Report on the Japanese Veterinary Antimicrobial Resistance Monitoring System

2018–2019

National Veterinary Assay Laboratory

Ministry of Agriculture, Forestry and Fisheries

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Contents

1. Introduction

Antimicrobial agents are essential for maintaining the health and welfare of both animals and humans. However, their use has also been linked to the emergence and increasing prevalence of antimicrobial-resistant bacteria. In 1969, Swann reported on the transmission of antimicrobial-resistant bacteria, which had emerged as a consequence of the use of veterinary antimicrobial agents, to humans via food-producing animal products, subsequently reducing the efficacy of these antimicrobial drugs in humans[1)]. In addition, the development of antimicrobial resistance in these bacteria reduces the efficacy of veterinary antimicrobial drugs.

Antimicrobial agents have been used for the prevention, control, and treatment of infectious diseases in animals worldwide, and in some countries have also been used for non-therapeutic purposes in food-producing animals. The Japanese Veterinary Antimicrobial Resistance Monitoring System (JVARM) was established in 1999 in response to international concern regarding the impact of antimicrobial resistance on public and animal health[2)]. Preliminary monitoring for antimicrobial-resistant bacteria was conducted in 1999 and the program has operated continuously since that time. However, although antimicrobial use for veterinary purposes represents a selective force promoting the emergence and increasing prevalence of antimicrobial-resistant bacteria in food-producing animals, these bacteria have also evolved in the absence of antimicrobial selective pressures.

In May 2015, the World Health Assembly endorsed the Global Action Plan on Antimicrobial Resistance[3)] and urged all Member States to develop relevant national action plans within 2 years. Japan's "National Action Plan on Antimicrobial Resistance (AMR) 2016–2020" endorses the current status and monitoring of antimicrobial-resistant bacteria and national antimicrobial use as an important strategy for both evaluating the impact of the action plan on antimicrobial resistance and planning future national policy.

According to the national action plan, we have been strengthening our monitoring and have started monitoring among diseased and healthy companion animals. Moreover, in 2017, we also commenced the collection of data on the sales of human antimicrobial for use in animal clinics.

This report outlines the trends in antimicrobial resistance among indicator bacteria isolated from healthy food-producing animals and pathogenic bacteria isolated from diseased animals, including companion animals, as well as the volume antimicrobial sales over the 2-year period from 2018 to 2019, as assessed by the JVARM program.

2. The Japanese Veterinary Antimicrobial Resistance Monitoring System (JVARM)

2.1 Objectives

JVARM was set up to monitor the occurrence of antimicrobial-resistant bacteria in food-producing animals and the sales of antimicrobials for animal use. These objectives will contribute to determining the efficacy of antimicrobials in food-producing animals, encourage the prudent use of such antimicrobials, and enable us to ascertain the effects on public health.

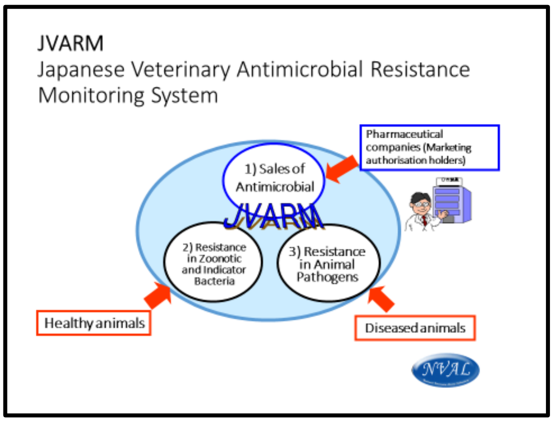

Fig. 2.1. Overview of JVARM.

2.2 Overview

JVARM includes the following three components. (1) monitoring the volume of the sale of antimicrobials for animal use, (2) monitoring antimicrobial resistance in zoonotic and indicator bacteria isolated from healthy animals, and (3) monitoring antimicrobial resistance in pathogens isolated from diseased animals (see Fig. 2.1.). Until 2011, all bacteria assessed by this program were isolated from food-producing animals on farms. However, since 2012, samples have also been collected from slaughterhouses to increase the breadth of monitoring.

(1) Monitoring of Antimicrobial Sales

The system that is currently used to monitor the volume of antimicrobial sales is shown in Fig. 2.2. Each year, marketing authorization holders of veterinary medical products (VMPs) are required to submit their sales data to the National Veterinary Assay Laboratory (NVAL) in accordance with "The Act on Securing Quality, Efficacy, and Safety of Pharmaceuticals, Medical Devices, Regenerative and Cellular Therapy Products, Gene Therapy Products, and Cosmetics (Law No.145, Series of 1960)". NVAL collates, analyzes, and evaluates these data, and then publishes them in an annual report, titled "Amount of medicines and quasi-drugs for animal use," on its website (https://www.maff.go.jp/nval/yakuzai/yakuzai_p3_6.html).

Data on the weight (in kilograms) of the active ingredients in antimicrobial products that are sold annually for the treatment of animals are collected and then subdivided according to animal species. However, this method of analysis only provides an estimate of the volume of antimicrobial sales for each target species, as a single antimicrobial product is frequently used for multiple animal species.

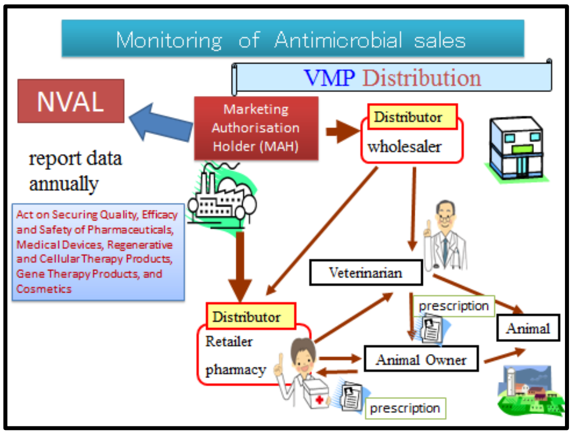

Fig. 2.2. Monitoring of antimicrobial sales

(2) Monitoring of Antimicrobial-resistant Bacteria

Zoonotic and indicator bacteria isolated from healthy animals and pathogenic bacteria isolated from diseased animals are continuously collected for antimicrobial susceptibility testing. Zoonotic bacteria include *Salmonella* species, *Campylobacter jejuni*, and *Campylobacter coli*; indicator bacteria include *Escherichia coli*, *Enterococcus faecium*, and *Enterococcus faecalis*; and animal pathogens include *Salmonella* species, *Staphylococcus* species, *E. coli*, *Mannheimia haemolytica*, and *Klebsiella pneumoniae*. Minimum inhibitory concentrations (MICs) of antimicrobial agents for target bacteria are then determined using the microdilution method, as described by the Clinical and Laboratory Standards Institute (CLSI)[4].

2.3 Implementation System

(1) Monitoring System for Farms with Diseased Animals

The JVARM monitoring system for bacterial strains isolated from diseased animals on farms is shown in Fig. 2.3. Animal pathogens that are designated by NVAL as target bacteria for a particular year are collected by Livestock Hygiene Service Centers (LHSCs) in each prefecture. The LHSCs isolate and identify certain types of pathogenic bacteria as part of their regular work, and send the bacteria to NVAL, which conducts MIC measurements and reports the results on its website (https://www.maff.go.jp/nval/yakuzai/yakuzai_p3.html).

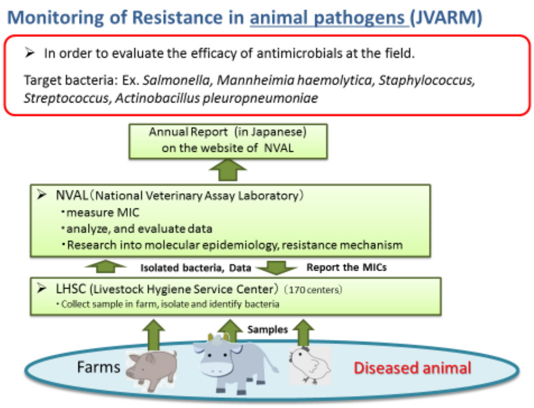

Fig. 2.3. The monitoring system used for diseased animals on farms

(2) Monitoring System for Slaughterhouses

The JVARM monitoring system employed for slaughterhouses is shown in Fig. 2.4. Ministry of Agriculture, Forestry and Fisheries (MAFF) contracts the isolation, identification, and MIC measurement of target bacteria to private research laboratories. These laboratories send the results and tested bacteria to NVAL, which is responsible for preserving the bacteria, collating and analyzing all data, and reporting the findings to MAFF headquarters. Data collection and the preservation of *E. faecium* and *E. faecalis* are conducted at the Food and Agricultural Materials Inspection Center (FAMIC).

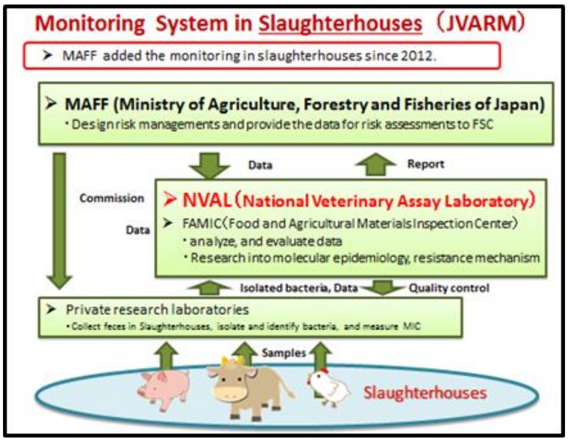

Fig. 2.4. The monitoring system used for slaughterhouses.

(3) Monitoring System for Companion Animals

Monitoring of healthy companion animals (dogs and cats) was inaugurated in 2018, as one of the measures designed to strengthen surveillance and monitoring according to the Japanese national action plan on antimicrobial resistance 2016–2020. The JVARM monitoring system for companion animals is shown in Fig. 2.5. This monitoring is conducted in collaboration with Japan Veterinary Medical Association (JVMA). The JVMA members are collected a rectal swab from healthy dog and cat visited hospital for health check, vaccination, trimming or so on. Sample numbers were allocated in following with small animal clinic number in each prefecture. The research laboratory contracted by MAFF collects samples from JVMA member clinics and isolated *E. coli* and *Enterococcus* spp. The contracted laboratory performs MIC determinations, and sends the results and tested bacterial strains to NVAL, which preserves the bacteria, collates and analyzes all the data, and reports the findings to MAFF headquarters.

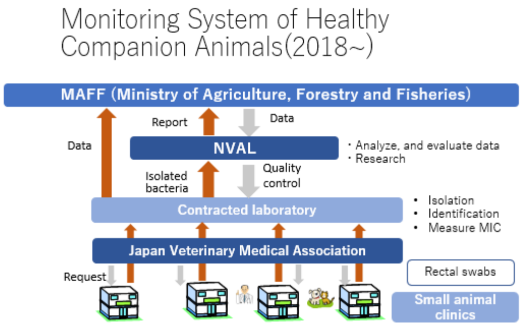

Fig. 2.5. The monitoring system used for healthy companion animals.

Monitoring of diseased companion animals (dogs and cats) was inaugurated in 2017 The JVARM monitoring system for diseased companion animals is shown in Fig. 2.6. The research laboratory contracted by MAFF collects target bacteria from cooperating private clinical laboratories. The contracted laboratory re-identifies the target bacteria, performs MIC determinations, and sends the results and tested bacterial strains to NVAL, which preserves the bacteria, collates and analyzes all the data, and reports the findings to MAFF headquarters.

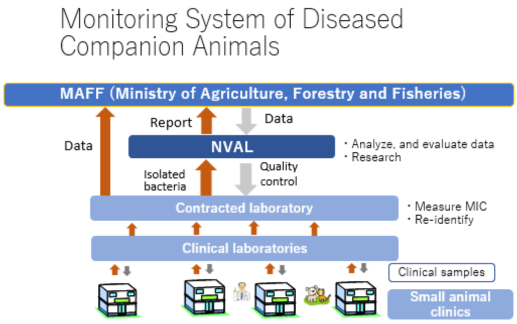

Fig. 2.6. The monitoring system used for diseased companion animals.

2.4 Quality Assurance/Control Systems

Quality control is carried out at the participating laboratories that perform antimicrobial susceptibility testing to assist with monitoring of the precision and accuracy of the testing procedures, the performance of the reagents used, and the training of personnel involved. Strict adherence to standardized techniques is vital to ensure that the data collected are reliable and reproducible. Quality control reference bacteria are also tested in each participating laboratory to ensure standardization. Moreover, each year, NVAL holds a national training course for LHSC staff on antimicrobial resistance and standardized laboratory methods for the isolation, identification, and antimicrobial susceptibility testing of target bacteria. NVAL also undertakes inspections of the private research laboratories.

2.5 Publication of Data

Given that antimicrobial resistance affects both animal and human health, it is of paramount importance that information on antimicrobial resistance is distributed as rapidly as possible. NVAL officially publishes such information in scientific journals and on its website (https://www.maff.go.jp/nval/yakuzai/yakuzai_p3.html). Similarly, research conducted by NVAL on the molecular epidemiology and resistance mechanisms of bacteria is published in scientific journals (https://www.maff.go.jp/nval/yakuzai/pdf/jvarm_publications_list_20230420.pdf).

3. An Overview of the Availability of Veterinary Antimicrobial Products Used for Animal Treatment or as Antimicrobial Feed Additives in Japan

The numbers of animals that were slaughtered for meat in slaughterhouses and poultry slaughtering plants between 2017 and 2019 are shown in Table 3.1. There were no substantial changes in the number of meat-producing animals produced between 1999 and 2019 (Fig. 3.1.). During this period, however, the number of individual farms underwent a continual reduction, whereas there was an increase in farm scale (data not shown).

Table 3.1. Numbers of animals (1,000 heads/birds) slaughtered in slaughterhouses and poultry slaughtering plants between 2017 and 2019

	Cattle	Calf	Horse	Pig	Broiler	Fowl*
2017	1,040.0	5.2	9.8	16,336.9	688,314	81,432
2018	1,051.7	4.6	9.8	16,429.2	703,814	84,604
2019	1,038.7	4.4	10.3	16,318.6	715,656	84,523

* Most of these birds were old layer chickens.

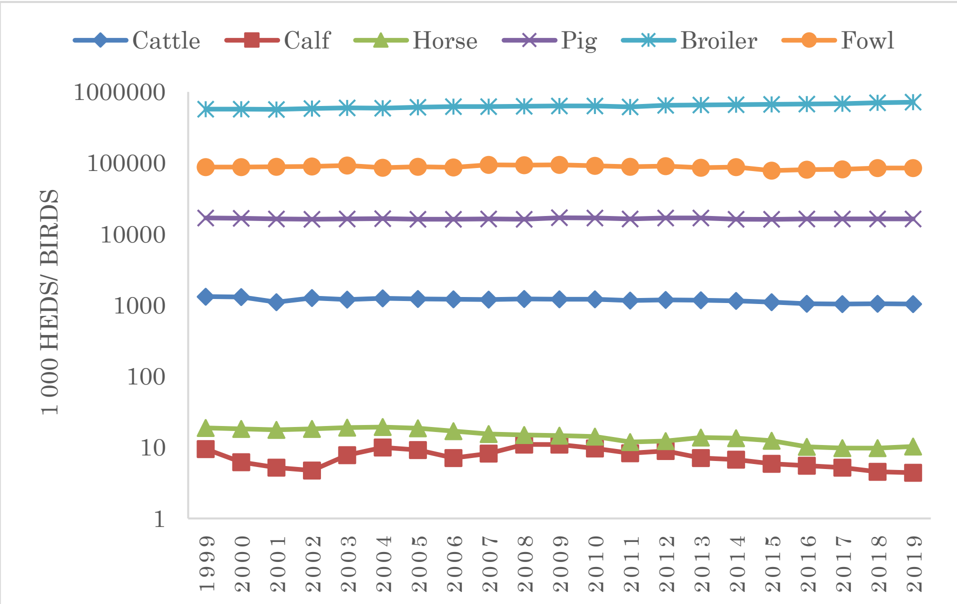

Fig. 3.1. Trends in the numbers of animals (1000 heads/birds) slaughtered in slaughterhouses and poultry slaughtering plants between 1999 and 2019.

Over the period between 2001 and 2019, the total volume of antimicrobial sales for animal use initially decreased and for a number of years fluctuated around 800 tons (Fig. 3.2.). Antimicrobials have tended to be used more frequently in pigs than in cattle or poultry (data not shown). In 2019, tetracyclines accounted for 37% of the total volume of sales in veterinary antimicrobials, whereas fluoroquinolones and cephalosporins each contributed to less than 1% of the total sales.

Antimicrobial feed additives were first used in Japan in the 1950s. Changes in the amount of feed additives that were manufactured in Japan between 2007 and 2019 are shown in Fig. 3.3. The total volume manufactured between 2007 and 2009 averaged 164 tons, whereas from 2010 to 2019, there was an increase in volume to an average 199 tons, which was mainly attributable to an increase in the production of ionophores. Ionophores are widely used for prevention of coccidiosis in the European Union and USA without prescription and comprised a large proportion of the feed additives [174 tons (86.8%)] used in 2019. In contrast, the amounts of polypeptides manufactured gradually fell to 6.4 tons (3.2%). Colistin included in polypeptides was withdrawn as a feed additive in 2018 and no longer manufactured. Present sold polypeptides are enramycin and nosiheptide. Furthermore, tetracyclines and macrolides are also banned in 2019 and not been manufactured and sold as feed additives.

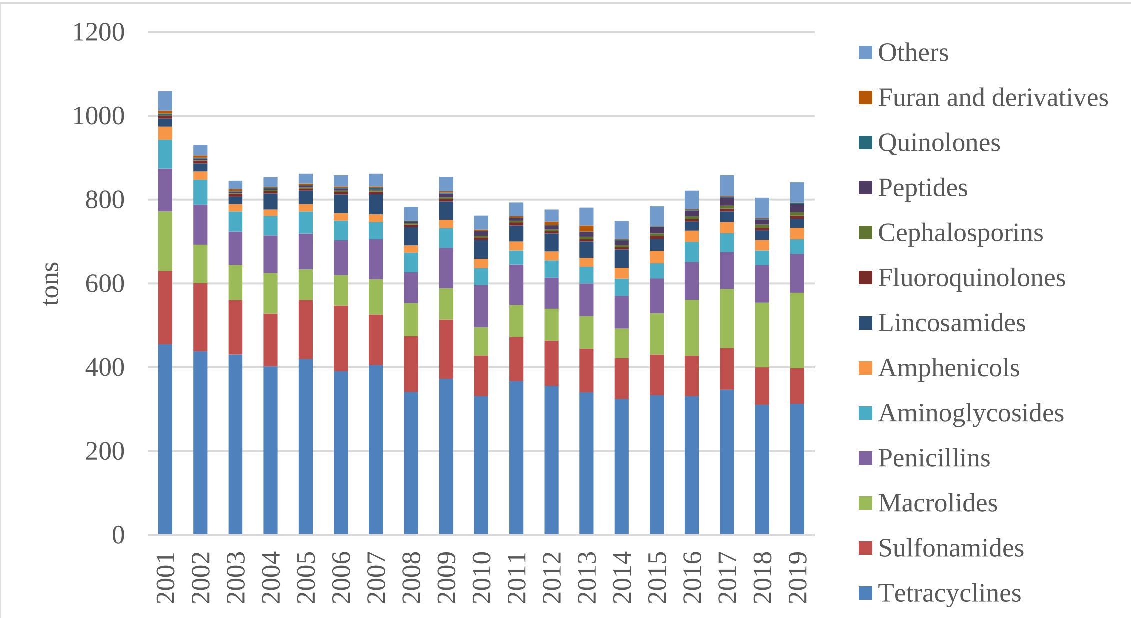

Fig. 3.2. Volumes of veterinary antimicrobials (in tons of active ingredient) sold by pharmaceutical companies in Japan between 2001 and 2019.

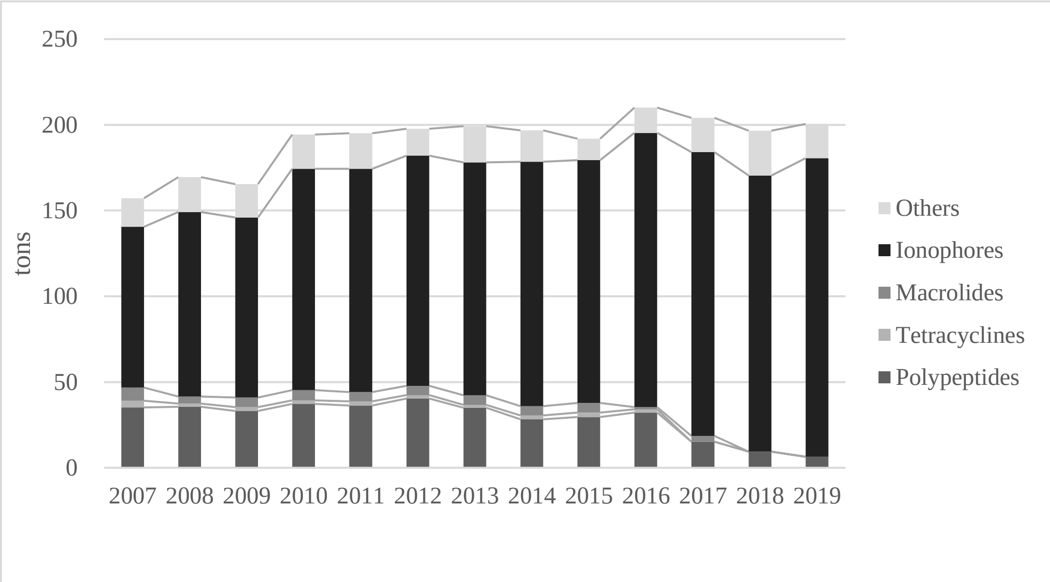

Fig. 3.3. Amounts of antimicrobial feed additives (in tons of active ingredient) manufactured in Japan between 2007 and 2019.

In many countries, veterinarians are permitted to prescribe human medicines, including antimicrobials, for treatment of animals under their responsibility. Human medicines are considered to be used primarily in companion animal hospitals. Accordingly, we started to collect data on human antimicrobials sales from 2016 for small animal clinics. These data were provided by members of the Japan Animal Drug and Instrument Dealers Association and the Federation of Japan Pharmaceutical Wholesalers Association. During 2018 and 2019, the total amount of antimicrobials sold to small animal clinics was from 5.4 tons to 5.5 tons, which is not substantially different from the sales of veterinary products (6.9 and 8.6 tons). In both human and veterinary medicines, the most frequently sold antimicrobials were cephalosporins and penicillins (Fig. 3.4.). First- and second-generation cephalosporins accounted for 95.5% to 94.8% of total cephalosporins used in human medicine and 92.9% to 94.3% in veterinary medicines, respectively.

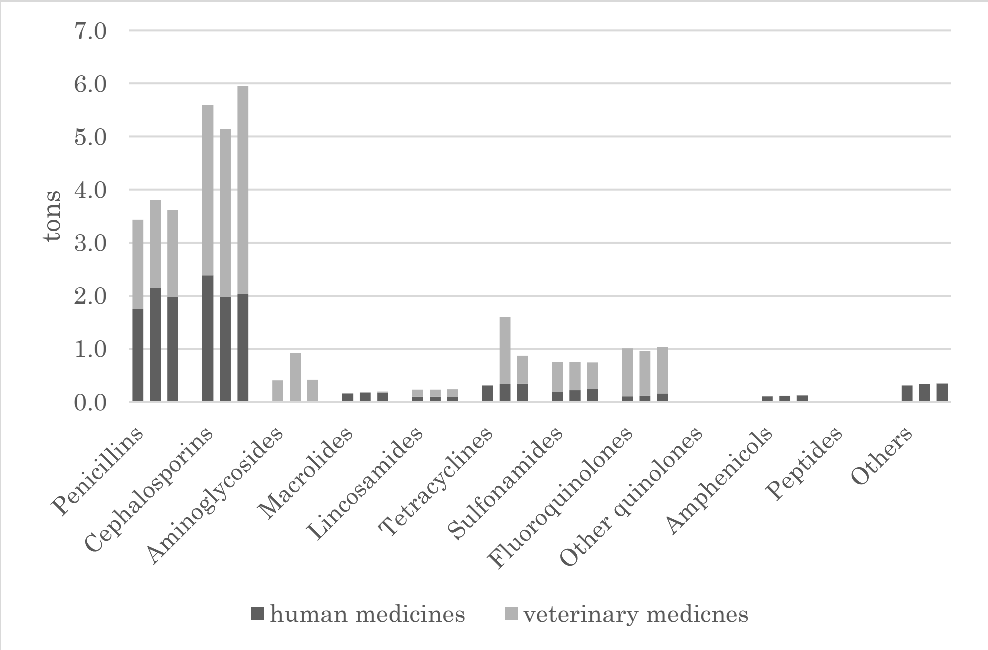

Fig. 3.4. Amounts of human and veterinary antimicrobial medicines (in tons of active ingredient) sold for use in companion animals in 2017 (left bar), 2018 (central bar) and 2019 (right bar).

4. Monitoring of Antimicrobial Resistance in 2018 and 2019

4.1 Healthy Animals in Slaughterhouses

The total numbers of bacteria isolated from food-producing animals in slaughterhouses are shown in Table 4.1. All isolates were subjected to antimicrobial susceptibility testing.

(1) *Escherichia coli*

A total of 923 isolates of *E. coli* (477 from cattle, 163 from pigs, and 283 from broilers) collected in 2018 and 2019 were available for antimicrobial susceptibility testing. The resistant rates are shown in Table 4.2. and the MIC distributions are shown in Tables 12.1.1. and 12.1.2., respectively.

Among these isolates, there were high rates of resistance to streptomycin and tetracycline (18.5%–49.4% and 22.9%–62.5%, respectively).

In contrast, there were low rates of resistance to cefazolin, cefotaxime, gentamicin, ciprofloxacin, and colistin (0.5%–7.7%, 0.0%–3.2%, 0.0%–6.3%, 0.0%–2.5%, and 0.0%–6.0%, respectively); rates of resistance to meropenem are 0.0%, one exception being ciprofloxacin-resistant *E. coli* isolated from chickens (12.3%–12.5%).

In general, *E. coli* isolates from pigs and broilers exhibited higher rates of resistance, which was most commonly against tetracycline (resistance rates in pigs and broilers of 47.5%–55.4% and 49.0%–62.5%, respectively), streptomycin (41.3%–49.4% and 40.6%–48.4%, respectively), ampicillin (32.5%–34.9% and 36.1%–36.7%, respectively), kanamycin (8.4%–10.0% and 37.5%–43.9%, respectively), nalidixic acid (11.3%–12.0% and 36.7%–40.6%, respectively), chloramphenicol (22.5%–25.3% and 15.6%–17.4%, respectively), and sulfamethoxazole/trimethoprim (23.8%–32.5% and 30.5%–33.5%, respectively).

The resistance rates of *E. coli* from healthy food-producing animals to third-generation cephalosporins and fluoroquinolones, an outcome indices for the Action Plan, have been maintained at a low level and are expected to meet their targets (The same level as in other G7 nations). On the other hand, resistance rate to that of tetracyclines was higher than its outcome indicator target (Average of resistance rates of three food-producing animal species 33%) (Figs 4.1. and 4.2.).

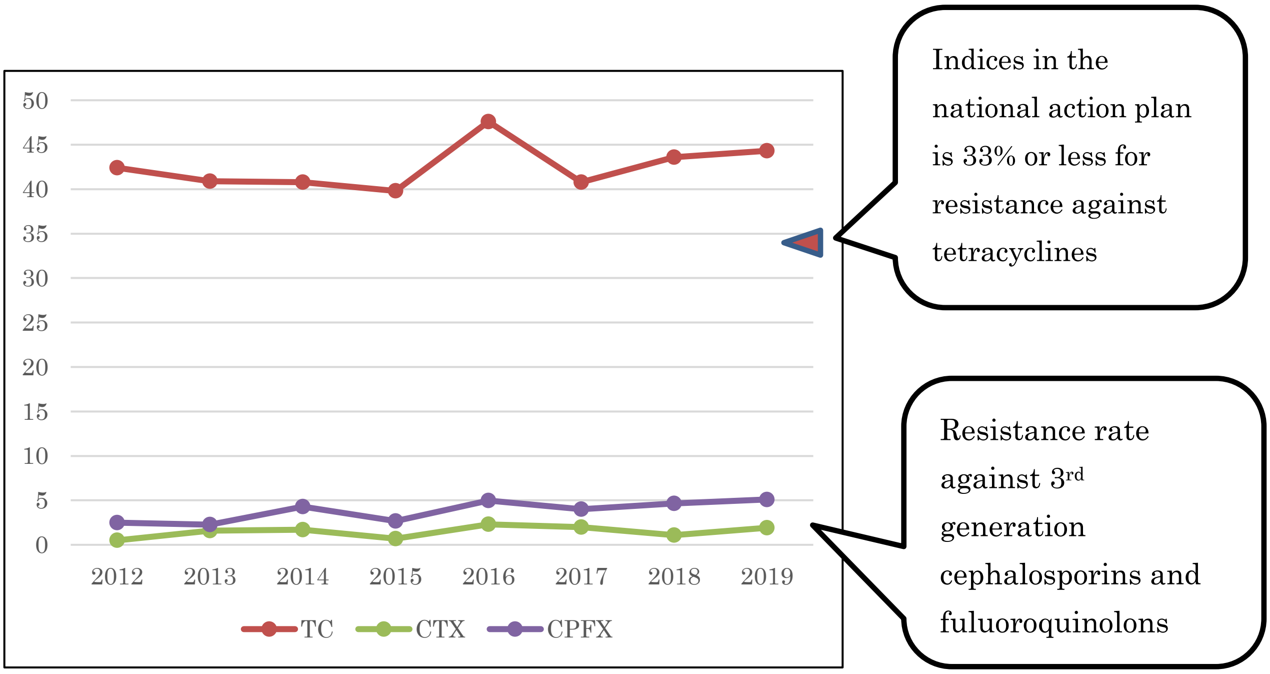

Fig 4.1. Indices for the Action Plan: proportion (%) of *Escherichia coli* isolate from healthy animal—Average of resistance rates of three animal species
TC : tetracycline, CT : cefotaxime, CPFX : ciprofloxacin

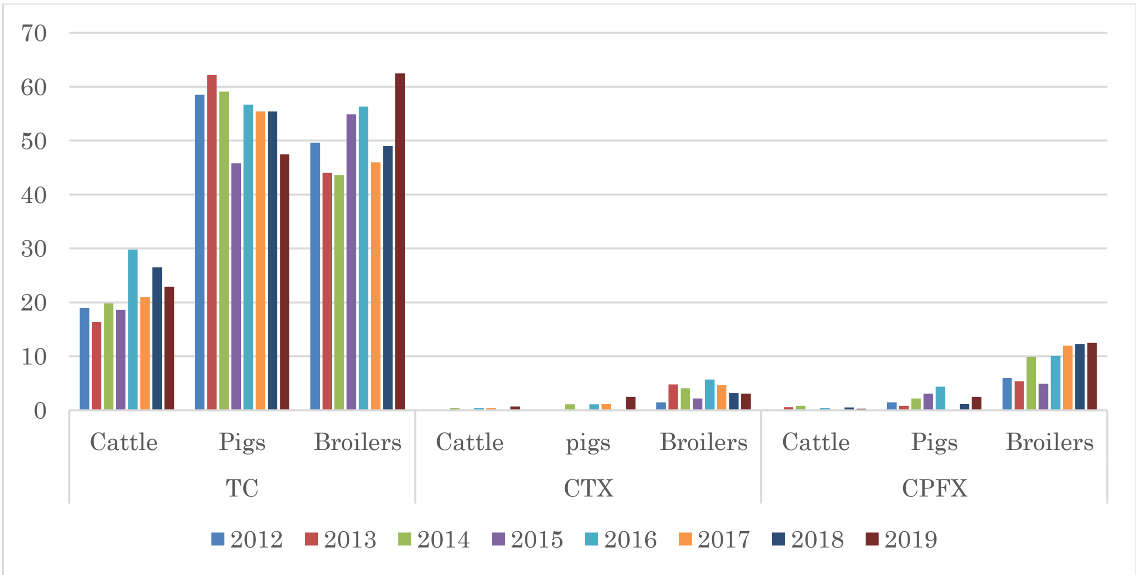

Fig. 4.2. Indices for the Action Plan: proportion (%) of *Escherichia coli* isolate from healthy animal—Resistance rate of each food-producing animal species

(2) *Enterococcus*

A total of 248 isolates (*E. faecalis*: 228 isolates, *E. faecium*:20 isolates) were collected in 2018 and 2019. The resistant rates are shown in Tables 4.3.1. and 4.3.2. and the MIC distributions are shown in Tables 12.2.1., 12.2.2. and 12.3.1., 12.3.2., respectively.

Only *E. faecalis* from broilers was able to collect more than 30 isolates, so only those resistance rates are described.

Among these isolates, there were high rates of resistance to tetracycline, kanamycin erythromycin, tylosin and lincomycin (66.7%–70.8% , 51.7%–66.0%, 43.4%-53.3%, 43.4%-55.0% and 43.4%-55.0% , respectively).

In contrast, there were low rates of resistance to gentamicin, chloramphenicol and ciprofloxacin (15.0%–15.1%, 11.3%–20.0%, 2.8%–3.3%, respectively). And also rates of resistance to vancomycin is 0%.

(3) *Campylobacter*

A total of 231 *C. jejuni* (149 from cattle and 82 from broilers) and 89 *C. coli* from pigs collected in 2018 and 2019 were subjected to antimicrobial susceptibility testing. The resistant rates are shown in Tables 4.4.1. and 4.4.2. and the MIC distributions are shown in Tables 12.4.1., 12.4.2. and 12.5.1. ,12.5.2., respectively.

The rates of resistance varied between bacterial species, and the resistance of *C. coli* against almost all antimicrobials tested was found to higher than that of *C. jejuni* isolates. Rates of resistance also tended to vary among animal species, with the highest levels of resistance against streptomycin, and tetracycline being detected in *C. coli* isolated from pigs.

For both *C. coli* and *C. jejuni*, resistance was most frequently observed against tetracycline (78.3%–86.2% and 23.4%–67.5%, respectively). Isolates also exhibited resistance against ampicillin (resistance rates in *C. jejuni* and *C. coli* of 8.6%–14.9% and 17.2%–26.7%, respectively), streptomycin (0.0%–8.6% and 68.3%–69.0%, respectively), chloramphenicol (0.0%–6.1% and 3.3%–3.4%, respectively), nalidixic acid (31.4%–60.5% and 45.0%–58.6%, respectively), ciprofloxacin (31.4%–59.6% and 40.0%–58.6%, respectively).

In addition, erythromycin and azithromycin resistance was frequently detected in *C. coli* isolated from pigs (20.7%–33.3% and 20.7%–31.7%, respectively), but for *C. jejuni* was detected only in isolates from cattle.

(4) *Salmonella*

A total of 224 *Salmonella* isolates collected from broilers in 2018 and 2019 were available for antimicrobial susceptibility testing, the MIC distributions of which are shown in Tables 12.6.1. and 12.6.2.

The predominant serovars isolated from broilers were *S.* Schwarzengrund (74-72 isolates, 63.2%-67.3%), *S.* Infantis (29-30 isolates, 24.8%-28.0%), and *S.* Typhimurium (5-0 isolates, 4.3%-0.0%) (Fig 4.3.).

The highest rates of resistance were observed for tetracycline (76.9%–69.2%), followed by kanamycin (68.4%–75.7%), streptomycin (77.3%–33.6%), trimethoprim/sulfamethoxazole (53.0%–52.3%), nalidixic acid (18.8%–8.4%), and ampicillin (6.8%–5.6%). In contrast, <5%

of the isolates exhibited resistance against cefotaxime and chloramphenicol. (Table 4.5.)

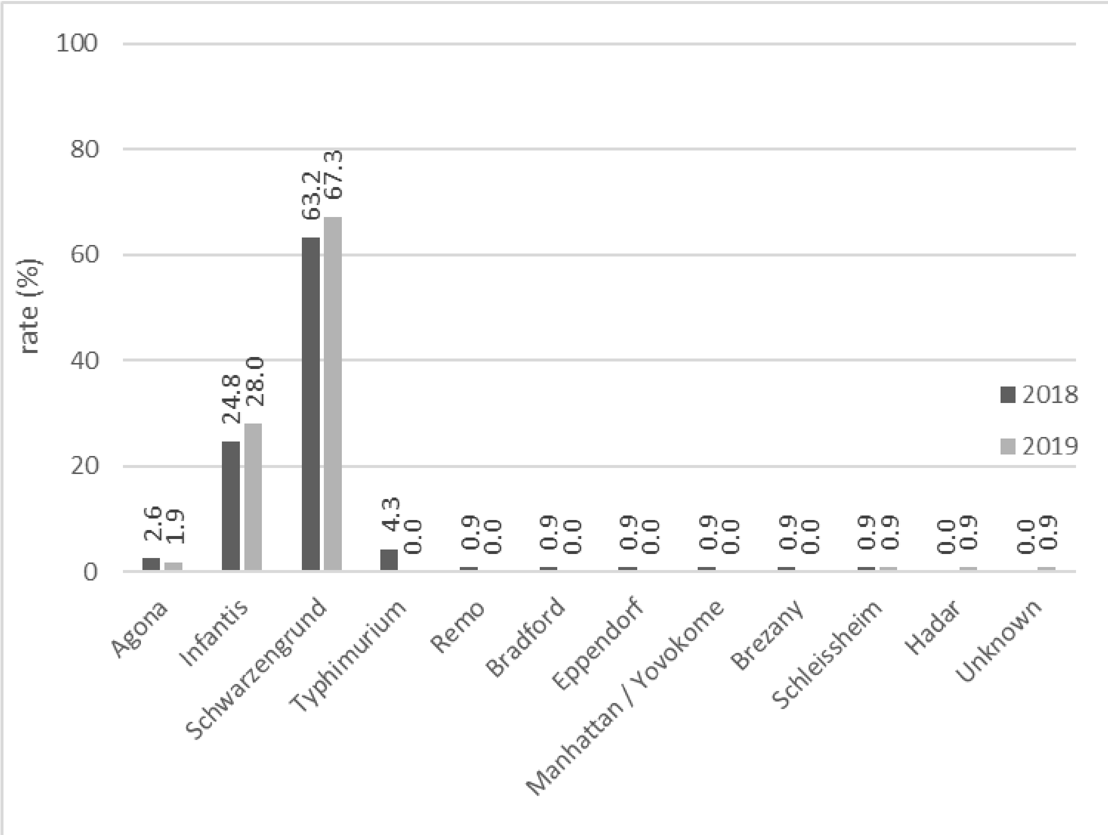

Fig 4.3. Proportion (%) of *Salmonella* spp. isolate from healthy broilers—Isolate rate of predominant serovars.

Table 4.1. Total numbers of bacteria isolated from food-producing animals in slaughterhouses between 2012 and 2019

Year	*E.coli*	*Enterococcus*	※*Campylobacter*	*Salmonella*
2012	576	528	282	94
2013	634	ND	330	118
2013	528	529	282	128
2015	554	546	316	123
2016	506	487	188	104
2017	485	472	225	112
2018	427	400	111	117
2019	496	461	209	107
Total	2073	2034	1011	467

※*C. jejuni* isolates from cattle and broiler. *C. coli* isolates from pigs

Table 4.2. Antimicrobial resistance rates of *Escherichia coli* isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agent	BP	Animal species	2012	2013	2014	2015	2016	2017	2018	2019
Ampicillin	32*	Cattle	2.4	6.5	3.0	5.5	7.4	4.8	11.6	6.3
		Pigs	32.3	26.0	43.0	34.4	36.7	33.7	34.9	32.5
		Broilers	30.8	35.5	40.1	43.5	36.1	39.3	36.1	36.7
Cefazolin	8* (32 before 2015)	Cattle	0.4	0.3	0.0	0.0	1.9	0.8	0.5	1.0
		Pigs	1.0	0.8	1.1	1.0	6.7	1.2	2.4	3.8
		Broilers	3.0	7.8	5.8	3.8	10.8[§1]	6.7[§1]	7.7[§1]	4.7[§1]
Cefotaxime	4*	Cattle	0.0	0.0	0.4	0.0	0.4	0.4	0.0	0.7
		Pigs	0.0	0.0	1.1	0.0	1.1	1.2	0.0	2.5
		Broilers	1.5	4.8	4.1	2.2	5.7	4.7	3.2	3.1
Meropenem	4*	Cattle	-	-	-	-	-	-	0.0	0.0
		Pigs	-	-	-	-	-	-	0.0	0.0
		Broilers	-	-	-	-	-	-	0.0	0.0
Streptomycin	32	Cattle	14.9	12.3	17.1	12.4	22.1	19.0	18.5	19.8
		Pigs	44.1	44.9	52.7	39.6	50.0	41.0	49.4	41.3
		Broilers	39.1	38.6	44.8	41.8	51.3	41.3	48.4	40.6
Gentamicin	16*	Cattle	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.0
		Pigs	0.5	2.4	6.5	2.1	3.3	3.6	3.6	2.5
		Broilers	1.5	1.8	2.9	2.2	5.1	6.0	5.2	6.3
Kanamycin	64*	Cattle	1.2	1.5	0.4	0.7	4.3	1.2	0.0	0.7
		Pigs	9.7	7.9	9.7	8.3	10.0	10.8	8.4	10.0
		Broilers	24.1	24.1	33.1	37.5	43.7	36.7	43.9	37.5
Tetracycline	16*	Cattle	19.0	16.4	19.8	18.6	29.8	21.0	26.5	22.9
		Pigs	58.5	62.2	59.1	45.8	56.7	55.4	55.4	47.5
		Broilers	49.6	44.0	43.6	54.9	56.3	46.0	49.0	62.5
Nalidixic acid	32*	Cattle	2.4	1.8	2.3	2.6	2.3	2.0	2.1	1.4
		Pigs	4.1	11.0	9.7	5.2	15.6	12.0	12.0	11.3
		Broilers	39.8	36.1	45.3	35.9	35.4	39.3	40.6	36.7
Ciprofloxacin	4*	Cattle	0.0	0.6	0.8	0.0	0.4	0.0	0.5	0.3
		Pigs	1.5	0.8	2.2	3.1	4.4	0.0	1.2	2.5
		Broilers	6.0	5.4	9.9	4.9	10.1	12.0	12.3	12.5
Colistin	4* (16 before 2015)	Cattle	0.0	0.0	0.8	0.0	0.4	1.2	0.0	0.3
		Pigs	0.0	0.0	0.0	0.0	4.4[§2]	2.4[§2]	6.0[§2]	2.5[§2]
		Broilers	0.8	0.6	0.0	0.5	2.5	3.3	0.0	0.0
Chloramphenicol	32*	Cattle	5.2	2.3	3.8	2.9	2.3	2.8	4.8	4.2
		Pigs	23.6	23.6	34.4	25.0	25.6	21.7	25.3	22.5
		Broilers	11.3	11.4	15.1	9.8	19.6	11.3	17.4	15.6
Sulfamethoxazole /Trimethoprim	76/4*	Cattle	2.0	2.9	5.3	2.9	0.4	2.0	5.3	2.8
		Pigs	23.6	26.8	34.4	30.2	4.4	26.5	32.5	23.8
		Broilers	24.8	31.9	30.2	28.3	10.1	34.7	33.5	30.5
Number of isolates tested (n)		Cattle	248	341	263	274	258	252	189	288
		Pigs	195	127	93	96	90	83	83	80
		Broilers	133	166	172	184	158	150	155	128

The unit of BP is μg/mL.

*** BP follows CLSI Criteria.**

§ 1 If the BP of 32 used until 2015 is applied, CEZ resistance rate in chicken-derived strains was 7.0% in 2016, 4.7% in 2017, and 3.2% in 2018, and 3.5% in 2019.

§ 2 If the BP of 16 used until 2015 is applied, CL resistance rate in pigs-derived strains was 1.1% in 2016, 0.0% in 2017, and 0.0% in 2018, and 0.0% in 2018.

Table 4.3.1. Antimicrobial resistance rates of *Enterococcus faecalis* isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agent*	BP	Animal species	2012	2014†	2015	2016	2017	2018	2019
Ampicillin	16§	Cattle	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Pigs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Chickens	0.0	0.6	0.0	0.0	0.0	0.0	0.0
Dihydrostreptomycin	128	Cattle	90.6	36.4	35.7	12.5	0.0	-	-
		Pigs	88.2	62.5	100.0	43.5	38.5	-	-
		Chickens	76.9	53.8	72.4	40.6	38.8	-	-
Gentamicin	32	Cattle	68.8	27.3	0.0	0.0	0.0	40.0	0.0
		Pigs	76.5	12.5	15.4	8.7	7.7	31.0	35.7
		Chickens	35.6	9.9	14.3	6.3	3.5	15.1	15.0
Kanamycin	128	Cattle	71.9	9.1	14.3	0.0	0.0	46.7	0.0
		Pigs	72.9	12.5	69.2	30.4	30.8	51.7	42.9
		Chickens	71.2	57.1	66.3	55.2	58.8	66.0	51.7
Oxytetracycline	16	Cattle	31.3	27.3	28.6	37.5	10.0	-	-
		Pigs	64.7	87.5	92.3	73.9	84.6	-	-
		Chickens	75.0	67.0	70.4	83.3	65.9	-	-
Tetracycline	16§	Cattle	-	-	-	-	-	26.7	25.0
		Pigs	-	-	-	-	-	65.5	57.1
		Chickens	-	-	-	-	-	70.8	66.7
Chloramphenicol	32§	Cattle	9.4	0.0	0.0	12.5	10.0	6.7	25.0
		Pigs	30.6	62.5	53.8	39.1	38.5	27.6	35.7
		Chickens	17.3	13.2	9.2	15.6	12.9	11.3	20.0
Erythromycin	8§	Cattle	21.9	9.1	0.0	0.0	10.0	0.0	25.0
		Pigs	51.8	62.5	69.2	52.2	61.5	44.8	50.0
		Chickens	58.7	64.8	60.2	59.4	58.8	43.4	53.3
Lincomycin	128	Cattle	34.4	9.1	0.0	0.0	10.0	0.0	25.0
		Pigs	76.5	75.0	92.3	56.5	61.5	51.7	50.0
		Chickens	57.7	45.1	54.1	59.4	55.3	43.4	55.0
Enrofloxacin	4	Cattle	3.1	0.0	0.0	0.0	0.0	-	-
		Pigs	5.9	0.0	7.7	0.0	0.0	-	-
		Chickens	2.9	1.1	0.0	2.1	0.0	-	-
Ciprofloxacin	4§	Cattle	-	-	-	-	-	0.0	0.0
		Pigs	-	-	-	-	-	3.4	7.1
		Chickens	-	-	-	-	-	2.8	3.3
Tylosin	64	Cattle	6.3	0.0	0.0	0.0	10.0	0.0	25.0
		Pigs	50.6	62.4	69.2	52.2	61.5	44.8	50.0
		Chickens	57.7	65.9	53.1	59.4	60.0	43.4	55.0
Vancomycin	32	Cattle	-	-	0.0	0.0	0.0	0.0	0.0
		Pigs	-	-	0.0	0.0	0.0	0.0	0.0
		Chickens	-	-	0.0	0.0	0.0	0.0	0.0
Strains tested (n)		Cattle	32	11	14	8	10	15	4
		Pigs	85	8	13	23	13	29	14
		Chickens	104	91	98	96	85	106	60

The unit of BP is µg/mL.

*** While AZM, SM, NA, BC and SNM were also included in the scope of the survey, the resistance rates were not listed because BP could not be established.**

† The monitoring was not conducted on Enterococcus spp. derived from animal slaughterhouses in FY2013.

§ BP follows CLSI Criteria.

-: Not under surveillance.

Table 4.3.2. Antimicrobial resistance rates of *Enterococcus faecium* isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agent*	BP	Animal species	2012	2014†	2015	2016	2017	2018	2019
Ampicillin	16§	Cattle	0.0	0.0	0.0	0.0	0.0	-	0.0
		Pigs	0.0	0.0	0.0	0.0	0.0	0.0	-
		Chickens	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Dihydrostreptomycin	128	Cattle	22.7	33.3	0.0	25.0	0.0	-	-
		Pigs	30.3	58.3	0.0	28.6	27.3	-	-
		Chickens	28.6	13.9	16.1	30.0	18.2	-	-
Gentamicin	32	Cattle	2.3	0.0	0.0	0.0	0.0	-	0.0
		Pigs	0.0	0.0	0.0	0.0	0.0	50.0	-
		Chickens	3.6	2.8	3.2	10.0	9.1	0.0	0.0
Kanamycin	128	Cattle	34.1	33.3	16.7	0.0	50.0	-	0.0
		Pigs	30.3	25.0	72.7	28.6	72.7	100.0	-
		Chickens	34.5	33.3	35.5	40.0	45.5	90.0	85.7
Oxytetracycline	16	Cattle	9.1	0.0	16.7	0.0	0.0	-	-
		Pigs	42.4	41.7	9.1	42.9	54.5	-	-
		Chickens	63.1	58.3	64.5	60.0	31.8	-	-
Tetracycline	16§	Cattle	-	-	-	-	-	-	0.0
		Pigs	-	-	-	-	-	50.0	-
		Chickens	-	-	-	-	-	60.0	57.1
Chloramphenicol	32§	Cattle	0.0	0.0	0.0	0.0	0.0	-	0.0
		Pigs	0.0	25.0	0.0	0.0	9.1	0.0	-
		Chickens	4.8	8.3	6.5	0.0	9.1	10.0	28.6
Erythromycin	8§	Cattle	11.4	0.0	33.3	25.0	0.0	-	0.0
		Pigs	15.2	58.3	54.5	57.1	45.5	0.0	-
		Chickens	32.1	30.6	35.5	20.0	27.3	40.0	28.6
Lincomycin	128	Cattle	9.1	0.0	0.0	0.0	0.0	-	0.0
		Pigs	39.4	50.0	9.1	28.6	27.3	0.0	-
		Chickens	31.0	19.4	29.0	20.0	27.3	20.0	28.6
Enrofloxacin	4	Cattle	36.4	0.0	16.7	25.0	0.0	-	-
		Pigs	45.5	25.0	0.0	0.0	27.3	-	-
		Chickens	65.5	13.9	71.0	30.0	18.2	-	-
Ciprofloxacin	4§	Cattle	-	-	-	-	-	-	0.0
		Pigs	-	-	-	-	-	0.0	-
		Chickens	-	-	-	-	-	20.0	42.9
Tylosin	64	Cattle	9.1	0.0	0.0	0.0	0.0	-	0.0
		Pigs	12.1	16.7	0.0	28.6	18.2	0.0	-
		Chickens	26.2	19.4	22.6	20.0	27.3	20.0	28.6
Vancomycin	32	Cattle	-	-	0.0	0.0	0.0	-	0.0
		Pigs	-	-	0.0	0.0	0.0	0.0	-
		Chickens	-	-	0.0	0.0	0.0	0.0	0.0
Strains tested (n)		Cattle	44	6	6	4	4	0	1
		Pigs	84	12	11	7	11	2	0
		Chickens	64	36	31	10	22	10	7

The unit of BP is μg/mL.

*** While AZM, SM, NA, BC and SNM were also included in the scope of the survey, the resistance rates were not listed because BP could not be established.**

† The monitoring was not conducted on Enterococcus spp. derived from animal slaughterhouses in FY2013.

§ BP follows CLSI Criteria.

-: Not under surveillance.

Table 4.4.1. Antimicrobial resistance rates of *Campylobacter jejuni* isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agents*	BP	Animal species	2012	2013	2014	2015	2016	2017	2018	2019
Ampicillin	32	Cattle	0.0	9.1	12.9	8.9	7.4	8.2	8.6	11.4
		Chickens	19.7	19.8	17.5	19.1	16.2	28.4	14.9	14.3
Streptomycin	32	Cattle	2.4	3.5	3.8	3.2	6.2	4.1	8.6	1.8
		Chickens	1.4	0.0	3.5	2.1	8.8	1.5	0.0	0.0
Erythromycin	32†	Cattle	0.0	0.7	0.0	1.3	0.0	0.0	5.7	0.0
		Chickens	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0
Azithromycin	4	Cattle	-	-	-	-	-	0.0	5.7	0.0
		Chickens	-	-	-	-	-	1.5	0.0	0.0
Tetracycline	16†	Cattle	45.1	52.4	49.2	52.2	63.0	72.2	65.7	67.5
		Chickens	38.0	44.4	38.6	28.7	33.8	46.3	23.4	34.3
Chloramphenicol	16	Cattle	0.0	6.3	0.0	1.3	1.2	6.2	2.9	6.1
		Chickens	0.0	0.0	1.8	0.0	2.9	0.0	2.1	0.0
Nalidixic acid	32	Cattle	34.1	33.6	50.8	42.7	44.4	48.5	31.4	60.5
		Chickens	39.4	48.1	29.8	27.7	57.4	46.3	31.9	37.1
Ciprofloxacin	4†	Cattle	34.1	29.4	49.2	40.8	44.4	50.5	31.4	59.6
		Chickens	39.4	39.5	29.8	26.6	51.5	44.8	29.8	34.3
Strains tested (n)		Cattle	82	143	132	157	81	97	35	114
		Chickens	71	81	57	94	68	67	47	35

The unit of BP is μg/mL.

While GM was also included in the scope of monitoring, the proportion of GM-resistant strains were not listed because BP could not be established.

† BP follows CLSI Criteria.

Table 4.4.2. Antimicrobial resistance rates of *Campylobacter coli* isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agent*	BP	Animal species	2012	2013	2014	2015	2016	2017	2018	2019
Ampicillin	32	Pigs	23.3	25.5	36.6	24.6	15.4	29.5	17.2	26.7
Streptomycin	32	Pigs	67.4	78.3	69.9	72.3	64.1	68.9	69.0	68.3
Erythromycin	32†	Pigs	32.6	44.3	43.0	26.2	38.5	31.1	20.7	33.3
Azithromycin	4	Pigs	–	–	–	–	–	31.1	20.7	31.7
Tetracycline	16†	Pigs	84.5	93.4	80.6	87.7	89.7	83.6	86.2	78.3
Chloramphenicol	16	Pigs	10.9	3.8	7.5	9.2	15.4	1.6	3.4	3.3
Nalidixic acid	32	Pigs	46.5	53.8	52.7	47.7	61.5	50.8	58.6	45.0
Ciprofloxacin	4†	Pigs	46.5	46.2	50.5	47.7	59.0	54.1	58.6	40.0
Strains tested (n)		Pigs	129	106	93	65	39	61	29	60

The unit of BP is μg/mL.

*** While GM was also included in the scope of monitoring, the proportion of GM-resistant strains were not listed because BP could not be established.**

† BP follows CLSI Criteria.

Table 4.5. Antimicrobial resistance rates of *Salmonella* species isolated from food-producing animals in slaughterhouses between 2012 and 2019

Agent	BP	Animal species	2012	2013	2014	2015	2016	2017	2018	2019
Ampicillin	32*	Broilers	31.9	22.9	17.2	13.0	13.5	8.0	6.8	5.6
Cefazolin	8* (32 before 2015)	Broilers	7.4	5.9	3.1	1.6	7.7	3.6	3.4	3.7
Cefotaxime	4*	Broilers	7.4	5.1	2.3	1.6	1.9	1.8	2.6	1.9
Meropenem	4*	Broilers	-	-	-	-	-	-	-	0.0
Streptomycin	32	Broilers	77.7	84.7	85.9	76.4	77.9	60.7	73.3	33.6
Gentamicin	16*	Broilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kanamycin	64*	Broilers	31.9	42.4	57.8	69.1	72.1	73.2	68.4	75.7
Tetracycline	16*	Broilers	74.5	82.2	85.2	83.7	82.7	77.7	76.9	69.2
Chloramphenicol	32*	Broilers	0.0	0.8	1.6	1.6	0.0	0.9	1.7	0.9
Colistin	4* (16 before 2015)	Broilers	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.9
Nalidixic acid	32*	Broilers	29.8	19.5	17.2	15.4	12.5	17.0	18.8	8.4
Ciprofloxacin	1* (4 before 2015)	Broilers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Sulfamethoxazole /Trimethoprim	76/4*	Broilers	31.9	48.3	51.6	57.7	56.7	55.4	53.0	52.3
Number of isolates tested (n)		Broilers	94	118	128	123	104	112	117	107

The unit of BP is μg/mL.

*** BP follows CLSI Criteria.**

4.2 Diseased Animals on Farms

(1) *Salmonella*

A total of 143 *Salmonella* isolates (57 from cattle, 64 from pigs and 22 from chicken or broilers) were collected in 2018, and a total of 142 isolates (57 from cattle, 69 from pigs and 16 from chicken or broiler) were collected in 2019. MIC distributions of which are shown in Tables 12.7.1. and 12.7.2., respectively.

The predominant serovars isolated from cattle were *S.* Typhimurium (12-10 isolates, 21.1%-17.5%), O4:i:- (24-24 isolates, 42.1%-42.1%), Thompson (4-4 isolates, 7.0%-7.0%) (Fig 4.4.). The predominant serovars isolated from pig were *S.* Typhimurium (26-26 isolates, 40.6%-37.7%), O4:i:- (19-17 isolates, 29.7%-24.6%), Choleraesuis (2-9 isolates, 3.1%-13.0%) (Fig 4.5)..

In general, *Salmonella* isolated from cattle and pigs had the highest rates of resistance, which was most commonly against tetracycline (resistance rates in cattle and pigs of 33.3%–63.2% and 50.0%–37.7%, respectively) and ampicillin (36.8%–61.4% and 50.0%–44.9%, respectively). （Table 4.6.）

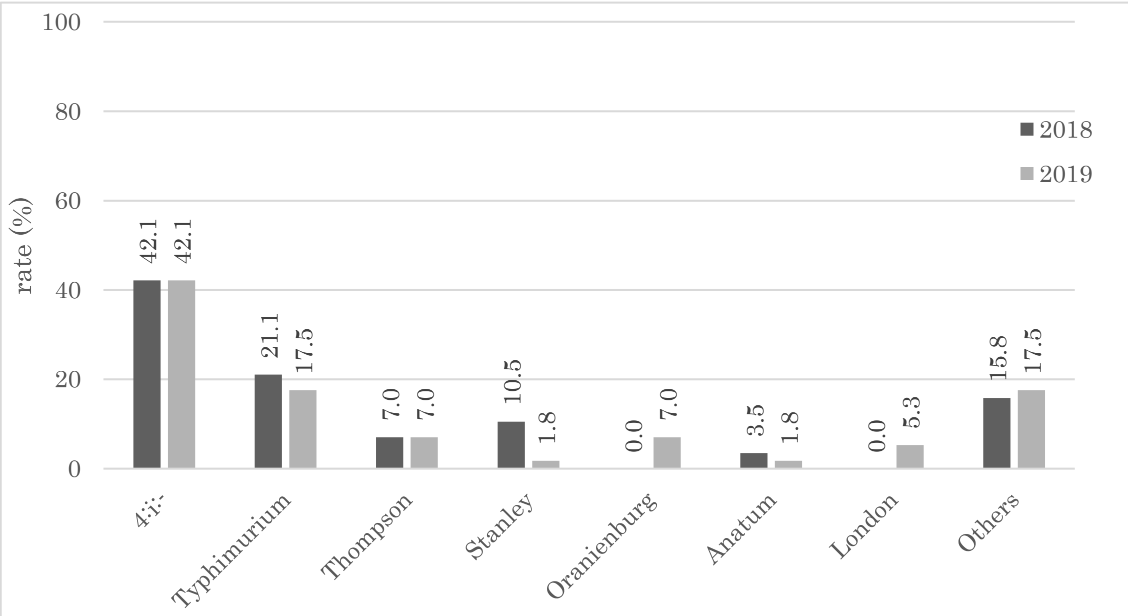

Fig 4.4. Proportion (%) of *Salmonella* spp. isolate from disease cattle—Isolate rate of predominant serovars.

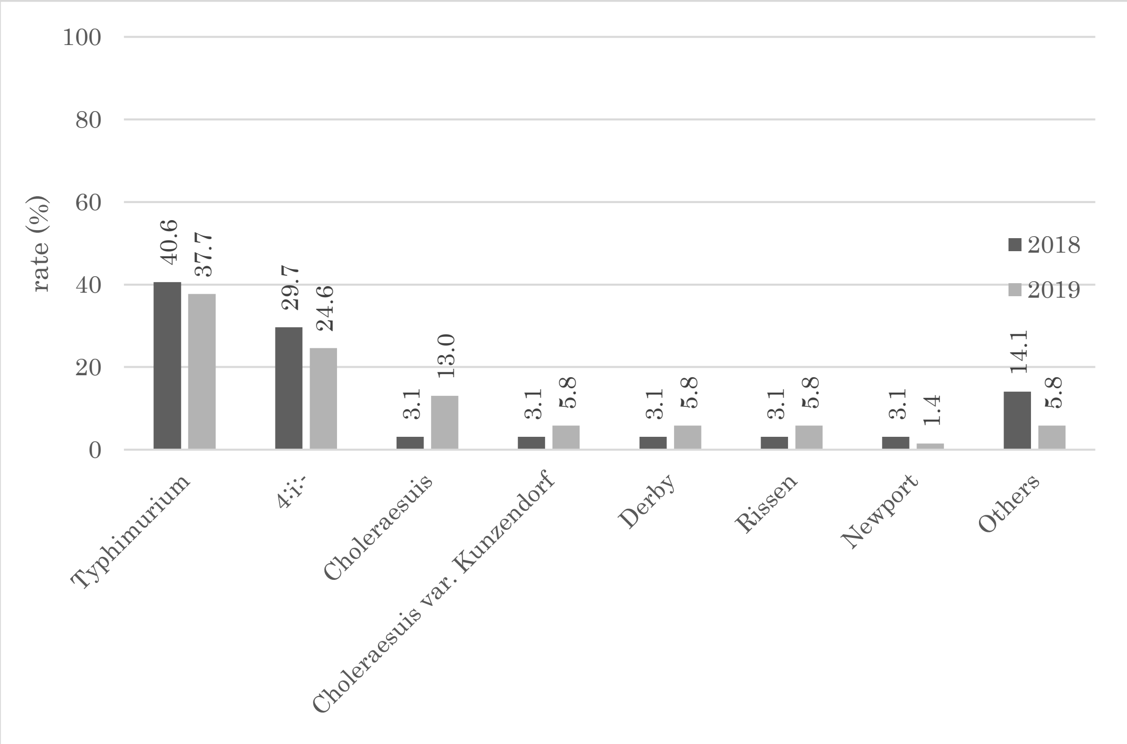

Fig 4.5. Proportion (%) of *Salmonella* spp. isolate from disease pig—Isolate rate of predominant serovars.

Table 4.6. Proportion (%) of antimicrobial-resistant *Salmonella* spp. isolated from diseased animals in 2018 and 2019

Antimicrobials	BP	2018				2019		
		Cattle n=57	Pig n=64	Chicken n=22		Cattle n=57	Pig n=69	Chicken n=16
Ampicillin	32	36.8	50.0	4.5		61.4	44.9	25.0
Cefazolin	8	1.8	9.4	0.0		5.3	17.4	0.0
Cefotaxime	4	0.0	0.0	0.0		1.8	0.0	0.0
Gentamicin	16	1.8	4.7	0.0		7.0	5.8	18.8
Kanamycin	64	0.0	4.7	63.6		12.3	14.5	68.8
Tetracycline	16	33.3	50.0	77.3		63.2	37.7	75.0
Meropenem	4	-	-	-		0.0	0.0	0.0
Nalidixic acid	32	1.8	20.3	0.0		3.5	21.7	50.0
Ciprofloxacin	4	0.0	0.0	0.0				
	1					1.8	1.4	18.8
Colistin	4	0.0	4.7	18.2		1.8	8.7	18.8
Chloramphenicol	32	3.5	21.9	0.0		29.8	8.7	0.0
Sulfamethoxazole /Trimethoprim	76/4	2.7	12.5	59.1		29.8	18.8	56.3

The unit of BP is µg/mL. BP follows CLSI Criteria.

(2) *Staphylococcus aureus*

Among *S. aureus* isolates, the highest rates of resistance were observed for ampicillin (8.0%–82.4%) and benzyl penicillin (0.0%–87.5%) followed by tetracycline (0.6%–77.5%), erythromycin (4.0%–52.9%), and chloramphenicol (0.0%–43.1%) (Table 4.7).

(3) *Escherichia coli*

Among *E. coli* isolates, the highest rates of resistance were observed for tetracycline (58.6%–72.5%) followed by streptomycin (51.0%–65.3%), ampicillin (47.5%–68.3%) and sulfamethoxazole and trimethoprim (19.6%–57.4%) (Table 4.8)

Table 4.7. Proportion (%) of antimicrobial-resistant *Staphylococcus aureus* isolated from diseased animals in 2018 and 2019

Antimicrobials	BP	2018			2019		
		Cattle n=172	Pig n=51	Chicken n=25	Cattle n=125	Pig n=40	Chicken n=17
Ampicillin	0.5	9.3	82.4	8.0	-	-	-
Benzylpenicillin	0.25	-	-	-	6.4	87.5	0.0
Oxacillin	4	-	-	-	2.4	15	0.0
Streptomycin	64	5.8	39.2	0.0	8.0	17.5	0.0
Gentamicin	16	0.0	11.8	4.0	0.0	7.5	0.0
Erythromycin	8	5.8	52.9	4.0	4.8	52.5	17.6
Tetracycline	16	0.6	60.8	20.0	2.4	77.5	17.6
Chloramphenicol	32	0.6	43.1	8.0	1.6	37.5	0.0
Ciprofloxacin	4	0.0	23.5	2.8	1.6	5.0	0.0

The unit of BP is μg/mL. BP follows CLSI Criteria.

Table 4.8. Proportion (%) of antimicrobial-resistant *Escherichia coli* isolated from diseased animals in 2018 and 2019

Antimicrobials	BP	2018			2019		
		Cattle	Pig	Chicken	Cattle	Pig	Chicken
		n=87	n=121	n=51	n=94	n=101	n=54
Ampicillin	32	51.7	62.8	52.9	62.8	68.3	47.5
Cefazolin	8	17.2	21.5	17.6	28.7	23.8	20.0
Cefotaxime	4	9.2	3.3	11.8	14.9	5.0	7.5
Streptomycin	32	57.5	54.5	51.0	63.8	65.3	65.0
Gentamicin	16	10.3	13.2	2.0	8.5	12.9	5.0
Kanamycin	64	28.7	32.2	27.5	31.9	27.7	25.0
Tetracycline	16	58.6	70.2	72.5	66.0	69.3	60.0
Meropenem	4	-	-	-	0.0	0.0	0.0
Nalidixic acid	32	33.3	33.1	35.3	36.2	27.7	60.0
Ciprofloxacin	4	21.8	11.6	5.9	25.5	12.7	22.5
	1	21.8	22.3	11.8	28.7	15.8	35.0
Colistin	4	11.5	35.5	2.0	11.7	27.7	10.0
Chloramphenicol	32	31.0	57.0	21.6	38.3	55.4	15.0
Sulfamethoxazole/ Trimethoprim	76/4	42.5	52.9	19.6	41.5	57.4	35.0

The unit of BP is μg/mL. BP follows CLSI Criteria.

4.3 Companion Animals

4.3.1 Healthy Companion Animals

The monitoring of healthy companion animals (dogs and cats) was commenced in 2018, with *E. coli* and *Enterococcus* spp. samples being collected from small animal clinics. The total numbers of bacteria isolated from companion animals are shown in Table 4.9. and 4.10. All isolates were subjected to antimicrobial susceptibility testing.

(1) *Escherichia coli*

A total of 309 *E. coli* isolates (151 from dogs and 158 from cats) were collected in 2018, and a total of 381 isolates (192 from dogs and 188 from cats) were collected in 2019. MIC distributions of which are shown in Tables 12.8.1. and 12.8.2., respectively.

The resistance of *E. coli* isolated from dogs and cats were found to show a similar pattern (Table. 4.9.).

Table.4.9. Resistant rates (%) of *E. coli* from healthy dogs and cats in 2018-2019

Antimicrobials	BP	2018		2019	
		Dogs n = 151	Cats n = 158	Dogs n = 192	Cats n = 188
Ampicillin	32	33.8	28.5	22.9	27.1
Cefazolin	32	17.2	17.1	13.0	11.7
Cefalexin	32	17.9	18.4	10.9	13.3
Cefotaxime	4	13.2	10.8	8.9	6.4
Meropenem	4	0.0	0.0	0.0	0.0
Streptomycin	32	19.2	11.4	13.0	11.7
Gentamicin	16	3.3	2.5	2.6	4.3
Kanamycin	64	5.3	1.9	3.6	3.2
Tetracycline	16	16.6	10.8	13.0	10.1
Chloramphenicol	32	4.6	1.3	5.7	3.7
Colistin	4	0.0	0.0	0.5	0.0
Nalidixic acid	32	27.8	24.7	20.8	28.7
Ciprofloxacin	1	18.5	12.0	8.9	13.3
Sulfamethoxazole/Trimethoprim	76/4	13.2	12.0	7.8	9.6

For both species, there were high rates of resistance against ampicillin and nalidixic acid. In other antimicrobials, resistance rates were less than 20% and resistance rates against meropenem were 0.0% in both dogs and cats.

(2) *Enterococcus*

A total of 236 *Enterococcus* spp. isolates (146 from dogs and 90 from cats) were collected in 2018, and a total of 247 *Enterococcus* spp. isolates (158 from dogs and 89 from cats) were collected in 2019. The species and isolated strain numbers are shown in Table 4.10. Among the *Enterococcus* spp. isolated from dogs and cats, *E. faecalis* was the most frequently encountered. Other than *E. faecalis*, *E. faecium*, *E. gallinarum*, *E. durans*, *E. avium*, *E. hirae*, *E. casselifravus* and *E. raffinosus* were obtained.

Table 4.10. Number of bacteria isolated from healthy companion animals in 2018 and 2019

Species	2018			2019		
	Dogs	Cats	Total	Dogs	Cats	Total
E. faecalis	102	64	166	123	76	199
E. faecium	24	7	31	3	1	4
E. gallinarum	1	2	3	16	5	21
E. durans	13	8	21	0	0	0
E. avium	2	6	8	3	1	4
E. hirae	3	0	3	6	5	11
E. casselifravus	1	2	3	7	1	8
E. raffinosus	0	1	1	0	0	0
Total	146	90	236	158	89	247

The resistant rates of *E. faecalis* were shown in Table 4.11. The MIC distributions of *E. faecalis* isolates are shown in Tables 12.9.1. and 12.9.2, respectively.

Table.4.11. Resistant rates (%) of *E. faecalis* from healthy dogs and cats in 2018-2019

Antimicrobials	**BP**	**2018**		**2019**	
		Dogs n = 101	Cats n = 64	Dogs n = 123	Cats n = 76
Ampicillin	16	1.0	0.0	0.0	0.0
Gentamicin	32	13.9	14.1	8.9	14.5
Tetracycline	16	66.3	56.3	47.2	68.4
Chloramphenicol	32	22.8	14.1	13.0	15.8
Erythromycin	8	39.6	39.1	24.4	35.5
Ciprofloxacin	4	5.9	17.2	3.3	10.5
Vancomycin	32	0.0	0.0	0.0	0.0

The resistance of *E. faecalis* isolated from dogs and cats were found to show a similar pattern. There was only a single ampicillin-resistant strain from dogs in 2018. In contrast, high rates of resistance to tetracycline were detected, followed erythromycin, whereas for other antimicrobials (chloramphenicol, ciprofloxacin, and gentamicin) rates of resistance were less than 30% among strains isolated from dogs and cats (excluding rates of resistance to chloramphenicol for dog-derived strains in 2018).

4.3.2 Diseased Companion Animals

In 2018 and 2019 the monitoring of diseased companion animals (dogs and cats) was implemented with *E. coli*, *Enterococcus* spp., coagulase-positive *Staphylococcus* spp., *Klebsiella* spp., *Pseudomonas aeruginosa* spp. and *Proteus mirabilis* samples being collected from clinical laboratories. The total numbers of bacteria isolated are shown in Table 4.12. All isolates were subjected to antimicrobial susceptibility testing.

Table 4.12. Number of bacteria isolated from diseased companion animals in 2018 and 2019

Species	Dogs		Cats	
	2018	2019	2018	2019
E. coli	154	93	178	128
Enterococcus	78	57	135	103
E. faecalis	57	39	100	62
E. faecium	15	18	30	35
E. gallinarum	3	0	2	2
E. durans	0	0	0	1
E. avium	1	0	2	2
E. hirae	0	0	0	0
E. casselifravus	1	0	1	1
E. raffinosus	1	0	0	0
Staphylococcus	93	41	82	72
S. pseudintermedius	83	22	78	42
S. aureus	3	17	2	30
S. shreiferi subsp. *Coagulans*	7	2	2	0
Klebsiella	49	20	81	37
K. pneumoniae	45	18	72	32
K. oxytoca	4	2	8	5
K. aerogenes	0	0	1	0

Pseudomonas aeruginosa	78	18	-	-
Proteus mirabilis	-	-	81	17

(1) *Escherichia coli*

A total of 247 *E. coli* isolates (154 from dogs and 93 from cats) were collected in 2018 and 306 *E. coli* isolates (178 from dogs and 128 from cats) were collected in 2019, the MIC distributions of which are shown in Tables 12.10.1 and 12.10.2.

The resistance of *E. coli* isolated from dogs and cats were found to show a similar pattern (Table 4.13.). For both species, there were high rates of resistance against ampicillin and quinolones (nalidixic acid and ciprofloxacin) (dogs: 51.1%-63.0%, 56.2%-72.7%, and 38.8%-55.2%; cats: 60.2%-65.6%, 46.9%-68.8%, and 37.5%-50.5%, respectively). In contrast, resistance to kanamycin (5.1%-7.8% and 7.0%-12.9%, respectively) was relatively low, only a few isolates were resistance to colistin (0.0% and 0.0%-1.1%, respectively) and no strains showing resistance against meropenem were isolated.

Table 4.13. Antimicrobial resistance rates (%) of *Escherichia coli* isolated from diseased companion animals in 2018 and 2019

Antimicrobials	BP	2018		2019	
		Dogs n=154	Cats n=93	Dogs n=178	Cats n=128
Ampicillin	32	63.0	65.6	51.1	60.2
Cefazolin	32	44.2	44.1	30.3	32.0
Cefalexin	32	42.9	47.3	31.5	31.3
Cefotaxime	4	41.6	39.8	26.4	26.6
Meropenem	4	0.0	0.0	0.0	0.0
Streptomycin	32	29.9	34.4	20.2	28.9
Gentamicin	16	18.8	15.1	12.9	9.4
Kanamycin	64	7.8	12.9	5.1	7.0
Tetracycline	16	27.9	29.0	21.3	26.6
Chloramphenicol	32	16.2	15.1	11.8	7.8
Colistin	4	0.0	1.1	0.0	0.0
Nalidixic acid	32	72.7	68.8	56.2	46.9
Ciprofloxacin	1	55.2	50.5	38.8	37.5
Sulfamethoxazole/Trimethoprim	76/4	27.9	34.4	17.4	22.7

(2) *Enterococcus*

A total of 135 *Enterococcus* spp. isolates (78 from dogs and 57 from cats) were collected in 2018 and 238 *Enterococcus* spp. isolates (135 from dogs and 103 from cats) were collected in 2019. The species and strain numbers of which are shown in Table 4.12. The MIC distributions of *E. faecalis* and *E. faecium* isolates are shown in Tables 12.11.1., 12.11.2. and 12.12.1., 12.12.2., respectively.

Among the *Enterococcus* spp. isolated from dogs and cats, *E. faecalis* was the most frequently encountered (57-100 from dogs and 39-62 from cats). There was a similar tendency with respect to the isolates obtained from dogs and cats (Tables 4.14.). For both animal species, there were no ampicillin-resistant strain. In contrast, high rates of resistance to tetracycline were detected (65.0%-66.7% in dogs and 67.7%-76.9% in cats), followed erythromycin (36.0%-36.8% in dogs and 33.9%-46.2% in cats), whereas for other antimicrobials (chloramphenicol, ciprofloxacin and gentamicin) rates of resistance of 8.8%-25.6% were detected among strains isolated from dogs and cats.

Table 4.14. Antimicrobial resistance rates (%) of *Enterococcus faecalis* isolated from diseased companion animals in 2018 and 2019

Antimicrobials	BP	2018		2019	
		Dogs n=57	Cats n=39	Dogs n=100	Cats n=62
Ampicillin	16	0.0	0.0	0.0	0.0
Gentamicin	32	8.8	15.4	22.0	14.5
Tetracycline	16	66.7	76.9	65.0	67.7
Chloramphenicol	32	15.8	23.1	24.0	14.5
Erythromycin	8	36.8	46.2	36.0	33.9
Ciprofloxacin	4	8.8	25.6	11.0	14.5
Vancomycin	32	-	-	0.0	0.0

E. faecium strains isolated from dogs and cats were also found to show similar resistance tendencies, although these differed from those identified for *E. faecalis* (Tables 4.14.–4.15.). The rates of resistance against ciprofloxacin (96.7%-100.0% in dogs and 94.3%-100.0% in cats). In contrast to *E. faecalis*, there were also high rates of resistance for ampicillin (90.0%-100.0% in dogs and 94.3%-100.0% in cats), and there were also relatively high rates of resistance against erythromycin, tetracycline, and gentamicin, whereas resistance rates for chloramphenicol were typically low (3.3%-6.7% in dogs and 0.0% in cats). No vancomycin resistant isolates were detected in both *E. faecalis* and *E. faecium.*

Table 4.15. Antimicrobial resistance rates (%) of *Enterococcus faecium* isolated from diseased companion animals in 2018 and 2019

Antimicrobials	BP	2018		2019	
		Dogs n=15	Cats n=18	Dogs n=30	Cats n=35
Ampicillin	16	100.0	100.0	90.0	94.3
Gentamicin	32	40.0	44.4	36.7	45.7
Tetracycline	16	80.0	66.7	80.0	61.0
Chloramphenicol	32	6.7	0.0	3.3	0.0
Erythromycin	8	46.7	72.2	66.7	51.4
Ciprofloxacin	4	100.0	100.0	96.7	94.3
Vancomycin	32	-	-	0.0	0.0

(3) *Staphylococcus pseudintermedius*

A total of 134 coagulase-positive *Staphylococcus* spp. isolates (93 from dogs and 41 from cats) were collected in 2018 and 154 the coagulase-positive *Staphylococcus* spp. isolates (82 from dogs and 72 from cats) in 2019. Species and strain numbers of which are shown in Table 4.12.

S. pseudintermedius (78-83 and 22-42 isolates from dogs and cats, respectively) was the most detected *Staphylococcus* spp., the MIC distributions of which are shown in Tables 12.13.1. and 12.13.2. The resistance rates of *S. pseudintermedius* strains isolated from dogs and cats showed similar patterns (Table 4.16.). In dogs, isolates showed highest resistance against benzylpenicillin (97.4%) followed by erythromycin and azithromycin (both 74.7%-79.5%), ciprofloxacin (75.6%-75.9%), whereas in cats, the highest rates of resistance were detected for ciprofloxacin (97.6%-100.0%), followed by benzylpenicillin (97.6%), azithromycin (86.4%-95.2%) and erythromycin (86.4%-95.2%). Resistance against other drugs ranged from 49.4% to 66.7% in dogs and 52.4% to 85.7% in cats. Although methicillin-resistant *S. pseudintermedius* (MRSP) is considered a major cause for concern in small animal clinics, we also detected high rates of resistance to oxacillin (56.6%-62.8% in dogs and 81.0%-81.8% in cats).

Table 4.16. Antimicrobial resistance rates (%) of *Staphylococcus pseudintermedius* isolated from diseased companion animals in 2018 and 2019

Antimicrobials	BP	2018		2019	
		Dogs n=83	Cats n=22	Dogs n=78	Cats n=42
Benzylpenicillin	0.25	-	-	97.4	97.6
Oxacillin	0.5	56.6	81.8	62.8	81.0
Gentamicin	16	54.2	63.6	64.1	52.4
Tetracycline	16	67.5	81.8	66.7	85.7
Erythromycin	8	74.7	86.4	79.5	95.2
Azithromycin	8	74.7	86.4	79.5	95.2
Ciprofloxacin	4	75.9	100.0	75.6	97.6
Chloramphenicol	32	49.4	72.7	60.3	83.3

(4) *Klebsiella pneumoniae*

A total of 130 *Klebsiella* spp. isolates (49 from dogs and 81 from cats) were collected in 2018, including 117 isolates of *K. pneumoniae* (45 from dogs and 72 from cats), 12 of *K. oxytoca* (4 from dogs and 8 from cats), and 1 of *K. aerogenes* (formerly *Enterobacter aerogenes*; 1 from cat) and 57 *Klebsiella* spp. isolates (20 from dogs and 37 from cats) were collected in 2019, including 50 isolates of *K. pneumoniae* (18 from dogs and 32 from cats), 7 of *K. oxytoca* (2 from dogs and 5 from cats) (Table 4.12.).

Among the *Klebsiella* spp. isolated, *K. pneumoniae* was the most encountered, the MIC distributions of which are shown in Tables 12.14.1. and 12.14.2. The rates of resistance shown by *K. pneumoniae* were found to be relatively high, particularly those against cephalosporins (36.1%–48.9% in dogs and 68.8%-94.4% in cats) and quinolones (47.2%–64.4% in dogs and 81.3%-100.0% in cats) (Table 4.17.). However, no strains showing resistance against colistin or meropenem were detected. Apart from chloramphenicol in 2019, the resistance rates of strains isolated from cats tended to be higher than those isolated from dogs.

Table 4.17. Antimicrobial resistance rates (%) of *Klebsiella pneumoniae* isolated from diseased companion animals in 2018 and 2019

Antimicrobials	**BP**	**2018**		**2019**	
		Dogs n=45	Cats n=18	Dogs n=72	Cats n=32
Cefazolin	32	46.7	94.4	40.3	75.0
Cefalexin	32	48.9	88.9	41.7	68.8
Cefotaxime	4	40.0	83.3	36.1	68.8
Meropenem	4	0.0	0.0	0.0	0.0
Streptomycin	32	37.8	61.1	29.2	62.5
Gentamicin	16	31.1	61.1	22.2	46.9
Kanamycin	64	11.1	22.2	4.2	12.5
Tetracycline	16	48.9	72.2	30.6	50.0
Chloramphenicol	32	35.6	50.0	19.4	15.6
Colistin	4	0.0	0.0	0.0	0.0
Nalidixic acid	32	64.4	100.0	47.2	84.4
Ciprofloxacin	1	60.0	100.0	47.2	81.3
Sulfamethoxazole/Trimethoprim	76/4	48.9	77.8	37.5	65.6

(5) *Pseudomonas aeruginosa* and *Proteus mirabilis*

In 2018, 78 *Pseudomonas aeruginosa* from dogs were isolated (Table 4.12.). Although there were one meropenem resistant isolate (1.3%), the isolate was not resistant to gentamicin. In 2019, 81 *Proteus mirabilis* from dog were isolated (Table 4.12.). The resistance rates shown by *P. mirabilis* was relatively low, those against cephalosporins (1.2%-3.7%) and quinolones (12.3%-28.4%) (Tables 12.15. and 12.16.).

There were 18 *P. aeruginosa* in 2018 and 17 *P. mirabilis* in 2019 were isolated from cats (Table 4.12.). Given the relatively small number, results for these isolates are not shown.

5. JVARM Publications

2018

Furuno, M., Uchiyama, M., Nakahara, Y., Uenoyama, K., Fukuhara, H., Morino, S., Kijima, M. A Japanese trial to monitor methicillin-resistant *Staphylococcus aureus* (MRSA) in imported pigs during the quarantine period. J. Glob. Antimicrob. Resist. 2018; 14: 182-184.

2019

Kijima, M., Shirakawa, T., Uchiyama, M., Kawanishi, M., Ozawa, M., & Koike, R. (2019). Trends in the serovar and antimicrobial resistance in clinical isolates of *Salmonella enterica* from cattle and pigs between 2002 and 2016 in Japan. Journal of applied microbiology, 127(6), 1869-1875.

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7. Participants in the JVARM Program

7.1. Data from the National Veterinary Assay Laboratory were provided by the following people:

2018

Yuko Endo (Head of Assay Division II), Mayumi Kijima, Michiko Kawanishi, Mari Matsuda, and Takahiro Shirakawa

2019

Tatsuro Sekiya (Head of Assay Division

II), Yoko Shimazaki, Manao Ozawa, Michiko Kawanishi, Mari Matsuda, Takahiro Shirakawa and Yukari Furuya

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2019

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8. Materials and Methods

8.1 Sampling

(1) Monitoring System for Farms

Sampling was carried out on farms across Japan by the prefectural LHSCs. *Salmonella* and *Staphylococcus* species were isolated from diagnostic submissions of clinical cases.

(2) Monitoring System for Slaughterhouses

Sampling in slaughterhouses was carried out by private research laboratories. At each slaughterhouse, fresh fecal samples were collected from the cecum of healthy broiler chickens and from the rectum of healthy cattle and healthy pigs.

E. coli, *Enterococcus* species, and *Campylobacter* species were isolated from the cecum- and rectum-derived fecal samples obtained from healthy cattle, pigs, and broilers, whereas species of *Salmonella* were isolated from only the cecum-derived fecal samples of healthy broilers.

(3) Monitoring System for Diseased Companion Animals (Dogs and Cats)

Clinical samples submitted from animal hospitals were collected from the private clinical laboratories that had agreed to cooperate with this monitoring. To reduce selection bias, sample numbers were allocated in accordance with the numbers of companion animal hospitals and one sample for each bacterial and host species should be collected from each hospital. A contracted research laboratory informed the cooperating clinical laboratories with respect to the target bacterial species, required numbers and acceptable sampling location, and the clinical laboratories selected and sent isolates accordingly.

The target bacterial species were as follows: *E. coli* and *Klebsiella* species derived from urine and the reproductive tract, *Enterococcus* species from urine and ears, coagulase-positive *Staphylococcus* species from urine and skin, *Pseudomonas aeruginosa* from urine and ear, and *Proteus mirabilis* from urine and ear.

(4) Monitoring System for Healthy Companion Animals (Dogs and Cats)

Japan Veterinary Medical Association (JVMA). The JVMA members are collected a rectal swab from healthy dogs and cats visited hospital for health check, vaccination, trimming or so on. It was done with informed consent for owners. Sample numbers were allocated in following with small animal clinic number in each prefecture. Rectal swabs are submitted to contracted laboratories and *E. coli* and *Enterococcus* spp. strains were isolated from samples.

8.2 Isolation and Identification

(1) *Escherichia coli*

E. coli strains isolated from each

sample were maintained on desoxycholate-hydrogen sulfate-lactose (DHL) agar (Eiken, Japan). Candidate colonies were identified biochemically using a commercially available kit (API20E; bioMérieux, Marcy l'Etoile, France) and stored at -80°C until used for testing.

(2) *Enterococcus*

Fecal samples were cultured via direct culturing using bile esculin azide agar (BEA; Difco Laboratories, Detroit, MI, USA) or using an enrichment procedure with buffered peptone water (Oxoid, Basingstoke, Hampshire, England). In the former procedure, plates were incubated at 37°C for 48–72 h, whereas in the latter, tubes were incubated at 37°C for 18–24 h and subsequently passaged onto the same types of plates as used for the direct culturing method.

Isolates were presumptively identified as enterococci based on colony morphology. These isolates were sub-cultured onto heart infusion agar (Difco) supplemented with 5% (v/v) sheep blood, following which hemolysis was observed and Gram staining was performed. Isolates were tested for catalase production, growth in heart infusion broth supplemented with 6.5% NaCl, and growth at 45°C. In addition, the hydrolysis of L-pyrrolidonyl-β-naphthylamide and pigmentation, and cell motility were evaluated, using the API 20 STREP system (bioMérieux). When required, further identification was undertaken based on D-xylose and sucrose fermentation tests[5]. All isolates were stored at -80°C until used for testing.

(3) *Campylobacter*

Species of *Campylobacter* were isolated on *Campylobacter* blood-free selective agar (mCCDA; Oxoid, UK) using the direct inoculation method. Isolates were identified biochemically and molecularly using PCR[6]. Two isolates per sample were then selected for antimicrobial susceptibility testing and suspended in 15% glycerin, to which buffered peptone water (Oxoid) had been added, and subsequently stored at -80°C until used for testing.

(4) *Salmonella*

Salmonella isolates from farms were provided by the Livestock Hygiene Service Centers from diagnostic submissions of clinical cases, whereas samples from slaughterhouses were obtained from cecum-derived fecal samples collected from healthy broilers. The fecal samples were cultured using an enrichment procedure with buffered peptone water (Oxoid). Tubes containing the samples were incubated at 37°C for 18–24 h, followed by subsequent passaging into Rappaport–Vassiliadis broth and incubation at 42°C for a further 18–24 h. Thereafter, cultures were then passaged onto CHROMagar™ *Salmonella* plates and incubated at 37°C for 18–24 h, following which they were presumptively identified as *Salmonella* based on colony morphology.

After biochemical identification, the serotype of the isolates was determined using slide and tube agglutination tests, according to the latest versions of the Kauffmann–White scheme[7)]. All isolates were stored at -80°C until used for testing.

8.3 Antimicrobial Susceptibility Testing

The MICs of *E. coli*, *Enterococcus*, *Campylobacter*, and *Salmonella* isolates were determined using the broth microdilution method according to CLSI guidelines. *Staphylococcus aureus* ATCC 29213 and *E. coli* ATCC 25922 were used as quality control strains, whereas *C. jejuni* ATCC 33560 was used for the quality control of MIC measurements in *Campylobacter* species.

8.4 Resistance Breakpoints

Resistance breakpoints were defined microbiologically in serial studies. For cases in which MICs for the isolates were bimodally distributed, values intermediate between the two peaks were defined as the breakpoints.

The MIC of each antimicrobial established by CLSI was interpreted using CLSI criteria. The breakpoints of other antimicrobial agents were determined microbiologically.

9. References

1) Swann, M.M. 1969. Report of the joint committee on the use of antibiotics in animal husbandry and veterinary medicine. HM Stationary Office. London.

2) Tamura, Y. 2003. The Japanese veterinary antimicrobial resistance monitoring system (JVARM) In: Bernard, V. (ed.). OIE International Standards on Antimicrobial Resistance. Paris, France: OIE (World Organization for Animal Health); 2003: 206–210.

3) World Health Organization. 2015. Global action plan on antimicrobial resistance, Geneva, Switzerland.

4) Clinical and Laboratory Standards Institute. 2017. Performance standards for antimicrobial susceptibility testing; twenty-fourth information supplement. CLSI document M100-S27. Clinical and Laboratory Standards Institute, Wayne, PA.

5) Teixeira, L.M., Carvalho, M.G.S., Facklam, R.R. 2007. *Enterococcus*. In: Murray, P.R., Baron, E.J., Jorgensen, J.H., Landry, M.L., Pfaller M.A. (eds.), Manual of Clinical Microbiology, 9th edn. 430–442. American Society for Microbiology, Washington, DC.

6) Liton, D., Lawson, A.J., Owen, R.J., Stanley, J. 1997. PCR detection, identification to species level, and fingerprinting of *Campylobacter jejuni* and *Campylobacter coli* direct from diarrheic samples. *J. Clin. Microbiol.* 35:2568–2572.

7) Grimont, P.A.D, Weill, F.X. 2007. Antigenic formulae of the *Salmonella* serovars, 9th ed. World Health Organization Collaborating Center for Reference and Research on *Salmonella,* Pasteur Institute, Paris, France.

Table 12.1.1. Distribution of MICs and resistance (%) in *Escherichia coli* from cattle (n=189), pigs (n=83) and broilers (n=155) in 2018_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	4	128	11.6						3	24	116	23	1	2	0	2	18	
	Pigs	8	>128	34.9						1	12	23	17	1	0	0	0	29	
	Broilers	4	>128	36.1						1	22	56	20	0	0	2	1	53	
Cefazolin	Cattle	1	2	0.5						141	43	4	0	0	0	0	1	0	
	Pigs	1	4	2.4						42	27	12	1	0	0	0	1	0	
	Broilers	2	4	7.7						77	48	18	4	3	0	0	0	5	
Cefotaxime	Cattle	≦0.12	≦0.12	0.0			187	0	1	1	0	0	0	0	0				
	Pigs	≦0.12	≦0.12	0.0			78	1	1	1	2	0	0	0	0				
	Broilers	≦0.12	≦0.12	3.2			145	2	1	1	1	0	1	1	3				
Meropenem	Cattle	≦0.12	≦0.12	0.0			189	0	0	0	0	0	0	0					
	Pigs	≦0.12	≦0.12	0.0			83	0	0	0	0	0	0	0					
	Broilers	≦0.12	≦0.12	0.0			154	1	0	0	0	0	0	0					
Streptomycin	Cattle	8	128	18.5								45	100	9	7	7	12	9	
	Pigs	16	>128	49.4								6	29	7	1	9	7	24	
	Broilers	16	>128	48.4								16	46	18	10	11	14	40	
Gentamicin	Cattle	1	1	0.0						175	14	0	0	0	0	0	0		
	Pigs	1	2	3.6						68	8	4	0	0	2	0	1		
	Broilers	1	2	5.2						136	9	1	1	2	3	1	2		
Kanamycin	Cattle	4	8	0.0							81	84	23	1	0	0	0	0	
	Pigs	4	16	8.4							17	37	14	7	1	0	0	7	
	Broilers	8	>128	43.9							22	49	15	1	0	0	1	67	
Tetracycline	Cattle	4	64	26.5						25	34	76	4	0	8	33	9		
	Pigs	32	>64	55.4						4	9	20	4	0	5	21	20		
	Broilers	8	>64	49.0						9	40	27	3	0	5	51	20		
Chloramphenicol	Cattle	8	8	4.8							0	44	129	7	2	3	3	1	
	Pigs	8	>128	25.3							1	12	41	8	2	3	1	15	
	Broilers	8	128	17.4							0	20	105	3	1	2	19	5	
Colistin	Cattle	≦0.25	0.5	0.0				161	26	2	0	0	0	0	0				
	Pigs	≦0.25	0.5	6.0				62	13	3	0	4	1	0	0				
	Broilers	≦0.25	0.5	0.0				116	36	2	1	0	0	0	0				
Nalidixic acid	Cattle	4	8	2.1						2	71	94	13	5	0	0	0	4	
	Pigs	4	32	12.0						0	25	38	5	5	4	0	0	6	
	Broilers	4	>128	40.6						0	31	55	4	2	0	1	10	52	
Ciprofloxacin	Cattle	≦0.03	≦0.03	0.5	171	10	2	1	4	0	0	0	0						
	Pigs	≦0.03	0.25	1.2	61	5	3	8	5	0	0	1	0						
	Broilers	≦0.03	4	12.3	86	2	7	22	10	6	3	7	12						

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	Distribution of MICs							
					2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole /Trimethoprim	Cattle	≦2.38/0.12	19/1	5.3	128	20	22	5	4	0	0	10
	Pigs	9.5/0.5	>152/8	32.5	20	14	10	9	3	1	0	26
	Broilers	4.75/0.25	>152/8	33.5	68	16	15	4	0	0	0	52

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.1.2. Distribution of MICs and resistance (%) in *Escherichia coli* from cattle (n=288), pigs (n=80) and broilers (n=128) in 2019_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	4	8	6.2						16	38	168	48	0	1	0	0	17	
	Pigs	4	>128	32.5						0	15	35	4	0	0	0	0	26	
	Broilers	4	>128	36.7						1	21	43	16	0	1	0	1	45	
Cefazolin	Cattle	≦1	2	1.0						221	61	3	1	0	0	0	1	1	
	Pigs	≦1	4	3.8						44	26	7	1	0	0	0	0	2	
	Broilers	2	4	4.7						56	53	13	1	0	1	0	0	4	
Cefotaxime	Cattle	≦0.12	≦0.12	0.7			282	0	4	0	0	0	1	1	0				
	Pigs	≦0.12	≦0.12	2.5			76	0	2	0	0	0	0	1	1				
	Broilers	≦0.12	≦0.12	3.1			121	3	0	0	0	1	2	1	0				
Meropenem	Cattle	≦0.12	≦0.12	0.0			288	0	0	0	0	0	0	0					
	Pigs	≦0.12	≦0.12	0.0			80	0	0	0	0	0	0	0					
	Broilers	≦0.12	≦0.12	0.0			128	0	0	0	0	0	0	0					
Streptomycin	Cattle	8	128	19.8								142	83	6	12	15	18	12	
	Pigs	8	>128	41.3								20	23	4	5	6	9	13	
	Broilers	16	>128	40.6								36	25	15	6	7	11	28	
Gentamicin	Cattle	≦1	≦1	0.0						288	0	0	0	0	0	0	0		
	Pigs	≦1	2	2.5						71	6	0	1	0	0	2	0		
	Broilers	≦1	≦1	6.2						116	3	1	0	3	4	1	0		
Kanamycin	Cattle	≦2	4	0.7							200	80	6	0	0	0	0	2	
	Pigs	4	16	10.0							37	27	7	1	0	0	0	8	
	Broilers	4	>128	37.5							53	23	3	1	0	0	0	48	
Tetracycline	Cattle	≦2	64	22.9						50	111	55	6	4	7	33	22		
	Pigs	4	128	47.5						6	23	12	1	0	0	19	19		
	Broilers	64	128	62.5						14	18	16	0	0	6	50	24		
Chloramphenicol	Cattle	8	8	4.2							0	73	193	10	3	0	7	2	
	Pigs	8	>128	22.5							0	13	48	1	2	5	1	10	
	Broilers	8	128	15.6							1	33	67	7	2	3	10	5	
Colistin	Cattle	≦0.25	≦0.25	0.3				274	10	3	0	1	0	0	0				
	Pigs	≦0.25	0.5	2.5				68	8	1	1	2	0	0	0				
	Broilers	≦0.25	0.5	0.0				107	21	0	0	0	0	0	0				
Nalidixic acid	Cattle	4	4	1.4						5	75	190	14	0	0	0	1	3	
	Pigs	4	128	11.2						2	15	46	5	3	0	0	2	7	
	Broilers	4	>128	36.7						1	34	35	4	7	2	1	6	38	
Ciprofloxacin	Cattle	≦0.03	≦0.03	0.3	278	1	3	3	2	0	0	0	1						
	Pigs	≦0.03	0.25	2.5	64	1	2	5	5	0	1	0	2						
	Broilers	≦0.03	4	12.5	72	0	8	17	10	3	2	6	10						

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	Distribution(%) of MICs							
					2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole /Trimethoprim	Cattle	≦2.38/0.12	4.75/0.25	2.8	228	42	9	1	0	0	0	8
	Pigs	≦2.38/0.12	>152/8	23.8	40	12	4	5	0	0	1	18
	Broilers	4.75/0.25	>152/8	30.5	63	15	6	4	1	0	3	36

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.2.1. Distribution of MICs and resistance (%) in *Enterococcus faecalis* from cattle (n=15), pigs (n=29) and broilers (n=106) in 2018_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution													
					0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	1	1	0.0	0	0	0	1	13	1	0	0	0	0	0	0		
	Pigs	1	1	0.0	0	0	0	2	26	1	0	0	0	0	0	0		
	Broilers	1	1	0.0	0	0	0	0	105	1	0	0	0	0	0	0		
Streptomycin	Cattle	128	256	-		0	0	0	0	0	0	0	0	1	0	11	2	1
	Pigs	128	>256	-		0	0	0	0	0	0	0	0	1	1	20	1	6
	Broilers	256	>256	-		0	0	0	0	0	0	0	0	1	3	46	9	47
Gentamicin	Cattle	16	32	40.0	0	0	0	0	0	0	1	0	8	6	0	0	0	
	Pigs	16	>128	31.0	0	0	0	0	0	1	0	2	17	5	0	1	3	
	Broilers	16	32	15.1	0	0	0	0	0	0	1	16	73	10	0	0	6	
Kanamycin	Cattle	64	128	46.7		0	0	0	0	0	0	0	1	0	7	7	0	0
	Pigs	128	>256	51.7		0	0	0	0	0	0	0	1	0	13	10	0	5
	Broilers	>256	>256	66.0		0	0	0	0	0	1	0	0	2	33	12	0	58
Erythromycin	Cattle	2	4	0.0	0	2	1	2	2	5	3	0	0	0	0	0		
	Pigs	2	>64	44.8	0	1	3	1	4	6	1	0	0	0	0	13		
	Broilers	2	>64	43.4	0	4	6	6	14	24	6	1	6	3	0	36		
Tylosin	Cattle	2	4	0.0	0	0	0	0	0	8	7	0	0	0	0	0		
	Pigs	4	>64	44.8	0	0	0	0	1	11	4	0	0	0	0	13		
	Broilers	2	>64	43.4	0	0	0	0	0	53	7	0	0	0	0	46		
Azithromycin	Cattle	4	8	-		0	0	3	1	2	3	6	0	0	0			
	Pigs	8	>32	-		0	0	4	1	2	4	5	0	0	13			
	Broilers	8	>32	-		0	0	6	9	9	12	23	1	0	46			
Lincomycin	Cattle	32	64	0.0		0	0	0	0	0	0	0	0	13	2	0	0	0
	Pigs	128	>256	51.7		0	0	0	0	0	0	1	0	13	0	1	1	13
	Broilers	32	>256	43.4		0	0	0	4	0	0	0	3	50	3	0	4	42
Tetracycline	Cattle	0.5	>32	26.7	0	0	0	8	3	0	0	0	0	1	3			
	Pigs	>32	>32	65.5	0	0	0	7	3	0	0	0	0	0	19			
	Broilers	>32	>32	70.8	0	0	0	13	16	2	0	0	1	20	54			
Chloramphenicol	Cattle	8	8	6.7		0	0	0	0	0	0	14	0	1	0	0	0	0
	Pigs	8	128	27.6		0	0	0	0	0	0	19	2	1	0	7	0	0
	Broilers	8	64	11.3		0	0	0	0	0	1	79	14	0	3	9	0	0
Bacitracin	Cattle	256	256	-		0	0	0	0	0	0	0	0	0	1	4	10	0
	Pigs	256	256	-		0	0	0	0	0	0	0	0	0	2	10	15	2
	Broilers	128	>256	-		0	0	0	0	0	0	0	1	1	9	46	31	18
Vancomycin	Cattle	1	2	0.0	0	0	0	1	12	2	0	0	0	0	0	0		
	Pigs	1	2	0.0	0	0	0	2	18	9	0	0	0	0	0	0		
	Broilers	1	2	0.0	0	0	0	3	74	29	0	0	0	0	0	0		
Nalidixic acid	Cattle	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	15	
	Pigs	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	29	
	Broilers	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	106	
Ciprofloxacin	Cattle	1	2	0.0	0	0	0	2	6	7	0	0	0	0	0	0		
	Pigs	1	2	3.4	0	0	0	3	17	8	1	0	0	0	0	0		
	Broilers	1	2	2.8	0	0	0	13	77	13	1	2	0	0	0	0		
Salinomycin	Cattle	1	1	-	0	0	0	0	14	1	0	0	0	0				
	Pigs	1	1	-	0	0	0	0	28	1	0	0	0	0				
	Broilers	1	8	-	0	0	0	1	57	2	17	29	0	0				

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.2.2. Distribution of MICs and resistance (%) in *Enterococcus faecalis* from cattle (n=4), pigs (n=14) and broilers (n=60) in 2019_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution													
					0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	1	1	0.0	0	0	0	0	4	0	0	0	0	0	0	0		
	Pigs	1	1	0.0	0	0	0	3	11	0	0	0	0	0	0	0		
	Broilers	1	1	0.0	0	0	0	1	58	1	0	0	0	0	0	0		
Streptomycin	Cattle	64	128	-		0	0	0	0	0	0	0	0	0	3	1	0	0
	Pigs	128	>256	-		0	0	0	0	0	0	0	0	0	3	6	1	4
	Broilers	128	>256	-		0	0	0	0	0	0	0	0	1	4	34	1	20
Gentamicin	Cattle	8	16	0.0	0	0	0	0	0	0	1	1	2	0	0	0	0	
	Pigs	16	>128	35.7	0	0	0	0	0	0	1	4	4	3	0	0	2	
	Broilers	16	32	15.0	0	0	0	0	0	1	0	19	31	6	0	0	3	
Kanamycin	Cattle	32	64	0.0		0	0	0	0	0	0	0	0	2	2	0	0	0
	Pigs	64	>256	42.9		0	0	0	0	0	0	0	0	2	6	0	0	6
	Broilers	128	>256	51.7		0	0	0	0	0	0	0	1	3	25	6	0	25
Erythromycin	Cattle	2	>64	25.0	0	0	0	0	1	1	1	0	0	0	0	1		
	Pigs	2	>64	50.0	0	1	0	3	1	2	0	0	0	0	0	7		
	Broilers	16	>64	53.3	1	1	4	5	5	9	3	1	4	1	0	26		
Tylosin	Cattle	2	>64	25.0	0	0	0	0	1	1	1	0	0	0	0	1		
	Pigs	4	>64	50.0	0	0	0	0	1	4	2	0	0	0	0	7		
	Broilers	>64	>64	55.0	0	0	0	0	0	19	8	0	0	0	1	32		
Azithromycin	Cattle	4	>32	-		0	0	0	0	1	1	1	0	0	1			
	Pigs	8	>32	-		0	0	1	1	2	1	2	0	0	7			
	Broilers	>32	>32	-		1	0	2	7	4	4	9	1	0	32			
Lincomycin	Cattle	32	>256	25.0		0	0	0	0	0	0	0	1	2	0	0	0	1
	Pigs	32	>256	50.0		0	0	0	0	0	0	2	0	5	0	1	0	6
	Broilers	256	>256	55.0		0	0	0	0	0	0	0	2	24	1	0	3	30
Tetracycline	Cattle	1	>32	25.0	0	0	1	1	1	0	0	0	0	0	1			
	Pigs	>32	>32	57.1	0	0	1	5	0	0	0	0	0	0	8			
	Broilers	>32	>32	66.7	0	0	1	15	4	0	0	0	1	6	33			
Chloramphenicol	Cattle	8	128	25.0		0	0	0	0	0	1	2	0	0	0	1	0	0
	Pigs	8	128	35.7		0	0	0	0	0	5	4	0	0	0	5	0	0
	Broilers	8	128	20.0		0	0	0	0	0	1	42	5	0	4	8	0	0
Bacitracin	Cattle	128	128	-		0	0	0	0	0	0	0	0	0	0	4	0	0
	Pigs	128	>256	-		0	0	0	0	0	0	0	0	0	2	5	5	2
	Broilers	128	>256	-		0	0	0	0	0	0	0	0	0	3	31	13	13
Vancomycin	Cattle	1	2	0.0	0	0	0	1	2	1	0	0	0	0	0	0		
	Pigs	1	2	0.0	0	0	0	1	11	2	0	0	0	0	0	0		
	Broilers	1	2	0.0	0	0	1	6	36	17	0	0	0	0	0	0		
Nalidixic acid	Cattle	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	4	
	Pigs	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	14	
	Broilers	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	60	
Ciprofloxacin	Cattle	1	2	0.0	0	0	1	0	2	1	0	0	0	0	0	0		
	Pigs	1	2	7.1	0	0	0	0	11	2	0	0	0	1	0	0		
	Broilers	1	2	3.3	0	0	0	9	43	6	0	1	0	1	0	0		
Salinomycin	Cattle	1	1	-	0	0	0	1	3	0	0	0	0	0				
	Pigs	1	1	-	0	0	0	0	14	0	0	0	0	0				
	Broilers	2	8	-	0	0	0	3	26	3	14	14	0	0				

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.3.1. Distribution of MICs and resistance (%) in *Enterococcus faecium* from pigs (n=2) and broilers (n=10) in 2018_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution													
					0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Pigs	2	8	0.0	0	0	0	0	0	1	0	1	0	0	0	0		
	Broilers	2	2	0.0	0	0	0	1	2	6	0	1	0	0	0	0		
Streptomycin	Pigs	64	128	-		0	0	0	0	0	0	0	0	0	1	1	0	0
	Broilers	64	64	-		0	0	0	0	0	0	0	0	2	7	0	0	1
Gentamicin	Pigs	8	32	50.0	0	0	0	0	0	0	0	1	0	1	0	0	0	
	Broilers	8	8	0.0	0	0	0	0	0	0	3	7	0	0	0	0	0	
Kanamycin	Pigs	128	256	100.0		0	0	0	0	0	0	0	0	0	0	1	1	0
	Broilers	128	256	90.0		0	0	0	0	0	0	0	0	0	1	4	4	1
Erythromycin	Pigs	4	4	0.0	0	0	0	0	0	0	2	0	0	0	0	0		
	Broilers	2	>64	40.0	0	2	0	1	1	2	0	0	0	2	0	2		
Tylosin	Pigs	4	8	0.0	0	0	0	0	0	0	1	1	0	0	0	0		
	Broilers	2	>64	20.0	0	0	0	0	2	3	2	1	0	0	0	2		
Azithromycin	Pigs	8	8	-		0	0	0	0	0	0	2	0	0	0			
	Broilers	4	>32	-		0	2	1	0	1	2	0	0	1	3			
Lincomycin	Pigs	16	32	0.0		0	0	0	0	0	0	0	1	1	0	0	0	0
	Broilers	2	>256	20.0		0	0	1	3	2	0	0	1	1	0	0	0	2
Tetracycline	Pigs	0.5	>32	50.0	0	0	0	1	0	0	0	0	0	0	1			
	Broilers	>32	>32	60.0	0	0	2	2	0	0	0	0	0	0	6			
Chloramphenicol	Pigs	8	8	0.0		0	0	0	0	0	0	2	0	0	0	0	0	0
	Broilers	8	16	10.0		0	0	0	0	0	2	5	2	1	0	0	0	0
Bacitracin	Pigs	>256	>256	-		0	0	0	0	0	0	0	0	0	0	0	0	2
	Broilers	256	>256	-		0	0	0	0	0	0	0	2	0	0	1	3	4
Vancomycin	Pigs	0.5	0.5	0.0	0	0	0	2	0	0	0	0	0	0	0	0		
	Broilers	0.5	1	0.0	0	0	0	8	2	0	0	0	0	0	0	0		
Nalidixic acid	Pigs	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	2	
	Broilers	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	10	
Ciprofloxacin	Pigs	1	2	0.0	0	0	0	0	1	1	0	0	0	0	0	0		
	Broilers	2	4	20.0	0	0	0	0	4	4	1	1	0	0	0	0		
Salinomycin	Pigs	1	1	-	0	0	0	0	2	0	0	0	0	0				
	Broilers	2	4	-	0	0	0	0	2	3	5	0	0	0				

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.3.2. Distribution of MICs and resistance (%) in *Enterococcus faecium* from cattle (n=1) and broilers (n=7) in 2019_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution													
					0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	0.5	0.5	0.0	0	0	0	1	0	0	0	0	0	0	0	0		
	Broilers	4	8	0.0	0	0	0	1	2	0	1	3	0	0	0	0		
Streptomycin	Cattle	16	16	-		0	0	0	0	0	0	0	1	0	0	0	0	0
	Broilers	64	64	-		0	0	0	0	0	0	0	0	1	6	0	0	0
Gentamicin	Cattle	2	2	0.0	0	0	0	0	0	1	0	0	0	0	0	0	0	
	Broilers	8	16	0.0	0	0	0	0	0	0	2	2	3	0	0	0	0	
Kanamycin	Cattle	32	32	0.0		0	0	0	0	0	0	0	0	1	0	0	0	0
	Broilers	256	>256	85.7		0	0	0	0	0	0	0	0	0	1	2	3	1
Erythromycin	Cattle	2	2	0.0	0	0	0	0	0	1	0	0	0	0	0	0		
	Broilers	1	>64	28.6	0	3	0	0	1	0	1	0	0	0	0	2		
Tylosin	Cattle	2	2	0.0	0	0	0	0	0	1	0	0	0	0	0	0		
	Broilers	4	>64	28.6	0	0	0	0	1	0	4	0	0	0	0	2		
Azithromycin	Cattle	2	2	-		0	0	0	0	1	0	0	0	0	0			
	Broilers	2	>32	-		0	3	0	0	1	0	1	0	0	2			
Lincomycin	Cattle	8	8	0.0		0	0	0	0	0	0	1	0	0	0	0	0	0
	Broilers	32	>256	28.6		0	0	0	0	0	0	0	1	3	1	0	0	2
Tetracycline	Cattle	0.5	0.5	0.0	0	0	0	1	0	0	0	0	0	0	0			
	Broilers	>32	>32	57.1	0	0	3	0	0	0	0	0	0	0	4			
Chloramphenicol	Cattle	4	4	0.0		0	0	0	0	0	1	0	0	0	0	0	0	0
	Broilers	8	32	28.6		0	0	0	0	0	3	1	1	2	0	0	0	0
Bacitracin	Cattle	>256	>256	-		0	0	0	0	0	0	0	0	0	0	0	0	1
	Broilers	256	>256	-		0	0	0	0	0	0	0	1	0	0	0	5	1
Vancomycin	Cattle	4	4	0.0	0	0	0	0	0	0	1	0	0	0	0	0		
	Broilers	0.5	1	0.0	0	0	0	5	2	0	0	0	0	0	0	0		
Nalidixic acid	Cattle	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	1	
	Broilers	>128	>128	-	0	0	0	0	0	0	0	0	0	0	0	0	7	
Ciprofloxacin	Cattle	1	1	0.0	0	0	0	0	1	0	0	0	0	0	0	0		
	Broilers	2	8	42.9	0	0	0	1	0	3	1	2	0	0	0	0		
Salinomycin	Cattle	1	1	-	0	0	0	0	1	0	0	0	0	0				
	Broilers	4	8	-	0	0	0	0	0	2	3	2	0	0				

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.4.1. Distribution of MICs and resistance (%) in *Campylobacter jejuni* from cattle (n=35) and broilers (n=47) in 2018_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	4	16	8.6				0	1	5	5	12	8	1	1	1	0	1	
	Broilers	4	64	14.9				0	2	2	4	22	6	4	2	5	0	0	
Gentamicin	Cattle	0.5	2	0.0			1	2	16	12	2	1	1	0	0	0			
	Broilers	0.5	1	0.0			0	3	35	7	2	0	0	0	0	0			
Streptomycin	Cattle	1	2	8.6			0	0	5	19	8	0	0	0	1	1	0	1	
	Broilers	1	1	0.0			0	0	4	39	3	1	0	0	0	0	0	0	
Azithromycin	Cattle	0.12	0.25	5.7	5	12	13	2	0	0	1	0	0	0	0	0	2		
	Broilers	0.06	0.25	0.0	7	25	9	4	0	2	0	0	0	0	0	0	0		
Erythromycin	Cattle	0.5	2	5.7		0	0	12	14	4	2	1	0	0	0	0	2		
	Broilers	0.5	1	0.0		0	2	13	22	6	3	0	0	1	0	0	0		
Tetracycline	Cattle	64	128	65.7		3	9	0	0	0	0	0	0	0	5	5	13		
	Broilers	0.12	64	23.4		11	13	8	4	0	0	0	0	0	3	4	4		
Nalidixic acid	Cattle	4	256	31.4					0	0	11	9	2	2	0	2	3	6	
	Broilers	4	256	31.9					0	0	11	13	7	1	0	4	5	6	
Ciprofloxacin	Cattle	0.12	16	31.4	0	1	18	3	2	0	0	0	3	7	1	0	0		
	Broilers	0.25	16	29.8	0	1	21	3	7	1	0	0	9	2	1	1	1		
Chloramphenicol	Cattle	1	2	2.9				0	0	21	11	1	1	1	0	0	0	0	
	Broilers	2	4	2.1				0	2	19	18	6	1	1	0	0	0	0	

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.4.2. Distribution of MICs and resistance (%) in *Campylobacter jejuni* from cattle (n=114) and broilers (n=35) in 2019_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	4	32	11.4				0	3	9	18	56	14	1	6	7	0	0	
	Broilers	4	32	14.3				0	0	6	4	12	6	2	3	0	0	2	
Gentamicin	Cattle	1	1	0.0			0	2	19	88	5	0	0	0	0	0			
	Broilers	1	1	0.0			0	1	12	21	1	0	0	0	0	0			
Streptomycin	Cattle	2	4	1.8			0	0	0	21	74	17	0	0	0	1	0	1	
	Broilers	1	2	0.0			0	0	1	20	13	1	0	0	0	0	0	0	
Azithromycin	Cattle	0.06	0.12	0.0	4	67	35	8	0	0	0	0	0	0	0	0	0		
	Broilers	0.06	0.12	0.0	8	22	5	0	0	0	0	0	0	0	0	0	0		
Erythromycin	Cattle	0.5	1	0.0		0	1	28	63	17	2	2	1	0	0	0	0		
	Broilers	0.25	0.5	0.0		0	3	16	14	2	0	0	0	0	0	0	0		
Tetracycline	Cattle	64	128	67.5		15	18	4	0	0	0	0	0	3	4	28	42		
	Broilers	0.12	64	34.3		11	10	2	0	0	0	0	0	0	4	7	1		
Nalidixic acid	Cattle	128	256	60.5					0	0	24	18	3	0	0	8	33	28	
	Broilers	4	128	37.1					0	0	11	10	1	0	0	3	9	1	
Ciprofloxacin	Cattle	8	16	59.6	1	2	34	9	0	0	0	2	30	30	6	0	0		
	Broilers	0.25	16	34.3	0	0	17	4	1	0	1	0	5	6	1	0	0		
Chloramphenicol	Cattle	1	2	6.1				1	7	74	25	0	0	4	3	0	0	0	
	Broilers	1	2	0.0				0	2	27	6	0	0	0	0	0	0	0	

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.5.1. Distribution of MICs and resistance (%) in *Campylobacter coli* from Pigs (n=29)in 2018_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Pigs	8	64	17.2				0	0	1	0	6	14	3	0	3	1	1	
Gentamicin	Pigs	2	2	0.0			0	0	0	9	18	2	0	0	0	0			
Streptomycin	Pigs	128	256	69.0			0	0	0	0	1	3	5	0	0	2	4	14	
Azithromycin	Pigs	0.25	128	20.7	0	0	5	11	6	1	0	0	0	0	0	1	5		
Erythromycin	Pigs	2	128	20.7		0	0	0	1	7	8	7	0	0	0	0	6		
Tetracycline	Pigs	128	128	86.2		0	1	1	0	1	0	0	1	0	4	4	17		
Nalidixic acid	Pigs	128	256	58.6					0	0	0	4	6	2	0	0	9	8	
Ciprofloxacin	Pigs	16	32	58.6	0	0	2	7	2	1	0	0	2	6	7	2	0		
Chloramphenicol	Pigs	2	8	3.4				0	0	0	15	11	2	0	1	0	0	0	

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.5.2. Distribution of MICs and resistance (%) in *Campylobacter coli* from Pigs (n=60) in 2019_Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Pigs	8	64	26.7				0	0	3	13	10	16	2	1	9	6	0	
Gentamicin	Pigs	2	2	0.0			0	0	0	13	47	0	0	0	0	0			
Streptomycin	Pigs	128	256	68.3			0	0	0	0	2	5	11	1	0	1	17	23	
Azithromycin	Pigs	0.25	128	31.7	0	1	22	14	3	1	0	0	0	0	0	1	18		
Erythromycin	Pigs	1	128	33.3		0	0	0	6	26	5	3	0	0	0	2	18		
Tetracycline	Pigs	64	128	78.3		1	6	4	2	0	0	0	0	1	13	16	17		
Nalidixic acid	Pigs	8	128	45.0					0	0	0	15	15	3	3	6	12	6	
Ciprofloxacin	Pigs	0.5	32	40.0	2	0	8	16	10	0	0	0	5	10	7	2	0		
Chloramphenicol	Pigs	2	4	3.3				1	1	12	39	5	0	0	2	0	0	0	

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.6.1. MIC distributions and resistance (%) for *Salmonella* spp. from healthy chickien or broilers (n=117), in 2018 - Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Chicken	≦1	4	6.8						77	26	6	0	0	0	0	1	7	
Cefazolin	Chicken	2	2	3.4						38	70	5	0	2	0	0	0	2	
Cefotaxime	Chicken	≦0.12	0.25	2.6			105	4	3	0	2	2	0	1	0				
Meropenem	Chicken	≦0.12	≦0.12	0.0			117	0	0	0	0	0	0	0					
Streptomycin	Chicken	32	64	73.3								4	15	12	54	26	5	0	
Gentamicin	Chicken	≦1	≦1	0.0						116	1	0	0	0	0	0	0		
Kanamycin	Chicken	>128	>128	68.4							30	4	0	3	0	1	0	79	
Tetracycline	Chicken	64	64	76.9						8	19	0	0	1	1	82	6		
Chloramphenicol	Chicken	4	8	1.7							6	66	41	2	0	0	0	2	
Colistin	Chicken	0.5	1	0.9				8	57	44	7	1	0	0	0				
Nalidixic acid	Chicken	4	>128	18.8						0	6	83	6	0	4	0	0	18	
Ciprofloxacin	Chicken	≦0.03	0.25	0.0	91	4	5	14	2	1	0	0	0						

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions							
					2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Chicken	>152/8	>152/8	53.0	30	19	4	2	0	0	0	62

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.6.2. MIC distributions and resistance (%) for *Salmonella* spp. from healthy chickien or broilers (n=107), in 2019 - Slaughterhouse

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Chicken	≦1	2	5.6						85	14	2	0	0	0	1	0	5	
Cefazolin	Chicken	2	2	3.7						19	82	2	1	1	0	0	0	2	
Cefotaxime	Chicken	≦0.12	≦0.12	1.9			103	2	0	0	0	1	1	0	0				
Meropenem	Chicken	≦0.12	≦0.12	0.0			107	0	0	0	0	0	0	0					
Streptomycin	Chicken	16	32	33.6								20	13	38	27	8	1	0	
Gentamicin	Chicken	≦1	≦1	0.0						105	2	0	0	0	0	0	0		
Kanamycin	Chicken	>128	>128	75.7							24	0	0	2	0	0	0	81	
Tetracycline	Chicken	64	64	69.2						12	21	0	0	0	9	63	2		
Chloramphenicol	Chicken	4	8	0.9							19	76	10	1	0	0	1	0	
Colistin	Chicken	2	2	1.9				14	16	18	57	2	0	0	0				
Nalidixic acid	Chicken	4	8	8.4						1	3	90	4	0	4	0	1	4	
Ciprofloxacin	Chicken	≦0.03	≦0.03	0.9	98	0	1	3	4	1	0	0	0						

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions							
					≦2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Chicken	>152/8	>152/8	52.3	34	13	1	3	0	0	0	56

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.7.1. MIC distributions and resistance (%) for *Salmonella* spp. from diseased cattle (n=80), pigs (n=64), chickien (n=22), in 2018 - Farm

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	4	>128	36.8						6	18	12	0	0	0	0	0	21	
	Pigs	16	>128	50.0						10	15	5	1	1	0	0	0	32	
	Chicken	2	4	4.5						6	13	2	0	0	0	0	0	1	
Cefazolin	Cattle	2	4	1.8						23	20	12	1	1	0	0	0	0	
	Pigs	2	4	9.4						16	23	19	5	1	0	0	0	0	
	Chicken	2	4	0.0						5	13	4	0	0	0	0	0	0	
Cefotaxime	Cattle	≦0.12	0.25	0.0			32	25	0	0	0	0	0	0	0				
	Pigs	≦0.12	0.25	0.0			35	25	4	0	0	0	0	0	0				
	Chicken	≦0.12	≦0.12	0.0			20	2	0	0	0	0	0	0	0				
Meropenem	Cattle	-	-	-			-	-	-	-	-	-	-	-					
	Pigs	−	−	-			-	-	-	-	-	-	-	-					
	Chicken	-	-	-			-	-	-	-	-	-	-	-					
Streptomycin	Cattle	16	>128	42.1							1	2	6	24	2	2	1	19	
	Pigs	32	>128	60.9							0	1	5	19	7	5	2	25	
	Chicken	32	32	68.2							0	1	3	3	13	2	0	0	
Gentamicin	Cattle	≦0.5	≦0.5	1.8					53	3	0	0	0	0	0	0	1		
	Pigs	≦0.5	1	4.7					57	4	0	0	0	0	0	1	2		
	Chicken	≦0.5	≦0.5	0.0					22	0	0	0	0	0	0	0	0		
Kanamycin	Cattle	2	4	0.0						6	38	10	2	1	0	0	0	0	
	Pigs	2	8	4.7						1	39	17	2	2	0	0	0	3	
	Chicken	>128	>128	63.6						1	7	0	0	0	0	0	0	14	
Tetracycline	Cattle	2	>64	33.3					1	16	20	1	0	0	0	0	19		
	Pigs	8	>64	50.0					0	8	21	1	2	1	1	4	26		
	Chicken	64	64	77.3					0	2	3	0	0	0	2	15	0		
Chloramphenicol	Cattle	8	8	3.5							0	5	50	0	1	0	1	0	
	Pigs	8	>128	21.9							0	6	34	10	2	0	4	8	
	Chicken	8	8	0.0							1	8	11	2	0	0	0	0	
Colistin	Cattle	0.25	1	0.0			0	44	13	0	0	0	0	0	0				
	Pigs	0.25	1	4.7			5	48	8	0	0	3	0	0	0				
	Chicken	0.5	>16	18.2			0	6	6	6	0	1	0	0	3				
Nalidixic acid	Cattle	8	8	1.8						0	1	27	28	0	0	0	0	1	
	Pigs	8	>128	20.3						0	0	19	29	3	0	0	0	13	
	Chicken	4	8	0.0						0	0	17	5	0	0	0	0	0	
Ciprofloxacin	Cattle	≦0.03	≦0.03	0.0	56	0	0	0	0	1	0	0	0						
	Pigs	≦0.03	0.25	0.0	48	3	1	7	2	3	0	0	0						
	Chicken	≦0.03	0.06	0.0	17	5	0	0	0	0	0	0	0						

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions							
					≦2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Cattle	4.75/0.25	4.75/0.25	2.7	28	25	2	1	0	0	0	1
	Pigs	4.75/0.25	>152/8	12.5	29	17	9	1	0	0	0	8
	Chicken	>152/8	>152/8	59.1	5	3	1	0	0	0	0	13

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.7.2. MIC distributions and resistance (%) for *Salmonella* spp. from disease cattle (n=57), pigs (n=69) and chickien (n=16), in 2019 - Farm

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Cattle	>128	>128	61.4						8	9	5	0	0	1	0	0	34	
	Pigs	4	>128	44.9						12	22	1	2	1	0	1	0	30	
	Chicken	2	>128	25.0						6	6	0	0	0	0	0	0	4	
Cefazolin	Cattle	2	8	5.3						10	19	16	9	0	1	0	0	2	
	Pigs	2	8	17.4						16	25	16	8	4	0	0	0	0	
	Chicken	2	4	0.0						4	9	3	0	0	0	0	0	0	
Cefotaxime	Cattle	≦0.12	0.25	1.8			45	10	0	1	0	0	0	0	1				
	Pigs	≦0.12	0.25	0.0			51	16	0	2	0	0	0	0	0				
	Chicken	≦0.12	≦0.12	0.0			16	0	0	0	0	0	0	0	0				
Meropenem	Cattle	≦0.12	≦0.12	0			56	1	0	0	0	0	0	0					
	Pigs	≦0.12	≦0.12	0			64	3	1	1	0	0	0	0					
	Chicken	≦0.12	≦0.12	0			16	0	0	0	0	0	0	0					
Streptomycin	Cattle	>128	>128	64.9								0	5	15	0	1	5	31	
	Pigs	32	>128	55.1								0	4	27	8	4	4	22	
	Chicken	64	>128	93.8								0	1	0	6	6	0	3	
Gentamicin	Cattle	≦1	≦1	7.0						52	1	0	0	1	0	0	3		
	Pigs	≦1	≦1	5.8						63	2	0	0	0	2	0	2		
	Chicken	≦1	32	18.8						13	0	0	0	0	2	0	1		
Kanamycin	Cattle	≦2	>128	12.3							30	15	2	0	3	0	0	7	
	Pigs	4	>128	14.5							31	20	4	3	1	0	0	10	
	Chicken	>128	>128	68.8							1	3	1	0	0	0	0	11	
Tetracycline	Cattle	2	>64	63.2						4	15	2	0	0	6	2	28		
	Pigs	2	>64	37.7						9	27	4	3	1	1	5	19		
	Chicken	64	>64	75.0						1	3	0	0	1	1	8	2		
Chloramphenicol	Cattle	16	>128	29.8							0	1	26	13	0	1	1	15	
	Pigs	8	16	8.7							0	8	33	22	1	2	1	2	
	Chicken	8	16	0.0							1	6	7	2	0	0	0	0	
Colistin	Cattle	0.5	1	1.8				3	48	4	1	1	0	0	0				
	Pigs	0.5	2	8.7				12	42	6	3	5	1	0	0				
	Chicken	1	4	18.8				1	2	8	2	3	0	0	0				
Nalidixic acid	Cattle	8	8	3.5						0	1	26	27	1	1	0	0	1	
	Pigs	8	>128	21.7						0	0	31	16	7	2	1	0	12	
	Chicken	8	>128	50.0						0	0	7	1	0	0	0	0	8	
Ciprofloxacin	Cattle	≦0.03	0.06	1.8	41	12	0	1	2	1	0	0	0						
	Pigs	≦0.03	0.50	1.4	40	9	2	6	11	1	0	0	0						
	Chicken	0.12	2.00	18.8	6	1	1	4	1	0	3	0	0						

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions							
					≦2.38/0.12	4.75/0.25	9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Cattle	4.75/0.25	>152/8	29.8	23	13	3	1	0	0	4	13
	Pigs	≦2.38/0.12	>152/8	18.8	39	9	5	0	3	0	1	12
	Chicken	>152/8	>152/8	56.3	6	1	0	0	0	0	0	9

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.8.1. MIC distribution and resistance (%) for *Escherichia coli* from healthy dogs (n=151) and cats (n=158) in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	8	>128	33.8								54	41	5	0	0	4	47	
	Cats	8	>128	28.5								71	40	2	1	2	5	37	
Cefazolin	Dogs	≦2	>128	17.2							114	8	2	1	1	1	0	24	
	Cats	≦2	>128	17.1							123	4	2	2	2	2	0	23	
Cefalexin	Dogs	8	>128	17.9							1	35	79	9	3	0	1	23	
	Cats	8	>128	18.4							0	47	74	8	0	1	5	23	
Cefotaxime	Dogs	≦0.5	8	13.2					127	0	4	1	4	3	6	3	3		
	Cats	≦0.5	4	10.8					135	2	4	3	1	5	5	2	1		
Meropenem	Dogs	≦0.5	≦0.5	0.0					151	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					158	0	0	0	0	0	0				
Streptomycin	Dogs	8	>128	19.2								68	51	3	2	4	4	19	
	Cats	≦4	64	11.4								98	41	1	1	2	5	10	
Gentamicin	Dogs	≦2	2	3.3							146	0	0	1	2	2	0		
	Cats	≦2	2	2.5							154	0	0	1	1	0	2		
Kanamycin	Dogs	≦4	8	5.3								134	7	2	0	0	0	8	
	Cats	≦4	4	1.9								150	5	0	0	0	0	3	
Tetracycline	Dogs	≦2	64	16.6							82	43	1	0	4	13	8		
	Cats	≦2	64	10.8							136	5	0	0	0	6	11		
Nalidixic acid	Dogs	≦4	>128	27.8								100	6	3	1	3	0	38	
	Cats	≦4	>128	24.7								115	4	0	0	2	5	32	
Ciprofloxacin	Dogs	≦0.06	>8	18.5		105	3	10	5	1	0	5	1	21					
	Cats	≦0.06	>8	12.0		115	3	18	3	0	0	2	1	16					
Colistin	Dogs	≦0.5	≦0.5	0.0					151	0	0	0	0	0	0				
	Cats	≦0.5	0.5	0.0					158	0	0	0	0	0	0				
Chloramphenicol	Dogs	8	16	4.6								13	115	16	0	1	0	6	
	Cats	8	8	1.3								13	136	7	0	0	1	1	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0.5	>152/8	13.2	130	1	0	0	0	20
	Cats	≦9.5/0.5	>152/8	12.0	137	1	1	0	0	19

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.8.2. MIC distributions and resistance (%) for *Escherichia coli* from healthy dogs (n=192) and cats (n=188), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	8	>128	22.9								89	58	1	0	2	0	42	
	Cats	≦4	>128	27.1								123	13	1	0	4	6	41	
Cefazolin	Dogs	≦2	32	13.0							159	8	2	2	3	0	1	17	
	Cats	≦2	32	11.7							151	12	1	2	6	1	0	15	
Cefalexin	Dogs	8	128	10.9							1	22	132	16	0	0	3	18	
	Cats	8	>128	13.3							0	34	116	13	0	0	5	20	
Cefotaxime	Dogs	≦0.5	2	8.9					171	1	3	2	5	1	2	4	3		
	Cats	≦0.5	≦0.5	6.4					173	2	1	1	0	5	4	2	0		
Meropenem	Dogs	≦0.5	≦0.5	0.0					192	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					188	0	0	0	0	0	0				
Streptomycin	Dogs	8	64	13.0								89	69	9	2	5	5	13	
	Cats	8	32	11.7								90	70	6	6	2	4	10	
Gentamicin	Dogs	≦2	≦2	2.6							187	0	0	0	2	3	0		
	Cats	≦2	≦2	4.3							179	1	0	2	4	2	0		
Kanamycin	Dogs	≦4	≦4	3.6								176	9	0	0	0	0	7	
	Cats	≦4	≦4	3.2								170	12	0	0	0	0	6	
Tetracycline	Dogs	≦2	64	13.0							100	67	0	0	0	9	16		
	Cats	≦2	32	10.1							134	35	0	0	1	10	8		
Nalidixic acid	Dogs	≦4	>128	20.8								141	8	3	1	2	6	31	
	Cats	≦4	>128	28.7								127	5	2	1	4	4	45	
Ciprofloxacin	Dogs	≦0.06	0.25	8.9		149	4	20	2	2	0	0	1	14					
	Cats	≦0.06	4	13.3		130	7	20	6	3	1	3	1	17					
Colistin	Dogs	≦0.5	≦0.5	0.5					191	0	0	1	0	0	0				
	Cats	≦0.5	≦0.5	0.0					188	0	0	0	0	0	0				
Chloramphenicol	Dogs	8	16	5.7								16	143	22	1	4	2	4	
	Cats	8	8	3.7								26	149	5	2	3	1	1	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0.5	≦9.5/0.5	7.8	176	0	1	0	0	15
	Cats	≦9.5/0.5	≦9.5/0.5	9.6	170	0	0	1	0	17

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.9.1. MIC distribution and resistance (%) for *Enterococcus faecalis* from healthy dogs (n=101) and cats (n=64), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distribution														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	1	1	1.0		0	0	1	5	84	10	0	0	0	1	0	0	0	
	Cats	1	2	0.0		0	0	0	1	44	19	0	0	0	0	0	0	0	
Gentamicin	Dogs	8	256	13.9			0	1	0	1	1	5	70	9	0	0	0	2	12
	Cats	8	256	14.1			0	0	0	0	0	8	44	3	0	0	1	0	8
Tetracycline	Dogs	64	64	66.3		0	0	0	15	18	1	0	0	2	11	47	7		
	Cats	32	64	56.3		0	0	0	9	19	0	0	0	0	4	30	2		
Chloramphenicol	Dogs	8	32	22.8				0	0	1	0	35	39	3	18	4	1	0	0
	Cats	8	32	14.1				0	0	0	0	8	45	2	9	0	0	0	0
Erythromycin	Dogs	2	>64	39.6	0	0	5	6	8	22	19	1	0	0	0	1	39		
	Cats	2	>64	39.1	0	0	3	1	9	18	8	0	0	0	0	0	25		
Azithromycin	Dogs	4	>64	-	0	0	1	3	5	5	18	27	2	0	0	0	40		
	Cats	4	>64	-	0	0	0	1	3	4	10	20	1	0	0	0	25		
Ciprofloxacin	Dogs	1	2	5.9	0	0	0	1	25	63	6	0	0	0	5	0	1		
	Cats	1	32	17.2	0	0	0	0	4	41	8	0	0	2	9	0	0		
Vancomycin	Dogs	1	2	0.0			0	0	1	82	18	0	0	0	0	0	0	0	0
	Cats	1	2	0.0			0	0	3	49	12	0	0	0	0	0	0	0	0

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.9.2. MIC distributions and resistance (%) for *Enterococcus faecalis* from healthy dogs (n=123) and cats (n=76), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	1	2	0.0		0	0	0	2	95	26	0	0	0	0	0	0	0	
	Cats	1	2	0.0		0	0	0	0	61	15	0	0	0	0	0	0	0	
Gentamicin	Dogs	8	16	8.9			0	0	0	0	0	5	70	37	0	0	0	1	10
	Cats	8	>256	14.5			0	0	0	0	1	10	44	10	1	0	0	1	9
Tetracycline	Dogs	1	64	47.2		0	0	0	14	49	1	0	1	0	5	49	4		
	Cats	64	64	68.4		0	0	0	2	22	0	0	0	0	4	47	1		
Chloramphenicol	Dogs	8	32	13.0				0	0	0	0	1	99	7	4	9	3	0	0
	Cats	8	64	15.8				0	0	0	0	0	51	13	0	12	0	0	0
Erythromycin	Dogs	2	>64	24.4	0	0	2	9	19	28	35	0	0	0	1	0	29		
	Cats	2	>64	35.5	0	0	3	6	7	18	14	1	0	0	0	0	27		
Azithromycin	Dogs	4	>64	-	0	0	0	0	3	11	32	42	5	0	1	0	29		
	Cats	4	>64	-	0	0	0	1	3	6	19	15	5	0	0	0	27		
Ciprofloxacin	Dogs	1	2	3.3	0	0	0	0	12	81	26	0	0	1	2	1	0		
	Cats	1	4	10.5	0	0	0	0	4	44	20	1	0	2	4	1	0		
Vancomycin	Dogs	1	2	0.0			0	0	1	95	25	2	0	0	0	0	0	0	0
	Cats	1	2	0.0			0	0	2	60	13	1	0	0	0	0	0	0	0

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.10.1. MIC distributions and resistance (%) for *Escherichia coli* from diseased dogs (n=154) and cats (n=93), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>128	>128	63.0								23	28	6	0	0	0	97	
	Cats	>128	>128	65.6								19	12	1	0	2	0	59	
Cefazolin	Dogs	4	>128	44.2							74	7	4	1	1	2	0	65	
	Cats	4	>128	44.1							42	5	4	1	0	4	2	35	
Cefalexin	Dogs	16	>128	42.9							0	5	57	26	0	0	2	64	
	Cats	16	>128	47.3							0	2	42	5	4	2	3	35	
Cefotaxime	Dogs	≦0.5	>64	41.6					89	0	1	1	0	8	11	18	26		
	Cats	≦0.5	>64	39.8					55	1	0	0	2	6	6	10	13		
Meropenem	Dogs	≦0.5	≦0.5	0.0					154	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					93	0	0	0	0	0	0				
Streptomycin	Dogs	8	>128	29.9								71	29	8	3	12	8	23	
	Cats	8	>128	34.4								40	18	3	1	3	5	23	
Gentamicin	Dogs	≦2	32	18.8							122	2	1	2	16	7	4		
	Cats	≦2	32	15.1							78	0	1	0	8	5	1		
Kanamycin	Dogs	≦4	32	7.8								104	26	8	4	2	0	10	
	Cats	≦4	>128	12.9								70	9	1	1	0	1	11	
Tetracycline	Dogs	4	>64	27.9							43	60	8	1	0	5	37		
	Cats	4	>64	29.0							42	19	5	1	1	4	21		
Nalidixic acid	Dogs	>128	>128	72.7								34	6	2	2	1	1	108	
	Cats	>128	>128	68.8								25	4	0	2	0	0	62	
Ciprofloxacin	Dogs	8	>8	55.2		42	3	9	15	3	2	1	6	73					
	Cats	1	>8	50.5		29	1	4	12	2	0	1	4	40					
Colistin	Dogs	≦0.5	≦0.5	0.0					149	5	0	0	0	0	0				
	Cats	≦0.5	≦0.5	1.1					92	0	0	1	0	0	0				
Chloramphenicol	Dogs	16	32	16.2					0	0	0	5	55	69	11	4	1	9	
	Cats	16	32	15.1					0	0	0	4	39	36	7	1	1	5	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0.5	>152/8	27.9	104	3	4	3	0	40
	Cats	≦9.5/0.5	>152/8	34.4	56	1	4	0	0	32

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.10.2. MIC distributions and resistance (%) for *Escherichia coli* from diseased dogs (n=178) and cats (n=128), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions 0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	32	>128	51.1								57	29	1	2	0	3	86	
	Cats	>128	>128	60.2								40	10	1	2	3	1	71	
Cefazolin	Dogs	≦2	>128	30.3							106	11	6	1	3	2	0	49	
	Cats	≦2	>128	32.0							80	7	0	0	4	0	1	36	
Cefalexin	Dogs	8	>128	31.5							1	15	94	12	4	2	1	49	
	Cats	8	>128	31.3							1	14	69	4	0	0	4	36	
Cefotaxime	Dogs	≦0.5	64	26.4					126	1	4	0	4	7	11	15	10		
	Cats	≦0.5	32	26.6					90	2	2	2	2	7	11	8	4		
Meropenem	Dogs	≦0.5	≦0.5	0.0					178	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					128	0	0	0	0	0	0				
Streptomycin	Dogs	8	>128	20.2								75	54	13	5	4	6	21	
	Cats	8	>128	28.9								45	40	6	2	8	5	22	
Gentamicin	Dogs	≦2	32	12.9							155	0	0	1	15	5	2		
	Cats	≦2	4	9.4							115	1	0	1	4	5	2		
Kanamycin	Dogs	≦4	8	5.1								149	14	4	2	0	0	9	
	Cats	≦4	8	7.0								103	14	1	1	0	1	8	
Tetracycline	Dogs	4	>64	21.3							69	68	3	0	0	16	22		
	Cats	≦2	>64	26.6							65	26	3	1	2	12	19		
Nalidixic acid	Dogs	>128	>128	56.2								68	4	6	0	4	4	92	
	Cats	8	>128	46.9								61	5	2	0	0	1	59	
Ciprofloxacin	Dogs	0.25	>8	38.8		71	6	20	12	1	0	3	3	62					
	Cats	0.12	>8	37.5		60	5	12	3	1	1	3	8	35					
Colistin	Dogs	≦0.5	≦0.5	0.0					171	7	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					120	8	0	0	0	0	0				
Chloramphenicol	Dogs	8	32	11.8								16	122	19	6	3	2	10	
	Cats	8	16	7.8								15	87	16	1	0	1	8	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions ≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0.5	>152/8	17.4	140	4	3	0	0	31
	Cats	≦9.5/0.5	>152/8	22.7	97	2	0	0	0	29

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.11.1. MIC distributions and resistance (%) for *Enterococcus faecalis* from diseased dogs (n=57) and cats (n=39), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	1	1	0.0					21	33	3	0	0	0	0	0	0		
	Cats	1	2	0.0					2	28	8	1	0	0	0	0	0		
Cefazolin	Dogs	16	32	-					1	0	2	2	8	23	20	1			
	Cats	32	64	-					0	0	0	1	0	10	24	3	1		
Cefalexin	Dogs	>64	>64	-					0	1	0	0	0	0	6	17	33		
	Cats	>64	>64	-					0	0	0	0	0	0	1	3	35		
Cefmetazole	Dogs	>64	>64	-					0	0	0	1	0	1	1	4	50		
	Cats	>64	>64	-					0	0	0	0	0	0	0	0	39		
Cefotaxime	Dogs	>64	>64	-					13	0	0	0	0	0	1	8	35		
	Cats	>64	>64	-					1	0	0	0	0	0	0	2	36		
Streptomycin	Dogs	64	>128	-							12	1	3	1	5	21	6	8	
	Cats	64	>128	-							0	0	0	3	1	16	12	7	
Gentamicin	Dogs	8	16	8.8						14	5	9	22	2	0	0	2	3	
	Cats	8	>128	15.4						4	3	4	20	2	0	1	0	5	
Tetracycline	Dogs	64	>64	66.7					9	10	0	0	0	1	4	26	7		
	Cats	64	64	76.9					2	7	0	0	0	0	1	27	2		
Erythromycin	Dogs	2	>32	36.8				4	10	14	8	0	0	0	0	21			
	Cats	2	>32	46.2				2	5	11	2	1	0	0	0	18			
Azithromycin	Dogs	4	>32	-				2	2	5	15	10	2	0	0	21			
	Cats	4	>32	-				1	0	5	8	6	0	1	0	18			
Chloramphenicol	Dogs	8	32	15.8						0	1	9	35	3	5	2	2	0	
	Cats	8	64	23.1						0	1	5	24	0	2	6	1	0	
Ciprofloxacin	Dogs	1	2	8.8				5	10	29	8	0	1	0	3	1			
	Cats	1	>32	25.6				0	4	18	7	1	0	1	2	6			

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.11.2. MIC distributions and resistance (%) for *Enterococcus faecalis* from diseased dogs (n=100) and cats (n=62), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	1	>128	0.0		0	0	0	0	82	18	0	0	0	0	0	0	0	
	Cats	1	2	0.0		0	0	1	3	34	24	0	0	0	0	0	0	0	
Gentamicin	Dogs	8	>256	22.0			0	0	0	0	1	7	48	22	3	1	0	0	18
	Cats	8	>256	14.5			0	1	0	0	1	7	39	5	0	1	0	1	7
Tetracycline	Dogs	64	64	65.0		0	0	0	3	32	0	0	0	0	5	54	6		
	Cats	64	64	67.7		0	0	0	0	20	0	0	0	0	7	34	1		
Chloramphenicol	Dogs	8	64	24.0				0	0	0	1	2	71	2	6	14	4	0	0
	Cats	8	32	14.5				0	0	0	0	2	50	1	4	4	1	0	0
Erythromycin	Dogs	2	>64	36.0	0	0	6	10	20	15	13	0	0	0	0	0	36		
	Cats	1	>64	33.9	0	0	1	6	11	15	8	0	1	0	0	1	19		
Azithromycin	Dogs	4	>64	-	0	0	0	0	13	9	25	17	0	0	0	0	36		
	Cats	4	>64	-	0	0	0	0	4	7	19	10	2	0	0	0	20		
Ciprofloxacin	Dogs	1	>64	11.0	0	0	0	0	9	57	23	1	0	1	5	4	0		
	Cats	1	16	14.5	0	0	0	0	3	33	17	2	0	1	2	2	2		
Vancomycin	Dogs	1	2	0.0			0	0	0	87	13	0	0	0	0	0	0	0	0
	Cats	1	2	0.0			0	0	3	44	15	0	0	0	0	0	0	0	0

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.12.1. MIC distributions and resistance (%) for *Enterococcus faecium* from diseased dogs (n=15) and cats (n=18), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>64	>64	100.0					0	0	0	0	0	0	2	5	8		
	Cats	>64	>64	100.0					0	0	0	0	0	0	1	3	14		
Cefazolin	Dogs	>64	>64	-					0	0	0	0	0	0	0	0	15		
	Cats	>64	>64	-					0	0	0	0	0	0	0	0	18		
Cefalexin	Dogs	>64	>64	-					0	0	0	0	0	0	0	0	15		
	Cats	>64	>64	-					0	0	0	0	0	0	0	0	18		
Cefmetazole	Dogs	>64	>64	-					0	0	0	0	0	0	0	0	15		
	Cats	>64	>64	-					0	0	0	0	0	0	0	0	18		
Cefotaxime	Dogs	>64	>64	-					0	0	0	0	0	0	0	0	15		
	Cats	>64	>64	-					0	0	0	0	0	0	0	0	18		
Streptomycin	Dogs	32	>128	-							0	0	0	3	5	1	0	6	
	Cats	>128	>128	-							0	0	0	1	5	1	0	11	
Gentamicin	Dogs	8	>128	40.0						1	4	1	3	0	3	0	0	3	
	Cats	8	>128	44.4						0	2	6	2	0	5	1	0	2	
Tetracycline	Dogs	32	>64	80.0					3	0	0	0	0	2	3	5	2		
	Cats	64	>64	66.7					3	3	0	0	0	0	1	7	4		
Erythromycin	Dogs	2	>32	46.7				0	0	2	6	0	0	0	0	7			
	Cats	>32	>32	72.2				0	0	0	4	1	0	0	0	13			
Azithromycin	Dogs	8	>32	-				0	0	0	2	4	2	0	0	7			
	Cats	>32	>32	-				0	0	0	0	2	3	0	0	13			
Chloramphenicol	Dogs	8	16	6.7						0	0	3	8	3	1	0	0	0	
	Cats	8	8	0.0						0	0	4	13	1	0	0	0	0	
Ciprofloxacin	Dogs	>32	>32	100.0				0	0	0	0	0	0	0	2	13			
	Cats	>32	>32	100.0				0	0	0	0	1	0	0	3	14			

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.12.2. MIC distributions and resistance (%) for *Enterococcus faecium* from diseased dogs (n=30) and cats (n=35), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>128	>128	90.0		0	0	1	0	0	2	0	0	0	1	4	2	20	
	Cats	>128	>128	94.3		0	0	1	0	0	1	0	0	0	2	3	7	21	
Gentamicin	Dogs	8	>256	36.7			0	0	1	0	1	6	9	2	2	1	0	1	7
	Cats	16	>256	45.7			0	0	0	1	2	4	10	2	1	2	5	1	7
Tetracycline	Dogs	64	>64	80.0		0	0	0	4	1	0	0	1	2	6	10	6		
	Cats	32	>64	60.0		0	0	0	14	0	0	0	0	0	7	7	7		
Chloramphenicol	Dogs	8	64	3.3				0	0	0	0	5	18	6	0	1	0	0	0
	Cats	8	8	0.0				0	0	0	0	6	29	0	0	0	0	0	0
Erythromycin	Dogs	2	>64	66.7	0	0	0	0	0	2	7	1	1	1	0	0	18		
	Cats	16	>64	51.4	0	0	0	0	0	4	12	1	0	1	0	0	17		
Azithromycin	Dogs	4	>64	-	0	0	0	0	0	0	2	7	1	1	0	1	18		
	Cats	16	>64	-	0	0	0	0	0	0	4	13	0	1	0	0	17		
Ciprofloxacin	Dogs	>64	>64	96.7	0	0	0	0	0	0	1	2	1	0	6	3	17		
	Cats	>64	>64	94.3	0	0	0	1	0	0	1	1	0	0	2	8	22		
Vancomycin	Dogs	1	1	0.0			0	0	5	23	1	1	0	0	0	0	0	0	0
	Cats	1	1	0.0			0	1	5	28	1	0	0	0	0	0	0	0	0

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.13.1. MIC distributions and resistance (%) for *Staphylococcus pseudintermedius* from diseased dogs (n=83) and cats (n=22), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	8	>16	-			6	6	10	3	5	5	8	16	24				
	Cats	>16	>16	-			0	0	0	3	1	0	0	1	17				
Oxacillin	Dogs	0.5	16	56.6			33	3	7	6	4	6	7	17					
	Cats	>8	>8	81.8			1	3	1	1	0	1	0	15					
Cefazolin	Dogs	0.25	8	-			40	16	6	1	4	5	6	5					
	Cats	4	>8	-			1	5	1	2	0	2	4	7					
Cefalexin	Dogs	4	>16	-				3	0	30	6	15	7	4	18				
	Cats	>16	>16	-				0	0	1	3	2	1	3	12				
Cefoxitin	Dogs	≦0.5	2	-					64	9	8	1	0	1					
	Cats	2	4	-					5	5	8	2	1	1					
Cefmetazole	Dogs	≦0.5	1	-					65	12	4	1	0	1					
	Cats	1	2	-					8	4	8	1	0	1					
Cefotaxime	Dogs	1	>8	-		3	1	31	3	8	10	6	7	14					
	Cats	>8	>8	-		0	0	1	1	1	3	2	2	12					
Streptomycin	Dogs	>128	>128	-								19	3	0	0	2	10	49	
	Cats	>128	>128	-								1	0	1	1	0	1	18	
Gentamicin	Dogs	16	32	54.2					16	1	0	7	14	23	18	4			
	Cats	16	>32	63.6					0	0	1	2	5	5	6	3			
Tetracycline	Dogs	32	>32	67.5					27	0	0	0	0	2	17	37			
	Cats	>32	>32	81.8					4	0	0	0	0	0	4	14			
Erythromycin	Dogs	>16	>16	74.7				19	2	0	0	0	0	1	61				
	Cats	>16	>16	86.4				2	1	0	0	0	0	0	19				
Azithromycin	Dogs	>16	>16	74.7				4	16	1	0	0	0	4	58				
	Cats	>16	>16	86.4				0	3	0	0	0	0	0	19				
Ciprofloxacin	Dogs	32	>32	75.9				17	2	1	0	2	0	4	33	24			
	Cats	>32	>32	100.0				0	0	0	0	0	0	2	8	12			
Chloramphenicol	Dogs	16	64	49.4							2	17	21	2	10	31			
	Cats	64	64	72.7							0	3	2	1	1	15			

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.13.2. MIC distributions and resistance (%) for *Staphylococcus pseudintermedius* from diseased dogs (n=78) and cats (n=42), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Benzylpenicillin	Dogs	>4	>4	97.4	2	0	0	0	0	0	2	1	73						
	Cats	>4	>4	97.6	1	0	0	0	0	2	1	1	37						
Oxacillin	Dogs	1	>8	62.8			29	0	8	10	3	2	4	22					
	Cats	>8	>8	81.0			6	2	3	3	2	0	0	26					
Cefazolin	Dogs	0.5	>8	-			30	7	14	3	1	2	7	14					
	Cats	4	>8	-			7	3	3	2	4	5	3	15					
Cefalexin	Dogs	8	>16	-				0	1	7	20	8	12	6	24				
	Cats	>16	>16	-				0	0	6	2	2	4	2	26				
Cefoxitin	Dogs	≦0.5	2	-					40	20	11	5	1	1					
	Cats	2	2	-					10	8	21	2	0	1					
Cefmetazole	Dogs	≦0.5	2	-					46	21	8	2	0	1					
	Cats	1	2	-					15	20	7	0	0	0					
Cefotaxime	Dogs	2	>8	-		0	1	29	0	5	7	11	2	23					
	Cats	>8	>8	-		0	2	5	1	1	3	4	1	25					
Streptomycin	Dogs	>128	>128	-								9	5	2	0	1	2	59	
	Cats	>128	>128	-								2	1	0	0	1	2	36	
Gentamicin	Dogs	16	32	64.1					14	0	0	2	12	24	23	3			
	Cats	16	32	52.4					3	0	3	3	11	11	10	1			
Tetracycline	Dogs	>32	>32	66.7					25	0	1	0	0	0	2	50			
	Cats	>32	>32	85.7					6	0	0	0	0	0	4	32			
Erythromycin	Dogs	>16	>16	79.5				14	2	0	0	0	0	0	62				
	Cats	>16	>16	95.2				1	1	0	0	0	0	0	40				
Azithromycin	Dogs	>16	>16	79.5				0	16	0	0	0	0	0	62				
	Cats	>16	>16	95.2				0	1	1	0	0	0	0	40				
Ciprofloxacin	Dogs	>32	>32	75.6				15	2	2	0	1	2	1	6	49			
	Cats	>32	>32	97.6				1	0	0	0	0	0	2	7	32			
Chloramphenicol	Dogs	64	64	60.3							1	5	23	2	4	43	0		
	Cats	64	64	83.3							0	2	5	0	10	25	0		

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.14.1. MIC distributions and resistance (%) for *Klebisiella pneumoniae* from diseased dogs (n=45) and cats (n=18), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>128	>128	93.3								0	0	3	10	5	1	26	
	Cats	>128	>128	100.0								0	0	0	0	0	0	18	
Cefazolin	Dogs	16	>128	46.7							21	1	0	2	1	1	1	18	
	Cats	>128	>128	94.4							0	1	0	0	0	1	1	15	
Cefalexin	Dogs	16	>128	48.9							1	14	7	1	2	2	1	17	
	Cats	>128	>128	88.9							0	0	1	1	0	1	0	15	
Cefotaxime	Dogs	≦0.5	>64	40.0					26	0	1	0	0	0	4	5	9		
	Cats	64	>64	83.3					1	1	1	0	0	0	4	6	5		
Meropenem	Dogs	≦0.5	≦0.5	0.0					45	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					18	0	0	0	0	0	0				
Streptomycin	Dogs	≦4	>128	37.8								24	2	2	2	2	5	8	
	Cats	128	>128	61.1								7	0	0	0	1	4	6	
Gentamicin	Dogs	≦2	>64	31.1							27	1	3	1	5	3	5		
	Cats	16	>64	61.1							6	0	1	2	4	3	2		
Kanamycin	Dogs	≦4	64	11.1								32	3	5	0	1	0	4	
	Cats	16	>128	22.2								4	2	3	5	0	0	4	
Tetracycline	Dogs	8	>64	48.9							14	6	3	1	2	3	16		
	Cats	>64	>64	72.2							2	1	2	0	0	1	12		
Nalidixic acid	Dogs	>128	>128	64.4								9	4	3	0	4	1	24	
	Cats	>128	>128	100.0								0	0	0	0	0	0	18	
Ciprofloxacin	Dogs	4	>8	60.0		14	1	1	2	2	1	3	0	21					
	Cats	>8	>8	100.0		0	0	0	0	0	0	0	2	16					
Colistin	Dogs	≦0.5	≦0.5	0.0					45	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					18	0	0	0	0	0	0				
Chloramphenicol	Dogs	8	>128	35.6								5	21	3	2	4	1	9	
	Cats	8	>128	50.0								4	5	0	2	1	1	5	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	38/2	>152/8	48.9	19	1	3	4	0	18
	Cats	>152/8	>152/8	77.8	4	0	0	1	0	13

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.14.2. MIC distributions and resistance (%) for *Klebisiella pneumoniae* from diseased dogs (n=72) and cats (n=32), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>128	>128	87.5								1	1	7	18	4	3	38	
	Cats	>128	>128	96.9								1	0	0	3	2	0	26	
Cefazolin	Dogs	≦2	>128	40.3							36	4	2	1	1	1	1	26	
	Cats	>128	>128	75.0							8	0	0	0	2	0	0	22	
Cefalexin	Dogs	8	>128	41.7							0	33	7	2	3	2	1	24	
	Cats	>128	>128	68.8							0	4	5	1	2	0	1	19	
Cefotaxime	Dogs	≦0.5	64	36.1					44	2	0	1	2	6	9	4	4		
	Cats	16	64	65.6					11	0	0	0	2	3	6	7	3		
Meropenem	Dogs	≦0.5	≦0.5	0.0					71	0	1	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					31	1	0	0	0	0	0				
Streptomycin	Dogs	≦4	>128	29.2								47	1	3	2	6	5	8	
	Cats	64	>128	62.5								9	2	1	1	6	5	8	
Gentamicin	Dogs	≦2	32	22.2							54	2	0	6	6	2	2		
	Cats	4	32	46.9							15	2	0	5	7	2	1		
Kanamycin	Dogs	≦4	16	4.2								60	3	4	2	1	0	2	
	Cats	≦4	64	12.5								16	3	6	3	2	0	2	
Tetracycline	Dogs	4	>64	30.6							30	18	2	1	1	3	17		
	Cats	8	>64	50.0							10	4	2	0	0	4	12		
Nalidixic acid	Dogs	16	>128	47.2								28	7	3	1	3	1	29	
	Cats	>128	>128	84.4								3	1	1	0	0	0	27	
Ciprofloxacin	Dogs	0.25	16	47.2		34	0	3	1	2	1	3	3	25					
	Cats	>8	>8	81.3		3	0	2	1	0	1	0	5	20					
Colistin	Dogs	≦0.5	≦0.5	0.0					68	4	0	0	0	0	0				
	Cats	≦0.5	1	0.0					28	3	1	0	0	0	0				
Chloramphenicol	Dogs	8	64	19.4								25	28	5	2	6	2	4	
	Cats	≦4	32	15.6								18	3	6	2	0	1	2	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0.5	>152/8	37.5	38	3	4	1	2	24
	Cats	>152/8	>152/8	65.6	8	1	2	0	0	21

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.15. MIC distributions and resistance (%) for *Pseudomonas aeruginosa* from diseased dogs (n=78) and cats (n=18), in 2018

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	>128	>128	-								0	0	0	0	1	1	76	
	Cats	>128	>128	-								0	0	0	0	0	0	18	
Cefazolin	Dogs	>128	>128	-							0	0	0	0	0	0	0	78	
	Cats	>128	>128	-							0	0	0	0	0	0	0	18	
Cefalexin	Dogs	>128	>128	-							0	0	0	0	0	0	0	78	
	Cats	>128	>128	-							0	0	0	0	0	0	0	18	
Cefotaxime	Dogs	32	>64	33.3					0	0	0	1	8	28	15	13	13		
	Cats	32	>64	38.9					0	0	0	0	1	6	4	5	2		
Meropenem	Dogs	≦0.5	1	1.3					59	13	4	1	0	1	0				
	Cats	≦0.5	2	5.6					11	4	2	0	0	1	0				
Streptomycin	Dogs	64	128	-								2	0	11	20	23	16	6	
	Cats	32	64	-								0	2	2	10	3		1	
Gentamicin	Dogs	≦2	4	1.3							58	17	2	0	0	0	1		
	Cats	≦2	≦2	5.6							17	0	0	1	0	0	0		
Kanamycin	Dogs	64	>128	-								3	2	2	13	28	19	11	
	Cats	64	128	-								0	2	2	3	8	2	1	
Tetracycline	Dogs	32	64	-							0	0	1	11	34	27	5		
	Cats	32	64	-							0	0	0	5	9	3	1		
Nalidixic acid	Dogs	>128	>128	-								1	0	0	1	7	19	50	
	Cats	>128	>128	-								0	0	1	0	0	3	14	
Ciprofloxacin	Dogs	0.25	4	21.8		4	19	18	13	7	5	7	0	5					
	Cats	0.25	8	27.8		1	6	6	0	0	1	0	3	1					
Colistin	Dogs	≦0.5	1	0.0					58	20	0	0	0	0	0				
	Cats	≦0.5	1	0.0					11	7	0	0	0	0	0				
Chloramphenicol	Dogs	128	>128	-								0	0	0	2	5	33	38	
	Cats	128	>128	-								0	0	0	0	2	8	8	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	>152/8	>152/8	-	0	0	0	11	14	53
	Cats	>152/8	>152/8	-	0	0	1	1	4	12

White fields represent the range of dilutions tested.

MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.

MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

Table 12.16. MIC distributions and resistance (%) for *Proteus mirabilis* from diseased dogs (n=81) and cats (n=17), in 2019

Antimicrobial agent	Animal species	MIC_{50}	MIC_{90}	%Resistant	MIC distributions														
					0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Ampicillin	Dogs	≦4	32	13.6								69	1	0	3	2	0	6	
	Cats	≦4	>128	29.4								10	2	0	1	1	1	2	
Cefazolin	Dogs	4	8	2.5							6	61	10	2	0	0	1	1	
	Cats	4	8	5.9							4	11	1	0	0	0	0	1	
Cefalexin	Dogs	16	16	3.7							0	1	23	54	1	0	0	2	
	Cats	16	16	5.9							0	0	8	8	0	0	0	1	
Cefotaxime	Dogs	≦0.5	≦0.5	1.2					79	0	1	0	0	1	0	0	0		
	Cats	≦0.5	≦0.5	5.9					16	0	0	0	0	0	0	1	0		
Meropenem	Dogs	≦0.5	≦0.5	0.0					81	0	0	0	0	0	0				
	Cats	≦0.5	≦0.5	0.0					17	0	0	0	0	0	0				
Streptomycin	Dogs	16	64	-								4	32	27	3	8	2	5	
	Cats	8	16	-								2	7	7	0	1	0	0	
Gentamicin	Dogs	≦2	≦2	1.2							77	1	2	0	0	0	1		
	Cats	≦2	≦2	0.0							17	0	0	0	0	0	0		
Kanamycin	Dogs	≦4	16	6.2								57	15	3	1	0	2	3	
	Cats	≦4	≦4	0.0								16	1	0	0	0	0	0	
Tetracycline	Dogs	32	64	98.8							1	0	0	1	48	29	2		
	Cats	32	64	100.0							0	0	0	0	13	4	0		
Nalidixic acid	Dogs	8	>128	28.4								3	49	6	5	7	1	10	
	Cats	8	16	5.9								0	11	5	0	1	0	0	
Ciprofloxacin	Dogs	≦0.06	1	12.3		54	9	5	3	2	3	3	1	1					
	Cats	≦0.06	0.25	5.9		12	2	2	0	0	1	0	0	0					
Colistin	Dogs	>16	>16	98.8					1	0	0	0	0	1	79				
	Cats	>16	>16	100.0					0	0	0	0	0	0	17				
Chloramphenicol	Dogs	8	64	24.7								4	43	14	5	7	4	4	
	Cats	8	32	17.6								1	9	4	3	0	0	0	

Antimicrobial agent		MIC_{50}	MIC_{90}	%Resistant	MIC distributions					
					≦9.5/0.5	19/1	38/2	76/4	152/8	>152/8
Sulfamethoxazole/ Trimethoprim	Dogs	≦9.5/0/5	>152/8	17.3	65	0	2	1	0	13
	Cats	≦9.5/0/5	>152/8	11.8	15	0	0	0	0	2

White fields represent the range of dilutions tested.
MIC values equal to or lower than the lowest concentration tested are presented as the lowest concentration.
MIC values greater than the highest concentration in the range are presented as one dilution step above the range.

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This report includes data gathered between 2018 and 2019, as well as some data from 1999 onward.

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