Veterinary Medicines Directorate

Supplementary Material 2 – Resistance methods and data

UK-VARSS 2022

Published November 2023
Updated March 2024

This publication is available at www.gov.uk/government/collections/veterinary-antimicrobial-resistance-and-sales-surveillance.

Suggested citation: UK-VARSS (2023). *Supplementary Material 2 (UK-VARSS 2022)*. New Haw, Addlestone: Veterinary Medicines Directorate.

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Published on 1st November 2023. Updated on 13th March 2024.

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S1.1: Harmonised monitoring requirements

Table S1.1.1: Summary of monitoring requirements in the UK from 2014 to 2022 by sampling year. Year tested is indicated by an X.

Pathogen/sample/animal species	2014*	2015	2016*	2017	2018*	2019	2020*	2021	2022*
Salmonella spp. – broilers, layers and fattening turkeys NCP	x		x		x		x		x
Salmonella spp. – broiler and fattening turkey carcases	x		x		x		x		
Salmonella spp. – pig carcases		x		x		x			
Salmonella spp. – pig caeca								x	
Escherichia *coli* – broiler and turkey caeca	x		x		x		x		x
Escherichia *coli* – pig caeca		x		x		x		x	
ESBL-, AmpC- or carbapenemase-producing *E. coli* – broiler and turkey caeca			x		x		x		x
ESBL-, AmpC- or carbapenemase-producing *E. coli* – pig caeca		x		x		x		x	
Campylobacter jejuni – broiler and fattening turkey caeca	x		x		x		x		x
Campylobacter coli, *Enterococcus faecium* and *Enterococcus faecalis* – broiler and fattening turkey caeca									x

Key:
Pig and bovine year
*Poultry year

S1.2: Methodology

Caecal samples were taken from healthy broilers and turkeys at slaughter by Food Standards Agency (FSA) personnel and sampled for indicator *Escherichia coli* and *Enterococci*, also *Campylobacter* in accordance with EU Decision 2020/1729. The sampling plan was randomised, stratified, and weighted by slaughter throughput. Samples were collected from the biggest slaughterhouses, jointly covering 73% of the UK broiler throughput and 90% of the UK turkey throughput in 2022. For turkeys, one caecal sample was collected per epidemiological unit (flock) sampled. For broilers ten caecal samples were collected per epidemiological unit and pooled before testing.

Boot/dust swabs were collected for the isolation of *Salmonella* in accordance with the National Control Programme (NCP) for layers, broilers and turkeys. Swabs were taken from all flocks included in the NCPs and all isolated *Salmonella* were tested, unless there were 170 isolates or more, in which case a randomised sample of the isolates obtained from those swabs was further analysed.

All countries within the UK were included in the sampling frame and contributed isolates from each of *E. coli*, *Salmonella*, *Campylobacter jejuni*, and *Campylobacter coli*. Isolates of *Enterococcus faecium* and *Enterococcus faecalis* were not taken from Northern Ireland.

Caecal samples were cultured for *E. coli*, *Campylobacter* spp. and *Enterococci* spp. using appropriate media. *Salmonella* isolates are not cultured from these caecal samples and are instead received by the NRLs for serotyping and susceptibility testing. This was the first year of using the EU-RL method to isolate *Campylobacter spp*. Modified charcoal-cefoperazone-deoxycholate (MCCDA) agar and Butzler agar were used for isolation of *C. jejuni* and *C. coli* without pre-enrichment. Matrix-assisted laser desorption/ionisation-time of flight, MALDI-ToF, was used to confirm identification.

S1.3: ESBL-/AmpC-/carbapenemase-producing *E. coli*

Caecal samples were cultured for ESBL-/AmpC-/carbapenemase-producing *E. coli* following standard procedures. This included a pre-enrichment step followed by inoculation of samples onto MacConkey agar plates supplemented with 1 mg/L cefotaxime for isolation of ESBL- or AmpC-producing *E. coli* and chromID OXA-48® and chromID CARBA® agars for isolation of carbapenemase-producing *E. coli*. An *E. coli* with an ESBL phenotype was defined as showing synergy with cefotaxime and clavulanate and/or ceftazidime and clavulanate. An *E. coli* with an AmpC phenotype was defined as showing decreased susceptibility to cefoxitin, cefotaxime and ceftazidime.

S1.4: Antibiotic Susceptibility Testing (AST)

AST was carried out by the national reference laboratories (NRLs). A single typical colony was selected for speciation and susceptibility testing. Standardised broth microdilution was used to determine the minimum inhibitory concentration (MIC) against a panel of antibiotics as listed in Decision 2020/1729 and EFSA guidelines. Tables of antibiotic panels and their corresponding cut-off values can be seen in **Tables S1.4.1 (a) to (c)** and **Tables S1.4.2 (a) to (c)**.

S1.5: Whole Genome Sequencing (WGS)

Whole genome sequencing (WGS) and *in silico* bioinformatic tools were used to detect the antibiotic resistance determinants present in the isolates with ESBL- or AmpC-phenotypes. The isolates were sequenced using the Illumina NextSeq platform followed by quality control steps and mapping of the raw reads to a database of antibiotic resistance genes, using the APHA SeqFinder pipeline (please see this and this paper). The sequence of *E. coli* isolates negative for all known ESBL-, AmpC- and carbapenemase-encoding genes were investigated for promoter mutations in *ampC*, which is compatible with increased expression of the chromosomal *E. coli ampC*, using the APHA SeqFinder pipeline.

S1.6: Interpretation

Epidemiological cut-off values (ECOFFs) were used to assess the susceptibility of the bacterial isolates to the antibiotics tested. ECOFFs represent the point at which bacteria have developed a higher level of resistance to an antibiotic than the background level of resistance that exists naturally for that bacterial species. ECOFFs are more sensitive than clinical breakpoints (CBPs) for detecting emerging resistance issues. A 'decreased susceptibility' or 'resistant' result based on ECOFFs does not necessarily imply a level of resistance that would correspond to clinical treatment failure.

The European Committee on Antimicrobial Susceptibility Testing (EUCAST) methodology for ECOFFs was used in this report. Where possible EUCAST ECOFFs were used to interpret the MIC values. Where these were not available or had changed since 2020 the EFSA recommended cut-off values were used. All historical data presented in chapter 3 of the report has been updated to reflect these cut-off values (apart from the percentage of *Salmonella* isolates fully sensitive to the antibiotic panel). For ease of comparison we have presented both the ECOFF and corresponding CBP values in **Tables S1.4.1 (a) to (c)** and **Tables S1.4.2 (a) to (c)**.

Table S1.4.1: The epidemiological cut-off (ECOFF) values applied when determining susceptibility of a) *E. coli* and *Salmonella*, b) *Campylobacter* spp. and c) *Enterococci* isolated from healthy poultry at slaughter. Values are expressed in mg/L.

a) *E. coli* and *Salmonella*

Antibiotic	*E. coli*	*Salmonella*
Amikacin	>8	>4
Ampicillin	>8	>8
Azithromycin	>16	>16
Cefotaxime	>0.25	>0.5
Ceftazidime	>0.5	>2
Chloramphenicol	>16	>16
Ciprofloxacin	>0.06	>0.06
Colistin	>2	>2
Gentamicin	>2	>2
Meropenem	>0.125	>0.125
Nalidixic acid	>8	>8
Sulfamethoxazole	>64	>256
Tetracycline	>8	>8
Tigecycline	>0.5	>0.5
Trimethoprim	>2	>2

b) *Campylobacter*

Antibiotic	*C. jejuni*	*C. coli*
Chloramphenicol	>16	>16
Ciprofloxacin	>0.5	>0.5
Ertapenem	>0.5	>0.5
Erythromycin	>4	>8
Gentamicin	>2	>2
Tetracycline	>1	>2

c) *Enterococci*

Antibiotic	*E. faecalis*	*E. faecium*
Ampicillin	>4	>4
Chloramphenicol	>32	>32
Ciprofloxacin	>4	>4
Daptomycin	>4	>8
Erythromycin	>4	>4
Gentamicin	>64	>32
Linezolid	>4	>4
Teicoplanin	>2	>2
Tetracycline	>4	>4
Tigecycline	>0.25	>0.25
Vancomycin	>4	>4

Table S1.4.2: The clinical breakpoint (CBP) values applied when determining susceptibility of a) *E. coli* and *Salmonella*, b) *Campylobacter* spp. and c) enterococci isolated from the healthy poultry at slaughter. Values are expressed in mg/L.

For individuals using screen readers, please note that cells read out as blank denotes that no data is available.

a) *E. coli* and *Salmonella*

Antibiotic	*E. coli*	*Salmonella*
Amikacin	>16	>16
Ampicillin	>8	>8
Azithromycin	-	-
Cefotaxime	>2	>2
Ceftazidime	>4	>4
Chloramphenicol	>8	>8
Ciprofloxacin	>0.5	>0.06
Colistin	>2	>2
Gentamicin	>4	>4
Meropenem	>8	>8
Nalidixic acid	-	-
Sulfamethoxazole	-	-
Tetracycline	-	-
Tigecycline	>0.5	-
Trimethoprim	>4	>4

b) *Campylobacter*

Antibiotic	*C. jejuni*	*C. coli*
Chloramphenicol	-	-
Ciprofloxacin	>0.5	>0.5
Ertapenem	-	-
Erythromycin	>4	>8
Gentamicin	-	-
Tetracycline	>2	>2

c) Enterococci

Antibiotic	*E. faecalis*	*E. faecium*
Ampicillin	>8	>8
Chloramphenicol	-	-
Ciprofloxacin	>4	>4
Daptomycin	-	-
Erythromycin	-	-
Gentamicin	-	-
Linezolid	>4	>4
Teicoplanin	>2	>2
Tetracycline	-	-
Tigecycline	>0.25	>0.25
Vancomycin	>4	>4

S2.1: Harmonised monitoring results of susceptibility testing in *Escherichia coli*

Please note, cefotaxime, ceftazidime, ciprofloxacin, nalidixic acid and colistin are high priority critically important antibiotics (HP-CIAs). For individuals using screen readers, please note that cells read out as blank denotes that no isolates were tested, or that no data is available.

Table S2.1.1: Susceptibility in *E. coli* interpreted using EUCAST a) ECOFFs and b) CBPs from caecal samples from healthy broilers at slaughter in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected to background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFFs

Antibiotic	2014 (n=159)	2016 (n=190)	2018 (n=183)	2020 (n=250)	2022 (n=170)
Amikacin	-	-	-	-	0
Ampicillin	116 (73.0)	128 (67.4)	85 (46.4)	101 (40.4)	80 (47.1)
Azithromycin	9 (5.7)	0	0	1 (0.4)	2 (1.2)
Cefotaxime	0	0	4 (2.2)	1 (0.4)	3 (1.8)
Ceftazidime	0	0	4 (2.2)	1 (0.4)	3 (1.8)
Chloramphenicol	14 (8.8)	7 (3.7)	5 (2.7)	8 (3.2)	9 (5.3)
Ciprofloxacin	39 (24.5)	41 (21.6)	29 (15.8)	26 (10.4)	15 (8.8)
Colistin	0	0	0	0	0
Gentamicin	32 (20.1)	14 (7.4)	19 (10.4)	10 (4.0)	1 (0.6)
Meropenem	0	0	0	0	0
Nalidixic acid	39 (24.5)	42 (22.1)	27 (14.8)	26 (10.4)	13 (7.6)
Sulfamethoxazole	104 (65.4)	100 (52.6)	74 (40.4)	78 (31.2)	45 (26.5)
Tetracycline	97 (61.0)	84 (44.2)	49 (26.8)	55 (22.0)	39 (22.9)
Tigecycline	1 (0.6)	0	24 (13.1)	0	0
Trimethoprim	75 (47.2)	81 (42.6)	50 (27.3)	60 (24.0)	41 (24.1)

b) CBPs

Antibiotic	2014 (n=159)	2016 (n=190)	2018 (n=183)	2020 (n=250)	2022 (n=170)
Amikacin	-	-	-	-	0
Ampicillin	116 (73.0)	128 (67.4)	85 (46.4)	101 (40.4)	80 (47.1)
Azithromycin	-	-	-	-	-
Cefotaxime	0	0	3 (1.6)	1 (0.4)	2 (1.2)
Ceftazidime	0	0	1 (0.5)	1 (0.4)	3 (1.8)
Chloramphenicol	20 (12.6)	13 (6.8)	11 (6.0)	12 (4.8)	15 (8.8)
Ciprofloxacin	7 (4.4)	4 (2.1)	8 (4.4)	6 (2.4)	3 (1.8)
Colistin	0	0	0	0	0
Gentamicin	31 (19.5)	13 (6.8)	18 (9.8)	10 (4.0)	0
Meropenem	0	0	0	0	0
Nalidixic acid	-	-	-	-	-
Sulfamethoxazole	-	-	-	-	-
Tetracycline	-	-	-	-	-
Tigecycline	0	0	0	0	0
Trimethoprim	75 (47.2)	81 (42.6)	50 (27.3)	60 (24.0)	41 (24.1)

Table S2.1.2: Susceptibility in *E. coli* interpreted using EUCAST a) ECOFFs and b) CBPs from caecal samples from healthy turkeys at slaughter in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFFs

Antibiotic	2014 (n=168)	2016 (n=224)	2018 (n=176)	2020 (n=197)	2022 (n=168)
Amikacin	-	-	-	-	0
Ampicillin	116 (69.0)	136 (60.7)	100 (56.8)	118 (59.9)	100 (59.5)
Azithromycin	1 (0.6)	2 (0.9)	0	2 (1.0)	0
Cefotaxime	0	1 (0.4)	0	2 (1.0)	1 (0.6)
Ceftazidime	0	1 (0.4)	0	2 (1.0)	1 (0.6)
Chloramphenicol	17 (10.1)	17 (7.6)	7 (4.0)	8 (4.1)	5 (3.0)
Ciprofloxacin	29 (17.3)	35 (15.6)	19 (10.8)	28 (14.2)	25 (14.9)
Colistin	0	0	0	0	0
Gentamicin	7 (4.2)	5 (2.2)	1 (0.6)	3 (1.5)	3 (1.8)
Meropenem	0	0	0	0	0
Nalidixic acid	31 (18.5)	35 (15.6)	12 (6.8)	13 (6.6)	8 (4.8)
Sulfamethoxazole	54 (32.1)	57 (25.4)	31 (17.6)	33 (16.8)	31 (18.5)
Tetracycline	132 (78.6)	150 (67.0)	82 (46.6)	109 (55.3)	95 (56.5)
Tigecycline	2 (1.2)	0	22 (12.5)	1 (0.5)	0
Trimethoprim	40 (23.8)	51 (22.8)	24 (13.6)	29 (14.7)	28 (16.7)

b) CBPs

Antibiotic	2014 (n=168)	2016 (n=224)	2018 (n=176)	2020 (n=197)	2022 (n=168)
Amikacin	-	-	-	-	0
Ampicillin	116 (69.0)	136 (60.7)	100 (56.8)	118 (59.9)	100 (59.5)
Azithromycin	-	-	-	-	0
Cefotaxime	0	1 (0.4)	0	2 (1.0)	1 (0.6)
Ceftazidime	0	1 (0.4)	0	1 (0.5)	0
Chloramphenicol	20 (11.9)	20 (8.9)	15 (8.5)	11 (5.6)	8 (4.8)
Ciprofloxacin	14 (8.3)	13 (5.8)	5 (2.8)	5 (2.5)	2 (1.2)
Colistin	0	0	0	0	0
Gentamicin	7 (4.2)	5 (2.2)	1 (0.6)	3 (1.5)	3 (1.8)
Meropenem	0	0	0	0	0
Nalidixic acid	-	-	-	-	-
Sulfamethoxazole	-	-	-	-	-
Tetracycline	-	-	-	-	-
Tigecycline	0	0	0	0	0
Trimethoprim	40 (23.8)	51 (22.8)	24 (13.6)	29 (14.7)	28 (16.7)

Table S2.1.3: Distribution of ESBL/AmpC and CPE enzymes detected in *E. coli* from healthy broilers at slaughter in the UK in 2022**.** Note - if more than one isolate was of an unknown sequence type (ST), it has been assumed that they belonged to different STs.

Enzyme	Number of isolates	Proportion of isolates (n=36) (%)	Proportion of caecal samples (n=332) (%)	Number of unique STs	Sequence type (ST)
CMY-2	7	19.4	2.1	1	155
CTX-M-15	9	25.0	2.7	4	10, 1163, 1196, 5905
CTX-M-3	1	2.8	0.3	1	34
CTX-M-55	4	11.1	1.2	3	602, 2705, 6448
CTX-M-65, OXA-10	1	2.8	0.3	1	131
DHA-1	2	5.6	0.6	1	1196
SHV-12	9	25.0	2.7	4	10, 57, 2156, 2165
TEM-52c	1	2.8	0.3	1	10
Unknown	2	5.6	0.6	2	297, 752

Table S2.1.4: Decreased susceptibility in ESBL-/AmpC-producing *E. coli* from caecal samples from healthy broilers at slaughter in the UK for 2022.

Antibiotic	Number of isolates with MIC>ECOFF	Proportion of isolates (%) (n=36)	Total proportion from caecal samples (%) (n=332)
Amikacin	0	0.0	0.0
Ampicillin	36	100.0	10.8
Azithromycin	8	22.2	2.4
Cefepime	26	72.2	7.8
Cefotaxime	36	100.0	10.8
Cefotaxime & Clavulanic acid	9	25.0	2.7
Cefoxitin	9	25.0	2.7
Ceftazidime	36	100.0	10.8
Ceftazidime & Clavulanic acid	9	25.0	2.7
Chloramphenicol	17	47.2	5.1
Ciprofloxacin	24	66.7	7.2
Colistin	0	0.0	0.0
Ertapenem	0	0.0	0.0
Gentamicin	1	2.8	0.3
Imipenem	0	0.0	0.0
Meropenem	0	0.0	0.0
Nalidixic acid	14	38.9	4.2
Sulfamethoxazole	27	75.0	8.1
Temocillin	0	0.0	0.0
Tetracycline	35	97.2	10.5
Tigecycline	0	0.0	0.0
Trimethoprim	21	58.3	6.3

Table S2.1.5: Distribution of ESBL/AmpC and CPE enzymes detected in *E. coli* from healthy turkeys at slaughter in the UK in 2022**.** Note - if more than one isolate was of an unknown sequence type (ST), it has been assumed that they belonged to different STs.

Enzyme	Number of isolates	Proportion of isolates (n=19) (%)	Proportion of caecal samples (n=247) (%)	Number of unique STs	Sequence type (ST)
AmpC promoter	2	10.5	0.8	1	88
CTX-M-1	1	5.3	0.4	1	5281
CTX-M-15	2	10.5	0.8	1	3580
CTX-M-55	5	26.3	2.0	2	69, 93
OXA-10, SHV-12	6	31.6	2.4	1	515
SHV-12	3	15.8	1.2	2	155, 683

Table S2.1.6: Decreased susceptibility in ESBL-/AmpC-producing *E. coli* from caecal samples from healthy turkeys at slaughter in the UK for 2022.

Antibiotic	Number of isolates with MIC>ECOFF	Proportion of isolates (%) (n=19)	Total proportion from caecal samples (%) (n=247)
Amikacin	0	0.0	0.0
Ampicillin	19	100.0	7.7
Azithromycin	0	0.0	0.0
Cefepime	9	47.4	3.6
Cefotaxime	19	100.0	7.7
Cefotaxime & Clavulanic acid	2	10.5	0.8
Cefoxitin	2	10.5	0.8
Ceftazidime	19	100.0	7.7
Ceftazidime & Clavulanic acid	2	10.5	0.8
Chloramphenicol	5	26.3	2.0
Ciprofloxacin	8	42.1	3.2
Colistin	0	0.0	0.0
Ertapenem	0	0.0	0.0
Gentamicin	0	0.0	0.0
Imipenem	0	0.0	0.0
Meropenem	0	0.0	0.0
Nalidixic acid	1	5.3	0.4
Sulfamethoxazole	12	63.2	4.9
Temocillin	0	0.0	0.0

Tetracycline	13	68.4	5.3
Tigecycline	0	0.0	0.0
Trimethoprim	1	5.3	0.4

S2.2: Harmonised monitoring results of susceptibility testing in *Salmonella* spp.

Please note, cefotaxime, ceftazidime, ciprofloxacin, nalidixic acid and colistin are HP-CIAs. For individuals using screen readers, please note that cells read out as blank denotes that no isolates were tested, or that no data is available.

Table S2.2.1: Susceptibility in *Salmonella* spp. interpreted using both EUCAST a) ECOFFs and b) CBPs from samples from broiler flocks in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFF

Antibiotic	2014 (n=168)	2016 (n=170)	2018 (n=171)	2020 (n=168)	2022 (n=170)
Amikacin	-	-	-	-	0
Ampicillin	6 (3.6)	6 (3.5)	5 (2.9)	7 (4.2)	6 (3.5)
Azithromycin	0	0	0	0	0
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	2 (1.2)	1 (0.6)	0	1 (0.6)	0
Ciprofloxacin	6 (3.6)	15 (8.8)	11 (6.4)	4 (2.4)	4 (2.4)
Colistin	0	0	2 (1.2)	0	0
Gentamicin	14 (8.3)	1 (0.6)	0	0	0
Meropenem	0	0	0	0	0
Nalidixic acid	10 (6.0)	15 (8.8)	10 (5.8)	4 (2.4)	6 (3.5)
Sulfamethoxazole	52 (31.0)	31 (18.2)	10 (5.8)	42 (25.0)	21 (12.4)
Tetracycline	34 (20.2)	33 (19.4)	7 (4.1)	31 (18.5)	10 (5.9)
Tigecycline	36 (21.4)	19 (11.2)	18 (10.5)	34 (20.2)	13 (7.7)
Trimethoprim	32 (19.0)	0	6 (3.5)	33 (19.6)	19 (11.2)

b) CBP

Antibiotic	2014 (n=168)	2016 (n=170)	2018 (n=171)	2020 (n=168)	2022 (n=170)
Amikacin	-	-	-	-	0
Ampicillin	6 (3.6)	6 (3.5)	5 (2.9)	7 (4.2)	6 (3.5)
Azithromycin	-	-	-	-	-
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	2 (1.2)	10 (5.9)	26 (15.2)	11 (6.5)	18 (10.6)
Ciprofloxacin	6 (3.6)	15 (8.8)	11 (6.4)	4 (2.4)	4 (2.4)
Colistin	0	0	2 (1.2)	0	0
Gentamicin	12 (7.1)	2 (1.2)	0	0	0
Meropenem	0	0	0	0	0
Nalidixic acid	-	-	-	-	-
Sulfamethoxazole	-	-	-	-	-
Tetracycline	-	-	-	-	-
Tigecycline	-	-	-	-	-
Trimethoprim	31 (18.5)	0	6 (3.5)	33 (19.6)	19 (11.2)

Table S2.2.2: Susceptibility in *Salmonella* spp. interpreted using both EUCAST a) ECOFFs and b) CBPs from samples from turkey flocks in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFF

Antibiotic	2014 (n=162)	2016 (n=169)	2018 (n=170)	2020 (n=166)	2022 (n=119)
Amikacin	-	-	-	-	0
Ampicillin	37 (22.8)	9 (5.3)	8 (4.7)	61 (36.7)	49 (41.2)
Azithromycin	16 (9.9)	0	0	0	0
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	1 (0.6)	1 (0.6)	0	0	0
Ciprofloxacin	33 (20.4)	3 (1.8)	9 (5.3)	13 (7.8)	11 (9.2)
Colistin	0	0	0	0	1 (0.8)
Gentamicin	0	1 (0.6)	2 (1.2)	0	2 (1.7)
Meropenem	0	0	0	0	0
Nalidixic acid	33 (20.4)	3 (1.8)	7 (4.1)	13 (7.8)	10 (8.4)
Sulfamethoxazole	74 (45.7)	126 (74.6)	128 (75.3)	63 (38.0)	39 (32.8)
Tetracycline	79 (48.8)	128 (75.7)	128 (75.3)	62 (37.3)	40 (33.6)
Tigecycline	47 (29.0)	3 (1.8)	25 (14.7)	4 (2.4)	22 (18.5)
Trimethoprim	12 (7.4)	4 (2.4)	3 (1.8)	39 (23.5)	4 (3.4)

b) CBP

Antibiotic	2014 (n=162)	2016 (n=169)	2018 (n=170)	2020 (n=166)	2022 (n=119)
Amikacin	-	-	-	-	0
Ampicillin	37 (22.8)	9 (5.3)	8 (4.7)	61 (36.7)	49 (41.2)
Azithromycin	-	-	-	-	-
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	25 (15.4)	5 (3.0)	2 (1.2)	0	7 (5.9)
Ciprofloxacin	0	3 (1.8)	9 (5.3)	13 (7.8)	11 (9.2)
Colistin	0	0	0	0	1 (0.8)
Gentamicin	0	1 (0.6)	2 (1.2)	0	2 (1.7)
Meropenem	0	0	0	0	0
Nalidixic acid	-	-	-	-	-
Sulfamethoxazole	-	-	-	-	-
Tetracycline	-	-	-	-	-
Tigecycline	-	-	-	-	-
Trimethoprim	12 (7.4)	4 (2.4)	3 (1.8)	39 (23.5)	4 (3.4)

Table S2.2.3: Susceptibility in *Salmonella* spp. interpreted using both EUCAST a) ECOFFs and b) CBPs from samples from layer flocks in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFF

Antibiotic	2014 (n=58)	2016 (n=34)	2018 (n=52)	2020 (n=74)	2022 (n=56)
Amikacin	-	-	-	-	0
Ampicillin	0	2 (5.9)	8 (15.4)	7 (9.5)	0
Azithromycin	0	0	0	0	0
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	0	0	1 (1.9)	2 (2.7)	0
Ciprofloxacin	1 (1.7)	3 (8.8)	2 (3.8)	4 (5.4)	1 (1.8)
Colistin	3 (5.2)	0	0	9 (12.2)	2 (3.6)
Gentamicin	0	0	1 (1.9)	2 (2.7)	0
Meropenem	0	0	0	0	0
Nalidixic acid	1 (1.7)	4 (11.8)	2 (3.8)	4 (5.4)	1 (1.8)
Sulfamethoxazole	0	4 (11.8)	7 (13.5)	8 (10.8)	1 (1.8)
Tetracycline	0	2 (5.9)	6 (11.5)	7 (9.5)	1 (1.8)
Tigecycline	2 (3.4)	0	4 (7.7)	1 (1.4)	0
Trimethoprim	0	1 (2.9)	3 (5.8)	8 (10.8)	0

b) CBP

Antibiotic	2014 (n=58)	2016 (n=34)	2018 (n=52)	2020 (n=74)	2022 (n=56)
Amikacin	-	-	-	-	0
Ampicillin	0	2 (5.9)	8 (15.4)	7 (9.5)	0
Azithromycin	-	-	-	-	0
Cefotaxime	0	0	0	0	0
Ceftazidime	0	0	0	0	0
Chloramphenicol	1 (1.7)	1 (2.9)	1 (1.9)	3 (4.1)	0
Ciprofloxacin	1 (1.7)	3 (8.8)	2 (3.8)	4 (5.4)	1 (1.8)
Colistin	3 (5.2)	0	0	9 (12.2)	2 (3.6)
Gentamicin	0	0	1 (1.9)	2 (2.7)	0
Meropenem	0	0	0	0	0
Nalidixic acid	-	-	-	-	-
Sulfamethoxazole	-	-	-	-	-
Tetracycline	-	-	-	-	-
Tigecycline	-	-	-	-	-
Trimethoprim	0	1 (2.9)	3 (5.8)	8 (10.8)	0

S2.3: Harmonised monitoring results of susceptibility testing in *Campylobacter* spp.

Please note, ciprofloxacin is a HP-CIAs. For individuals using screen readers, please note that cells read out as blank denotes that no isolates were tested, or that no data is available.

Table S2.3.1: Susceptibility in *C. jejuni* interpreted using both EUCAST a) ECOFFs and b) CBPs from caecal samples from healthy broilers at slaughter in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFF

Antibiotic	2014 (n=165)	2016 (n=180)	2018 (n=171)	2020 (n=179)	2022 (n=180)
Chloramphenicol	-	-	-	-	0
Ciprofloxacin	72 (43.6)	73 (40.6)	82 (48.0)	106 (59.2)	106 (58.9)
Ertapenem	-	-	-	-	24 (13.3)
Erythromycin	0	1 (0.6)	1 (0.6)	1 (0.6)	5 (2.8)
Gentamicin	0	0	1 (0.6)	0	0
Tetracyclines	97 (58.8)	101 (56.1)	111 (64.9)	119 (66.5)	118 (65.6)

b) CBP

Antibiotic	2014 (n=165)	2016 (n=180)	2018 (n=171)	2020 (n=179)	2022 (n=180)
Chloramphenicol	-	-	-	-	-
Ciprofloxacin	72 (43.6)	73 (40.6)	82 (48.0)	106 (59.2)	106 (58.9)
Ertapenem	-	-	-	-	-
Erythromycin	0	1 (0.6)	1 (0.6)	1 (0.6)	5 (2.8)
Gentamicin	-	-	-	-	-
Tetracyclines	95 (57.6)	101 (56.1)	110 (64.3)	119 (66.5)	116 (64.4)

Table S2.3.2: Susceptibility in *C. jejuni* interpreted using both EUCAST a) ECOFFs and b) CBPs from caecal samples from healthy turkeys at slaughter in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2014, 2016, 2018, 2020 and 2022.

a) ECOFF

Antibiotic	2014 (n=157)	2016 (n=190)	2018 (n=174)	2020 (n=169)	2022 (n=136)
Chloramphenicol	-	-	-	-	0
Ciprofloxacin	55 (35.0)	66 (34.7)	54 (31.0)	62 (36.7)	35 (25.7)
Ertapenem	-	-	-	-	23 (16.9)
Erythromycin	1 (0.6)	2 (1.1)	1 (0.6)	1 (0.6)	0
Gentamicin	2 (1.3)	0	0	0	0
Tetracyclines	102 (65.0)	82 (43.2)	78 (44.8)	67 (39.6)	58 (42.6)

b) CBP

Antibiotic	2014 (n=157)	2016 (n=190)	2018 (n=174)	2020 (n=169)	2022 (n=136)
Chloramphenicol	-	-	-	-	-
Ciprofloxacin	55 (35.0)	66 (34.7)	54 (31.0)	62 (36.7)	35 (25.7)
Ertapenem	-	-	-	-	-
Erythromycin	1 (0.6)	2 (1.1)	1 (0.6)	1 (0.6)	0
Gentamicin	-	-	-	-	-
Tetracyclines	102 (65.0)	79 (41.6)	78 (44.8)	67 (39.6)	58 (42.6)

Table S2.3.3: Susceptibility in *C. coli* interpreted using both EUCAST ECOFFs and CBPs from caecal samples from healthy broilers and turkeys at slaughter in the UK. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2022.

Antibiotic	Broiler (n=59)		Turkey (n=110)	
	ECOFF	CBP	ECOFF	CBP
Chloramphenicol	0	-	0	-
Ciprofloxacin	16 (27.1)	16 (27.1)	49 (44.5)	49 (44.5)
Ertapenem	13 (22.0)	-	69 (62.7)	-
Erythromycin	2 (3.4)	2 (3.4)	0	0
Gentamicin	0	-	0	-
Tetracyclines	28 (47.5)	28 (47.5)	72 (65.5)	72 (65.5)

S2.4: Harmonised monitoring results of susceptibility testing in Enterococci spp.

Please note, ciprofloxacin, teicoplanin and vancomycin are HP-CIAs. For individuals using screen readers, please note that cells read out as blank denotes that no isolates were tested, or that no data is available.

Table S2.4.1: Susceptibility in *E. faecalis* interpreted using both EUCAST ECOFFs and CBPs from caecal samples from healthy broilers at slaughter in the GB. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2022.

Antibiotic	Broiler (n=74)		Turkey (n=100)	
	ECOFF	CBP	ECOFF	CBP
Ampicillin	0	0	0	0
Chloramphenicol	0	-	0	-
Ciprofloxacin	0	0	0	0
Daptomycin	0	-	0	-
Erythromycin	36 (48.6)	-	63 (63.0)	-
Gentamicin	0	-	0	-
Linezolid	0	0	0	0
Teicoplanin	0	0	0	0
Tetracycline	46 (62.2)	-	86 (86.0)	-
Tigecycline	0	0	0	0
Vancomycin	0	0	0	0

Table S2.4.2: Susceptibility in *E. faecium* interpreted using both EUCAST ECOFFs and CBPs from caecal samples from healthy broilers at slaughter in the GB. This table shows the number and percentage of isolates with higher resistance levels than expected background levels for that species for 2022.

Antibiotic	Broiler (n=166)		Turkey (n=181)	
	ECOFF	CBP	ECOFF	CBP
Ampicillin	9 (5.4)	8 (4.8)	19 (10.5)	9 (5.0)
Chloramphenicol	0	-	0)	-
Ciprofloxacin	10 (6.0)	10 (6.0)	9 (5.0)	9 (5.0)
Daptomycin	0	-	0	-
Erythromycin	53 (31.9)	-	105 (58.0)	-
Gentamicin	0	-	0	-
Linezolid	0	0	0	0
Teicoplanin	0	0	0	0
Tetracycline	92 (55.4)	-	131 (72.4)	-
Tigecycline	0	0	0	0
Vancomycin	0	0	0	0

S3.1: Methodology susceptibility testing

S3.1.1 Core data

The susceptibility tests described in UK-VARSS (excluding the MIC testing of veterinary pathogens and the Private Laboratory Initiative) were performed using the method formerly recommended by the British Society for Antimicrobial Chemotherapy (BSAC).

Tests were performed (unless otherwise stated) by disc diffusion on Iso-Sensitest Agar (Oxoid) with appropriate media supplementation where necessary for fastidious organisms. The disc antibiotic concentrations used were as stated in Table S3.1.1.1, and a semi-confluent inoculum was used.

The method used for assessing the susceptibility to antibiotics is, unless otherwise stated in the report, the disc diffusion method described by BSAC. This assumes that the level of antibiotic achieved at the site of infection in the animal is similar to that achieved in a human treated with the same antibiotic. This assumption may not always be correct: different concentrations may be achieved at the site of infection in animals as a consequence of different dosing regimens or pharmacokinetics in different animal species.

Use of the susceptibility testing method formerly employed in human medicine in the UK in many hospitals and clinical medical establishments, enabled and facilitated direct comparison of veterinary susceptibility results with medical susceptibility results collected using similar methods. Direct comparison with the susceptibility results reported in other countries can be difficult because of differences in methodology and breakpoints. However, BSAC clinical breakpoints were harmonised and completely aligned with those of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) which are commonly adopted across Europe. Thus, although different disc diffusion methods are employed in the BSAC and EUCAST procedures, the result obtained by either method should be the same because susceptibility is determined in both methods according to the same breakpoint.

Isolates were classed as either sensitive or resistant; intermediate isolates under the BSAC guidelines are considered resistant. The disc diffusion breakpoints used are given in Table S3.1.1.1 which also provides the MIC corresponding to that zone diameter breakpoint, where this is known or has been estimated from APHA data on file.

Published breakpoints are not available for all animal species or for all of the bacterial/antibiotic combinations which may require testing. In these cases, a uniform cut-off point of 13mm zone size diameter has been used to discriminate between sensitive and resistant strains; an intermediate category of susceptibility has not been recorded. This breakpoint is the historical APHA veterinary breakpoint and although it has been used for a considerable number of years, published validation data are not available for a number of bacterial/antibiotic combinations. However, where most isolates of a particular bacterial species are either highly resistant or fully susceptible to an antibiotic, breakpoint issues may affect only a low number of isolates.

Breakpoints used to interpret the results from the antimicrobial susceptibility testing are reviewed on a regular basis. Data presented in this report and the supplementary material are retrospectively updated when required to reflect any changes to the interpretative criteria and to ensure consistency and comparability of the data.

Susceptibility was determined for certain antibiotics not authorised for use in any food-producing animal species (for example, cefpodoxime) or not authorised for particular animal species (for example, tetracycline in sheep). This is to provide a full picture of resistance emergence and/or as a surrogate (for example, tetracycline, chlortetracycline and oxytetracycline are all equivalent for resistance testing purposes.).

Multiple antibacterial resistance, or multi-drug resistance (MDR), where referred to in the core data, is defined in this report as resistance to any of three or more separate antibiotic classes which were tested for a particular isolate. There is no internationally agreed definition of multiple resistance, and the term has been used differently in different studies. The panels of antimicrobials which may be tested at a particular APHA laboratory can also show slight variation, dependent on the circumstances of the case and the requirements of the veterinary surgeon administering treatment. The multiple resistance figures should therefore be regarded as subject to a degree of variation.

Please note that the methodology for susceptibility testing used by the SRUC is detailed in the Scottish One Health Antimicrobial Use and Antimicrobial Resistance (SONAAR) report.

Please note that throughout this section, cefalexin, cefotaxime, ceftazidime, cefpodoxime, ceftiofur, ciprofloxacin, colistin and enrofloxacin are all highest priority critically important antibiotics (HP-CIAs). It should also be noted that within this section, a hyphen indicates that no isolates were tested, or that no data is available. For individuals using screen readers, please note that cells read out as blank, indicate that no isolates were tested, or that no data is available.

Table S3.1.1.1: Disc diffusion breakpoints, corresponding MIC breakpoints and breakpoints under review for the main bacteria covered in the core data of this report

a) England and Wales

Please note that for erythromycin the R ≤21 mm breakpoint is for beta-haemolytic streptococci and R ≤19 mm for other streptococci, for penicillin the R ≤19 mm breakpoint is for beta-haemolytic streptococci and R ≤16 mm for other streptococci and the tetracycline R ≤19 mm breakpoint is for beta-haemolytic streptococci and R ≤23 mm for other streptococci. Additionally, some *Haemophilus-Pasteurella-Actinobacillus*, or "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*.

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 (AMP)	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

Antibiotic	Disc charge (micrograms)	*Escherichia coli,* Enterobacteriaceae	*Salmonella*	*Staphylococci*	*Streptococci*	*Pasteurella, Mannheimia*
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
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)	30	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

Antibiotic	Disc charge (micrograms)	*Escherichia coli*, Enterobacteriaceae	*Salmonella*	*Staphylococci*	*Streptococci*	*Pasteurella, Mannheimia*
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
Sulfonamide compounds (S)	3/300	NA	≤13 mm	NA	NA	NA
Tetracycline (TE)	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/ sulfonamide (SXT)	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

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, for example, amikacin (AK), are the set used for *Salmonella* susceptibility testing.
- *S. aureus* isolates resistant to amoxicillin/clavulanate are currently screened for susceptibility to cefoxitin and by agglutination tests for altered penicillin binding protein in order to detect *mecA* and *mecC.*

b) Scotland

Antibiotic	Disc charge (micrograms)	*Escherichia coli*, Enterobacteriaceae	*Salmonella*
Amoxicillin/clavulanate (AMC)	20/10	R ≤14 mm I ≤18 mm	R ≤14 mm I ≤18 mm
Ampicillin (AMP)	10	R ≤11 mm I ≤14 mm	R ≤11 mm I ≤14 mm
Apramycin (APR)	15	R ≤13 mm I ≤14 mm	R ≤13 mm I ≤14 mm
Cefotaxime (CTX)	30	R ≤17 mm I ≤19 mm	NA
Cefpodoxime	10	R ≤ 19 mm	R ≤ 19 mm
Enrofloxacin	5	R ≤16 mm I ≤20 mm	R ≤16 mm I ≤20 mm
Florfenicol	30	R ≤12 mm I ≤17mm	R ≤12 mm I ≤17mm
Nalidixic acid (NA)	30	NA	≤13 mm
Neomycin (N)	10	R ≤19 mm	R ≤19 mm
Spectinomycin	25	R ≤14 mm	R ≤14 mm
Streptomycin (S)	10	R ≤11 mm I ≤14 mm	NA
Tetracycline (TE)	10	R ≤19 mm	R ≤19 mm
Trimethoprim/ sulfonamide (SXT)	25	R ≤15 mm	R ≤15 mm

Table S3.1.1.2: Antibiotic disc concentrations used in Northern Ireland, defined by expected zone diameter in millimetres.

Antibiotic	Disc	Resistant	Intermediate	Susceptible
Amoxicillin	AMC30	≤13	14–17	≥18
Ampicillin	AMP10	≤13	14–16	≥17
Apramycin	APR15	N/A	N/A	N/A
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	N/A	N/A	N/A
Furazolidone	FR100	N/A	N/A	≥17
Gentamicin	CN10	≤12	13–14	≥15

Kanamycin	K30	≤13	14–17	≥18
Nalidixic acid	NA30	≤13	14–18	≥19
Spectinomycin	SH100	N/A	N/A	N/A
Streptomycin	S10	≤11	12–14	≥15
Sulfonamides	S3/300	≤12	13–16	≥17
Tetracycline	TE30	≤11	12–14	≥15
Trimethoprim	W5	≤10	11–15	≥16

S3.1.2 MIC testing of veterinary pathogens

MIC testing results are presented in the UK-VARSS report for *Streptococcus* suis and *Brachyspira hyodysenteriae* isolates from pigs. MIC results from a subset of the bacterial respiratory pathogens tested of cattle, sheep and pigs are included in section S4.7 below. These were all isolated from diagnostic submissions to the Animal and Plant Health Agency (APHA) and its partner laboratories in 2022. The population of bacterial organisms described in this report has therefore originated, for the most part, from samples of field cases of clinical disease undergoing investigation by veterinary surgeons for diagnostic purposes. The figures thus reflect the AMR of respiratory bacterial pathogens of clinical veterinary significance recovered from farm animals in England and Wales. In some instances, the samples may originate from animals that have already been treated with antibiotics and therefore may have been under selective pressure.

Susceptibility testing was performed using broth microdilution to determine MIC values, on microtitre plates, with cation adjusted Mueller-Hinton broth. Appropriate media supplementation with Veterinary Fastidious Medium was performed for *A. pleuropneumoniae* (CLSI VET01S ED5:2020). Broth microdilution methods conforming to the International Standards Organisation provide a robust and reliable means of determining susceptibility and are commonly used in harmonised monitoring programmes.

Resistance has been interpreted using clinical breakpoints; isolates have been classed as either sensitive or resistant using veterinary CBPs from CLSI in the first instance, or CA-SFM when these are not available; if veterinary breakpoints were not available, human CBPs were used (see Table S3.1.2.1). For some veterinary antibiotic and organism combinations, there are no published breakpoints available and in these cases, resistance cannot be interpreted from MIC distributions. EUCAST has also recently published ECOFFs and tentative ECOFFs (TECOFFs) for some of the organisms, and where these have been available, results have also been interpreted by these means. The CBP relates to efficacy of treatment in each animal species, whereas the ECOFFs differentiate non-wild type from wild-type organisms, that is to say ECOFFs detect those bacteria which have any degree of increased resistance. The ECOFFs are therefore useful to demonstrate an emerging decline in susceptibility.

Table S3.1.2.1: MIC breakpoints used for the interpretation of antibacterial susceptibility for veterinary pathogens from cattle, pigs, chickens and sheep. Cattle breakpoints were applied to sheep isolates unless indicated otherwise.

a) Respiratory pathogens

Please note, for amoxicillin/clavulanate, the clavulanate concentration is fixed at 2 mg/ml. For tilmicosin in cattle and sheep, a breakpoint for porcine isolates was used. For spectinomycin and gamithromycin in pigs, breakpoint for bovine isolates was used.

Antibiotic	***Pasteurella multocida***			***Mannheimia haemolytica***		***Actinobacillus pleuropneumoniae***	***Bibersteinia trehalosi***
	Cattle	**Pigs**	**Sheep**	**Cattle**	**Sheep**	**Pigs**	**Sheep**
Amoxicillin/clavulanate	R > 16/2	R > 16/2	R > 16/2	R > 16/2	R > 16/2	NA	R > 16/2
	R > 1	R > 1	R > 1	R > 1	R > 1		R > 1
Ampicillin	R > 1	R ≥ 2	R > 1	R > 1	R > 1	R ≥ 2	R > 1
		R > 1					
Ceftiofur	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8
	R > 4	R > 4	R > 4	R > 4	R > 4		R > 4
Doxycycline	R >8	R >8	R >8	R >8	R >8	R >8	R >8
	R > 1	R > 1	R > 1				
Enrofloxacin	R ≥ 2	R ≥ 1	R ≥ 2	R ≥ 2	R ≥ 2	R ≥ 1	R ≥ 2
	R > 2	R > 2	R > 2	R > 2	R > 2	R > 2	R > 2
Florfenicol	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 8
	R > 4	R > 4	R > 4	R > 4	R > 4	R > 4	R > 4
Gamithromycin	R ≥ 16	R ≥ 16	R ≥ 16	R ≥ 16	R ≥ 16	NA	R ≥ 16
Spectinomycin	R ≥ 128	R ≥ 128	R ≥ 128	R ≥ 128	R ≥ 128	NA	R ≥ 128
Tetracycline	R ≥ 8	R ≥ 2	R ≥ 8	R ≥ 8	R ≥ 8	R ≥ 2	R ≥ 8

Antibiotic	*Pasteurella multocida*			*Mannheimia haemolytica*		*Actinobacillus pleuropneumoniae*	*Bibersteinia trehalosi*
	R > 8	R > 8	R > 8	R > 8	R > 8		R > 8
Tiamulin	NA	NA	NA	NA	NA	R ≥ 32	NA
Tildipirosin	R ≥ 32	S < 4	R ≥ 32	R ≥ 16	R ≥ 16	S ≤ 16	R ≥ 16
Tilmicosin	R ≥ 32	R ≥ 32	R ≥ 32	R ≥ 32	R ≥ 32	R ≥ 32	R ≥ 32
	R > 16	R > 16	R > 16	R > 16	R > 16	R > 16	R > 16
Trimethoprim/ Sulfonamide	R >8	R >8	R >8	R >8	R >8	R >8	R >8
	R > 0.25	R > 0.25	R > 0.25				
Tulathromycin	R ≥ 64	R ≥ 64	R ≥ 64	R ≥ 64	R ≥ 64	S ≤ 64	R ≥ 64

Key:

- CLSI veterinary clinical breakpoint
- CASFM veterinary clinical breakpoint
- EUCAST human breakpoint

b) Other pathogens

Antibiotic	*Escherichia coli*	*Streptococcus uberis*	*Streptococcus suis*	*Brachyspira hyodysenteriae*
	Chickens	**Cattle**	**Pigs**	**Pigs**
Amikacin	NA	-	-	-
Amoxicillin/ clavulanate	R > 32/16	-	-	-
	R > 16/8	-	-	-
Ampicillin	R > 8	-	-	-
Apramycin	R > 16	-	-	-
Cefotaxime	R > 2	-	-	-
Ceftazidime	R > 4	-	-	-
Ceftiofur	R ≥ 8	R > 8	R > 8	-
	R > 4	S ≤ 2	S ≤ 2	-
Cephalexin	R > 16	-	-	-
	R > 32	-	-	-
Colistin	R > 2	-	-	-
	R > 2	-	-	-
Doxycycline	R >16	R > 1	R > 1	R > 2
	R > 8	S ≤ 0.25	S ≤ 0.25	-
Enrofloxacin	R ≥ 2	R > 2	R > 2	-
	R > 2	S ≤ 0.5	S ≤ 0.5	-
Erythromycin	-	R > 1	R > 1	-
		S ≤ 0.25	S ≤ 0.25	-
Florfenicol	R ≥ 16	R > 8	R > 8	-
		S ≤ 2	S ≤ 2	-
Gamithromycin	R ≥ 16	-	-	-
Lincomycin	-	R > 8	R > 8	R > 8
		S ≤ 2	S ≤ 2	-
Meropenem	NA	-	-	-
Neomycin	R > 16	NA	-	-
Penicillin	-	R > 1	R > 1	-
		S ≤ 0.25	S ≤ 0.25	-
Spectinomycin	NA	-	-	-
Streptomycin	R > 16	-	-	-
Tetracycline	R ≥ 16	R > 2	R > 2	-
	R > 8	S ≤ 0.25	S ≤ 0.5	-
Tiamulin	-	-	-	R > 2
Trimethoprim/ Sulfonamide	R > 8	-	R > 2	-
	R > 4	-	S ≤ 1	-
Tylosin	-	-	-	R > 8
Tylvalosin	-	-	-	R > 8

Key:

CLSI veterinary clinical breakpoint

CASFM veterinary clinical breakpoint

EUCAST human breakpoint

Suggested broth microdilution clinical breakpoints are considered to be one dilution lower than clinical breakpoints for agar dilution

\- Not tested

S3.1.3 Private Laboratory Initiative

The methods used to determine antimicrobial susceptibility, are based on those in CLSI Vet01 July 2013[1]. Tests were performed by disc diffusion on Mueller-Hinton agar (MHA) without supplements for *Enterobacteriaceae* and staphylococci, and Mueller-Hinton agar with blood (MH-F) for streptococci. The inoculum used gives confluent growth of bacterial colonies. Zone edges are read at the point of complete inhibition. A summary of the disc diffusion breakpoints applied by the Vale Veterinary Laboratory are found in Table S3.1.3.1 below.

Table 3.1.3.1: Disc diffusion breakpoints applied by Vale Veterinary Laboratories for the interpretation of resistance of bovine mastitis pathogens in millimetres.

Antibiotic	*Escherichia coli*	*Staphylococcus aureus*	*Streptococcus dysgalactiae*	*Streptococcus uberis*
Amoxicillin/clavulanate	R < 19	R < 20	NA	NA
Ampicillin	R < 14	13 - 17	R < 24	R < 24
Cefapirin	14 - 18	14 - 18	14 - 18	14 - 18
Cloxacillin	NA	R < 18	R < 18	R < 18
Neomycin	R < 11	R < 14	NA	NA
Oxytetracycline	11 - 15	14-19	NA	NA
Penicillin	NA	R < 18	R < 18	R < 18
Spectinomycin	R < 20	R < 20	NA	NA
Trimethoprim/ sulfonamide	R < 13	R < 14	R < 15	R < 15

[1] The Vale Veterinary Laboratory, personal communications, 2021

S4.1: Clinical surveillance data for isolates of zoonotic pathogens from all species

Table S4.1.1: Resistance (interpreted using breakpoints) in all *E. coli* from cattle, sheep, pigs, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	0/135 (0)	-	-
Amoxicillin/clavulanate	82/446 (18.4)	245/600 (40.8)	20/168 (11.9)
Ampicillin	473/976 (48.5)	427/600 (71.2)	53/168 (31.5)
Apramycin	58/927 (6.3)	55/464 (11.9)	7/82 (8.5)
Cefotaxime	5/136 (3.7)	-	0/3 (0)
Cefpodoxime	5/572 (0.9)	334/592 (56.4)	2/165 (1.2)
Ceftazidime	1/136 (0.7)	-	-
Chloramphenicol	43/135 (31.9)	-	-
Doxycycline	31/105 (29.5)	-	-
Enrofloxacin	24/976 (2.5)	163/600 (27.2)	2/168 (1.2)
Florfenicol	43/183 (23.5)	208/410 (50.7)	22/82 (26.8)
Neomycin	126/864 (14.6)	594/600 (99.0)	14/167 (8.4)
Spectinomycin	226/926 (24.4)	5/135 (3.7)	44/82 (53.7)
Streptomycin	74/136 (54.4)	133/135 (98.5)	6/89 (6.7)
Tetracycline	452/976 (46.3)	378/600 (63.0)	53/168 (31.5)
Trimethoprim/sulfonamide	326/976 (33.4)	287/600 (47.8)	26/168 (15.5)

Table S4.1.2: Resistance (interpreted using breakpoints) in all *Salmonella* from cattle, pigs, sheep, chickens and turkeys (combined) in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	3/2947 (0.1)	-	-
Amoxicillin/clavulanate	0/2947 (0)	1/90 (1.1)	3/104 (2.9)
Ampicillin	303/2947 (10.3)	13/90 (14.4)	3/104 (2.9)
Apramycin	59/2947 (2.0)	3/90 (3.3)	0/104 (0)
Cefotaxime	4/2947 (0.1)	2/90 (2.2)	-
Cefpodoxime	-	-	0/104 (0)
Ceftazidime	2/2947 (0.1)	0/90 (0)	-
Chloramphenicol	184/2947 (6.2)	7/90 (7.8)	-
Ciprofloxacin	12/2947 (0.4)	5/90 (5.6)	-
Enrofloxacin	-	-	0/104 (0)
Florfenicol	-	-	3/104 (2.9)
Furazolidone	8/2947 (0.3)	12/90 (13.3)	-
Gentamicin	67/2947 (2.3)	3/90 (3.3)	-
Nalidixic acid	49/2947 (1.7)	14/90 (15.6)	3/104 (2.9)
Neomycin	114/2947 (3.9)	-	0/104 (0)
Spectinomycin	-	18/90 (20.0)	104/104 (100)
Streptomycin	377/2947 (12.8)	23/90 (25.6)	-
Sulfonamide compounds	439/2947 (14.9)	23/90 (25.6)	-
Tetracycline	328/2947 (11.1)	21/90 (23.3)	8/104 (7.7)
Trimethoprim/sulfonamide	290/2947 (9.8)	14/90 (15.6)	0/104 (0)

Table S4.1.3: Findings of LA-MRSA by government laboratories for England and Wales in 2022.

Clonal complex	Species	Source of the sample
CC398 (t034)	Pig	Clinical
Unknown (t034)	Pig	Clinical
CC398 (t011)	Bovine	Clinical

S4.2: Clinical surveillance data for isolates from pigs

Table S4.2.1: Resistance (interpreted using breakpoints) in all *E. coli* from pigs (all ages) in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistance.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amoxicillin/clavulanate	-	14/35 (40.0)	5/23 (21.7)
Ampicillin	233/467 (49.9)	33/35 (94.3)	14/23 (60.9)
Apramycin	52/467 (11.1)	10/35 (28.6)	7/23 (30.4)
Cefotaxime	-	-	0/3 (0)
Cefpodoxime	3/467 (0.6)	11/33 (33.3)	0/20 (0)
Enrofloxacin	8/467 (1.7)	6/35 (17.1)	1/23 (4.3)
Florfenicol	-	6/35 (17.1)	6/23 (26.1)
Neomycin	49/467 (10.5)	35/35 (100)	3/22 (13.6)
Spectinomycin	135/467 (28.9)	-	12/23 (52.2)
Streptomycin	-	-	3/3 (100)
Tetracycline	235/467 (50.3)	27/35 (77.1)	17/23 (73.9)
Trimethoprim/sulfonamide	212/467 (45.4)	25/35 (71.4)	8/23 (34.8)

Table S4.2.2: Resistance (interpreted using breakpoints) in *E. coli* from pigs in a) England and Wales, b) Northern Ireland and c) Scotland for 2022, split by age category. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.
Please note that no post-weaning or adult data is available for Northern Ireland.

a) England and Wales

Antibiotic	Neonatal	Post-weaning	Adult
Ampicillin	23/59 (39.0)	163/294 (55.4)	15/32 (46.9)
Apramycin	0/59 (0)	50/294 (17.0)	0/32 (0)

Cefpodoxime	1/59 (1.7)	1/294 (0.3)	1/32 (3.1)
Enrofloxacin	2/59 (3.4)	6/294 (2.0)	0/32 (0)
Neomycin	2/59 (3.4)	43/294 (14.6)	1/32 (3.1)
Spectinomycin	10/59 (16.9)	103/294 (35.0)	4/32 (12.5)
Tetracycline	26/59 (44.1)	163/294 (55.4)	11/32 (34.4)
Trimethoprim/sulfonamide	19/59 (32.2)	156/294 (53.1)	11/32 (34.4)

b) Northern Ireland

Antibiotic	Neonatal
Amoxicillin/clavulanate	2/6 (33.3)
Ampicillin	6/6 (100)
Apramycin	1/6 (16.7)
Cefpodoxime	1/6 (16.7)
Enrofloxacin	1/6 (16.7)
Florfenicol	0/6 (0)
Neomycin	6/6 (100)
Tetracycline	4/6 (66.7)
Trimethoprim/sulfonamide	4/6 (66.7)

c) Scotland

Antibiotic	Neonatal	Post-weaning	Adult
Amoxicillin/clavulanate	3/11 (27.3)	0/6 (0)	2/6 (33.3)
Ampicillin	5/11 (45.5)	6/6 (100)	3/6 (50.0)
Apramycin	2/11 (18.2)	4/6 (66.7)	1/6 (16.7)
Cefotaxime	0/3 (0)	-	-
Cefpodoxime	0/8 (0)	0/6 (0)	0/6 (0)

Enrofloxacin	1/11 (9.1)	0/6 (0)	0/6 (0)
Florfenicol	3/11 (27.3)	0/6 (0)	3/6 (50.0)
Neomycin	3/10 (30.0)	0/6 (0)	0/6 (0)
Spectinomycin	5/11 (45.5)	6/6 (100)	1/6 (16.7)
Streptomycin	3/3 (100)	-	-
Tetracycline	7/11 (63.6)	6/6 (100)	4/6 (66.7)
Trimethoprim/sulfonamide	4/11 (36.4)	4/6 (66.7)	0/6 (0)

Table S4.2.3: Resistance (interpreted using breakpoints) in all *Salmonella* from pigs in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	3/262 (1.1)	-	-
Amoxicillin/clavulanate	0/262 (0)	1/13 (7.7)	0/3 (0)
Ampicillin	182/262 (69.5)	11/13 (84.6)	1/3 (33.3)
Apramycin	52/262 (19.8)	3/13 (23.1)	0/3 (0)
Cefotaxime	0/262 (0)	2/13 (15.4)	-
Cefpodoxime	-	-	0/3 (0)
Ceftazidime	0/262 (0)	0/13 (0)	-
Chloramphenicol	145/262 (55.3)	6/13 (46.2)	-
Ciprofloxacin	1/262 (0.4)	0/13 (0)	-
Enrofloxacin	-	-	0/3 (0)
Florfenicol	-	-	0/3 (0)
Furazolidone	0/262 (0)	0/13 (0)	-
Gentamicin	54/262 (20.6)	3/13 (23.1)	-

Nalidixic acid	1/262 (0.4)	2/13 (15.4)	0/3 (0)
Neomycin	73/262 (27.9)	-	0/3 (0)
Spectinomycin	-	7/13 (53.8)	1/3 (33.3)
Streptomycin	131/262 (50.0)	10/13 (76.9)	-
Sulfonamide compounds	175/262 (66.8)	11/13 (84.6)	-
Tetracycline	144/262 (55.0)	9/13 (69.2)	1/3 (33.3)
Trimethoprim/sulfonamide	147/262 (56.1)	6/13 (46.2)	0/3 (0)

Table S4.2.4: Resistance (interpreted using breakpoints) of *Actinobacillus pleuropneumoniae*, *Glaesserella (Haemophilus) parasuis* and *Pasteurella multocida* from respiratory infections of pigs in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Actinobacillus pleuropneumoniae*	*Glaesserella (Haemophilus) parasuis*	*Pasteurella multocida*
Ampicillin	0/7 (0)	0/5 (0)	0/41 (0)
Apramycin	4/7 (57.1)	0/5 (0)	1/41 (2.4)
Cefpodoxime	0/7 (0)	0/5 (0)	0/41 (0)
Enrofloxacin	0/7 (0)	0/5 (0)	0/41 (0)
Neomycin	7/7 (100)	3/5 (60.0)	0/41 (0)
Spectinomycin	7/7 (100)	0/5 (0)	0/41 (0)
Tetracycline	0/7 (0)	0/5 (0)	32/41 (78.0)
Trimethoprim/sulfonamide	0/7 (0)	1/5 (20.0)	10/41 (24.4)

Table S4.2.5: MIC values in mg/ml of *Brachyspira hyodysenteriae* isolates from infections of pigs to tiamulin in England and Wales in 2022**.**

Year	<0.06	0.125	0.25	0.5	1	2	4	8	>8
2022	17	1	1	2				1	

Table S4.2.6 Resistance (interpreted using breakpoints) of *Erysipelothrix rhusiopathiae, Staphylococcus hyicus, Staphylococcus xylosus* and *Streptococcus suis* from infections of pigs in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Erysipelothrix rhusiopathiae*	*Staphylococcus hyicus*	*Staphylococcus xylosus*	*Streptococcus suis*
Ampicillin	0/3 (0)	2/8 (25.0)	1/1 (100.0)	0/72 (0)
Enrofloxacin	0/3 (0)	0/8 (0)	0/1 (0)	0/72 (0)
Lincomycin	0/3 (0)	2/8 (25.0)	0/1 (0)	26/71 (36.6)
Penicillin	0/3 (0)	2/8 (25.0)	1/1 (100.0)	0/71 (0)
Tetracycline	0/3 (0)	3/8 (37.5)	0/1 (0)	55/72 (76.4)
Trimethoprim/ sulfonamide	2/3 (66.7)	0/8 (0)	0/1 (0)	12/72 (16.7)
Tylosin	0/3 (0)	1/8 (12.5)	0/1 (0)	31/71 (43.7)

S4.3: Clinical surveillance data for isolates from poultry

Table S4.3.1: Resistance (interpreted using breakpoints) in all *E. coli* from chickens (all ages) in England and Wales and Northern Ireland in 2022**.** No isolates were tested in Scotland in 2022.The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland
Amoxicillin/clavulanate	8/42 (19.0)	14/49 (28.6)
Ampicillin	43/99 (43.4)	32/49 (65.3)
Apramycin	2/99 (2.0)	3/49 (6.1)
Cefpodoxime	2/99 (2.0)	23/49 (46.9)
Doxycycline	31/99 (31.3)	-
Enrofloxacin	7/99 (7.1)	11/49 (22.4)
Florfenicol	-	2/2 (100)
Neomycin	1/41 (2.4)	48/49 (98.0)
Spectinomycin	21/99 (21.2)	-
Tetracycline	32/99 (32.3)	29/49 (59.2)
Trimethoprim/sulfonamide	19/99 (19.2)	14/49 (28.6)

Table S4.3.2: Resistance (interpreted using breakpoints) in all *E. coli* from turkeys (all ages) in England and Wales in 2022. No isolates from Northern Ireland and Scotland were tested in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales
Amoxicillin/clavulanate	-
Ampicillin	0/6 (0)
Apramycin	0/6 (0)
Cefpodoxime	0/6 (0)
Doxycycline	0/6 (0)
Enrofloxacin	0/6 (0)
Neomycin	-
Spectinomycin	0/6 (0)
Tetracycline	0/6 (0)
Trimethoprim/sulfonamide	0/6 (0)

Table S4.3.3: Resistance (interpreted using breakpoints) in all *Salmonella* from chickens and turkeys in England and Wales in 2022. In Northern Ireland only chickens were tested and no chicken or turkey isolates from Scotland were tested in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

	England and Wales		Northern Ireland
Antibiotic	**Chickens**	**Turkeys**	**Chickens**
Amikacin	0/2040 (0)	0/127 (0)	-
Amoxicillin/clavulanate	0/2040 (0)	0/127 (0)	0/21 (0)
Ampicillin	63/2040 (3.1)	39/127 (30.7)	0/21 (0)
Apramycin	6/2040 (0.3)	0/127 (0)	0/21 (0)
Cefotaxime	4/2040 (0.2)	0/127 (0)	0/21 (0)
Ceftazidime	2/2040 (0.1)	0/127 (0)	0/21 (0)
Chloramphenicol	16/2040 (0.8)	10/127 (7.9)	0/21 (0)
Ciprofloxacin	8/2040 (0.4)	1/127 (0.8)	5/21 (23.8)
Furazolidone	8/2040 (0.4)	0/127 (0)	12/21 (57.1)
Gentamicin	10/2040 (0.5)	2/127 (1.6)	0/21 (0)
Nalidixic acid	18/2040 (0.9)	28/127 (22.0)	12/21 (57.1)
Neomycin	39/2040 (1.9)	1/127 (0.8)	-
Spectinomycin	-	-	10/21 (47.6)
Streptomycin	151/2040 (7.4)	44/127 (34.5)	10/21 (47.6)
Sulfonamide compounds	188/2040 (9.2)	33/127 (26.0)	10/21 (47.6)
Tetracycline	110/2040 (5.4)	33/127 (26.0)	10/21 (47.6)
Trimethoprim/sulfonamide	137/2040 (6.7)	4/127 (3.1)	7/21 (33.3)

Table S4.3.4: Resistance (interpreted using breakpoints) of *Staphylococcus aureus* from infections of chickens in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Staphylococcus aureus*
Amoxicillin/clavulanate	0/1 (0)
Ampicillin	0/1 (0)
Doxycycline	0/1 (0)
Enrofloxacin	0/1 (0)
Erythromycin	0/1 (0)
Lincomycin	0/1 (0)
Penicillin	0/1 (0)
Tetracycline	0/1 (0)
Trimethoprim/sulfonamide	0/1 (0)
Tylosin	0/1 (0)

Table S4.3.5: Resistance (interpreted using breakpoints) of *Klebsiella pneumoniae* from infections of avian species in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Klebsiella pneumoniae*
Amoxicillin/clavulanate	0/1 (0)
Ampicillin	1/1 (100)
Cefpodoxime	0/1 (0)
Doxycycline	0/1 (0)
Enrofloxacin	0/1 (0)
Neomycin	0/1 (0)
Spectinomycin	0/1 (0)

Tetracycline	0/1 (0)
Trimethoprim/sulfonamide	0/1 (0)

Table S4.3.6: Resistance (interpreted using breakpoints) of *Erysipelothrix rhusiopathiae* from infections of turkeys in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	***Erysipelothrix rhusiopathiae***
Ampicillin	0/1 (0)
Doxycycline	0/1 (0)
Enrofloxacin	0/1 (0)
Lincomycin	0/1 (0)
Penicillin	0/1 (0)
Tetracycline	0/1 (0)
Trimethoprim/sulfonamide	1/1 (100)
Tylosin	0/1 (0)

S4.4: Clinical surveillance data for isolates from cattle

Table S4.4.1: Resistance (interpreted using breakpoints) in all *E. coli* from cattle (all ages) in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	0/109 (0)	-	-
Amoxicillin/clavulanate	66/254 (26.0)	193/426 (45.3)	12/125 (9.6)
Ampicillin	162/254 (63.8)	305/426 (71.6)	31/125 (24.8)
Apramycin	3/229 (1.3)	40/298 (13.4)	0/40 (0)
Cefotaxime	5/110 (4.5)	-	-
Cefpodoxime	-	249/422 (59.0)	2/125 (1.6)
Ceftazidime	1/110 (0.9)	-	-
Chloramphenicol	41/109 (37.6)	-	-
Enrofloxacin	8/254 (3.1)	130/426 (30.5)	1/125 (0.8)
Florfenicol	41/134 (30.6)	182/298 (61.1)	15/40 (37.5)
Neomycin	71/229 (31.0)	422/426 (99.1)	11/125 (8.8)
Spectinomycin	54/228 (23.7)	5/128 (3.9)	29/40 (72.5)
Streptomycin	66/109 (60.6)	126/128 (98.4)	2/85 (2.4)
Tetracycline	147/254 (57.9)	277/426 (65.0)	30/125 (24.0)
Trimethoprim/sulfonamide	86/254 (33.9)	221/426 (51.9)	13/125 (10.4)

Table S4.4.2: Resistance (interpreted using breakpoints) in *E. coli* from cattle in a) England and Wales, b) Northern Ireland and c) Scotland for 2022, split by age category. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.
Please note that no pre-weaning or adult data is available for Northern Ireland.

a) England and Wales

Antibiotic	Neonatal	Pre-weaning	Adult
Amikacin	0/83 (0)	0/22 (0)	-
Amoxicillin/clavulanate	34/99 (34.3)	25/84 (29.8)	1/23 (4.3)
Ampicillin	80/99 (80.8)	55/84 (65.5)	6/23 (26.1)
Apramycin	2/99 (2.0)	0/73 (0)	1/19 (5.3)
Cefotaxime	5/84 (6.0)	0/22 (0)	-
Ceftazidime	1/84 (1.2)	0/22 (0)	-
Chloramphenicol	31/83 (37.3)	10/22 (45.5)	-
Enrofloxacin	4/99 (4.0)	3/84 (3.6)	0/23 (0)
Florfenicol	28/83 (33.7)	7/33 (21.2)	-
Neomycin	45/99 (45.5)	21/73 (28.8)	0/19 (0)
Spectinomycin	30/99 (30.3)	20/73 (27.4)	2/19 (10.5)
Streptomycin	48/83 (57.8)	16/22 (72.2)	-
Tetracycline	66/99 (66.7)	55/84 (65.5)	9/23 (39.1)
Trimethoprim/sulfonamide	43/99 (43.4)	31/84 (36.9)	5/23 (21.7)

b) Northern Ireland

Antibiotic	Neonatal
Amoxicillin/clavulanate	40/76 (52.6)
Ampicillin	65/76 (85.5)

Apramycin	5/75 (6.7)
Cefpodoxime	44/76 (57.9)
Enrofloxacin	28/76 (36.8)
Florfenicol	44/76 (57.9)
Neomycin	75/76 (98.7)
Tetracycline	58/76 (76.3)
Trimethoprim/sulfonamide	53/76 (69.7)

c) Scotland

Antibiotic	Neonatal	Pre-weaning	Adult
Amoxicillin/clavulanate	1/91 (1.1)	6/11 (54.5)	5/23 (21.7)
Ampicillin	7/91 (7.7)	8/11 (72.7)	16/23 (69.6)
Apramycin	0/6 (0)	0/11 (0)	0/23 (0)
Cefpodoxime	0/91 (0)	1/11 (9.1)	1/23 (4.3)
Enrofloxacin	1/91 (1.1)	0/11 (0)	0/23 (0)
Florfenicol	0/6 (0)	6/11 (54.5)	9/23 (39.1)
Neomycin	1/91 (1.1)	4/11 (36.4)	6/23 (26.1)
Spectinomycin	5/6 (83.3)	10/11 (90.9)	14/23 (60.9)
Streptomycin	2/85 (2.4)	-	-
Tetracycline	4/91 (4.4)	9/11 (81.8)	17/23 (73.9)
Trimethoprim/sulfonamide	2/91 (2.2)	5/11 (45.5)	6/23 (26.1)

Table S4.4.3: Resistance (interpreted using breakpoints) in all *Salmonella* from cattle in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	0/431 (0)	-	-
Amoxicillin/clavulanate	0/431 (0)	0/38 (0)	3/77 (3.9)
Ampicillin	16/431 (3.7)	2/38 (5.3)	3/77 (3.9)
Apramycin	0/431 (0)	0/38 (0)	3/77 (3.9)
Cefotaxime	0/431 (0)	0/38 (0)	-
Cefpodoxime	-	-	0/77 (0)
Ceftazidime	0/431 (0)	0/38 (0)	-
Chloramphenicol	10/431 (2.3)	1/38 (2.6)	-
Ciprofloxacin	1/431 (0.2)	0/38 (0)	-
Enrofloxacin	-	-	0/77 (0)
Florfenicol	-	-	3/77 (3.9)
Furazolidone	0/431 (0)	0/38 (0)	-
Gentamicin	0/431 (0)	0/38 (0)	-
Nalidixic acid	1/431 (0.2)	0/38 (0)	3/77 (3.9)
Neomycin	0/431 (0)	-	0/77 (0)
Spectinomycin	-	1/38 (2.6)	77/77 (100)
Streptomycin	48/431 (11.1)	3/38 (7.9)	-
Sulfonamide compounds	40/431 (9.3)	2/38 (5.3)	-
Tetracycline	38/431 (8.8)	2/38 (5.3)	7/77 (9.1)
Trimethoprim/sulfonamide	1/431 (0.2)	1/38 (2.6)	0/77 (0)

Table S4.4.4: Resistance (interpreted using breakpoints) in *E. coli* mastitis isolates from England and Wales for 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	2022
Amoxicillin/clavulanate	3/39 (7.7)
Ampicillin	16/39 (41.0)
Cefpodoxime	0/39 (0)
Enrofloxacin	1/39 (2.6)
Neomycin	1/39 (2.6)
Streptomycin	7/39 (17.9)
Tetracycline	8/39 (20.5)
Trimethoprim/sulfonamide	5/39 (12.8)

Table S4.4.5: Resistance (interpreted using breakpoints) of *Staphylococci* and *Streptococci* from mastitis cases from England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Staphylococcus aureus*	*Streptococcus dysgalactiae*	*Streptococcus uberis*
Amoxicillin/clavulanate	1/24 (4.2)	0/16 (0)	0/56 (0)
Ampicillin	4/24 (16.7)	0/16 (0)	0/56 (0)
Cefalexin	0/24 (0)	0/16 (0)	2/56 (3.6)
Neomycin	2/24 (8.3)	4/14 (28.6)	36/53 (67.9)
Novobiocin	1/24 (4.2)	3/14 (21.4)	2/53 (3.8)
Penicillin	5/24 (20.8)	0/16 (0)	0/56 (0)
Tetracycline	3/24 (12.5)	16/16 (100)	26/56 (46.4)
Tylosin	2/24 (8.3)	2/16 (12.5)	3/56 (5.4)

Table S4.4.6: Resistance (interpreted using breakpoints) of *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Trueperella pyogenes* from mastitis cases from England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested.

Antibiotic	*Klebsiella pneumoniae*	*Pseudomonas aeruginosa*	*Trueperella pyogenes*
Amoxicillin/clavulanate	1/8 (12.5)	6/6 (100)	0/1 (0)
Ampicillin	8/8 (100)	6/6 (100)	0/1 (0)
Cefalexin	-	-	0/1 (0)
Cefotaxime	-	6/6 (100)	-
Cefpodoxime	1/8 (12.5)	-	-
Ceftazidime	-	0/6 (0)	-
Enrofloxacin	0/8 (0)	0/6 (0)	-
Neomycin	0/6 (0)	1/3 (33.3)	0/1 (0)
Novobiocin	-	-	0/1 (0)
Penicillin	-	-	0/1 (0)
Streptomycin	1/6 (16.7)	0/3 (0)	-
Tetracycline	1/8 (12.5)	6/6 (100)	0/1 (0)
Trimethoprim/sulfonamide	0/8 (0)	5/6 (83.3)	-
Tylosin	-	-	0/1 (0)

Table S4.4.7: Resistance (interpreted using breakpoints) of *Histophilus somni*, *Mannheimia haemolytica* and *Pasteurella multocida* from respiratory infections of cattle in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Histophilus somni*	*Mannheimia haemolytica*	*Pasteurella multocida*
Amoxicillin/clavulanate	0/3 (0)	0/69 (0)	1/90 (1.1)
Ampicillin	0/3 (0)	0/69 (0)	2/88 (2.3)
Cefpodoxime	0/3 (0)	0/68 (0)	0/90 (0)
Enrofloxacin	0/3 (0)	0/69 (0)	0/90 (0)
Florfenicol	0/3 (0)	0/69 (0)	0/89 (0)

Tetracycline	0/3 (0)	53/69 (76.8)	70/90 (77.8)
Trimethoprim/sulfonamide	0/3 (0)	0/69 (0)	0/90 (0)

S4.5: Clinical surveillance data for isolates from sheep

Table S4.5.1: Resistance (interpreted using breakpoints) in all *E. coli* from sheep (all ages) in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	0/26 (0)	-	-
Amoxicillin/clavulanate	8/150 (5.3)	16/71 (22.5)	3/20 (15.0)
Ampicillin	35/150 (23.3)	42/71 (59.2)	8/20 (40.0)
Apramycin	1/126 (0.8)	2/66 (3.0)	0/19 (0)
Cefotaxime	0/26 (0)	-	-
Cefpodoxime	-	44/71 (62.0)	0/20 (0)
Ceftazidime	0/26 (0)	-	-
Chloramphenicol	2/26 (7.7)	-	-
Enrofloxacin	1/150 (0.7)	11/71 (15.5)	0/20 (0)
Florfenicol	2/49 (4.1)	16/66 (24.2)	1/19 (5.3)
Neomycin	5/127 (3.9)	70/71 (98.6)	0/20 (0)
Spectinomycin	16/126 (12.7)	0/4 (0)	3/19 (15.8)
Streptomycin	8/27 (29.6)	4/4 (100)	1/1 (100)
Tetracycline	38/150 (25.3)	36/71 (50.7)	8/20 (40.0)
Trimethoprim/sulfonamide	9/150 (6.0)	20/71 (28.2)	5/20 (25.0)

Table S4.5.2: Resistance (interpreted using breakpoints) in *E. coli* from sheep in a) England and Wales, b) Northern Ireland and c) Scotland from 2022, split by age category. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.
Please note that no pre-weaning or adult data is available for Northern Ireland.

a) England and Wales

Antibiotic	Neonatal	Pre-weaning	Adult
Amikacin	0/22 (0)	-	-
Amoxicillin/clavulanate	4/43 (9.3)	2/31 (6.5)	1/43 (2.3)
Ampicillin	14/43 (32.6)	7/31 (22.6)	12/43 (27.9)
Apramycin	1/43 (2.3)	0/24 (0)	0/34 (0)
Cefotaxime	0/22 (0)	0/3 (0)	-
Ceftazidime	0/22 (0)	0/3 (0)	-
Chloramphenicol	2/22 (9.1)	0/3 (0)	-
Enrofloxacin	0/43 (0)	0/31 (0)	0/43 (0)
Florfenicol	1/22 (4.5)	0/10 (0)	0/9 (0)
Neomycin	1/43 (2.3)	2/24 (8.3)	1/35 (2.9)
Spectinomycin	10/43 (23.3)	3/24 (12.5)	3/34 (8.8)
Streptomycin	7/22 (31.8)	1/3 (33.3)	-
Tetracycline	13/43 (30.2)	9/31 (29.0)	15/43 (34.9)
Trimethoprim/sulfonamide	5/43 (11.6)	2/31 (6.5)	2/43 (4.7)

b) Northern Ireland

Antibiotic	Neonatal
Amoxicillin/clavulanate	14/31 (45.2)
Ampicillin	23/31 (74.2)
Apramycin	1/31 (3.2)
Cefpodoxime	22/31 (71.0)
Enrofloxacin	5/31 (16.1)
Florfenicol	11/31 (35.5)
Neomycin	31/31 (100)
Tetracycline	21/31 (67.7)
Trimethoprim/sulfonamide	14/31 (45.2)

c) Scotland

Antibiotic	Neonatal	Pre-weaning	Adult
Amoxicillin/clavulanate	1/5 (20.0)	1/9 (11.1)	1/6 (16.7)
Ampicillin	3/5 (60.0)	4/9 (44.4)	1/6 (16.7)
Apramycin	0/5 (0)	0/9 (0)	0/5 (0)
Cefpodoxime	0/5 (0)	0/9 (0)	0/6 (0)
Enrofloxacin	0/5 (0)	0/9 (0)	0/6 (0)
Florfenicol	0/5 (0)	1/9 (11.1)	0/5 (0)
Neomycin	0/5 (0)	0/9 (0)	0/6 (0)
Spectinomycin	1/5 (20.0)	2/9 (22.2)	0/5 (0)
Streptomycin	-	-	1/1 (100)
Tetracycline	3/5 (60.0)	4/9 (44.4)	1/6 (16.7)
Trimethoprim/sulfonamide	3/5 (60.0)	1/9 (11.1)	1/6 (16.7)

Table S4.5.3: Resistance (interpreted using breakpoints) in all *Salmonella* from sheep in England and Wales, Northern Ireland and Scotland in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales	Northern Ireland	Scotland
Amikacin	0/87 (0)	-	-
Amoxicillin/clavulanate	0/87 (0)	0/18 (0)	0/24 (0)
Ampicillin	3/87 (3.4)	0/18 (0)	0/24 (0)
Apramycin	1/87 (1.1)	0/18 (0)	0/24 (0)
Cefotaxime	0/87 (0)	0/18 (0)	-
Cefpodoxime	-	-	0/24 (0)
Ceftazidime	0/87 (0)	0/18 (0)	-
Chloramphenicol	3/87 (3.4)	0/18 (0)	-
Ciprofloxacin	1/87 (1.1)	0/18 (0)	-
Enrofloxacin	-	-	0/24 (0)
Florfenicol	-	-	0/24 (0)
Furazolidone	0/87 (0)	0/18 (0)	-
Gentamicin	1/87 (1.1)	0/18 (0)	-
Nalidixic acid	1/87 (1.1)	0/18 (0)	0/24 (0)
Neomycin	1/87 (1.1)	-	0/24 (0)
Spectinomycin	-	0/18 (0)	0/24 (0)
Streptomycin	3/87 (3.4)	0/18 (0)	-
Sulfonamide compounds	3/87 (3.4)	0/18 (0)	-
Tetracycline	3/87 (3.4)	0/18 (0)	0/24 (0)
Trimethoprim/sulfonamide	2/87 (2.3)	0/18 (0)	0/24 (0)

Table S4.5.4: Resistance (interpreted using breakpoints) of *Bibersteinia trehalosi, Mannheimia haemolytica* and *Pasteurella multocida* from respiratory infections of sheep in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Bibersteinia trehalosi*	*Mannheimia haemolytica*	*Pasteurella multocida*
Amoxicillin/ clavulanate	0/34 (0)	0/145 (0)	0/20 (0)
Ampicillin	1/34 (2.9)	0/145 (0)	0/20 (0)
Cefpodoxime	0/34 (0)	0/145 (0)	0/20 (0)
Enrofloxacin	0/34 (0)	0/145 (0)	0/20 (0)
Florfenicol	0/34 (0)	0/145 (0)	0/20 (0)
Tetracycline	18/34 (52.9)	106/145 (73.1)	10/20 (50.0)
Trimethoprim/sulfonamide	0/34 (0)	0/145 (0)	0/20 (0)

Table S4.5.5: Resistance (interpreted using breakpoints) of *Erysipelothrix rhusiopathiae, Listeria monocytogenes, Staphylococcus aureus* and *Streptococcus dysgalactiae* from infections of sheep in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Erysipelothrix rhusiopathiae*	*Listeria monocytogenes*	*Staphylococcus aureus*	*Streptococcus dysgalactiae*
Amoxicillin/ clavulanate	0/1 (0)	0/5 (0)	0/24 (0)	0/16 (0)
Ampicillin	0/1 (0)	0/5 (0)	0/24 (0)	0/16 (0)
Cefalexin	0/1 (0)	1/5 (20.0)	0/24 (0)	0/16 (0)
Neomycin	-	-	1/16 (6.3)	-
Penicillin	0/1 (0)	0/5 (0)	0/24 (0)	0/16 (0)
Tetracycline	0/1 (0)	0/5 (0)	1/24 (4.2)	15/16 (93.8)
Trimethoprim/sulfonamide	1/1 (100)	0/4 (0)	0/8 (0)	0/9 (0)
Tylosin	0/1 (0)	0/5 (0)	0/24 (0)	0/16 (0)

S4.6: Clinical surveillance data for isolates from dogs

Table S4.6.1: Resistance (interpreted using breakpoints) in all *Salmonella* from dogs in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	England and Wales
Amikacin	0/924 (0)
Amoxicillin/clavulanate	4/924 (0.4)
Ampicillin	133/924 (14.4)
Apramycin	8/924 (0.9)
Cefotaxime	3/924 (0.3)
Ceftazidime	3/924 (0.3)
Chloramphenicol	40/924 (4.3)
Ciprofloxacin	13/924 (1.4)
Furazolidone	11/924 (1.2)
Gentamicin	11/924 (1.2)
Nalidixic acid	41/924 (4.4)
Neomycin	13/924 (1.4)
Streptomycin	127/924 (13.7)
Sulfonamide compounds	136/924 (14.7)
Tetracycline	140/924 (15.1)
Trimethoprim/sulfonamide	36/924 (3.9)

S4.7: MIC testing of veterinary pathogens

Table S4.7.1: Resistance (interpreted using breakpoints) of *Escherichia coli* from chickens, turkeys, sheep, cattle and pigs in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	Chickens	Turkeys	Sheep	Cattle	Pigs
Ampicillin	7/14 (50.0)	0/3 (0)	7/43 (16.3)	48/96 (50.0)	143/254 (56.3)
Amoxicillin/ clavulanate	3/14 (21.4)	0/3 (0)	0/43 (0)	14/96 (14.6)	8/254 (3.1)
Apramycin	-	0/3 (0)	0/43 (0)	1/96 (1.0)	34/254 (13.4)
Cephalexin	2/14 (14.3)	0/3 (0)	0/43 (0)	3/96 (3.1)	1/254 (0.4)
Cefotaxime	2/14 (14.3)	0/3 (0)	0/43 (0)	0/96 (0)	0/254 (0)
Ceftazidime	2/14 (14.3)	0/3 (0)	0/43 (0)	1/96 (1.0)	0/254 (0)
Ceftiofur	1/14 (7.1)	0/3 (0)	0/43 (0)	0/96 (0)	0/254 (0)
Cefquinome	0/14 (0)	0/3 (0)	0/43 (0)	0/96 (0)	0/254 (0)
Colistin	0/14 (0)	0/3 (0)	0/43 (0)	0/96 (0)	0/254 (0)
Doxycycline	2/14 (14.3)	1/3 (33.3)	4/43 (9.3)	27/96 (28.1)	77/254 (30.3)
Enrofloxacin	2/14 (14.3)	1/3 (33.3)	0/43 (0)	1/96 (1.0)	7/254 (2.8)
Florfenicol	0/14 (0)	1/3 (3.33)	0/43 (0)	16/96 (16.7)	40/254 (15.7)
Neomycin	1/14 (7.1)	0/3 (0)	0/43 (0)	21/96 (21.9)	28/254 (11.0)
Streptomycin	2/14 (14.3)	1/3 (33.3)	6/43 (14.0)	40/96 (41.7)	115/254 (45.3)
Tetracycline	3/14 (21.4)	0/3 (0)	7/43 (16.3)	42/96 (43.8)	126/254 (49.6)
Trimethoprim/ sulfonamide	1/14 (7.1)	0/3 (0)	1/43 (2.3)	20/96 (20.8)	118/254 (46.5)

Table S4.7.2: Resistance (interpreted using breakpoints) of *Actinobacillus pleuropneumoniae*, *Brachyspira hyodysenteriae, Pasteurella multocida, Streptococcus dysgalactiae* and *Streptococcus suis* from infections of pigs in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Actinobacillus pleuropneumoniae*	*Brachyspira hyodysenteriae*	*Pasteurella multocida*	*Streptococcus dysgalactiae*	*Streptococcus suis*
Ampicillin	1/6 (16.7)	-	0/28 (0)	-	-
Amoxicillin/ clavulanate	-	-	0/28 (0)	-	-
Ceftiofur	0/6 (0)	-	0/28 (0)	0/23 (0)	0/105 (0)
Doxycycline	0/6 (0)	0/22 (0)	0/28 (0)	13/23 (56.5)	67/105 (63.8)
Enrofloxacin	0/6 (0)	-	0/28 (0)	0/23 (0)	0/105 (0)
Erythromycin	-	-	-	3/23 (13.0)	46/105 (43.8)
Gamithromycin	-	-	0/28 (0)	-	-
Florfenicol	0/6 (0)	-	0/28 (0)	0/23 (0)	0/105 (0)
Lincomycin	-	4/22 (18.2)	-	11/23 (47.8)	42/105 (40.0)
Penicillin	-	-	-	0/23 (0)	6/105 (5.7)
Spectinomycin	-	-	0/28 (0)	-	-
Tetracycline	0/6 (0)	-	5/28 (17.9)	23/23 (100)	77/105 (73.3)
Tiamulin	0/6 (0)	1/22 (4.5)	-	-	-
Tildipirosin	0/6 (0)	-	0/28 (0)	-	-
Tilmicosin	0/6 (0)	-	0/28 (0)	-	-
Trimethoprim/ Sulfonamide	0/6 (0)	-	5/28 (17.9)	0/23 (0)	18/105 (17.1)
Tulathromycin	0/6 (0)	-	0/28 (0)	-	-
Tylosin	-	14/22 (63.6)	-	-	-
Tylvalosin	-	10/22 (45.5)	-	-	-

Table S4.7.3 Resistance (interpreted using breakpoints) of *Mannheimia haemolytica, Pasteurella multocida, Staphylococcus aureus*, *Streptococcus dysgalactiae and Streptococcus uberis* from respiratory infections of cattle in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Mannheimia haemolytica*	*Pasteurella multocida*	*Staphylococcus aureus*	*Streptococcus dysgalactiae*	*Streptococcus uberis*
Ampicillin	0/21 (0)	1/33 (3.0)	-	-	-
Amoxicillin/ clavulanate	0/21 (0)	0/33 (0)	-	-	-
Ceftiofur	0/21 (0)	0/33 (0)	0/5 (0)	0/6 (0)	0/12 (0)
Doxycycline	0/21 (0)	0/33 (0)	1/5 (20.0)	5/6 (83.3)	1/12 (8.3)
Enrofloxacin	0/21 (0)	0/33 (0)	0/5 (0)	0/6 (0)	0/12 (0)
Erythromycin	-	-	1/5 (20.0)	3/6 (50.0)	0/12 (0)
Florfenicol	2/21 (9.5)	2/33 (6.1)	-	0/6 (0)	0/12 (0)
Gamithromycin	1/21 (4.8)	7/33 (21.2)	-	-	-
Lincomycin	-	-	1/5 (20.0)	1/6 (16.7)	3/12 (25.0)
Neomycin	-	-	0/5 (0)	-	-
Penicillin	-	-	0/5 (0)	0/6 (0)	0/12 (0)
Spectinomycin	0/21 (0)	11/33 (33.3)	-	-	-
Tetracycline	2/21 (9.5)	18/33 (54.5)	1/5 (20.0)	6/6 (100)	1/12 (8.3)
Tildipirosin	1/21 (4.8)	6/33 (18.2)	-	-	-
Tilmicosin	2/21 (9.5)	7/33 (21.2)	-	-	-
Trimethoprim/ Sulfonamide	0/21 (0)	0/33 (0)	0/5 (0)	0/6 (0)	0/12 (0)
Tulathromycin	1/21 (4.8)	7/33 (21.2)	-	-	-

Table S4.7.4: Resistance (interpreted using breakpoints) of *Bibersteinia trehalosi*, *Mannheimia haemolytica*, *Pasteurella multocida*, *Staphylococcus aureus* and *Streptococcus dysgalactiae* from infections of sheep in England and Wales in 2022. The table shows the number of resistant isolates out of the total number tested and the percentage of resistant isolates.

Antibiotic	*Bibersteinia trehalosi*	*Mannheimia haemolytica*	*Pasteurella multocida*	*Staphylococcus aureus*	*Streptococcus dysgalactiae*
Ampicillin	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Amoxicillin/ clavulanate	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Ceftiofur	0/8 (0)	0/44 (0)	0/6 (0)	0/8 (0)	0/7 (0)
Doxycycline	0/8 (0)	0/44 (0)	0/6 (0)	0/8 (0)	2/7 (28.6)
Enrofloxacin	0/8 (0)	0/44 (0)	0/6 (0)	0/8 (0)	0/7 (0)
Erythromycin	-	-	-	0/8 (0)	1/7 (14.3)
Florfenicol	0/8 (0)	0/44 (0)	0/6 (0)	-	0/7 (0)
Gamithromycin	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Lincomycin	-	-	-	0/8 (0)	1/7 (14.3)
Neomycin	-	-	-	0/8 (0)	-
Penicillin	-	-	-	0/8 (0)	0/7 (0)
Spectinomycin	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Tetracycline	0/8 (0)	0/44 (0)	0/6 (0)	0/8 (0)	7/7 (100)
Tildipirosin	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Tilmicosin	0/8 (0)	0/44 (0)	0/6 (0)	-	-
Trimethoprim/ Sulfonamide	0/8 (0)	0/44 (0)	0/6 (0)	0/8 (0)	0/7 (0)
Tulathromycin	0/8 (0)	1/44 (2.3)	0/6 (0)	-	-