turkeys, *dogs*	Injectable, tablet, oral/water
Enrofloxacin	Cattle, pigs, sheep, chickens, turkeys, goats, *cats, dogs, rabbits, reptiles, ornamental birds, rodents*	Injectable, tablet, oral/water
Ibafloxacin	No currently authorised products	-
Marbofloxacin	Cattle, pigs, *cats, dogs*	Tablet, injectable, ear drops
Orbifloxacin	*Dogs*	Ear drops, oral/water
Pradofloxacin	*Cats, dogs*	Tablet
Macrolides		
Erythromycin	Chickens	Oral/water
Gamithromycin	Cattle	Injectable
Spiramycin	Cattle, *dogs, cats*	Injectable, tablet
Tildipirosin	Cattle, pigs	Injectable
Tilmicosin	Cattle, pigs, sheep, chickens, turkeys, *rabbits*	Injectable, premix, oral/water
Tulathromycin	Cattle, pigs	Injectable
Tylosin	Cattle, pigs, chickens, turkeys	Oral/water, premix, injectable
Tylvalosin	Pigs, chickens, turkeys, game birds	Oral/water, premix

Antibiotic class/ active ingredient	Authorised species	Administration route
Other		
Amphenicols		
Florfenicol	Cattle, pigs, sheep, salmon	Injectable, oral/water, premix, ear gel
Lincomycins		
Lincomycin	Cattle, pigs, chicken, *cats, dogs*	Oral/water, premix, injectable, intramammary solution
Clindamycin	*Cats, dogs*	Tablet, oral/water
Pirlimycin	Cattle	Intramammary solution
Pleuromutilins		
Tiamulin	Pigs, chickens, turkeys, *rabbits*	Oral/water, premix, injectable
Valnemulin	Pigs, *rabbits*	Oral/water, premix
Polymyxins		
Colistin*	Cattle, pigs, sheep, chickens	Oral/water
Polymyxin B	*Cats, dogs*	Ear drops, cutaneous suspension
Other antibiotics		
Fusidic acid	*Cats, dogs, rabbits*	Ear drops, gel
Novobiocin	Cattle	Intramammary suspension

* Denotes the classes of antibiotics which are considered 'Highest Priority Critically Important Antibiotics for people' (HP-CIAs) based on classification by the Antimicrobial Advice Ad Hoc Expert Group (AMEG) of the EMA.
Note: Non-food-producing animal species are indicated in italics.

Certain active ingredients included in the results in chapters 3 and 4 are not authorised for use in food-producing animals. These antibiotics (listed below) are however included in the test panels to monitor emergence or risk of resistance to those antibiotics in bacteria in man, or because no breakpoints are available for the antibiotic for which testing ideally should be taking place.

Antibiotic class	Active ingredient
Aminoglycosides	Amikacin
Amphenicols	Chloramphenicol
3rd generation cephalosporins	Cefotaxime
	Cefpodoxime
	Ceftazidime
Fluoroquinolones	Ciprofloxacin
Other antiinfectives and antiseptics	Furazolidone
Quinolones	Nalidixic acid

S1.4: Cascade Prescribing

The Cascade is a legislative provision in the Veterinary Medicines Regulations that allows a veterinary surgeon to prescribe unauthorised medicines that would not otherwise be permitted, e.g. imported medicines or a medicine licensed for another animal species or human use. The principle of the Cascade is that, if there is no suitable veterinary medicine authorised in the UK to treat a condition, the veterinary surgeon responsible for the animal may in particular circumstances (for example to avoid causing unacceptable suffering) treat with an unauthorised medicine. Food-producing animals may only be treated under the Cascade with medicines whose pharmacologically active substances are listed in the Table of Allowed Substances in Commission Regulation EU No. 37/2010.

The data used in this report do not include data on sales of imported or human antibiotics used in animals in accordance with the prescribing Cascade, as currently there is no mechanism by which such information can be obtained. The understanding is that use of human products in food-producing animal species is not extensive, due to issues with longer withdrawal periods when using such products.

The VMD continues to explore methods that can accurately incorporate information on the amounts of antibiotics imported into or exported out of the UK, as well as methods that can accurately incorporate sales of antibiotics licensed for humans that are sold for animal use under the Cascade prescribing system.

S3.1: EU Harmonised Monitoring Requirements of Decision 2013/652/EU

Table S3.1.1: Summary of requirements of European Commission Implementing Decision 2013/652/EU

Pathogen/sample/animal species	Sampling year						
	2014	2015	2016	2017	2018	2019	2020
Salmonella spp. – broilers	x		x		x		x
Salmonella spp. – layers	x		x		x		x
Salmonella spp. – fattening turkeys	x		x		x		x
Salmonella spp. – broiler carcases	x		x		x		x
Salmonella spp. – fattening turkey carcases	x		x		x		x
Salmonella spp. – pig carcases		x		x		x	
Campylobacter jejuni – broilers	x		x		x		x
Campylobacter jejuni – fattening turkeys	x		x		x		x
Escherichia coli – broiler caeca	x		x		x		x
Escherichia coli – turkey caeca	x		x		x		x
Escherichia coli – pig caeca		x		x		x	
ESBL-, AmpC- or carbapenemase-producing *E. coli* – broiler caeca	x		x		x		x
ESBL-, AmpC- or carbapenemase-producing *E. coli* – turkey caeca	x		x		x		x
ESBL-, AmpC- or carbapenemase-producing *E. coli* – pig caeca		x		x		x	
ESBL-, AmpC- or carbapenemase-producing *E. coli* – fresh broiler meat, pig meat and bovine meat gathered at retail	x	x	x	x	x	x	x
Campylobacter coli – broilers	x		x		x		x
Campylobacter coli – pigs		x		x		x	
E. faecium and *E. faecalis* – broilers, fattening turkeys, fattening pigs, bovines <1 year of age	x	x	x	x	x	x	x

Key:
x = Mandatory
x = Voluntary
Pig and bovine year
Poultry year

Note: The UK is exempt from the monitoring of resistance in isolates of bovine origin as we do not meet the cattle (<1 year of age) slaughter throughput as specified in the legislation.

S3.2: EU Harmonised Monitoring Results of Susceptibility Testing in *Escherichia coli*

The epidemiological cut-off (ECOFF) and clinical breakpoint (CBP) values applied for this section were taken from the latest EFSA technical specifications (European Food Safety Authority et al., 2019a). Data from 2014 and 2016 were retrospectively updated where applicable.

Table S3.2.1: Susceptibility in *E. coli* (interpreted using both EUCAST CBPs and ECOFFs) from caecal samples from broilers at slaughter in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=159)		2016 (n=190)		2018 (n=183)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	116 (73.0)	116 (73.0)	128 (67.4)	128 (67.4)	85 (46.4)	85 (46.4)
Azithromycin	*	9 (5.7)	*	0	*	0
Cefotaxime^	0	0	0	0	3 (1.6)	4 (2.2)
Ceftazidime^	0	0	0	0	1 (0.5)	4 (2.2)
Chloramphenicol	20 (12.6)	14 (8.8)	13 (6.8)	7 (3.7)	11 (6.0)	5 (2.7)
Ciprofloxacin^	7 (4.4)	39 (24.5)	4 (2.1)	41 (21.6)	8 (4.4)	29 (15.8)
Colistin^	0	0	0	0	0	0
Gentamicin	31 (19.5)	32 (20.1)	13 (6.8)	14 (7.4)	18 (9.8)	19 (10.4)
Meropenem	0	0	0	0	0	0
Nalidixic acid	*	39 (24.5)	*	40 (21.1)	*	27 (14.8)
Sulfamethoxazole	*	104 (65.4)	*	100 (52.6)	*	74 (40.4)
Tetracycline	*	97 (61.0)	*	84 (44.2)	*	49 (26.8)
Tigecycline	0	0	0	0	0	0
Trimethoprim	75 (47.2)	75 (47.2)	81 (42.6)	81 (42.6)	50 (27.3)	50 (27.3)

^ HP-CIA

* No clinical breakpoint value available

Table S3.2.2: Susceptibility in *E. coli* (interpreted using both EUCAST CBPs and ECOFFs) from caecal samples from turkeys at slaughter in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=168)		2016 (n=224)		2018 (n=176)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	116 (69.0)	116 (69.0)	136 (60.7)	136 (60.7)	100 (56.8)	100 (56.8)
Azithromycin	*	1 (0.6)	*	2 (0.9)	*	0
Cefotaxime^	0	0	1 (0.4)	1 (0.4)	0	0
Ceftazidime^	0	0	1 (0.4)	1 (0.4)	0	0
Chloramphenicol	20 (11.9)	17 (10.1)	20 (8.9)	17 (7.6)	15 (8.5)	7 (4.0)
Ciprofloxacin^	14 (8.3)	29 (17.3)	13 (5.8)	35 (15.6)	5 (2.8)	19 (10.8)
Colistin^	0	0	0	0	0	0
Gentamicin	7 (4.2)	7 (4.2)	5 (2.2)	5 (2.2)	1 (0.6)	1 (0.6)
Meropenem	0	0	0	0	0	0
Nalidixic acid	*	31 (18.5)	*	32 (14.3)	*	11 (6.3)
Sulfamethoxazole	*	54 (32.1)	*	57 (25.4)	*	31 (17.6)
Tetracycline	*	132 (78.6)	*	150 (67.0)	*	82 (46.6)
Tigecycline	0	0	0	0	0	0
Trimethoprim	40 (23.8)	40 (23.8)	51 (22.8)	51 (22.8)	24 (13.6)	24 (13.6)

^ HP-CIA

* No clinical breakpoint value available

Table S3.2.3: Distribution and sequence type of ESBL, AmpC and carbapenemase enzymes detected in *E. coli* from healthy broilers in the UK; 2018

Enzyme	Number of isolates	Proportion of isolates (n=31) (%)	Proportion of caecal samples n=302) (%)	Number of unique STs	Sequence type (ST)
CMY-2	17	55	6	9	38 (n=1), 57 (n=1), 542 (n=1), 949 (n=2), 1585 (n=1), 1594 (n=3), 2040 (n=6), 8262 (n=1), one novel ST
CTX-M-1	11	35	4	6	48 (n=1), 57 (n=6), 88 (n=1), 155 (n=1), 398 (n=1), 7013 (n=1)
SHV-12	1	3	0	1	10 (n=1)
Up-regulated *ampC*	2	6	1	2	23 (n=1), 1431 (n=1)

Table S3.2.4: Decreased susceptibility in ESBL-/AmpC-producing *E. coli* from caecal samples from healthy broilers at slaughter in the UK; 2018

	Number of isolates with decreased susceptibility*		Proportion of isolates (%)	
Antibiotic	AmpC (n=19)	ESBL (n=12)	AmpC	ESBL
Ampicillin	19	12	100	100
Azithromycin	0	0	0	0
Cefepime^	0	12	0	100
Cefotaxime^	19	12	100	100
Cefoxitin^	19	0	100	0
Ceftazidime^	19	12	100	100
Chloramphenicol	0	0	0	0
Ciprofloxacin^	3	2	15	17
Colistin^	0	0	0	0
Ertapenem	0	0	0	0
Gentamicin	2	0	11	0
Imipenem	0	0	0	0
Meropenem	0	0	0	0
Nalidixic acid	3	2	16	17
Sulfamethoxazole	4	11	21	92
Tetracycline	3	10	16	84
Tigecycline	0	0	0	0
Trimethoprim	1	2	5	17

* Interpreted using EUCAST ECOFFs

^ HP-CIA

Table S3.2.5: Distribution and sequence type of ESBL, AmpC and carbapenemase enzymes detected in *E. coli* from healthy turkeys in the UK; 2018

Enzyme	Number of isolates	Proportion of isolates (n=14) (%)	Proportion of caecal samples (n=373) (%)	Number of unique STs	Sequence type (ST)
CTX-M-1	5	36	1	4	10 (n=2), 48 (n=1), 162 (n=1), 665 (n=1)
CTX-M-14	3	21	1	2	93 (n=2), one novel ST
CTX-M-15	1	7	0	1	One novel ST
Up-regulated *ampC*	5	36	1	2	1126 (n=1), 1730 (n=4)

Table S3.2.6: Decreased susceptibility in ESBL-/AmpC-producing *E. coli* from caecal samples from healthy turkeys at slaughter in the UK; 2018

	Number of isolates with decreased susceptibility*		Proportion of isolates (%)	
Antibiotic	AmpC (n=5)	ESBL (n=9)	AmpC	ESBL
Ampicillin	5	9	100	100
Azithromycin	0	0	0	0
Cefepime^	0	9	0	100
Cefotaxime^	5	9	100	100
Cefoxitin^	4	0	80	0
Ceftazidime^	5	9	100	100
Chloramphenicol	0	0	0	0
Ciprofloxacin^	0	4	0	44
Colistin^	0	0	0	0
Ertapenem	0	0	0	0
Gentamicin	0	0	0	0
Imipenem	0	0	0	0
Meropenem	0	0	0	0
Nalidixic acid	0	3	0	33
Sulfamethoxazole	0	9	0	100
Tetracycline	0	4	0	44
Tigecycline	0	0	0	0
Trimethoprim	0	6	0	67

* Interpreted using EUCAST ECOFFs
^ HP-CIA

S3.3: EU Harmonised Monitoring Results of Susceptibility Testing in *Salmonella* spp.

Table S3.3.1: Susceptibility in *Salmonella* spp. (interpreted using both EUCAST CBPs and ECOFFs) from samples from broiler flocks in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=168)		2016 (n=170)		2018 (n=171)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	6 (3.6)	6 (3.6)	6 (3.5)	6 (3.5)	5 (2.9)	5 (2.9)
Azithromycin	*	0	*	0	*	0
Cefotaxime^	0	0	0	0	0	0
Ceftazidime^	0	0	0	0	0	0
Chloramphenicol	12 (7.1)	2 (1.2)	10 (5.9)	1 (0.6)	26 (15.2)	0
Ciprofloxacin^	6 (3.6)	6 (3.6)	15 (8.8)	15 (8.8)	11 (6.4)	11 (6.4)
Colistin^	0	0	0	0	2 (1.2)	2 (1.2)
Gentamicin	12 (7.1)	14 (8.3)	2 (1.2)	2 (1.2)	0	0
Meropenem	0	0	0	0	0	0
Nalidixic acid	*	6 (3.6)	*	6 (3.5)	*	5 (2.9)
Sulfamethoxazole	*	52 (31.0)	*	31 (18.2)	*	10 (5.8)
Tetracycline	*	34 (20.2)	*	33 (19.4)	*	7 (4.1)
Tigecycline	*	10 (6.0)	*	0	*	0
Trimethoprim	31 (18.5)	32 (19.0)	0	0	6 (3.5)	6 (3.5)

^ HP-CIA

* No clinical breakpoint value available

Table S3.3.2: Susceptibility in *Salmonella* spp. (interpreted using both EUCAST CBPs and ECOFFs) from samples from layer flocks in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=58)		2016 (n=34)		2018 (n=52)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	0	0	2 (5.9)	2 (5.9)	8 (15.4)	8 (15.4)
Azithromycin	*	0	*	0	*	0
Cefotaxime^	0	0	0	0	0	0
Ceftazidime^	0	0	0	0	0	0
Chloramphenicol	1 (1.7)	0	1 (2.9)	0	1 (1.9)	1 (1.9)
Ciprofloxacin^	1 (1.7)	1 (1.7)	3 (8.8)	3 (8.8)	2 (3.8)	2 (3.8)
Colistin^	3 (5.2)	3 (5.2)	0	0	0	0
Gentamicin	0	0	0	0	1 (1.9)	1 (1.9)
Meropenem	0	0	0	0	0	0
Nalidixic acid	*	1 (1.7)	*	1 (2.9)	*	1 (1.9)
Sulfamethoxazole	*	0	*	4 (11.8)	*	7 (13.5)
Tetracycline	*	0	*	2 (5.9)	*	6 (11.5)
Tigecycline	*	0	*	0	*	0
Trimethoprim	0	0	1 (2.9)	1 (2.9)	3 (5.8)	3 (5.8)

^ HP-CIA

* No clinical breakpoint value available

Table S3.3.3: Susceptibility in *Salmonella* spp. (interpreted using both EUCAST CBPs and ECOFFs) from samples from turkey flocks in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=162)		2016 (n=169)		2018 (n=170)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	37 (22.8)	37 (22.8)	9 (5.3)	9 (5.3)	8 (4.7)	8 (4.7)
Azithromycin	*	0	*	0	*	0
Cefotaxime^	0	0	0	0	0	0
Ceftazidime^	0	0	0	0	0	0
Chloramphenicol	25 (15.4)	1 (0.6)	5 (3.0)	1 (0.6)	2 (1.2)	0
Ciprofloxacin^	33 (20.4)	33 (20.4)	3 (1.8)	3 (1.8)	9 (5.3)	9 (5.3)
Colistin^	0	0	0	0	0	0
Gentamicin	0	0	1 (0.6)	1 (0.6)	2 (1.2)	2 (1.2)
Meropenem	0	0	0	0	0	0
Nalidixic acid	*	33 (20.4)	*	3 (1.8)	*	7 (4.1)
Sulfamethoxazole	*	74 (45.7)	*	126 (74.6)	*	128 (75.3)
Tetracycline	*	79 (48.8)	*	128 (75.7)	*	128 (75.3)
Tigecycline	*	13 (8.0)	*	0	*	0
Trimethoprim	12 (7.4)	12 (7.4)	4 (2.4)	4 (2.4)	3 (1.8)	3 (1.8)

^ HP-CIA

* No clinical breakpoint value available

Table S3.3.4: Susceptibility in FBO *Salmonella* isolates from broiler and turkey neck skin samples in England and Wales; 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates				
	Broilers			Turkeys	
	2016 (n=17)	2018 (n=100)		2018 (n=3)	
Antibiotic	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ampicillin	0	0	0	0	0
Azithromycin	0	*	0	*	0
Cefotaxime^	0	0	0	0	0
Ceftazidime^	0	0	0	0	0
Chloramphenicol	0	4 (4.0)	0	0	0
Ciprofloxacin^	0	0	0	0	0
Colistin^	0	0	0	0	0
Gentamicin	0	0	0	0	0
Meropenem	0	0	0	0	0
Nalidixic acid	0	*	0	*	0
Sulfamethoxazole	2	*	1 (1.0)	*	2
Tetracycline	1	*	0	*	2
Tigecycline	0	*	0	*	0
Trimethoprim	2	1 (1.0)	1 (1.0)	0	0

^ HP-CIA

* No clinical breakpoint value available

S3.4: EU Harmonised Monitoring Results of Susceptibility Testing in *Campylobacter jejuni*

Table S3.4.1: Susceptibility in *C. jejuni* (interpreted using both EUCAST CBPs and ECOFFs) from caecal samples from broilers at slaughter in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=165)		2016 (n=180)		2018 (n=171)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ciprofloxacin^	72 (43.6)	72 (43.6)	73 (40.6)	73 (40.6)	82 (48.0)	82 (48.0)
Erythromycin	0	0	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)
Gentamicin	0	0	0	0	1 (0.6)	1 (0.6)
Nalidixic acid	73 (44.2)	73 (44.2)	74 (41.1)	74 (41.1)	83 (48.5)	83 (48.5)
Streptomycin	0	0	2 (1.1)	2 (1.1)	5 (2.9)	5 (2.9)
Tetracyclines	97 (58.8)	97 (58.8)	101 (56.1)	101 (56.1)	111 (64.9)	111 (64.9)

^ HP-CIA

Table S3.4.2: Susceptibility in *C. jejuni* (interpreted using both EUCAST CBPs and ECOFFs) from caecal samples from turkeys at slaughter in the UK; 2014, 2016 and 2018

	No. (%) resistant (CBP) or less susceptible (ECOFF) isolates					
	2014 (n=157)		2016 (n=190)		2018 (n=174)	
Antibiotic	CBPs	ECOFFs	CBPs	ECOFFs	CBPs	ECOFFs
Ciprofloxacin^	55 (35.0)	55 (35.0)	66 (34.7)	66 (34.7)	54 (31.0)	54 (31.0)
Erythromycin	1 (0.6)	1 (0.6)	2 (1.1)	2 (1.1)	1 (0.6)	1 (0.6)
Gentamicin	2 (1.3)	2 (1.3)	0	0	0	0
Nalidixic acid	55 (35.0)	55 (35.0)	62 (32.6)	62 (32.6)	55 (31.6)	55 (31.6)
Streptomycin	2 (1.3)	2 (1.3)	3 (1.6)	3 (1.6)	3 (1.7)	3 (1.7)
Tetracyclines	102 (65.0)	102 (65.0)	82 (43.2)	82 (43.2)	78 (44.8)	78 (44.8)

^ HP-CIA

S4.1: Methodology Susceptibility Testing

Table S4.1.1: Disc diffusion breakpoints, corresponding MIC breakpoints and breakpoints under review for the main bacteria covered in this report

Antibiotic	Disc charge (micrograms)	*Escherichia coli*, Enterobacteriaceae	*Salmonella*	*Staphylococci*	*Streptococci*	*Pasteurella, Mannheimia*
Amikacin (AK)	30	R ≤18 mm R ≥16 mg/l	R ≤18 mm R ≥16 mg/l	NA	NA	NA
Amoxicillin/clavulanate (AMC)	20/10	R ≤14 mm R >8 mg/l	R ≤14 mm R > 8mg/l	NA	NA	R ≤13 mm
Amoxicillin/clavulanate	2/1	NA	NA	R ≤17 mm R >1 mg/l	R ≤13 mm	NA
Ampicillin (AM)	10	R ≤14 mm R >8 mg/l	R ≤14 mm R >8 mg/l	R ≤13 mm	R ≤13 mm	R ≤29 mm R >1 mg/l
Apramycin (APR)	15	R ≤13 mm R ≥32 mg/l	R ≤13 mm R ≥32 mg/l	NA	NA	R ≤13 mm†
Cefalexin^	30	R ≤15 mm R >16 mg/l	NA	R ≤13 mm	R ≤24 mm R >2 mg/l	R ≤13 mm
Cefotaxime^ (CTX)	30	R ≤29 mm R ≥2 mg/l	R ≤29 mm R ≥2 mg/l	NA	NA	NA
Cefpodoxime^	10	R ≤ 19 mm R >1 mg/l	NA	NA	NA	R ≤13 mm
Ceftazidime^ (CAZ)	30	R ≤ 26 mm R ≥2 mg/l	R ≤26 mm R ≥2 mg/l	NA	NA	NA

Antibiotic	Disc charge (micrograms)	*Escherichia coli,* Enterobacteriaceae	*Salmonella*	*Staphylococci*	*Streptococci*	*Pasteurella, Mannheimia*
Chloramphenicol (C)	30	R ≤20 mm R >8 mg/l	R ≤20 mm R >8 mg/l	NA	NA	NA
Ciprofloxacin^ (CIP)	1	NA	R ≤16 mm R ≥1 mg/l	NA	NA	NA
Doxycycline	30	R ≤13 mm	NA	R ≤30 mm R ≥2 mg/l	NA	R ≤13 mm
Enrofloxacin^	5	R ≤13 mm R ≥4 mg/l	NA	R ≤13 mm	R ≤13 mm	R ≤13 mm
Erythromycin	5	NA	NA	R ≤19 mm R ≥2 mg/l	R ≤21 mm* R ≥0.5 mg/l	R ≤13 mm
Florfenicol	30	R ≤13 mm R >32 mg/l	NA	NA	R ≤13 mm	R ≤13 mm
Furazolidone (FR)	15	NA	≤13 mm	NA	NA	NA
Gentamicin (CN)	10	NA	R ≤19 mm R ≥4 mg/l	NA	NA	NA
Lincomycin	10	NA	NA	R ≤13 mm	R ≤13 mm	R ≤13 mm
Nalidixic acid (NA)	NA	NA	≤13 mm	NA	NA	NA
Neomycin (N)	10	R ≤13 mm R >8 mg/l	R ≤13 mm R >8 mg/l	NA	NA	NA
Neomycin	30	NA	NA	R ≤13 mm	R ≤13 mm	NA
Novobiocin	30	NA	NA	R ≤13 mm	R ≤13 mm	NA
Penicillin	1IU	NA	NA	R ≤24 mm R >0.12 mg/l	R ≤19 mm** R >0.25 mg/l	NA
Spectinomycin	25	R ≤13 mm	NA	NA	NA	R ≤13 mm†
Streptomycin (S)	10	R ≤12 mm R >8 mg/l	R ≤13 mm R > ~8 mg/l	NA	NA	R ≤13 mm†

Antibiotic	Disc charge (micrograms)	*Escherichia coli,* Enterobacteriaceae	*Salmonella*	*Staphylococci*	*Streptococci*	*Pasteurella, Mannheimia*
Sulphonamide compounds (SU)	300	NA	≤13 mm	NA	NA	NA
Tetracycline (T)	10	R ≤13 mm R >8 mg/l	R ≤13 mm R >8 mg/l	R ≤19 mm R ≥2 mg/l	R ≤19 mm*** R ≥2 mg/l	R ≤25 mm R >1 mg/l
Trimethoprim/sulphonamide (TM)	25	R ≤15 mm R ≥4 mg/l	R ≤15 mm R ≥4 mg/l	R ≤16 mm R ≥4 mg/l	R ≤19 mm R ≥2 mg/l	R ≤13 mm
Tylosin	30	NA	NA	R ≤13 mm	R ≤13 mm	R ≤13 mm

^ HP-CIA

* Erythromycin R ≤21 mm for beta-haemolytic streptococci; R ≤19 mm for other streptococci.

** Penicillin R ≤19 mm for beta-haemolytic streptococci; R ≤16 mm for other streptococci.

*** Tetracycline R ≤19 mm for beta-haemolytic streptococci; R ≤23 mm for other streptococci.

† Some *Haemophilus-Pasteurella-Actinobacillus* i.e. "HPA" organisms, for example *Actinobacillus pleuropneumoniae,* show a degree of intrinsic resistance to aminoglycosides. The historical veterinary breakpoint was used for *H. somni* and *A. pleuropneumoniae*.

Key:

- BSAC human clinical breakpoint
- APHA historical veterinary disc diffusion zone size breakpoint and MIC corresponding to that zone size breakpoint, derived from studies of zone size and MIC
- Animal Health and Veterinary Laboratories Agency (AHVLA) historical veterinary breakpoint (under ongoing review)

Notes:

- Where zone size disc diffusion data collected using the BSAC method and MIC data are both available then it is possible to draw regression lines and investigate the MIC which approximately corresponds to the historical veterinary breakpoint of 13 mm. This has been done for several compounds (highlighted in blue in the table above).
- BSAC state that all *Salmonella* isolates should be reported as resistant to gentamicin and amikacin; resistance traits are used for epidemiological purposes (correlation with particular resistance mechanisms) in this report.
- The 16 antibiotics with antibiotic code, e.g. amikacin (AK), are the set used for *Salmonella* susceptibility testing.

Table S4.1.2: Antibiotic disc concentrations used in Northern Ireland

		Expected zone diameter (mm)		
Antibiotic	**Disc**	**Resistant**	**Intermediate**	**Susceptible**
Amoxicillin	AMC30	≤13	14–17	≥18
Ampicillin	AMP10	≤13	14–16	≥17
Apramycin	APR15	Not available		
Cefotaxime^	CTX30	≤22	23–25	≥26
Ceftazidime^	CAZ30	≤17	18–20	≥21
Chloramphenicol	C30	≤12	13–17	≥18
Ciprofloxacin^	CIP5	≤15	16–20	≥21
Framycetin	FY100	Not available		
Furazolidone	FR100	Not available		≥17
Gentamicin	CN10	≤12	13–14	≥15
Kanamycin	K30	≤13	14–17	≥18
Nalidixic acid	NA30	≤13	14–18	≥19
Spectinomycin	SH100	Not available		
Streptomycin	S10	≤11	12–14	≥15
Sulphonamides	S3.300	≤12	13–16	≥17
Tetracycline	TE30	≤11	12–14	≥15
Trimethoprim	W5	≤10	11–15	≥16

^ HP-CIA

S4.2: Clinical Surveillance Data for Isolates from Bovine Mastitis Cases

Table S4.2.1: Resistance (interpreted using breakpoints) in *Escherichia coli* mastitis isolates from England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)		
Antibiotic	**2016**	**2017**	**2018**
Amoxicillin/clavulanate	6/106 (5.7)	4/79 (5.1)	6/110 (5.5)
Ampicillin	29/106 (27.4)	17/79 (21.5)	24/110 (21.8)
Cefpodoxime^	0/106 (0)	1/79 (1.3)	1/110 (0.9)
Enrofloxacin^	2/106 (1.9)	2/79 (2.5)	3/110 (2.7)
Neomycin	8/106 (7.5)	3/79 (3.8)	3/110 (2.7)
Streptomycin	15/106 (14.2)	6/79 (7.6)	11/110 (10.0)
Tetracycline	18/106 (17.0)	12/79 (15.2)	15/110 (13.6)
Trimethoprim/sulphonamide	14/106 (13.2)	6/79 (7.6)	7/110 (6.4)

^ HP-CIA

Table S4.2.2: Resistance (interpreted using breakpoints) in *Escherichia coli* mastitis isolates from Scotland; 2018

	No. resistant/No. tested (% resistant)
Antibiotic	**2018**
Amoxicillin/clavulanate	15/157 (9.6)
Ampicillin	28/157 (17.8)
Cefpodoxime^	1/157 (0.6)
Enrofloxacin^	3/157 (1.9)
Neomycin	3/157 (1.9)
Streptomycin	14/147 (9.5)
Tetracycline	36/157 (22.9)
Trimethoprim/sulphonamide	16/157 (10.2)

^ HP-CIA

Table S4.2.3: Resistance (interpreted using breakpoints) of *Staphylococci* and *Streptococci* from mastitis cases from England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)								
	Streptococcus dysgalactiae			*Streptococcus uberis*			*Staphylococcus aureus*		
Antibiotic	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Amoxicillin/clavulanate	0/41 (0)	0/39 (0)	0/32 (0)	0/94 (0)	0/97 (0)	0/84 (0)	4/62 (6.5)	3/78 (3.8)	0/36 (0)
Ampicillin	0/41 (0)	0/39 (0)	0/32 (0)	0/94 (0)	0/97 (0)	0/84 (0)	7/62 (11.3)	16/78 (20.5)	10/36 (27.8)
Neomycin	10/40 (25.0)	5/35 (14.3)	1/32 (3.1)	47/93 (50.5)	67/96 (69.8)	38/84 (45.2)	0/62 (0)	0/78 (0)	0/36 (0)
Novobiocin	4/40 (10.0)	0/35 (0)	0/32 (0)	6/93 (6.5)	3/96 (3.1)	4/84 (4.8)	0/62 (0)	0/78 (0)	0/36 (0)
Penicillin	0/41 (0)	0/39 (0)	0/32 (0)	0/94 (0)	0/97 (0)	0/84 (0)	8/62 (12.9)	16/78 (20.5)	10/36 (27.8)
Tetracycline	40/41 (97.6)	33/39 (84.6)	28/32 (87.5)	37/94 (39.4)	42/97 (43.3)	29/84 (34.5)	1/62 (1.6)	1/78 (1.3)	1/36 (2.8)
Tylosin	4/41 (9.8)	6/39 (15.4)	0/32 (0)	8/94 (8.5)	9/97 (9.3)	10/84 (11.9)	0/62 (0)	0/78 (0)	1/36 (2.8)

Table S4.2.4: Resistance (interpreted using breakpoints) of *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* from mastitis cases from England and Wales; 2016–2018

	No. resistant/No. tested					
	Klebsiella pneumoniae			*Pseudomonas aeruginosa*		
Antibiotic	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Amoxicillin/clavulanate	0/12	2/13	1/11	6/6	2/2	5/5
Ampicillin	11/12	9/13	11/11	6/6	2/2	5/5
Cefalexin^	1/1	-	-	6/6	2/2	5/5
Cefotaxime^	1/1	0/1	-	0/6	2/2	5/5
Cefpodoxime^	1/10	0/9	0/9	6/6	2/2	5/5
Ceftazidime^	1/1	0/1	-	0/6	0/2	0/5
Enrofloxacin^	0/12	0/13	0/11	0/6	0/2	0/5
Neomycin	0/11	0/12	0/10	0/4	0/2	2/4
Streptomycin	1/9	0/9	1/8	0/4	0/2	0/4
Tetracycline	2/12	0/13	2/11	6/6	2/2	5/5
Trimethoprim/sulphonamide	1/12	0/13	2/11	5/6	2/2	5/5

^ HP-CIA*; - No isolates tested

S4.3: Clinical Surveillance Data for Isolates from Respiratory Infections of Cattle

Table S4.3.1: Resistance (interpreted using breakpoints) of *Pasteurella multocida*, *Mannheimia haemolytica and Trueperella pyogenes* from respiratory infections of cattle* in England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)								
	Pasteurella multocida			*Mannheimia haemolytica*			*Trueperella pyogenes*		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	0/76 (0)	0/75 (0)	0/76 (0)	0/35 (0)	0/43 (0)	0/44 (0)	0/4	0/3	-
Ampicillin	2/76 (2.6)	11/75 (14.7)	2/76 (2.6)	0/35 (0)	2/43 (4.7)	1/44 (2.3)	0/4	0/3	-
Cefalexin^	-	-		-	-	-	0/4	0/3	-
Cefpodoxime^	0/76 (0)	0/75 (0)	0/76 (0)	0/35 (0)	0/42 (0)	0/44 (0)	-	-	-
Enrofloxacin^	0/76 (0)	0/75 (0)	0/76 (0)	0/35 (0)	0/43 (0)	0/44 (0)	-	-	-
Florfenicol	2/70 (2.9)	0/75 (0)	0/74 (0)	1/35 (2.9)	1/42 (2.4)	0/44 (0)	0/4	0/3	-
Tetracycline	44/76 (57.9)	51/75 (68.0)	39/76 (51.3)	16/35 (45.7)[1]	19/43 (44.2)[1]	22/44 (50.0)	2/4	2/3	-
Trimethoprim/ sulphonamide	0/76 (0)	1/75 (1.3)	0/76 (0)	0/35 (0)	0/43 (0)	0/44 (0)	0/4	1/3	-
Tylosin	-	-	0/1	-	-	1/1	1/4	0/3	-

^ HP-CIA

* No resistant *Histophilus somni* isolates were detected in 2016 and 2018 but a single isolate in 2017 was resistant to tetracycline

- No isolates tested

[1] Data from 2016 and 2017 were updated retrospectively, applying a revised BSAC breakpoint value

S4.4: Clinical Surveillance Data for Isolates from Respiratory Infections of Pigs

Table S4.4.1: Resistance (interpreted using breakpoints) of *Pasteurella multocida* and *Actinobacillus pleuropneumoniae* from respiratory infections of pigs in England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)					
	Pasteurella multocida			*Actinobacillus pleuropneumoniae*		
Antibiotic	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Amoxicillin/clavulanate	0/19 (0)	0/23 (0)	-	0/14	0/8	-
Ampicillin	6/31 (19.4)	5/40 (12.5)	3/35 (8.6)	1/15	0/9	1/13
Apramycin	1/31 (3.2)	4/40 (10.0)	0/35 (0)	3/15	0/9	9/13
Cefpodoxime^	0/31 (0)	0/40 (0)	0/35 (0)	0/15	0/9	0/13
Doxycycline	0/19 (0)	0/23 (0)	-	0/14	1/8	-
Enrofloxacin^	0/31 (0)	0/40 (0)	0/35 (0)	0/15	0/9	0/13
Florfenicol	0/19 (0)	0/23 (0)	-	0/14	0/8	-
Neomycin	3/31 (9.7)	0/40 (0)	0/35 (0)	3/15	1/9	10/13
Spectinomycin	0/31 (0)	0/40 (0)	2/35 (5.7)	2/15	0/9	10/13
Streptomycin	6/19 (31.6)	3/23 (13.0)	-	2/14	1/8	-
Tetracycline	25/31 (80.6)	32/40 (80.0)	21/35 (60.0)	7/15	3/9	0/13
Trimethoprim/sulphonamide	7/31 (22.6)	8/40 (20.0)	5/35 (14.3)	7/15	0/9	1/13
Tylosin	7/19 (36.8)	-	-	14/14	5/8	-

^ HP-CIA

- No isolates tested

S4.5: Clinical Surveillance Data for Isolates from Respiratory Infections of Sheep

Table S4.5.1: Resistance (interpreted using breakpoints) of *Pasteurella multocida*, *Mannheimia haemolytica*, *Bibersteinia trehalosi* and *Trueperella pyogenes* from sheep in England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)											
	Pasteurella multocida			*Mannheimia haemolytica*			*Bibersteinia trehalosi*			*Trueperella pyogenes*		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	0/4	0/7	0/8	0/49 (0)	0/71 (0)	0/81 (0)	0/95 (0)	0/75 (0)	0/50 (0)	0/2	0/1	0/1
Ampicillin	0/4	2/7	0/8	0/49 (0)	1/71 (1.4)	2/81 (2.5)	0/95 (0)	0/75 (0)	0/50 (0)	0/2	0/1	0/1
Cefalexin^	-	-	-	-	-	-	-	-	-	0/2	0/1	0/1
Cefpodoxime^	0/4	0/7	0/8	0/49 (0)	0/71 (0)	0/80 (0)	0/95 (0)	0/75 (0)	0/49 (0)	-	-	-
Enrofloxacin^	0/4	0/7	0/8	0/49 (0)	0/71 (0)	0/81 (0)	1/95 (1.1)	0/75 (0)	0/50 (0)	-	-	-
Florfenicol	0/4	0/7	0/8	0/47 (0)	0/70 (0)	1/76 (1.3)	0/95 (0)	0/75 (0)	1/49 (2.0)	0/2	0/1	0/1
Tetracycline	2/4	3/7	3/8	28/49 (57.1)[1]	39/71 (54.9)[1]	38/81 (46.9)	2/95 (2.1)	1/75 (1.3)	1/50 (2.0)	1/2	1/1	0/1
Trimethoprim/ sulphonamide	0/4	0/7	0/8	0/49 (0)	0/71 (0)	0/81 (0)	0/95 (0)	0/75 (0)	0/50 (0)	0/2	1/1	0/1
Tylosin	-	-	-	-	-	-	-	-	-	1/2	0/1	0/1

^ HP-CIA

- No isolates tested

[1] Data from 2016 and 2017 were updated retrospectively, applying a revised BSAC breakpoint value

S4.6: Clinical Surveillance Data for Other Veterinary Pathogens

Table S4.6.1: MIC values of *Brachyspira hyodysenteriae* isolates from infections of pigs to tiamulin in England and Wales; 2010–2018

	MIC								
Year	<0.06	0.125	0.25	0.5	1	2	4	8	>8
2010	10	1	-	1	1	-	-	-	-
2011	10	-	-	-	-	2	-	-	-
2012	2	-	2	-	-	2	1	-	2
2013	-	-	1	2	1	-	1	-	3
2014	-	-	-	-	-	2	-	1	1
2015	-	-	3	-	-	1	-	1	-
2016	1	-	-	-	1	-	1	-	-
2017	3	-	1	2	1	1	-	-	-
2018	8	1	1	2	-	-	1	-	-

- No isolates with this MIC value

Table S4.6.2: Resistance (interpreted using breakpoints) of *Streptococcus suis* from infections of pigs in England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)		
Antibiotic	2016	2017	2018
Ampicillin	0/86 (0)	0/86 (0)	0/84 (0)
Enrofloxacin^	0/86 (0)	0/86 (0)	0/84 (0)
Lincomycin	30/86 (34.9)	40/86 (46.5)	32/84 (38.1)
Penicillin	0/86 (0)	0/86 (0)	1/84 (1.2)
Tetracycline	78/86 (90.7)	82/86 (95.3)	72/84 (85.7)
Trimethoprim/sulphonamide	11/86 (12.8)	16/86 (18.6)	17/84 (20.2)
Tylosin	37/86 (43.0)	48/86 (55.8)	43/84 (51.2)

^ HP-CIA

Table S4.6.3: Resistance (interpreted using breakpoints) of *Erysipelothrix rhusiopathiae* from infections of pigs in England and Wales; 2016–2018

	No. resistant/No. tested (% resistant)		
Antibiotic	2016	2017	2018
Ampicillin	0/18	0/6	0/3
Enrofloxacin^	0/18	0/6	0/3
Lincomycin	0/18	0/6	0/3
Tetracycline	6/18	1/6	0/3
Trimethoprim/sulphonamide	8/18	5/6	0/3
Tylosin	0/18	0/6	0/3

^ HP-CIA

Table S4.6.4: Resistance (interpreted using breakpoints) of *Staphylococcus aureus* from infections of chickens in England and Wales; 2016–2018

Antibiotic	No. resistant/No. tested (% resistant) 2016	2017	2018
Amoxicillin/clavulanate	1/12	0/6	-
Ampicillin	1/15	1/6	0/2
Doxycycline	1/15	2/6	0/2
Enrofloxacin^	1/15	0/6	0/2
Erythromycin	1/12	0/6	-
Lincomycin	0/15	0/6	0/2
Tetracycline	3/15	1/6	0/2
Trimethoprim/sulphonamide	0/15	0/6	0/2
Tylosin	1/15	-	0/2

^ HP-CIA

- No isolates tested

Table S4.6.5 Resistance (interpreted using breakpoints) of *Listeria monocytogenes* and *Streptococcus dysgalactiae* from infections of sheep in England and Wales; 2016–2018

Antibiotic	No. resistant/No. tested (% resistant) *Listeria monocytogenes* 2016	2017	2018	*Streptococcus dysgalactiae* 2016	2017	2018
Amoxicillin/ clavulanate	0/49 (0)	0/19	0/11	0/35 (0)	0/33 (0)	0/22 (0)
Ampicillin	0/49 (0)	0/19	0/11	0/35 (0)	0/33 (0)	0/22 (0)
Cefalexin^	7/49 (14.3)	3/19	9/11	0/35 (0)	2/33 (6.1)	1/22 (4.5)
Florfenicol	0/49 (0)	0/10	0/11	0/35 (0)	0/15	-
Penicillin	-	0/19	0/11	-	-	-
Tetracycline	2/49 (4.1)	0/19	0/11	34/35 (97.1)	31/33 (93.9)	17/22 (77.3)
Trimethoprim/ sulphonamide	0/49 (0)	0/10	0/11	0/35 (0)	0/15	0/5
Tylosin	0/49 (0)	0/19	0/11	4/35 (11.4)	4/33 (12.1)	0/22 (0)

^ HP-CIA

- No isolates tested

S4.7 Clinical Surveillance Data for *E. coli*

Table S4.7.1: Resistance (interpreted using breakpoints) in all *E. coli* from cattle, sheep, pigs, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	4/467 (0.9)	0/266 (0)	1/280 (0.4)	-	-	-	-	-	-
Amoxicillin/ clavulanate	221/1123 (19.7)	149/694 (21.5)	137/484 (28.3)	504/906 (55.6)	426/816 (52.2)	333/794 (41.9)	69/485 (14.2)	71/461 (15.4)	165/624 (26.4)
Ampicillin	683/1200 (56.7)	420/810 (51.9)	450/788 (57.1)	733/906 (80.9)	633/817 (77.5)	585/794 (73.7)	183/484 (37.8)	136/461 (29.5)	270/628 (43.0)
Apramycin	68/1135 (6.0)	39/756 (5.2)	49/737 (6.6)	97/865 (11.2)	64/634 (10.1)	64/647 (9.9)	7/426 (1.6)	-	-
Cefotaxime^	62/469 (13.2)	32/267 (12.0)	27/282 (9.6)	-	-	-	-	-	-
Cefpodoxime^	7/314 (2.2)	8/377 (2.1)	10/316 (3.2)	387/891 (43.4)	499/807 (61.8)	435/780 (55.8)	12/427 (2.8)	11/461 (2.4)	14/611 (2.3)
Ceftazidime^	41/469 (8.7)	18/267 (6.7)	12/282 (4.3)	-	-	-	-	-	-
Chloramphenicol	200/467 (42.8)	104/266 (39.1)	108/280 (38.6)	-	-	-	0/4	-	-
Colistin^	-	-	1/712 (0.1)	-	-	-	-	-	-
Doxycycline	165/538 (30.7)	151/323 (46.7)	25/79 (31.6)	-	-	-	-	-	-
Enrofloxacin^	78/1200 (6.5)	48/810 (5.9)	32/788 (4.1)	380/908 (41.9)	319/816 (39.1)	267/795 (33.6)	17/485 (3.5)	9/461 (2.0)	35/622 (5.6)
Florfenicol	164/792 (20.7)	88/479 (18.4)	86/329 (26.1)	404/808 (50.0)	328/609 (53.9)	290/615 (47.2)	31/202 (15.4)	26/123 (21.1)	68/316 (21.5)
Neomycin	249/1100 (22.6)	134/695 (19.3)	114/679 (16.8)	583/586 (99.5)	803/810 (99.1)	787/789 (99.7)	28/485 (5.8)	17/461 (3.7)	41/622 (6.6)
Spectinomycin	423/1135 (37.3)	233/756 (30.8)	267/737 (36.2)	3/35 (8.6)	6/177 (3.4)	9/132 (6.8)	78/426 (18.3)	63/461 (13.7)	115/466 (24.7)
Streptomycin	394/743 (53.0)	198/429 (46.2)	149/282 (52.8)	33/33 (100)	172/176 (97.7)	130/132 (98.5)	4/54 (7.4)	3/118 (2.5)	16/188 (8.5)
Tetracycline	727/1200 (60.6)	463/810 (57.2)	447/788 (56.7)	687/907 (75.7)	442/817 (54.1)	512/792 (64.6)	175/485 (36.1)	162/461 (35.1)	304/626 (48.6)
Trimethoprim/ sulphonamide	461/1200 (38.4)	271/810 (33.5)	293/788 (37.2)	551/907 (60.7)	440/817 (53.9)	421/795 (53.0)	99/485 (20.4)	66/461 (14.3)	151/622 (24.3)

^ HP-CIA

- No isolates tested or no data available

Table S4.7.2: Resistance (interpreted using breakpoints) in all *E. coli* from cattle (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	3/365 (0.8)	0/206 (0)	0/208 (0)	-	-	-	-	-	-
Amoxicillin/ clavulanate	175/450 (38.9)	118/285 (41.4)	112/304 (36.8)	410/685 (59.9)	360/655 (55.0)	265/586 (45.2)	48/161 (29.8)	37/181 (20.4)	97/309 (31.4)
Ampicillin	343/450 (76.2)	204/285 (71.6)	215/304 (70.7)	571/684 (83.5)	511/656 (77.9)	449/586 (76.6)	76/161 (47.2)	59/181 (32.6)	154/313 (49.2)
Apramycin	17/425 (4.0)	6/261 (2.3)	14/282 (5.0)	71/655 (10.8)	45/479 (9.4)	42/460 (9.1)	3/102 (2.9)	-	-
Cefotaxime^	48/367 (15.8)	30/207 (14.5)	25/209 (12.0)	-	-	-	-	-	-
Cefpodoxime^	-	-		304/680 (44.7)	406/649 (62.6)	326/585 (55.7)	10/103 (9.7)	4/181 (2.2)	5/301 (1.7)
Ceftazidime^	38/367 (10.4)	17/207 (8.2)	12/209 (5.7)	-	-	-	-	-	-
Chloramphenicol	173/365 (47.4)	95/206 (46.1)	91/208 (43.8)	-	-	-	0/4 (0)	-	-
Colistin^	-	-	0/315 (0)	-	-	-	-	-	-
Doxycycline	-	-	-	-	-	-	-	-	-
Enrofloxacin^	47/450 (10.4)	30/285 (10.5)	20/304 (6.6)	337/686 (49.1)	287/656 (43.8)	226/586 (38.6)	13/161 (8.1)	7/181 (3.9)	15/307 (4.9)
Florfenicol	132/392 (33.7)	69/230 (30.0)	73/230 (31.7)	373/653 (57.1)	292/477 (61.2)	245/456 (53.7)	28/104 (26.9)	23/63 (36.5)	47/162 (29.0)
Neomycin	174/425 (40.9)	95/261 (36.4)	77/282 (27.3)	420/422 (99.5)	645/650 (99.2)	580/582 (99.7)	22/161 (13.7)	15/181 (8.3)	31/307 (10.1)
Spectinomycin	166/425 (39.1)	86/261 (33.0)	111/282 (39.4)	2/33 (6.1)	6/174 (3.4)	8/126 (6.3)	31/102 (30.4)	23/181 (12.7)	55/157 (35.0)
Streptomycin	221/365 (60.5)	118/206 (57.3)	112/208 (53.8)	31/31 (100)	169/173 (97.7)	124/126 (98.4)	4/54 (7.4)	3/118 (2.5)	14/184 (7.6)
Tetracycline	331/450 (73.6)	199/285 (69.8)	198/304 (65.1)	542/685 (79.1)	342/656 (52.1)	394/586 (67.2)	74/161 (46.0)	64/181 (35.4)	168/311 (54.0)
Trimethoprim/ sulphonamide	210/450 (46.7)	123/285 (43.2)	125/304 (41.1)	452/685 (66.0)	374/656 (57.0)	333/586 (56.8)	39/161 (24.2)	28/181 (15.5)	76/307 (24.8)

^ HP-CIA

- No isolates tested or no data available

Table S4.7.3: Resistance (interpreted using breakpoints) in all *E. coli* from pigs (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	-	-	-	-	-	-	-	-	-
Amoxicillin/ clavulanate	11/267 (4.1)	6/161 (3.7)	-	39/77 (50.6)	28/54 (51.9)	31/71 (43.7)	4/28 (14.3)	4/11	37/91 (40.7)
Ampicillin	165/300 (55.0)	105/215 (48.8)	134/244 (54.9)	61/78 (78.2)	46/54 (85.2)	52/71 (73.2)	9/28 (32.1)	6/11	53/91 (58.2)
Apramycin	40/300 (13.3)	30/215 (14.0)	30/244 (12.3)	13/77 (16.9)	10/52 (19.2)	16/71 (22.5)	0/28 (0)	-	-
Cefotaxime^	-	-	-	-	-	-	-	-	-
Cefpodoxime^	7/300 (2.3)	2/215 (0.9)	7/244 (2.9)	19/77 (24.7)	27/52 (51.9)	37/71 (52.1)	0/28 (0)	1/11	8/87 (9.2)
Ceftazidime^	-	-	-	-	-	-	-	-	-
Chloramphenicol	-	-	-	-	-	-	-	-	-
Colistin^	-	-	1/216 (0.5)	-	-	-	-	-	-
Doxycycline	128/267 (47.9)	105/161 (65.2)	-	-	-	-	-	-	-
Enrofloxacin^	17/300 (5.7)	9/215 (4.2)	8/244 (3.3)	16/78 (20.5)	10/53 (18.9)	20/71 (28.2)	3/28 (10.7)	0/11	16/91 (17.6)
Florfenicol	21/267 (7.9)	14/161 (8.7)	-	8/77 (10.4)	6/54 (11.1)	20/71 (28.2)	0/28 (0)	1/11	12/89 (13.5)
Neomycin	19/300 (6.3)	16/215 (7.4)	21/244 (8.6)	74/74 (100)	52/54 (96.3)	71/71 (100)	0/28 (0)	0/11	2/91 (2.2)
Spectinomycin	138/300 (46.0)	82/215 (38.1)	90/244 (36.9)	-	-	-	6/28 (21.4)	4/11	24/89 (27.0)
Streptomycin	116/267 (43.4)	56/161 (34.8)	-	-	-	-	-	-	-
Tetracycline	199/300 (66.3)	135/215 (62.8)	149/244 (61.1)	60/78 (76.9)	44/54 (81.5)	57/71 (80.3)	12/28 (42.9)	3/11	57/91 (62.6)
Trimethoprim/ sulphonamide	163/300 (54.3)	98/215 (45.6)	116/244 (47.5)	50/78 (64.1)	34/54 (63.0)	54/72 (75.0)	11/28 (39.3)	5/11	45/91 (49.5)

^ HP-CIA

- No isolates tested or no data available

Table S4.7.4: Resistance (interpreted using breakpoints) in all *E. coli* from sheep (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	1/102 (1.0)	0/60 (0)	1/72 (1.4)	-	-	-	-	-	-
Amoxicillin/ clavulanate	26/179 (14.5)	22/148 (14.9)	24/161 (14.9)	30/68 (44.1)	31/73 (42.5)	26/79 (32.9)	13/70 (18.6)	17/49 (34.7)	28/67 (41.8)
Ampicillin	86/179 (48.0)	64/148 (43.2)	75/161 (46.6)	54/68 (79.4)	53/73 (72.6)	52/79 (65.8)	27/70 (38.6)	22/49 (44.9)	37/67 (55.2)
Apramycin	5/139 (3.6)	0/118 (0)	4/132 (3.0)	6/67 (9.0)	8/72 (11.1)	4/78 (5.1)	0/70 (0)	-	-
Cefotaxime^	4/102 (3.9)	2/60 (3.3)	2/73 (2.7)	-	-	-	-	-	-
Cefpodoxime^	-	-	-	21/68 (30.9)	41/73 (56.2)	40/80 (50.0)	2/70 (2.9)	0/49 (0)	0/66 (0)
Ceftazidime^	3/102 (2.9)	1/60 (1.7)	0/73 (0)	-	-	-	-	-	-
Chloramphenicol	27/102 (26.5)	9/60 (15.0)	17/72 (23.6)	-	-	-	-	-	-
Colistin^	-	-	0/130 (0)	-	-	-	-	-	-
Doxycycline	-	-	-	-	-	-	-	-	-
Enrofloxacin^	7/179 (3.9)	5/148 (3.4)	2/161 (1.2)	9/68 (13.2)	14/73 (19.2)	15/80 (18.8)	1/70 (1.4)	1/49 (2.0)	2/67 (3.0)
Florfenicol	11/133 (8.3)	5/88 (5.7)	13/99 (13.1)	16/67 (23.9)	26/71 (36.6)	22/78 (28.2)	3/70 (4.3)	2/49 (4.1)	9/64 (14.1)
Neomycin	23/148 (15.5)	11/120 (9.2)	16/134 (11.9)	38/38 (100)	73/73 (100)	78/78 (100)	5/70 (7.1)	1/49 (2.0)	5/67 (7.5)
Spectinomycin	63/139 (45.3)	44/118 (37.3)	47/132 (35.6)	-	-	1/1	18/70 (25.7)	17/49 (34.7)	31/63 (49.2)
Streptomycin	57/111 (51.4)	24/62 (38.7)	37/74 (50.0)	-	-	1/1	-	-	2/3
Tetracycline	111/179 (62.0)	82/148 (55.4)	78/161 (48.4)	47/68 (69.1)	41/73 (56.2)	43/79 (54.4)	34/70 (48.6)	24/49 (49.0)	38/67 (56.7)
Trimethoprim/ sulphonamide	39/179 (21.8)	24/148 (16.2)	36/161 (22.4)	26/68 (38.2)	27/73 (37.0)	26/79 (32.9)	12/70 (17.1)	9/49 (18.4)	19/67 (28.4)

^ HP-CIA

- No isolates tested or no data available

Table S4.7.5: Resistance (interpreted using breakpoints) in all *E. coli* from chickens (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	-	-	-	-	-	-	-	-	-
Amoxicillin/ clavulanate	8/223 (3.6)	3/96 (3.1)	1/17	5/30 (16.7)	2/16	2/22 (9.1)	4/212 (1.9)	13/212 (6.1)	3/156 (1.9)
Ampicillin	82/264 (31.1)	41/144 (28.5)	21/72 (29.2)	13/30 (43.3)	9/16	9/22 (40.9)	63/212 (29.7)	47/212 (22.2)	26/156 (16.7)
Apramycin	6/264 (2.3)	3/144 (2.1)	1/72 (1.4)	1/30 (3.3)	0/16	0/21 (0)	3/212 (1.4)	-	-
Cefotaxime^	-	-	-	-	-	-	-	-	-
Cefpodoxime^	9/264 (3.4)	6/144 (4.2)	3/72 (4.2)	21/31 (67.7)	12/16	18/22 (81.8)	0/212 (0)	6/212 (2.8)	1/156 (0.6)
Ceftazidime^	-	-	-	-	-	-	-	-	-
Chloramphenicol	-	-	-	-	-	-	-	-	-
Colistin^	-	-	0/48 (0)	-	-	-	-	-	-
Doxycycline	34/264 (12.9)	37/144 (25.7)	21/72 (29.2)	-	-	-	-	-	-
Enrofloxacin^	7/264 (2.7)	1/144 (0.7)	2/72 (2.8)	6/30 (20.0)	4/16	1/22 (45.5)	0/212 (0)	1/212 (0.5)	2/156 (1.3)
Florfenicol	-	-	-	3/3	1/1	0/2	-	-	-
Neomycin	32/223 (14.3)	12/96 (12.5)	0/17	15/15	16/16	22/22 (100)	1/212 (0.5)	1/212 (0.5)	3/156 (1.9)
Spectinomycin	53/264 (20.1)	19/144 (13.2)	19/72 (26.4)	-	-	-	20/212 (9.4)	19/212 (9.0)	5/156 (3.2)
Tetracycline	81/264 (30.7)	37/144 (25.7)	19/72 (26.4)	11/30 (36.7)	6/16	5/22 (22.7)	47/212 (22.2)	70/212 (33.0)	41/156 (26.3)
Trimethoprim/ sulphonamide	48/264 (18.1)	20/144 (13.9)	14/72 (19.4)	5/30 (16.7)	3/16	0/22 (0)	31/212 (14.6)	22/212 (10.4)	11/156 (7.1)

^ HP-CIA

- No isolates tested or no data available

Table S4.7.6: Resistance (interpreted using breakpoints) in all *E. coli* from turkeys (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amikacin	-	-	-	-	-	-	-	-	-
Amoxicillin/clavulanate	1/4	0/4	0/2	3/8	1/7	0/2	0/14	0/8	0/1
Ampicillin	7/7	6/18	5/7	7/8	5/7	2/2	8/13	2/8	0/1
Apramycin	0/7	0/18	0/7	3/8	0/6	0/2	1/14	-	-
Cefotaxime^	-	-	-	-	-	-	-	-	-
Cefpodoxime^	0/7	0/18	-	6/8	4/6	2/2	0/14	0/8	0/1
Ceftazidime^	-	-	-	-	-	-	-	-	-
Chloramphenicol	-	-	-	-	-	-	-	-	-
Colistin^	-	-	0/3	-	-	-	-	-	-
Doxycycline	3/7	9/18	4/7	-	-	-	-	-	-
Enrofloxacin^	0/7	3/18	0/7	2/8	1/7	0/2	0/14	0/8	0/1
Florfenicol	-	-	-	-	-	-	-	-	0/1
Neomycin	1/4	0/3	0/2	6/6	7/7	2/2	0/14	0/8	0/1
Spectinomycin	3/7	2/18	0/7	-	-	-	3/14	0/8	0/1
Streptomycin	-	-	-	-	-	-	-	-	0/1
Tetracycline	5/7	10/18	3/7	6/8	3/7	1/2	8/14	1/8	0/1
Trimethoprim/sulphonamide	1/7	6/18	2/7	3/8	2/7	0/2	6/14	2/8	0/1

^ HP-CIA

- No isolates tested or no data available

Table S4.7.7: Resistance (interpreted using breakpoints) in *E. coli* from cattle in England and Wales, Northern Ireland and Scotland; 2016

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Neonatal	Neonatal	Pre-weaning	Adult
Amikacin	3/305 (1.0)	0/33 (0)	0/1	-	-	-	-
Amoxicillin/clavulanate	136/336 (40.5)	30/62 (48.4)	0/16	338/524 (64.5)	33/103 (32.0)	11/38 (29.0)	4/20 (20.0)
Ampicillin	266/336 (79.2)	53/62 (85.5)	5/16	457/523 (87.4)	48/103 (46.6)	20/38 (52.6)	8/20 (40.0)
Apramycin	15/328 (4.6)	1/54 (1.9)	0/12	60/525 (11.4)	3/52 (5.8)	0/35 (0)	0/15
Cefotaxime^	49/306 (16.0)	5/34 (14.7)	0/1	-	-	-	-
Ceftazidime^	31/306 (10.1)	5/34 (14.7)	0/1	-	-	-	0/3
Chloramphenicol	147/305 (48.2)	12/33 (36.4)	0/1	-	0/1	0/3	-
Enrofloxacin^	35/336 (10.4)	8/62 (12.9)	2/16	227/525 (43.2)	6/103 (5.8)	4/38 (10.5)	3/20 (15.0)
Florfenicol	107/314 (34.1)	12/42 (28.6)	0/5	308/525 (58.7)	11/53 (20.8)	14/35 (40.0)	3/16
Neomycin	145/328 (44.2)	18/54 (33.3)	1/12	337/338 (99.7)	10/103 (9.7)	10/38 (26.3)	2/20 (10.0)
Spectinomycin	131/328 (39.9)	21/54 (38.9)	3/12	-	18/52 (34.6)	11/35 (31.4)	2/15
Streptomycin	186/305 (61.0)	20/33 (60.6)	1/1	-	3/50 (6.0)	-	1/4
Tetracycline	257/336 (76.5)	47/62 (75.8)	7/16	437/524 (83.4)	44/103 (42.7)	24/38 (63.2)	6/20 (30.0)
Trimethoprim/sulphonamide	161/336 (47.9)	29/62 (46.8)	6/16	365/524 (69.7)	19/103 (18.5)	17/38 (44.7)	3/20 (15.0)

[1] No pre-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.8: Resistance (interpreted using breakpoints) in *E. coli* from cattle in England and Wales, Northern Ireland and Scotland; 2017

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Neonatal	Neonatal	Pre-weaning	Adult
Amikacin	0/164 (0)	0/23 (0)	0/3	-	-	-	-
Amoxicillin/clavulanate	81/184 (44.0)	23/48 (47.9)	2/26 (7.7)	261/364 (71.7)	23/38 (60.5)	5/13	9/130 (6.9)
Ampicillin	144/184 (78.3)	34/48 (70.8)	9/26 (34.6)	338/364 (92.9)	32/38 (84.2)	7/13	20/130 (15.4)
Apramycin	3/177 (1.7)	3/38 (7.9)	0/23 (0)	40/364 (11.0)	-	-	-
Cefotaxime^	20/164 (12.2)	5/23 (21.7)	0/3	-	-	-	-
Cefpodoxime^	-	-	-	242/362 (66.9)	1/38 (2.6)	2/13	1/130 (0.8)
Ceftazidime^	11/164 (6.7)	3/23 (13.0)	0/3	-	-	-	-
Chloramphenicol	75/164 (45.7)	12/23 (52.2)	0/3	-	-	-	-
Enrofloxacin^	17/184 (9.2)	9/48 (18.8)	1/26 (3.8)	213/364 (58.5)	3/38 (7.9)	2/13	2/130 (1.5)
Florfenicol	47/171 (27.5)	15/33 (45.5)	1/6	226/364 (62.1)	14/38 (36.8)	6/13	3/12
Neomycin	68/177 (38.4)	18/38 (47.4)	1/23 (4.3)	359/361 (99.4)	12/38 (31.6)	2/13	1/130 (0.8)
Spectinomycin	66/177 (37.3)	11/38 (28.9)	3/23 (13.0)	-	15/38 (39.5)	2/13	6/130 (4.6)
Streptomycin	94/164 (57.3)	16/23 (69.6)	1/3	-	-	-	3/118 (2.5)
Tetracycline	137/184 (74.5)	37/48 (77.1)	9/26 (34.6)	321/364 (88.2)	33/38 (86.8)	10/13	21/130 (16.2)
Trimethoprim/sulphonamide	83/184 (45.1)	26/48 (54.2)	5/26 (19.2)	272/364 (74.7)	15/38 (39.5)	5/13	8/130 (6.2)

[1] No pre-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.9: Resistance (interpreted using breakpoints) in *E. coli* from cattle in England and Wales, Northern Ireland and Scotland; 2018

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Neonatal	Neonatal	Pre-weaning	Adult[2]
Amikacin	0/159 (0)	0/30 (0)	-	-	-	-	-
Amoxicillin/clavulanate	73/181 (40.3)	21/65 (32.3)	3/20	203/365 (0.6)	25/48 (52.1)	16/28 (57.1)	-
Ampicillin	144/181 (79.6)	37/65 (56.9)	6/20	322/366 (0.9)	41/50 (82.0)	22/28 (78.6)	-
Apramycin	8/173 (4.6)	3/58 (5.2)	1/17	37/366 (0.1)	-	-	-
Cefotaxime^	18/159 (11.3)	3/30 (10.0)	1/1	-	-	-	-
Cefpodoxime^	-	-	-	206/365 (0.6)	2/45 (4.4)	0/27	-
Ceftazidime^	7/159 (4.4)	1/30 (3.3)	1/1	-	-	-	-
Chloramphenicol	69/159 (43.4)	13/30 (43.3)	-	-	-	-	-
Enrofloxacin^	8/181 (4.4)	4/65 (6.2)	1/20	173/366 (0.5)	2/47 (4.3)	4/28 (14.3)	-
Florfenicol	50/167 (29.9)	14/37 (37.8)	1/3	198/363 (0.5)	14/48 (29.2)	9/28 (32.1)	-
Neomycin	53/173 (30.6)	15/58 (25.9)	1/17	361/362 (1.0)	10/47 (21.3)	4/28 (14.3)	-
Spectinomycin	72/173 (41.6)	24/58 (41.4)	1/17	-	20/46 (43.5)	7/27 (25.9)	-
Streptomycin	86/159 (54.1)	14/30 (46.7)	-	-	-	-	-
Tetracycline	127/181 (70.2)	41/65 (63.1)	7/20	305/366 (0.8)	40/49 (81.6)	26/28 (92.9)	-
Trimethoprim/sulphonamide	77/181 (42.5)	28/65 (43.1)	5/20	265/366 (0.7)	17/47 (36.2)	13/28 (46.4)	-

[1] No pre-weaning or adult data available for Northern Ireland

[2] All *E. coli* obtained from adult cattle were from mastitis cases and results are presented in Table S4.2.2

^ HP-CIA

- No isolates tested or no data available

Table S4.7.10: Resistance (interpreted using breakpoints) in *E. coli* from pigs in England and Wales, Northern Ireland and Scotland; 2016

	No. resistant/No. tested (Percentage resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Post-weaning	Adult	Neonatal	Neonatal	Post-weaning	Adult
Amoxicillin/clavulanate	2/62 (3.2)	8/155 (5.2)	-	12/21 (57.1)	0/3	3/19	1/6
Ampicillin	40/71 (56.3)	94/168 (56)	1/1	14/21 (66.7)	1/3	7/19	1/6
Apramycin	1/71 (1.4)	33/168 (19.6)	0/1	6/21 (28.6)	0/3	0/19	0/6
Cefpodoxime^	2/71 (2.8)	4/168 (2.4)	0/1	6/21 (28.6)	0/3	0/19	0/6
Doxycycline	33/62 (53.2)	78/155 (50.3)	-	-	-	-	-
Enrofloxacin^	9/71 (12.7)	4/168 (2.4)	0/1	6/21 (28.6)	1/3	2/19	0/6
Florfenicol	3/62 (4.8)	15/155 (9.7)	-	2/21 (9.5)	0/3	0/19	0/6
Neomycin	3/71 (4.2)	12/168 (7.1)	0/1	21/21 (100)	0/3	0/19	0/6
Spectinomycin	29/71 (40.8)	88/168 (52.4)	0/1	-	1/3	4/19	1/6
Streptomycin	22/62 (35.5)	71/155 (45.8)	-	-	-	-	-
Tetracycline	51/71 (71.8)	116/168 (69.0)	0/1	17/21 (81.0)	2/3	9/19	1/6
Trimethoprim/sulphonamide	36/71 (50.7)	101/168 (60.1)	0/1	14/21 (66.7)	3/3	7/19	1/6

[1] No post-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.11: Resistance (interpreted using breakpoints) in *E. coli* from pigs in England and Wales, Northern Ireland and Scotland; 2017

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Post-weaning	Adult	Adult	Neonatal	Post-weaning	Adult
Amikacin	-	-	-	-	-	-	-
Amoxicillin/clavulanate	2/32 (6.3)	2/95 (2.1)	1/2	2/9	1/6	2/4	1/1
Ampicillin	18/40 (45.0)	61/119 (51.3)	2/3	8/9	2/6	3/4	1/1
Apramycin	1/40 (2.5)	27/119 (22.7)	0/3	2/9	-	-	-
Cefotaxime^	-	-	-	-	-	-	-
Cefpodoxime^	1/40 (2.5)	1/119 (0.8)	0/3	2/9	0/6	1/4	0/1
Ceftazidime^	-	-	-	-	-	-	-
Chloramphenicol	-	-	-	-	-	-	-
Doxycycline	19/32 (59.4)	62/95 (65.3)	1/2	-	-	-	-
Enrofloxacin^	6/40 (15.0)	3/119 (2.5)	0/3	2/9	0/6	0/4	0/1
Florfenicol	1/32 (3.1)	13/95 (13.7)	0/2	2/9	0/6	1/4	0/1
Neomycin	3/40 (7.5)	10/119 (8.4)	0/3	9/9	0/6	0/4	0/1
Spectinomycin	20/40 (50.0)	46/119 (38.7)	0/3	-	1/6	3/4	0/1
Streptomycin	8/32 (25.0)	29/95 (30.5)	2/2	-	-	-	-
Tetracycline	22/40 (55.0)	77/119 (64.7)	1/3	9/9	4/6	2/4	1/1
Trimethoprim/sulphonamide	16/40 (40.0)	60/119 (50.4)	2/3	5/9	1/6	2/4	0/1

[1] No post-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.12: Resistance (interpreted using breakpoints) in *E. coli* from pigs in England and Wales, Northern Ireland and Scotland; 2018

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Post-weaning	Adult	Neonatal	Neonatal	Post-weaning	Adult
Amoxicillin/clavulanate	2/2	-	-	7/16	18/44 (40.9)	-	19/47 (40.4)
Ampicillin	29/59 (49.2)	63/115 (54.8)	5/10	11/16	25/44 (56.8)	-	28/47 (59.6)
Apramycin	1/59 (1.7)	23/115 (20.0)	1/10	3/16	-	-	-
Cefpodoxime^	2/59 (3.4)	2/115 (1.7)	0/10	7/16	4/42 (9.5)	-	4/45 (8.9)
Doxycycline	1/2	-	-	-	-	-	-
Enrofloxacin^	5/59 (8.5)	2/115 (1.7)	0/10	9/16	8/44 (18.2)	-	8/47 (17.0)
Florfenicol	0/2	-	-	4/16	6/43 (14.0)	-	6/46 (13.0)
Neomycin	3/59 (5.1)	14/115 (12.2)	0/10	15/15	1/44 (2.3)	-	1/47 (2.1)
Spectinomycin	29/59 (49.2)	42/115 (36.5)	1/10	-	12/43 (27.9)	-	12/46 (26.1)
Streptomycin	1/2	-	-	-	-	-	-
Tetracycline	35/59 (59.3)	74/115 (64.3)	4/10	15/16	27/44 (61.4)	-	30/47 (63.8)
Trimethoprim/sulphonamide	20/59 (33.9)	63/115 (54.8)	2/10	15/16	22/44 (50.0)	-	23/47 (48.9)

[1] No post-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested

Table S4.7.13: Resistance (interpreted using breakpoints) in *E. coli* from sheep in England and Wales, Northern Ireland and Scotland; 2016

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Neonatal	Neonatal	Pre-weaning	Adult
Amoxicillin/clavulanate	18/101 (17.8)	2/26 (7.7)	3/30 (10.0)	24/44 (54.5)	9/42 (21.4)	4/13	0/15
Ampicillin	60/101 (59.4)	10/26 (38.5)	9/30 (30.0)	36/44 (81.8)	19/42 (45.2)	7/13	1/15
Apramycin	3/98 (3.1)	1/17	1/13	3/44 (6.8)	0/42 (0)	0/13	0/15
Cefotaxime^	3/86 (3.5)	0/11	-	-	-	-	-
Ceftazidime^	2/86 (2.3)	0/11	-	-	-	-	-
Chloramphenicol	21/86 (24.4)	5/11	-	-	-	-	-
Enrofloxacin^	5/101 (5.0)	0/26 (0)	1/30 (3.3)	8/44 (18.2)	1/42 (2.4)	0/13	0/15
Florfenicol	7/88 (8.0)	2/18	1/13	10/44 (22.7)	1/42 (2.4)	2/13	0/15
Neomycin	20/99 (20.2)	0/19	1/17	27/27 (100)	4/42 (9.5)	1/13	0/15
Spectinomycin	51/98 (52.0)	6/17	2/13	-	13/42 (31.0)	3/13	2/15
Streptomycin	48/87 (55.2)	6/13	1/4	-	-	-	-
Tetracycline	79/101 (78.2)	13/26 (50.0)	11/30 (36.7)	31/44 (70.5)	20/42 (47.6)	9/13	5/15
Trimethoprim/sulphonamide	30/101 (29.7)	3/26 (11.5)	2/30 (6.7)	22/44 (50.0)	10/42 (23.8)	2/13	0/15

[1] No pre-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.14: Resistance (interpreted using breakpoints) in *E. coli* from sheep in England and Wales, Northern Ireland and Scotland; 2017

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Adult	Neonatal	Pre-weaning	Adult
Amikacin	0/56 (0)	0/1	-	-	-	-	-
Amoxicillin/clavulanate	15/75 (20.0)	4/17	2/36 (5.6)	21/32 (65.6)	4/21 (19.0)	6/10	7/18
Ampicillin	38/75 (50.7)	8/17	11/36 (30.6)	26/32 (81.3)	6/21 (28.6)	8/10	8/18
Apramycin	0/71 (0)	0/7	0/25 (0)	6/32 (18.8)	-	-	-
Cefotaxime^	2/56 (3.6)	0/1	-	-	-	-	-
Cefpodoxime^	-	-	-	18/32 (56.3)	0/21 (0)	0/10	0/18
Ceftazidime^	1/56 (1.8)	0/1	-	-	-	-	-
Chloramphenicol	9/56 (16.1)	0/1	-	-	-	-	-
Enrofloxacin^	3/75 (4.0)	1/17	1/36 (2.8)	9/32 (28.1)	1/21 (4.8)	0/10	0/18
Florfenicol	4/60 (6.7)	1/11	0/9	15/31 (48.4)	1/21 (4.8)	0/10	1/18
Neomycin	8/71 (11.3)	1/7	2/27 (7.4)	32/32 (100)	1/21 (4.8)	0/10	0/18
Spectinomycin	35/71 (49.3)	3/7	4/25 (16.0)	-	6/21 (28.6)	4/10	7/18
Streptomycin	22/56 (39.3)	0/1	1/2	-	-	-	-
Tetracycline	48/75 (64.0)	11/17	14/36 (38.9)	22/32 (68.8)	11/21 (52.4)	9/10	8/18
Trimethoprim/sulphonamide	19/75 (25.3)	0/17	4/36 (11.1)	17/32 (53.1)	2/21 (9.5)	4/10	3/18

[1] No pre-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

Table S4.7.15: Resistance (interpreted using breakpoints) in *E. coli* from sheep in England and Wales, Northern Ireland and Scotland; 2018

	No. resistant/No. tested (% resistant)						
	England & Wales			Northern Ireland[1]	Scotland		
Antibiotic	Neonatal	Pre-weaning	Adult	Neonatal	Neonatal	Pre-weaning	Adult
Amoxicillin/clavulanate	14/69 (20.3)	6/32 (18.8)	1/26 (3.8)	20/52 (38.5)	11/21 (52.4)	1/4	16/42 (38.1)
Ampicillin	34/69 (49.3)	14/32 (43.8)	11/26 (42.3)	36/52 (69.2)	14/21 (66.7)	2/4	21/42 (50.0)
Apramycin	2/68 (2.9)	1/23 (4.3)	0/19	3/52 (5.8)	-	-	-
Cefotaxime^	1/58 (1.7)	1/7	0/2	-	-	-	-
Cefpodoxime^	-	-	-	26/52 (50.0)	0/21 (0)	0/4	0/41 (0)
Ceftazidime^	0/58 (0)	0/7	0/2	-	-	-	-
Chloramphenicol	13/58 (22.4)	4/7	0/2	-	-	-	-
Enrofloxacin^	1/69 (1.4)	0/32 (0)	1/26 (3.8)	14/52 (26.9)	0/21 (0)	0/4	2/42 (4.8)
Florfenicol	8/59 (13.6)	4/16	0/7	17/51 (33.3)	2/21 (9.5)	2/4	5/39 (12.8)
Neomycin	12/68 (17.6)	1/23 (4.3)	2/21 (9.5)	50/50 (100)	2/21 (9.5)	0/4	3/42 (7.1)
Spectinomycin	30/68 (44.1)	8/23 (34.8)	3/19	-	14/21 (66.7)	1/4	16/38 (42.1)
Streptomycin	27/58 (46.6)	4/7	1/4	-	-	-	2/3
Tetracycline	40/69 (58.0)	17/32 (53.1)	8/26 (30.8)	30/52 (57.7)	14/21 (66.7)	2/4	22/42 (52.4)
Trimethoprim/sulphonamide	18/69 (26.1)	9/32 (28.1)	4/26 (15.4)	19/52 (36.5)	7/21 (33.3)	1/4	11/42 (26.2)

[1] No pre-weaning or adult data available for Northern Ireland

^ HP-CIA

- No isolates tested or no data available

S4.8: Clinical Surveillance Data for *Salmonella*

Table S4.8.1: Resistance (interpreted using breakpoints) in all *Salmonella* from cattle, pigs, sheep, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	1/1394 (0.1)	3/1707 (0.2)	3/2789 (0.1)	5/228 (2.2)	8/86 (9.3)	4/103 (3.9)	2/131 (1.5)	22/164 (13.4)	13/210 (6.2)
Ampicillin	192/1394 (13.8)	231/1707 (13.5)	284/2789 (10.2)	20/228 (8.8)	9/86 (10.5)	17/103 (16.5)	4/131 (3.1)	26/164 (15.9)	67/282 (23.8)
Apramycin	38/1394 (2.7)	38/1707 (2.2)	35/2789 (1.3)	7/228 (3.1)	3/86 (3.5)	7/103 (6.8)	2/128 (1.6)	-	-
Cefotaxime^	1/1394 (0.1)	0/1707 (0)	2/2789 (0.1)	1/228 (0.4)	0/86 (0)	0/103 (0)	-	-	0/282 (0)
Ceftazidime^	1/1394 (0.1)	0/1707 (0)	2/2789 (0.1)	0/228 (0)	0/86 (0)	0/103 (0)	-	-	-
Chloramphenicol	114/1394 (8.2)	128/1707 (7.5)	156/2789 (5.6)	15/228 (6.6)	3/86 (3.5)	9/103 (8.7)	-	-	24/282 (8.5)
Ciprofloxacin^	8/1394 (0.6)	5/1707 (0.3)	3/2789 (0.1)	0/228 (0)	0/86 (0)	0/103 (0)	-	-	8/282 (2.8)
Furazolidone	9/1394 (0.6)	14/1707 (0.8)	13/2789 (0.5)	1/228 (0.4)	0/86 (0)	0/103 (0)	-	-	3/282 (1.1)
Gentamicin	42/1394 (3.0)	40/1707 (2.3)	48/2789 (1.7)	7/228 (3.1)	3/86 (3.5)	7/103 (6.8)	-	-	1/282 (0.4)
Nalidixic acid	31/1394 (2.2)	62/1707 (3.6)	22/2789 (0.8)	13/228 (5.7)	9/86 (10.5)	4/103 (3.9)	0/128 (0)	2/164 (1.2)	8/282 (2.8)
Neomycin	14/1394 (1.0)	34/1707 (2.0)	50/2789 (1.8)	-	-	-	1/131 (0.8)	0/164 (0)	0/282 (0)
Spectinomycin	-	-	-	-	-	10/103 (9.7)	-	-	30/282 (10.6)
Streptomycin	304/1394 (21.8)	353/1707 (20.7)	460/2789 (16.5)	44/228 (19.3)	13/86 (15.1)	19/103 (18.4)	-	-	75/282 (26.6)
Sulphonamide compounds	421/1394 (30.2)	447/1707 (26.2)	561/2789 (20.1)	36/228 (15.8)	9/86 (10.5)	-	-	-	82/282 (29.1)
Tetracycline	370/1394 (26.5)	393/1707 (23.0)	480/2789 (17.2)	18/228 (7.9)	9/86 (10.5)	18/103 (17.5)	7/131 (5.3)	31/164 (18.9)	84/282 (29.8)
Trimethoprim/ sulphonamide	177/1394 (12.7)	162/1707 (9.5)	212/2789 (7.6)	-	3/86 (3.5)	7/103 (6.8)	0/131 (0)	2/164 (1.2)	3/282 (1.1)

^ HP-CIA

- No isolates tested

Table S4.8.2: Resistance (interpreted using breakpoints) in all *Salmonella* from cattle (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	0/336 (0)	1/392 (0.3)	3/489 (0.6)	0/75 (0)	2/73 (2.7)	0/76 (0)	0/88 (0)	21/114 (18.4)	9/130 (6.9)
Ampicillin	36/336 (10.7)	54/392 (13.8)	45/489 (9.2)	2/75 (2.7)	2/73 (2.7)	4/76 (5.3)	0/88 (0)	21/114 (18.4)	13/140 (9.3)
Apramycin	0/336 (0)	0/392 (0)	3/489 (0.6)	1/75 (1.3)	0/73 (0)	2/76 (2.6)	1/87 (1.2)	-	-
Cefotaxime^	0/336 (0)	0/392 (0)	0/489 (0.0)	0/75 (0)	0/73 (0)	0/76 (0)	-	-	0/140 (0)
Ceftazidime^	0/336 (0)	0/392 (0)	0/489 (0.0)	0/75 (0)	0/73 (0)	0/76 (0)	-	-	-
Chloramphenicol	23/336 (6.8)	4/392 (10.7)	32/489 (6.5)	1/75 (1.3)	0/73 (0)	2/76 (2.6)	-	-	20/140 (14.3)
Ciprofloxacin^	0/336 (0)	0/392 (0)	0/489 (0.0)	0/75 (0)	0/73 (0)	0/76 (0)	-	-	0/140 (0)
Furazolidone	0/336 (0)	0/392 (0)	0/489 (0.0)	0/75 (0)	0/73 (0)	0/76 (0)	-	-	0/140 (0)
Gentamicin	0/336 (0)	0/392 (0)	3/489 (0.6)	0/75 (0)	0/73 (0)	2/76 (2.6)	-	-	1/140 (0.7)
Nalidixic acid	3/336 (0.9)	1/392 (0.5)	5/489 (1.0)	4/75 (5.3)	8/73 (11.0)	1/76 (1.3)	0/87 (0)	2/114 (1.8)	4/140 (2.9)
Neomycin	0/336 (0)	0/392 (0)	5/489 (1.0)	-	-	-	0/88 (0)	0/114 (0)	0/140 (0)
Spectinomycin	-	-	-	-	-	2/76 (2.6)	-	-	15/140 (10.7)
Streptomycin	41/336 (12.2)	58/392 (14.8)	68/489 (13.9)	8/75 (10.7)	5/73 (6.8)	5/76 (6.6)	1/87 (1.2)	-	17/140 (12.1)
Sulphonamide compounds	37/336 (11.0)	58/392 (14.8)	68/489 (13.9)	2/75 (2.7)	2/73 (2.7)	-	-	-	22/140 (15.7)
Tetracycline	35/336 (10.4)	55/392 (14.0)	56/489 (11.5)	2/75 (2.7)	1/73 (1.4)	4/76 (5.3)	3/88 (3.4)	24/114 (21.1)	19/140 (13.6)
Trimethoprim/ sulphonamide	2/336 (0.6)	0/392 (0)	2/489 (0.4)	-	0/73 (0)	2/76 (2.6)	0/88 (0)	1/114 (0.9)	1/140 (0.7)

^ HP-CIA

- No isolates tested

Table S4.8.3: Resistance (interpreted using breakpoints) in all *Salmonella* from pigs (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2015	2016	2017
Amoxicillin/ clavulanate	1/160 (0.6)	1/158 (0.6)	0/202 (0)	3/16	6/8	4/13	1/5	1/7	0/19 (0)
Ampicillin	116/160 (72.5)	124/158 (78.5)	146/202 (72.3)	11/16	7/8	11/13	3/5	5/7	48/74 (64.9)
Apramycin	35/160 (21.9)	37/158 (23.4)	29/202 (14.4)	5/16	3/8	5/13	0/5	-	-
Cefotaxime^	0/160 (0)	0/158 (0)	0/202 (0)	0/16	0/8	0/13	-	-	0/74 (0)
Ceftazidime^	0/160 (0)	0/158 (0)	0/202 (0)	0/16	0/8	0/13	-	-	-
Chloramphenicol	70/160 (43.8)	63/158 (39.9)	104/202 (51.5)	12/16	3/8	7/13	-	-	0/74 (0)
Ciprofloxacin^	0/160 (0)	0/158 (0)	0/202 (0)	0/16	0/8	0/13	-	-	0/74 (0)
Furazolidone	0/160 (0)	0/158 (0)	0/202 (0)	0/16	0/8	0/13	-	-	0/74 (0)
Gentamicin	35/160 (21.9)	38/158 (24.1)	34/202 (16.8)	5/16	3/8	5/13	-	-	0/74 (0)
Nalidixic acid	3/160 (1.9)	2/158 (1.3)	0/202 (0)	2/16	1/8	3/13	0/5	0/7	1/74 (1.4)
Neomycin	10/160 (6.3)	31/158 (19.6)	24/202 (11.9)	-	-	-	0/5	0/7	0/74 (0
Spectinomycin	-	-	-	-	-	8/13			9/74 (12.2)
Streptomycin	123/160 (76.9)	123/158 (77.8)	144/202 (71.3)	14/16	7/8	12/13	-	-	52/74 (70.3)
Sulphonamide compounds	137/160 (85.6)	139/158 (88.0)	161/202 (79.7)	14/16	7/8	-	-	-	52/74 (70.3)
Tetracycline	128/160 (80.0)	124/158 (78.5)	151/202 (74.8)	14/16	8/8	12/13	3/5	4/7	58/74 (78.4)
Trimethoprim/ sulphonamide	76/160 (47.5)	79/158 (50.0)	105/202 (52.0)	-	3/8	5/13	0/5	1/7	1/74 (1.4)

^ HP-CIA

- No isolates tested

Table S4.8.4: Resistance (interpreted using breakpoints) in all *Salmonella* from sheep (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/clavulanate	0/91 (0)	0/104 (0)	0/276 (0.0)	1/15	0/3	0/11	1/38 (2.6)	0/43 (0)	4/61 (6.6)
Ampicillin	11/91 (12.1)	17/104 (16.3)	18/276 (6.5)	2/15	0/3	2/11	1/38 (2.6)	0/43 (0)	6/68 (8.8)
Apramycin	0/91 (0)	0/104 (0)	2/276 (0.7)	0/15	0/3	0/11	1/36 (2.8)	-	-
Cefotaxime^	0/91 (0)	0/104 (0)	0/276 (0.0)	0/15	0/3	0/11	-	-	0/68 (0)
Ceftazidime^	0/91 (0)	0/104 (0)	0/276 (0.0)	0/15	0/3	0/11	-	-	-
Chloramphenicol	11/91 (12.1)	17/104 (16.3)	15/276 (5.4)	1/15	0/3	0/11	-	-	4/68 (5.9)
Ciprofloxacin^	0/91 (0)	0/104 (0)	0/276 (0.0)	0/15	0/3	0/11	-	-	0/68 (0)
Furazolidone	0/91 (0)	0/104 (0)	1/276 (0.4)	0/15	0/3	0/11	-	-	3/68 (4.4)
Gentamicin	0/91 (0)	0/104 (0)	1/276 (0.4)	0/15	0/3	0/11	-	-	0/68 (0)
Nalidixic acid	0/91 (0)	0/104 (0)	0/276 (0.0)	1/15	0/3	0/11	0/36 (0)	0/43 (0)	3/68 (4.4)
Neomycin	0/91 (0)	0/104 (0)	1/276 (0.4)	-	-	-	1/38 (2.6)	0/43 (0)	0/68 (0)
Spectinomycin	-	-	-	-	-	0/11	-	-	6/68 (8.8)
Streptomycin	14/91 (15.4)	17/104 (16.3)	21/276 (7.6)	2/15	0/3	2/11	-	-	6/68 (8.8)
Sulphonamide compounds	12/91 (13.2)	17/104 (16.3)	20/276 (7.2)	2/15	0/3	0/11	-	-	8/68 (11.8)
Tetracycline	13/91 (14.3)	17/104 (16.3)	19/276 (6.9)	2/15	0/3	2/11	1/38 (2.6)	3/43 (7.0)	7/68 (10.3)
Trimethoprim/sulphonamide	0/91 (0)	0/104 (0)	1/276 (0.4)	-	0/3	0/11	0/38 (0)	-	1/68 (1.5)

^ HP-CIA

- No isolates tested

Table S4.8.5: Resistance (interpreted using breakpoints) in all *Salmonella* from chickens (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018*

	No. resistant/No. tested (% resistant)					
	England & Wales			Northern Ireland		
Antibiotic	2016	2017	2018	2016	2017	2018
Amoxicillin/clavulanate	0/696 (0)	1/873 (0.1)	0/1640 (0)	1/110 (0.9)	-	-
Ampicillin	21/696 (3.0)	25/873 (2.9)	49/1640 (3.0)	5/110 (4.5)	-	-
Apramycin	3/696 (0.4)	1/873 (0.1)	0/1640 (0)	2/110 (1.8)	-	-
Cefotaxime^	1/696 (0.1)	0/873 (0)	2/1640 (0.1)	1/110 (0.9)	-	-
Ceftazidime^	1/696 (0.1)	0/873 (0)	2/1640 (0.1)	0/110 (0)	-	-
Chloramphenicol	10/696 (1.4)	6/873 (0.7)	3/1640 (0.2)	1/110 (0.9)	-	-
Ciprofloxacin^	6/696 (0.9)	4/873 (0.5)	2/1640 (0.1)	0/110 (0)	-	-
Furazolidone	9/696 (1.3)	14/873 (1.6)	11/1640 (0.7)	1/110 (0.9)	-	-
Gentamicin	7/696 (1.0)	1/873 (0.1)	8/1640 (0.5)	2/110 (1.8)	-	-
Nalidixic acid	18/696 (2.6)	25/873 (2.9)	7/1640 (0.4)	5/110 (4.5)	-	-
Neomycin	4/696 (0.6)	2/873 (0.2)	18/1640 (1.1)	-	-	-
Streptomycin	67/696 (9.6)	74/873 (8.5)	97/1640 (5.9)	16/110 (14.5)	-	-
Sulphonamide compounds	155/696 (22.3)	130/873 (14.9)	185/1640 (11.3)	14/110 (12.7)	-	-
Tetracycline	116/696 (16.7)	94/873 (10.8)	128/1640 (7.8)	9/110 (8.2)	-	-
Trimethoprim/sulphonamide	93/696 (13.4)	79/873 (9.0)	98/1640 (6.0)	-	-	-

* Insufficient data available from Scotland (2016–2018) and Northern Ireland (2017–2018)

- No isolates tested or no data available

Table S4.8.6: Resistance (interpreted using breakpoints) in all *Salmonella* from turkeys (all ages) in England and Wales, Northern Ireland and Scotland; 2016–2018*

	No. resistant/No. tested (% resistant) England & Wales		
Antibiotic	**2016**	**2017**	**2018**
Amoxicillin/clavulanate	0/111 (0)	0/180 (0)	0/182 (0)
Ampicillin	8/111 (7.2)	11/180 (6.1)	26/182 (14.4)
Apramycin	0/111 (0)	0/180 (0)	1/182 (0.6)
Cefotaxime^	0/111 (0)	0/180 (0)	0/182 (0)
Ceftazidime^	0/111 (0)	0/180 (0)	0/182 (0)
Chloramphenicol	0/111 (0)	0/180 (0)	2/182 (1.1)
Ciprofloxacin^	2/111 (1.8)	1/180 (0.6)	1/182 (0.6)
Furazolidone	0/111 (0)	0/180 (0)	0/182 (0)
Gentamicin	0/111 (0)	1/180 (0.6)	2/182 (1.1)
Nalidixic acid	7/111 (6.3)	33/180 (18.3)	11/182 (6.0)
Neomycin	0/111 (0)	1/180 (0.6)	2/182 (1.1)
Streptomycin	59/111 (53.2)	81/180 (45.0)	131/182 (71.8)
Sulphonamide compounds	80/111 (72.1)	103/180 (57.2)	127/182 (69.6)
Tetracycline	78/111 (70.3)	103/180 (57.2)	126/182 (69.1)
Trimethoprim/sulphonamide	6/111 (5.4)	4/180 (2.2)	5/182 (2.8)

* Insufficient data available from Scotland and Northern Ireland

^ HP-CIA

Table S4.8.7: Resistance (interpreted using breakpoints) in all *Salmonella* Dublin from cattle, pigs, sheep, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/clavulanate	-	-	0/320 (0)	-	-	0/68 (0)	-	-	0/109 (0)
Ampicillin	1/245 (0.4)	0/272 (0)	0/320 (0)	0/81 (0)	0/72 (0)	0/68 (0)	0/56 (0)	0/68 (0)	2/118 (1.7)
Apramycin	-	-	0/320 (0)	-	-	0/68 (0)	-	-	-
Cefotaxime^	-	-	0/320 (0)	-	-	0/68 (0)	-	-	0/118 (0)
Ceftazidime^	-	-	0/320 (0)	-	-	0/68 (0)	-	-	-
Chloramphenicol	1/245 (0.4)	0/272 (0)	1/320 (0.3)	0/81 (0)	0/72 (0)	0/68 (0)	-	-	10/118 (8.5)
Ciprofloxacin^	-	-	0/320 (0)	-	-	0/68 (0)	-	-	0/118 (0)
Furazolidone	0/245 (0)	0/272 (0)	0/320 (0)	0/81 (0)	0/72 (0)	0/68 (0)	-	-	0/118 (0)
Gentamicin	-	-	0/320 (0)	-	-	0/68 (0)	-	-	1/118 (0.8)
Nalidixic acid	3/245 (1.2)	0/272 (0)	7/320 (2.2)	4/81 (4.9)	8/72 (11.1)	1/68 (1.5)	0/55 (0)	2/68 (2.9)	4/118 (3.4)
Neomycin	0/245 (0)	0/272 (0)	1/320 (0.3)	-	-	-	0/56 (0)	0/68 (0)	0/118 (0)
Streptomycin	4/245 (1.6)	0/272 (0)	1/320 (0.3)	7/81 (8.6)	3/72 (4.2)	1/68 (1.5)	-	-	4/118 (3.4)
Sulphonamide compounds	0/245 (0)	0/272 (0)	1/320 (0.3)	-	0/72 (0)	-	-	-	10/118 (8.5)
Tetracycline	1/245 (0.4)	0/272 (0)	1/320 (0.3)	0/81 (0)	0/72 (0)	0/68 (0)	3/56 (5.4)	2/68 (2.9)	7/118 (5.9)
Trimethoprim/sulphonamide	0/245 (0)	0/272 (0)	0/320 (0)	0/81 (0)	-	0/68 (0)	0/56 (0)	0/68 (0)	1/118 (0.8)

^ HP-CIA

- No isolates tested or no data available

Table S4.8.8: Resistance (interpreted using breakpoints) in all *Salmonella* Typhimurium from cattle, pigs, sheep, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	-	-	3/504 (0.6)	-	-	4/15	-	-	13/32 (40.6)
Ampicillin	100/166 (60.2)	109/187 (58.3)	152/504 (30.2)	15/22 (68.2)	9/11	15/15	3/3	20/27 (74.1)	63/82 (76.8)
Apramycin	4/166 (2.4)	0/187 (0)	9/504 (1.8)	-	3/11	6/15	-	-	-
Cefotaxime^	-	-	0/504 (0)	-	-	0/15	-	-	0/82 (0)
Ceftazidime^	-	-	0/504 (0)	-	-	0/15	-	-	-
Chloramphenicol	96/166 (57.8)	100/187 (53.5)	151/504 (30.0)	14/22 (63.6)	3/11	8/15	-	-	14/82 (17.1)
Ciprofloxacin^	-	-	1/504 (0.2)	-	-	0/15	-	-	0/82 (0)
Furazolidone	1/166 (0.6)	0/187 (0)	0/504 (0)	0/22 (0)	0/11	0/15	-	-	1/82 (1.2)
Gentamicin	-	-	8/504 (1.6)	-	-	6/15	-	-	0/82 (0)
Nalidixic acid	0/166 (0)	3/187 (1.6)	2/504 (0.4)	4/22 (18.2)	1/11	3/15	0/3	0/27 (0)	2/82 (2.4)
Neomycin	1/166 (0.6)	0/187 (0)	9/504 (1.8)	-	-	-	0/3	0/27 (0)	0/82 (0)
Streptomycin	106/166 (63.9)	107/187 (57.1)	205/504 (40.7)	19/22 (86.4)	10/11	15/15	-	-	70/82 (85.4)
Sulphonamide compounds	110/166 (66.3)	117/187 (62.6)	222/504 (44.0)	19/22 (86.4)	9/11	-	-	-	67/82 (81.7)
Tetracycline	102/166 (61.4)	102/187 (54.5)	183/504 (36.3)	18/22 (81.8)	8/11	15/15	3/3	25/27 (92.6)	73/82 (89.0)
Trimethoprim/ sulphonamide	48/166 (28.9)	37/187 (19.8)	79/504 (15.7)	-	-	6/15	0/3	0/27 (0)	0/82 (0)

^ HP-CIA

- No isolates tested or no data available

Table S4.8.9: Resistance (interpreted using breakpoints) in all *Salmonella* other than Dublin and Typhimurium from cattle, pigs, sheep, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland; 2016–2018

	No. resistant/No. tested (% resistant)								
	England & Wales			Northern Ireland			Scotland		
Antibiotic	2016	2017	2018	2016	2017	2018	2016	2017	2018
Amoxicillin/ clavulanate	-	-	2/3589 (0.1)	-	-	0/17	-	-	0/69 (0)
Ampicillin	220/1986 (11.1)	273/2652 (10.3)	276/3589 (7.7)	5/125 (4.0)	0/3 (0)	0/17	1/72 (1.4)	2/69 (2.9)	2/82 (2.4)
Apramycin	40/1986 (2.0)	42/2652 (1.6)	29/3589 (0.8)	-	0/3 (0)	0/17	-	-	-
Cefotaxime	-	-	2/3589 (0.1)	-	-	0/17	-	-	0/82 (0)
Ceftazidime	-	-	3/3589 (0.1)	-	-	0/17	-	-	-
Chloramphenicol	52/1986 (2.6)	53/2652 (2.0)	54/3589 (1.5)	1/125 (0.8)	0/3 (0)	0/17	-	-	0/82 (0)
Ciprofloxacin	-	-	6/3589 (0.2)	-	-	0/17			0/82 (0)
Furazolidone	28/1986 (1.4)	42/2652 (1.6)	43/3589 (1.2)	1/125 (0.8)	0/3 (0)	0/17	-	-	2/82 (2.4)
Gentamicin	-	-	42/3589 (1.2)	-	-	0/17	-	-	0/82 (0)
Nalidixic acid	52/1986 (2.6)	154/2652 (5.8)	50/3589 (1.4)	5/125 (4.0)	0/3 (0)	0/17	0/72 (0)	0/69 (0)	2/82 (2.4)
Neomycin	44/1986 (2.2)	53/2652 (2.0)	65/3589 (1.8)	-	-	-	1/72 (1.4)	0/69 (0)	0/82 (0)
Streptomycin	318/1986 (16.0)	347/2652 (13.1)	420/3589 (11.7)	18/125 (14.4)	0/3 (0)	0/17	-	-	1/82 (1.2)
Sulphonamide compounds	471/1986 (23.7)	504/2652 (19.0)	563/3589 (15.7)	17/125 (13.6)	0/3 (0)	-	-	-	5/82 (6.1)
Tetracycline	455/1986 (22.9)	520/2652 (19.6)	535/3589 (14.9)	13/125 (10.4)	1/3 (33.3)	1/17	1/72 (1.4)	4/69 (5.8)	4/82 (4.9)
Trimethoprim/ sulphonamides	207/1986 (10.4)	164/2652 (6.2)	190/3589 (5.3)	-	-	0/17	0/72 (0)	0/69 (0)	2/82 (2.4)

- No isolates tested or no data available

^ HP-CIA

Table S4.8.10: Top ten *Salmonella* serovars isolated in Northern Ireland; 2016–2018

Rank	2016	2017	2018
1	Dublin (81 isolations)	Dublin (173 isolations)	Dublin (69 isolations)
2	Mbandaka (46 isolations)	(Monophasic) Typhimurium (26 isolations)	Monophasic ST (10 isolations)
3	Muenster (37 isolations)	*Salmonella* sp. (8 isolations)	Mbandaka (6 isolations)
4	Typhimurium (22 isolations)	Derby (3 isolations)	Agama (6 isolations)
5	Senftenberg (11 isolations)	Newport (2 isolations)	Typhimurium (5 isolations)
6	Derby (5 isolations)	*	Diarizonae o 61 (2 isolations)
7	Tennessee (4 isolations)		
8	Diarizonae 61:-:1,5,7 (4 isolations)		Montevideo (2 isolations) Newport (2 isolations)
9	Brandenburg (2 isolations)		Anatum (1 isolation)
10	Choleraesuis (2 isolations)		Ruiru (1 isolation)

* No other serovars detected in 2017

Table S4.8.11: Top ten *Salmonella* serovars isolated in Scotland; 2016–2018

Rank	2016	2017	2018
1	Dublin (68 isolations)	Dublin (74 isolations)	Dublin (118 isolations)
2	Typhimurium (25 isolations)	Typhimurium (30 isolations)	Typhimurium (82 isolations)
3	Montevideo (17 isolations)	Arizonae (28 isolations)	Arizonae (36 isolations)
4	Bovismorbificans (14 isolations)	Bovismorbificans (19 isolations)	Montevideo (18 isolations)
5	Minnesota (17 isolations)	Montevideo (16 isolations)	Bovismorbificans (8 isolations)
6	Arizonae (13 isolations)	Mbandaka (9 isolations)	Mbandaka (7 isolations)
7	Mbandaka (9 isolations)	Urbana (7 isolations)	Derby (4 isolations)
8	Panama (6 isolations)	Derby (2 isolations)	Reading (3 isolations)
9	4,5,12:i:- (3 isolations)	Enteritidis/Minnesota/ Reading/Agama (1 isolation each)	Panama (2 isolations)
10	Binza (2 isolations)		Enteritidis (1 isolation)