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CELEBRATING 30 YEARS DANMAP 2025

Perspectives of DANMAP 2025

The Danish Integrated Antimicrobial Resistance Monitoring and Research Programme



Diagnostic Infectious Disease Preparedness, Statens Serum Institut
National Food Institute, Technical University of Denmark

Perspectives of DANMAP 2025

Editors and main authors:
Ana Sofia Ribeiro Duarte
Majda Attauabi
Mikkel Lindegaard
Timo Röder
Ute Wolff Sönksen
Vibe Dalhoff Andersen

Contributing authors:
Camilla Thougaard Vester
Egle Kudirkiene
Lina Maria Cavaco
Jeppe Boel
Jesper Larsen
Johanna Munch Haraldsdóttir
Marianne Sandberg

DANMAP Steering Committee:
National Food Institute: Frank Møller Aarestrup, Marianne Sandberg
Statens Serum Institut: Anders Rhod Larsen, Ute Wolff Sönksen

Contact:
Ana Sofia Ribeiro Duarte (asrd@food.dtu.dk)
National Food Institute,
Technical University of Denmark
Henrik Dams Allé, Building 204, DK-2800 Kgs. Lyngby

Ute Wolff Sönksen (uws@ssi.dk)
Diagnostic Infectious Disease Preparedness – Bacteria, Parasites and Fungi
Statens Serum Institut
Artillerivej 5, DK-2300 Copenhagen S

Layout: Anja Bjarnum, Statens Serum Institut
Images: Colourbox and Line T. Madsen, Statens Serum Institut
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Read more - the DANMAP 2025 report

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1. Introduction

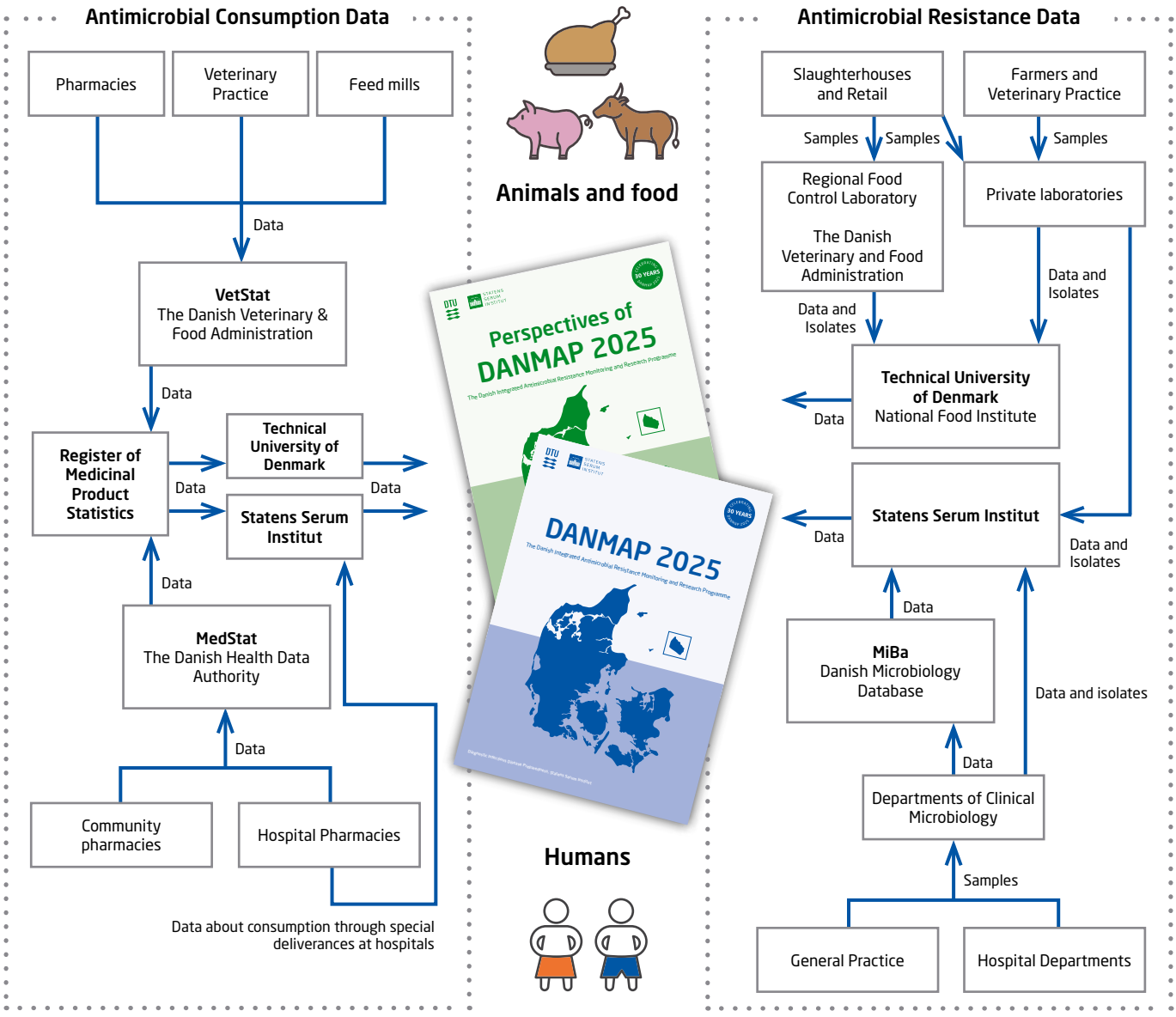
Welcome to Perspectives of DANMAP

We are very pleased to welcome you to this newly designed summary. Our goal with this edition is to make the extensive and complex data from the full report more accessible and easier to read, understand and use. This "short version" of the Danish programme for monitoring of antimicrobial resistance (AMR) in humans, animals and food as well as antibiotic use in humans and animals aims at presenting the highlights and core findings of the DANMAP 2025 report in a more digested way. Denmark has a long and proud tradition of surveilling antimicrobial usage and resistance and a long tradition of working across boundaries. This report reflects exactly that: a shared, transparent effort to present data for action.

A central focus of this year's summary is taking a step back, celebrating 30 years of DANMAP, but also looking ahead, trying to gain insights into the bigger picture. How are we actually doing with our national action plans for the mitigation and management of antimicrobial resistance. Managing resistance is not a task for one single sector, which is why you will find updates tracking our progress on both sides-from human healthcare to the veterinary and food production sectors. It is a genuine "One Health" approach in practice, showing what we can achieve when authorities, researchers, doctors, and veterinarians sit down at the same table. Whether you are a healthcare professional, a vetenarian, a policymaker, or simply curious about public health, we hope these pages offer useful insights.

Tackling AMR is a continuous, collective journey. Thank you for following us, engaging with the data, and contributing to the "fight against AMR". **Enjoy the reading!**

Figure 1.1 Organisation of DANMAP regarding data and data flow



2. Thirty years of DANMAP

DANMAP was established in 1995 to deliver the scientific proof that antimicrobial growth promoters were a potential threat for human health. Fortunately for the surveillance programme, the then recently established system for collecting samples from food animals, meat and humans (originally developed to monitor the zoonotic transmission of *Salmonella*) could be expanded to cover AMR monitoring. The same applied to the required framework for data analysis, report preparation, and dissemination to both politicians and established stakeholder networks.

The first comprehensive DANMAP report was published in 1996, the structure of which is still the backbone of the surveillance programme today, consisting of data on human antimicrobial consumption, antimicrobial resistance in clinical human isolates, antimicrobial usage in both food and companion animals, and antimicrobial resistance in indicator bacteria from healthy animals and meat. In recent years, antimicrobial resistance data for clinical pathogens in animals have also been included in the reporting.

Although data sources and registers, diagnostic methods and methodologies as well as health systems, farming and food production have evolved and changed over the years, the continuity and consistency of the programme enables data presentation that span the whole period. Below are selected main findings, figures and tables to visualize trends and changes over the 30 years of DANMAP.

Human health sector

Antimicrobial Consumption

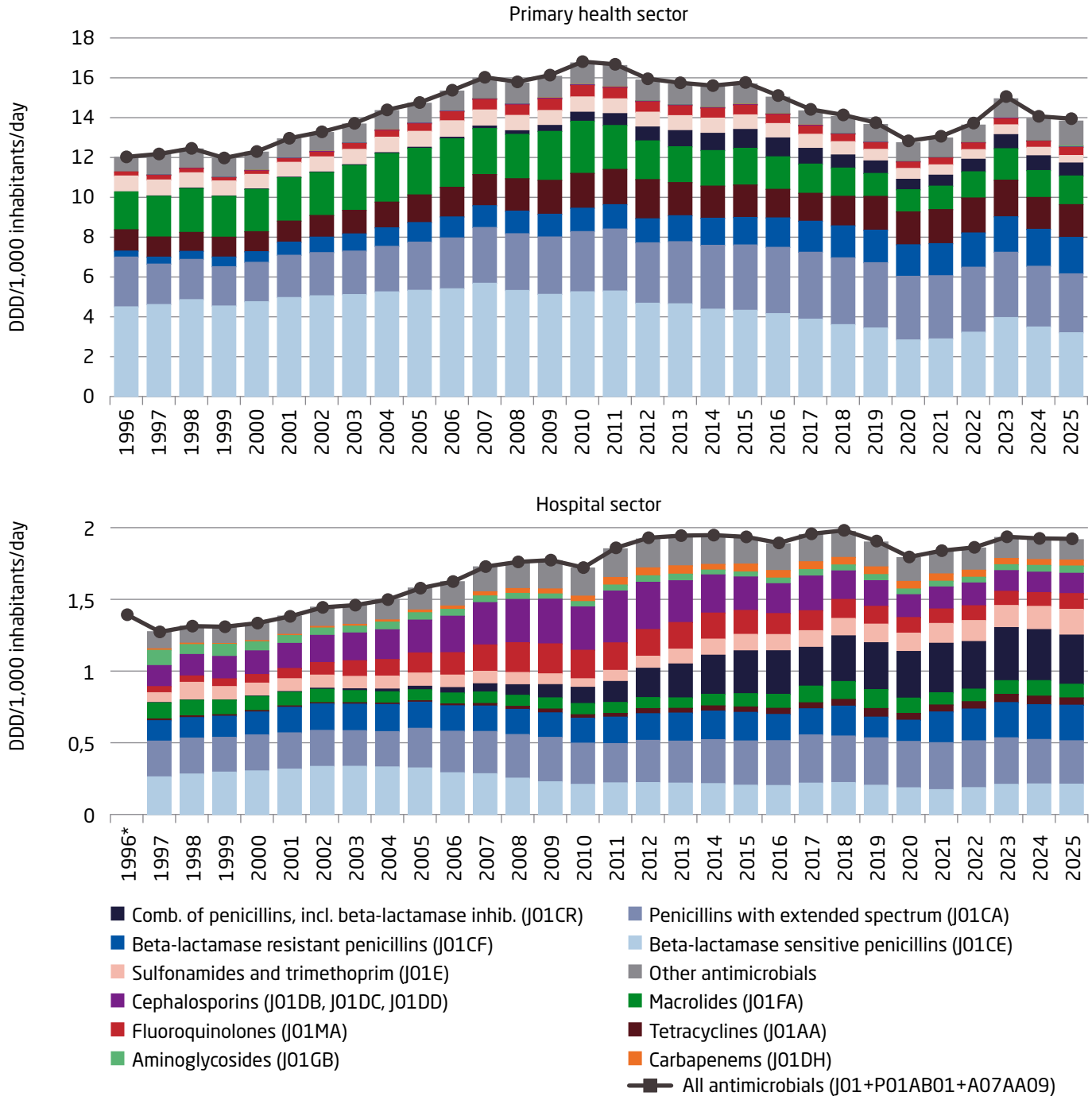
Surveillance of antimicrobial consumption in the human healthcare sector was initially based on wholesale data from the pharmaceutical industry, but has since 2001 shifted to sales data reported directly from community and hospital pharmacies. In primary healthcare, surveillance consists of information from prescriptions issued to individual patients, whereas hospital surveillance consists of sales to clinical wards or departments and is therefore not patient-based.

To summarize the main trends, the consumption of antimicrobials in Danish primary care increased from 1996 until it peaked in 2010–2011. This was followed by a steady decrease until 2020, when the COVID-19 pandemic caused a further steep decline (Figure 2.1). In the post-pandemic years of 2022–2023, antimicrobial consumption bounced back, but it has shown a renewed downward trend over the last two years. Comparable increases for the beginning of the period can be observed in hospital antimicrobial use, albeit lasting until 2018 when measured in Defined Daily Doses per 1,000 inhabitants (DID) - the same denominator used for primary care, though it is rarely applied to hospital data. Table 2.1 compares antimicrobial consumption data over the past 20 years using different denominators.

Figure 2.1 also demonstrates how penicillins have dominated the composition of the used antimicrobials in Danish health care. At the other end of the spectrum, consumption of critically important antimicrobials (carbapenems, cephalosporins and fluoroquinolones) has been kept at low consumption levels, mainly restricted to hospital acute care.

Over the years, several iniatives have been made to affect the consumption of antimicrobials in a more rational and prudent direction. For instance, the National Antibiotic Council was established in 2010, a One Health AMR strategy was developed in 2011, National Action Plans were issued in 2017 and in 2025 accompanied by regularly updated treatment guidelines from authorities and medical societies. In later years, in light of product shortages, unstable supply chains and geopolitical uncertainties, initiatives to maintain access to traditional narrow spectrum penicillins have been prioritised at national, Nordic and European level.

Figure 2.1 Consumption of antimicrobials in Denmark since the establishment of DANMAP, by healthcare sector, 1996-2025



* In 1996, data on use of individual antimicrobial groups at hospitals were not available.

Table 2.1 Antibiotic consumption in primary health care and at hospitals, all antimicrobials (J01+P01AB01), Denmark, 2006-2025

Denominator*	2006	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Trend 20 yr	Trend 10 yr
Primary health care													
DID	15,02	15,65	14,68	13,94	13,75	12,79	12,82	13,58	14,55	14,33	13,47	10% ↓	14% ↓
Number of treated patients per 1,000 inhabitants	313,41	269,72	255,72	242,55	234,34	205,27	207,85	224,57	242,08	232,89	213,26	32% ↓	21% ↓
Hospital care													
DAD	64,93	92,75	100	102,7	126,33	131,52	130,27	133,91	142,02	145,16	144,65	223% ↑	156% ↑
DBD	273,76	438	455,74	449,92	501,85	516,15	510,81	520,71	545,13	548,14	540,7	198% ↑	123% ↑

* DID = Defined Daily doses (DDD) per 1,000 inhabitants pr day, DAD = DDD per 100 admissions per day, DBD = DDD per 100 bed-days.

Antimicrobial Resistance

Since the inception of DANMAP, the surveillance of antimicrobial resistance in human clinical pathogens has continuously evolved. It began by covering a small geographic area (two of the fourteen former counties) and has expanded to encompass the entire country. Similarly, reporting has shifted from individual submissions by departments of clinical microbiology (DCM) to an electronic, comprehensive national system providing real-time, patient-level data. Additionally, this system integrates specialized data provided by the reference laboratories at Statens Serum Institut.

Initially, data from the two counties (and their corresponding two departments of clinical microbiology) included antimicrobial susceptibility testing for *Escherichia coli* from urine and blood cultures for just three antimicrobials: ampicillin, cefuroxime, and gentamicin. However, within just a few years, resistance data covered the majority of the population as additional laboratories joined the program. In DANMAP 2001, eleven of fourteen counties were represented, and the authors reported that it was becoming increasingly difficult to present and make sense of the data. This included challenges related to missing standardization - such as use of different testing methods at the DCMs or lack of algorithm for removing duplicate isolates - which had not yet been achieved. Finally, in DANMAP 2006, national-level data were reported for *E. coli* dating back to the year 2000 for five antimicrobials: ampicillin, gentamicin, cefuroxime, tetracycline, and mecillinam (Figure 2.2).

Since then, the implementation of MiBa (the Danish Microbiology Database) in 2011, and later the eRES project (the integration of harmonized resistance data into MiBa) in 2018, have had a profound effect on resistance reporting. This centralized all microbiological test results from the DCMs in Denmark, including antimicrobial susceptibility testing, and has served as the basis for register-based reporting since DANMAP 2018.

Antimicrobial susceptibility data for *Staphylococcus aureus* bacteraemia (SAB) (Figure 2.3) have followed a different path. Since 1957, SAB has been monitored through the voluntary submission of isolates from hospitals to the national reference laboratory at Statens Serum Institut, where they undergo further characterization, such as *spa*-typing and antimicrobial susceptibility testing (AST). However, since 2020, AST data have been retrieved from MiBa instead. Together with AMR data, an epidemiological classification of the samples and cases is included, as are recent outbreaks of methicillin-resistant *S. aureus* (MRSA). More comprehensive data on SAB can be found in the annual SAB reports, where the *spa*-typing and AST data are combined with data from the national patient registry, which includes demographics, comorbidities, and case fatality rates.

Figure 2.2 Resistance in *E. coli* from invasive infections in Denmark, 2000-2025

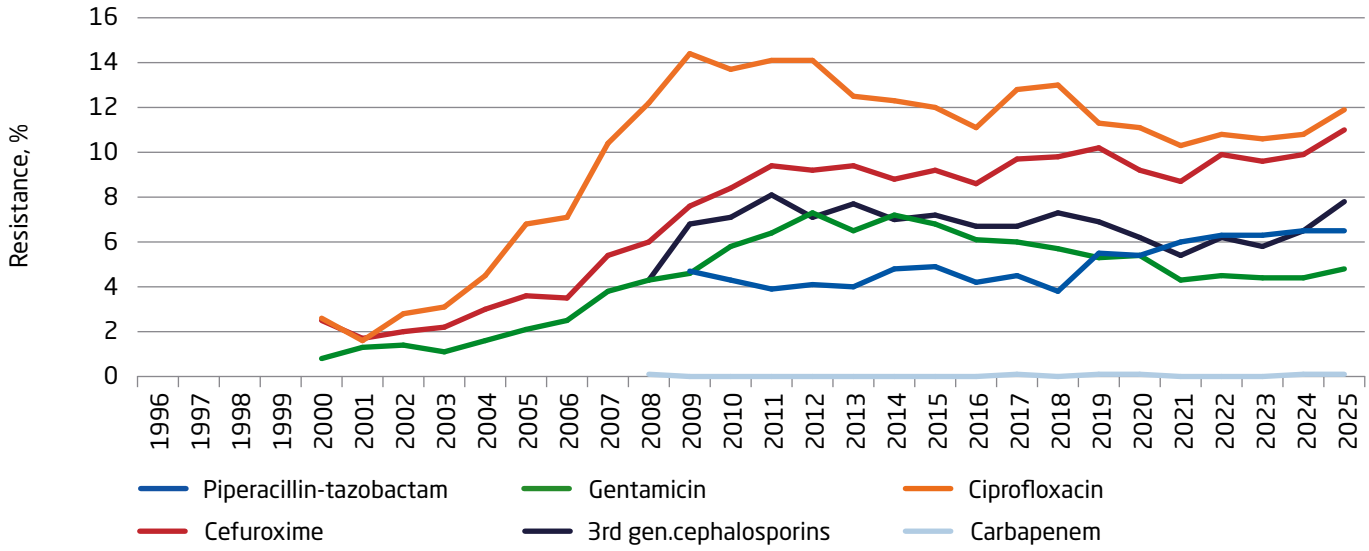
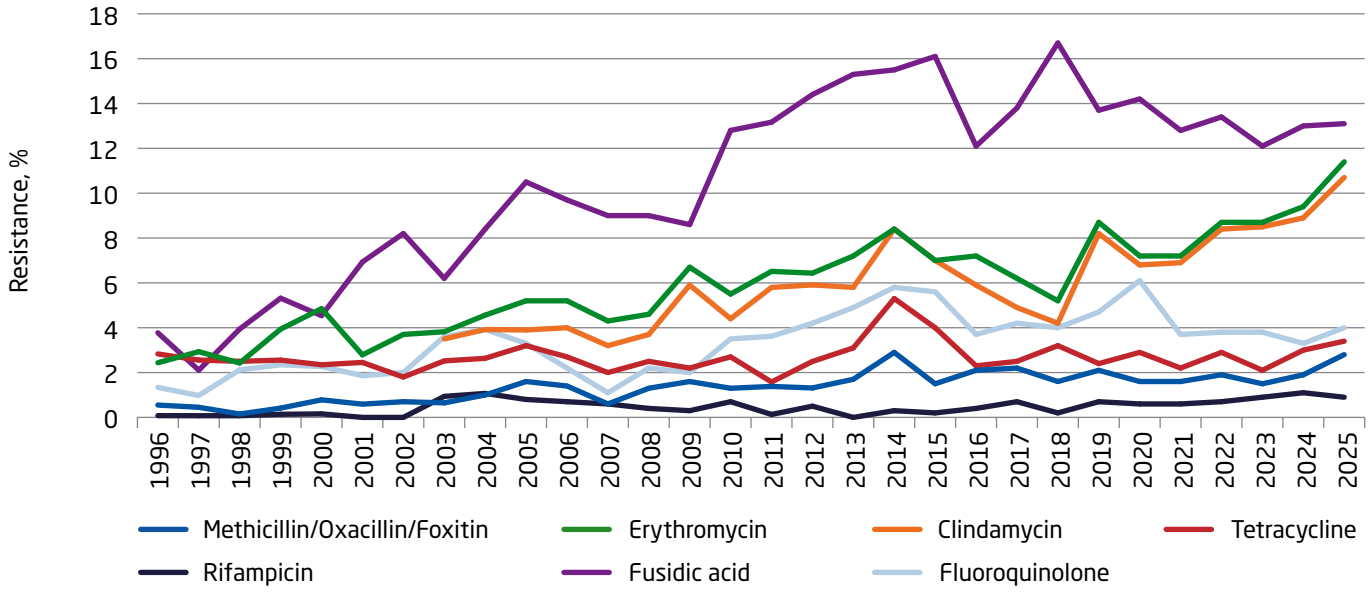


Figure 2.3 Resistance in *S. aureus* bacteraemia in Denmark, 1996-2025



Animal sector

Antimicrobial use

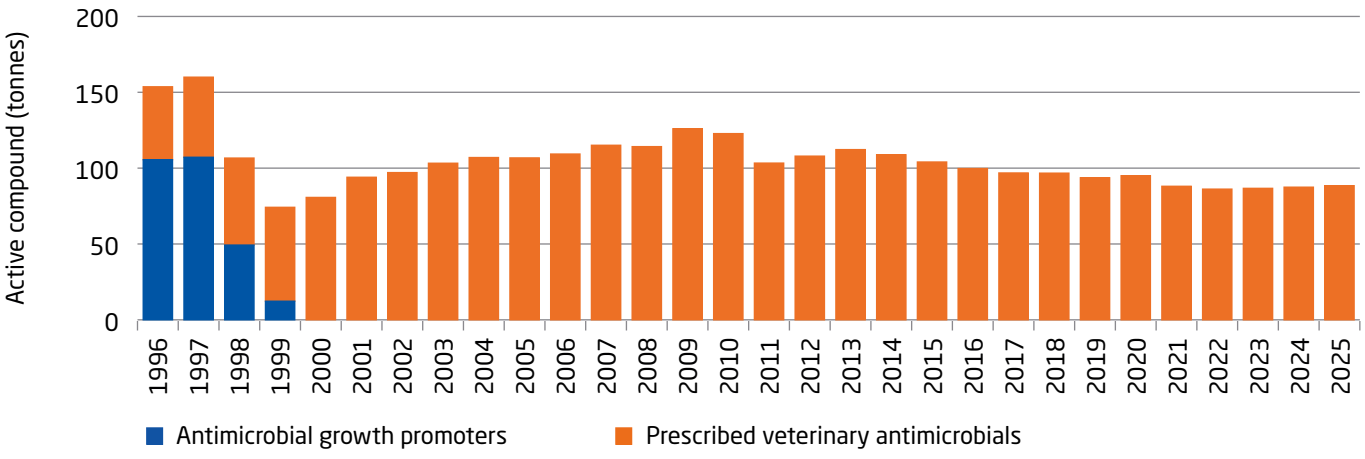
The surveillance of antimicrobial consumption in animals is based on sales data from pharmacies, veterinary practices, and feed mills. Since 2001, all medicines prescribed for use in animals have been recorded in Denmark's national database, VetStat, which collects detailed data on the consumption of veterinary prescription medicines. Prior to 2001 (1996-2000), the data were based on reports of total annual sales from the pharmaceutical industry and from the Danish Medicines Agency and Danish Plant Directorate.

Since the establishment of DANMAP, numerous initiatives have been introduced to reduce antimicrobial consumption in animals. These included the discontinuation of antimicrobial agents for growth promotion (2000), voluntary bans on the use of 3rd and 4th generation cephalosporins in pig production (2010), limiting the treatment of mastitis to simple penicillins (2010), the implementation of the Yellow Card Initiative (2010), differentiated tax on veterinary antimicrobials (2013), revision of the Yellow Card initiative with increased focus on critically important antimicrobials (2016), and more recently the EU-wide ban on the veterinary use of medicinal zinc oxide (2022). Collectively, these efforts have had a significant impact on antimicrobial consumption in animals – particularly in pigs. Figure 2.4 illustrates overall antimicrobial consumption in animals throughout 30 years of monitoring.

The overall use of antimicrobial active compounds in animals declined from 154 tonnes in 1996 (106 tonnes used as growth promoters and 48 tonnes for therapeutic use) to 88 tonnes in 2025. This represents a decrease of 42% in the total use of antimicrobials in animals over 30 years. Over the three decades, the lowest reported value in total antimicrobial consumption was 62 tonnes in 1999, shortly before the implementation of the national ban on the use of growth promoters. An increase in therapeutic use occurred in the subsequent decade, with the highest values observed in 2009 (126 tonnes) and 2010 (123 tonnes). Since then, several initiatives have been implemented with the objective of reducing antimicrobial consumption in animals, and in 2025 the total antimicrobial use was 28% lower compared to 2010.

The pig sector has consistently represented the primary contributor to veterinary antimicrobial consumption in Denmark. Consequently, significant shifts in use patterns within this sector have had a substantial influence on overall antimicrobial consumption. Over time, antimicrobial use in pigs has been shaped not only by regulatory interventions and stewardship initiatives, but also by structural changes in production systems. Notably, increases in pig production have played a significant role in influencing overall use patterns. In 1996, the annual production in thousand heads of the major food-producing animals in Denmark corresponded to 130,295 for poultry, 789 for cattle and 20,530 for pigs (DANMAP 1997, table 1). In 2025, the annual production in the same units corresponded to 126,736 for poultry, 1,041 for cattle and 31,966 for pigs. Note that the number of live pigs exported after weaning for slaughter abroad has been increasing for several years, having reached 54% of all pigs produced in 2025. Nevertheless, there has been an increase from 1996 to 2025 in the number of pigs being produced (born and weaned) in Denmark every year. In 2025, pigs accounted for approximately 85% of all veterinary-prescribed antimicrobials, corresponding to 74.88 tonnes out of the total 88.44 tonnes of active compounds prescribed for veterinary therapeutic use.

Figure 2.4 Antimicrobial consumption in animals, Denmark, 1996-2025



Antimicrobial resistance

Escherichia coli and Enterococci (*E. faecalis* and *E. faecium*) have been included in the DANMAP programme since its implementation as indicators of the occurrence of antimicrobial resistance in bacteria from food-producing animals and food. Indicator *E. coli* from healthy broilers, pigs and cattle sampled at slaughter has been continuously monitored since 1996, while data from *E. faecalis* and *E. faecium* has been more inconsistent.

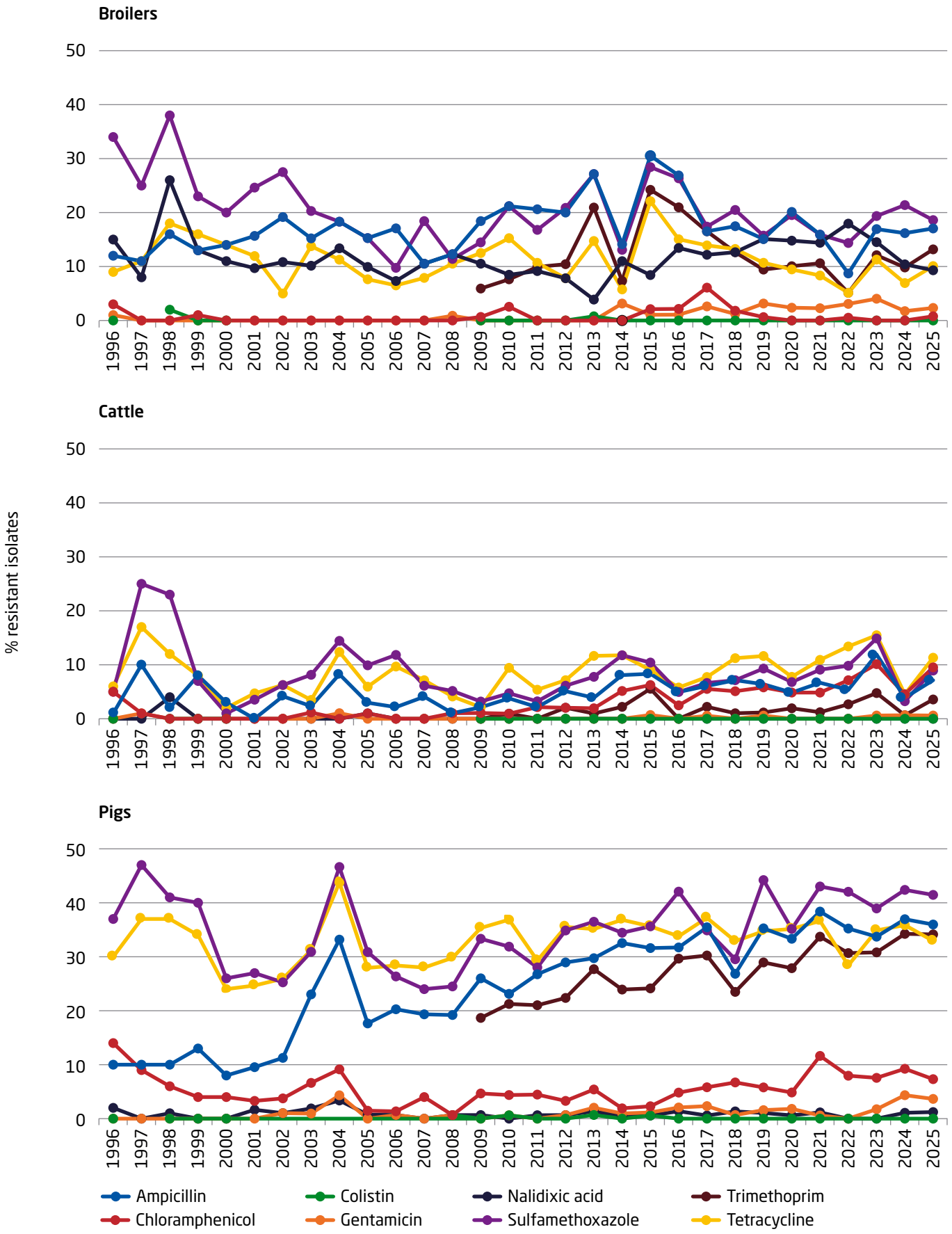
In DANMAP 1996, the antimicrobial resistance pattern was presented for 639 indicator *E. coli* isolates recovered from animals sampled at slaughter (172 broilers, 140 cattle and 327 pigs). After the implementation of the EU rules for the harmonized monitoring of AMR in food-producing animals in 2014, the number of reported isolates has become relatively stable, oscillating around 150-170 per animal species, per year. The panel of antimicrobial substances for which indicator *E. coli* has been tested has also varied over time (DANMAP 1996, table 1.5b and DANMAP 2025, table 10.2), as have the antimicrobial susceptibility testing methods employed. In DANMAP 1996, the first results available resulted both from disk diffusion and broth microdilution (DANMAP 1996, table 1.1), whereas presently only the latter is applied. Regarding the antimicrobial test panel, only eight substances belonging to eight antibiotic classes have been tested consistently every year between 1996-2025. The occurrence of resistance to these substances as shown in each annual report is presented in Figure 2.5. In 1996, the test panel included additionally the aminoglycosides apramycin, streptomycin, neomycin and spectinomycin, the fluoroquinolone enrofloxacin, and the cephalosporin ceftiofur. These are substances of relevance for veterinary use and most of them are presently part of the test panel for pathogenic *E. coli* isolates from pigs monitored in DANMAP. In 2025, the test panel for indicator *E. coli* included additionally the aminoglycoside amikacin, the fluoroquinolone ciprofloxacin, the macrolide azithromycin and the cephalosporins cefotaxime and ceftazidime. These are substances of high relevance for human treatment, and resistance to them is presently mandatory to monitor in indicator *E. coli* from food-producing animals in all EU countries.

Figure 2.5 shows across the selected substances overall highest levels of occurrence of resistance among isolates from pigs, followed by isolates from broilers, and the lowest levels in isolates from cattle. Across indicator *E. coli* from all three animal species, the highest occurrence of resistance has been consistently observed for the antimicrobials ampicillin, sulfamethoxazole, trimethoprim and tetracycline, which are responsible for the multidrug resistance (MDR) profile commonly encountered in *E. coli* – ASuT.

Notably, resistance to some individual substances was commonly present in *E. coli* from only one or two of the animal reservoirs. While resistance against fluoroquinolones (nalidixic acid) is common in *E. coli* from broilers but rare in *E. coli* from cattle and pigs, resistance to chloramphenicol occurs in *E. coli* from the two latter species but is rare in *E. coli* from broilers. In 2025 compared to 2016 the occurrence of resistance to chloramphenicol increased from 2.5% to 9.5% in isolates from cattle, and from 4.8% to 7.3% in isolates from pigs. Resistance to fluoroquinolones among *E. coli* from broilers has shown consistently increased levels (above 10%) in the period 2016-2023, with a maximum of 17.9% observed in 2022, however, it has been decreasing since 2023, and it was detected in 9.3% of the isolates in 2025.

Resistance towards colistin and gentamicin, two important antimicrobials for human treatment, has been absent or found at very low levels in indicator *E. coli* from all three reservoirs throughout the three decades. Noteworthy, the occurrence of resistance to gentamicin has been detected more frequently among isolates from broilers and pigs in recent years, although still at low levels (<5%).

Figure 2.5 Resistance (%) to selected antimicrobial substances among indicator *Escherichia coli* isolates from broilers, cattle and pigs, Denmark, 1996-2025

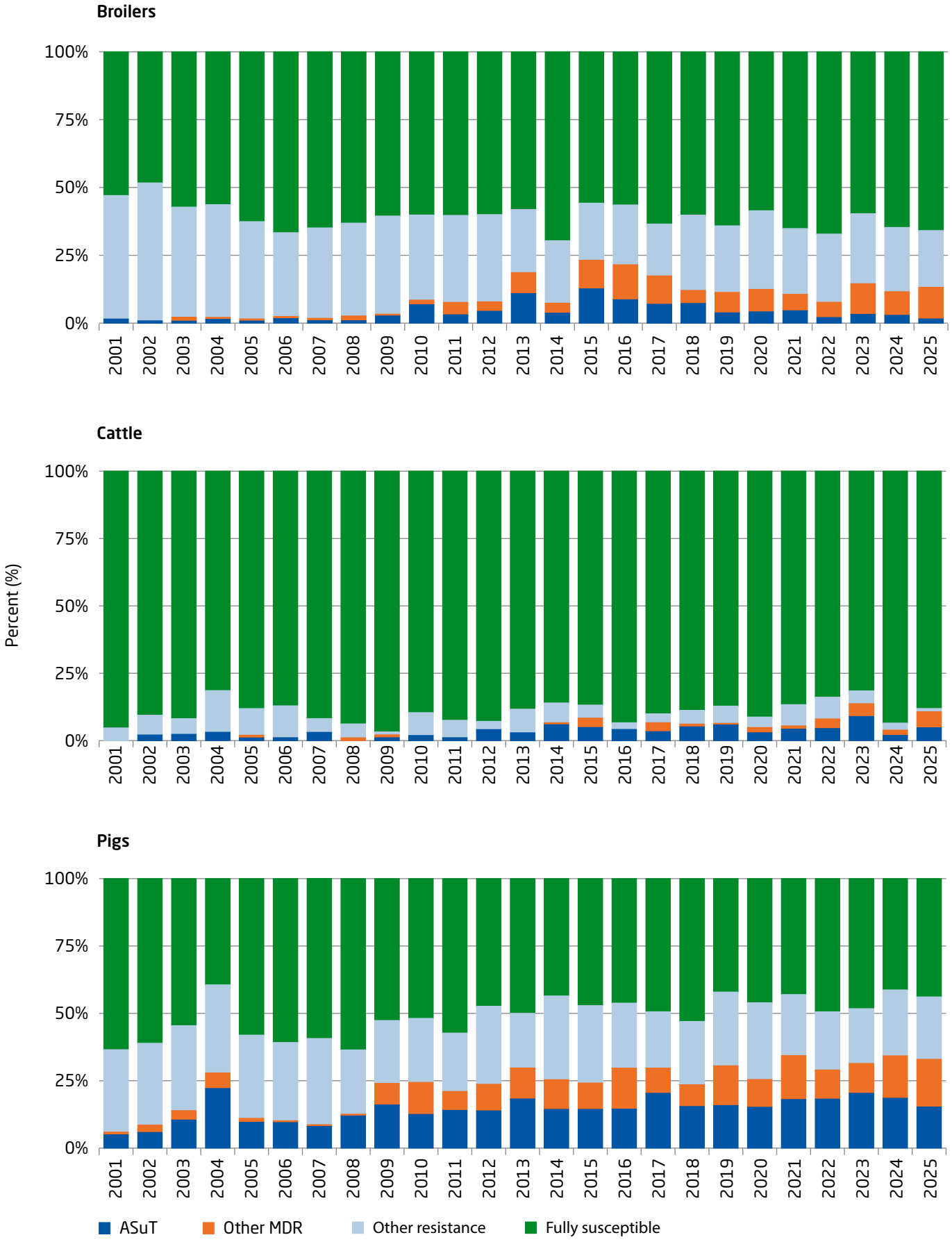


The testing method and the interpretation threshold for each substance may have varied over the years. Occurrence of resistance to trimethoprim is only shown from 2009 onwards due to data inconsistency.

The levels of complete susceptibility and MDR among indicator *E. coli* have also oscillated throughout the existence of the DANMAP programme. A 25-year overview (Figure 2.6) shows that fully susceptible *E. coli* isolates were dominant (50% or above, to a maximum of 69.6%) throughout the period in broilers (with the exception of 2002) and in cattle, with consistently high levels of detection in the latter, ranging between 81.4% in 2004 and 96.8% in 2009. Among *E. coli* from pigs, the occurrence of susceptibility to all tested antimicrobials was dominant (50% or above, to a maximum of 63.6%) until 2013 (except in 2004), and below 50% (to a minimum of 41.3%) in the years thereafter (except in 2018).

The proportion of ASuT and other MDR profiles in isolates from broilers was generally low in the earlier years, and started increasing around 2009-2010, reaching a maximum of 23.1% in 2015, before decreasing and plateauing from 2019 and onwards. Among cattle isolates, the occurrence of multidrug resistance, particularly ASuT, also increased midway, with the levels from 2012 onwards being higher than those observed in earlier years, reaching a maximum of 8.9% ASuT and 4.8% other MDR in 2023. ASuT was the predominant resistance profile throughout the whole period, except in 2025, when other MDR (6%) accounted for a larger proportion than ASuT (4.8%). Among resistant isolates from pigs, ASuT was the predominant profile for most of the surveillance period, with its occurrence increasing from 5% in 2001 to approximately 12% in 2009 and remaining at a stable level thereafter. The occurrence of other MDR profiles showed a clear increase from the period 2001-2008 (ranging from 0.7% to 5.8%) to the period after 2009 (ranging between 8% and 17.7%). Similarly to cattle isolates, in 2025, other MDR (17.7%) also accounted for a larger proportion than ASuT (15.2%) among pig isolates.

Figure 2.6 Relative distributions (%) of AMR profiles among *E. coli* from broilers, cattle and pigs, Denmark, 2001-2025



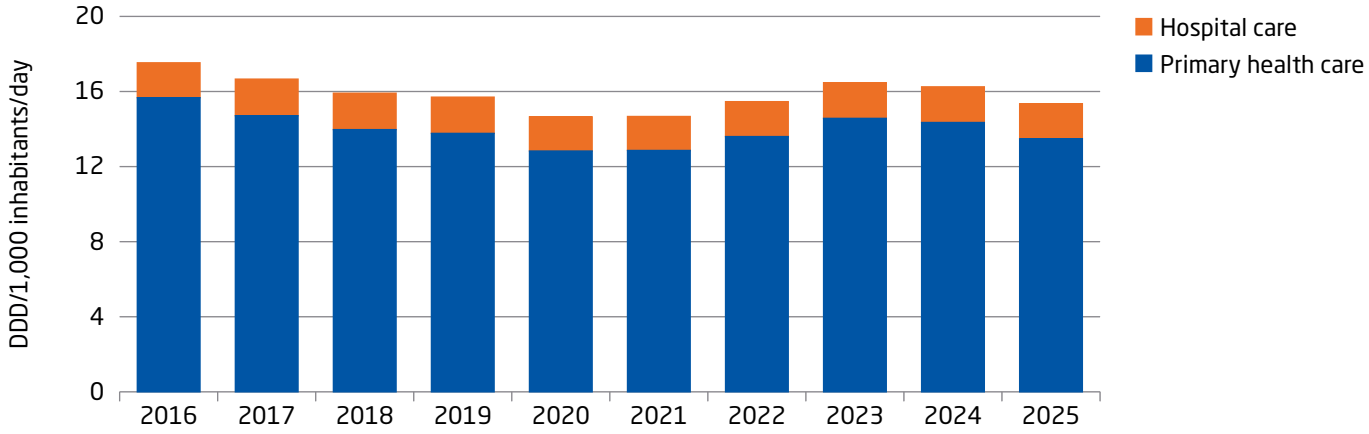
The bars show the percentage of isolates classified as ASuT (resistant to at least ampicillin, sulfamethoxazole and tetracycline), other MDR (other multidrug resistance profiles than ASuT), other resistance (resistance to one or two antimicrobial classes), or fully susceptible (sensitivity to all antimicrobial substances tested).

3. Human Sector

Highlights of antimicrobial consumption

In 2025, antimicrobial consumption in Denmark was 15.35 DID, 12.4% lower than the consumption in 2016 (17.53 DID) and 6% lower than in 2024 (16.25 DID). Changes in the total consumption were driven by changes in antimicrobial prescribing in primary care, which accounts for 88% of antibiotics used in Denmark.

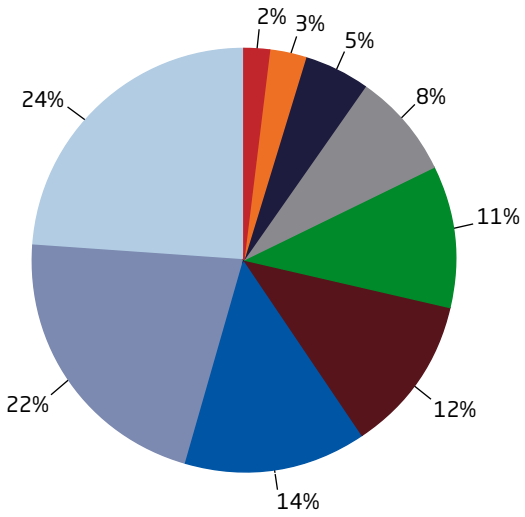
Figure 3.1 Total consumption of systemic antimicrobial agents in humans per health care sector, DDD per 1,000 inhabitants per day, Denmark, 2016-2025



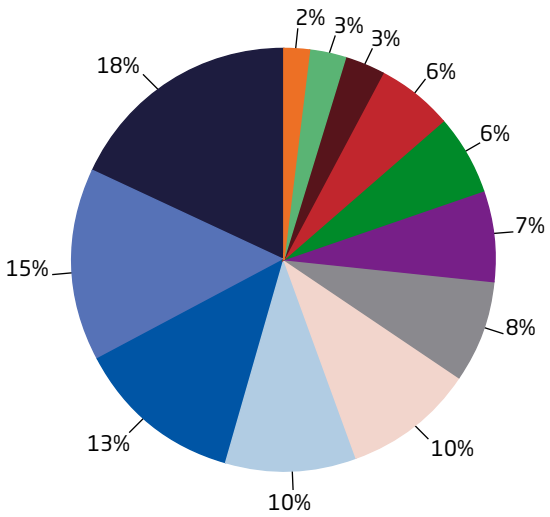
Penicillins are the main drug classes in Denmark. In primary health care they account for 65% and at hospitals for 55% (Figure 3.2). Hospitals prescribe the majority of broad spectrum and critically important antimicrobials (cephalosporins and carbapenems). Assessed by WHO's AWaRe classification system, "access antimicrobials" constituted 82% of the consumption in Denmark in 2025.

Figure 3.2 Percentage distribution of antimicrobial agents in primary health care and hospital care, DDD, Denmark, 2025

Primary care



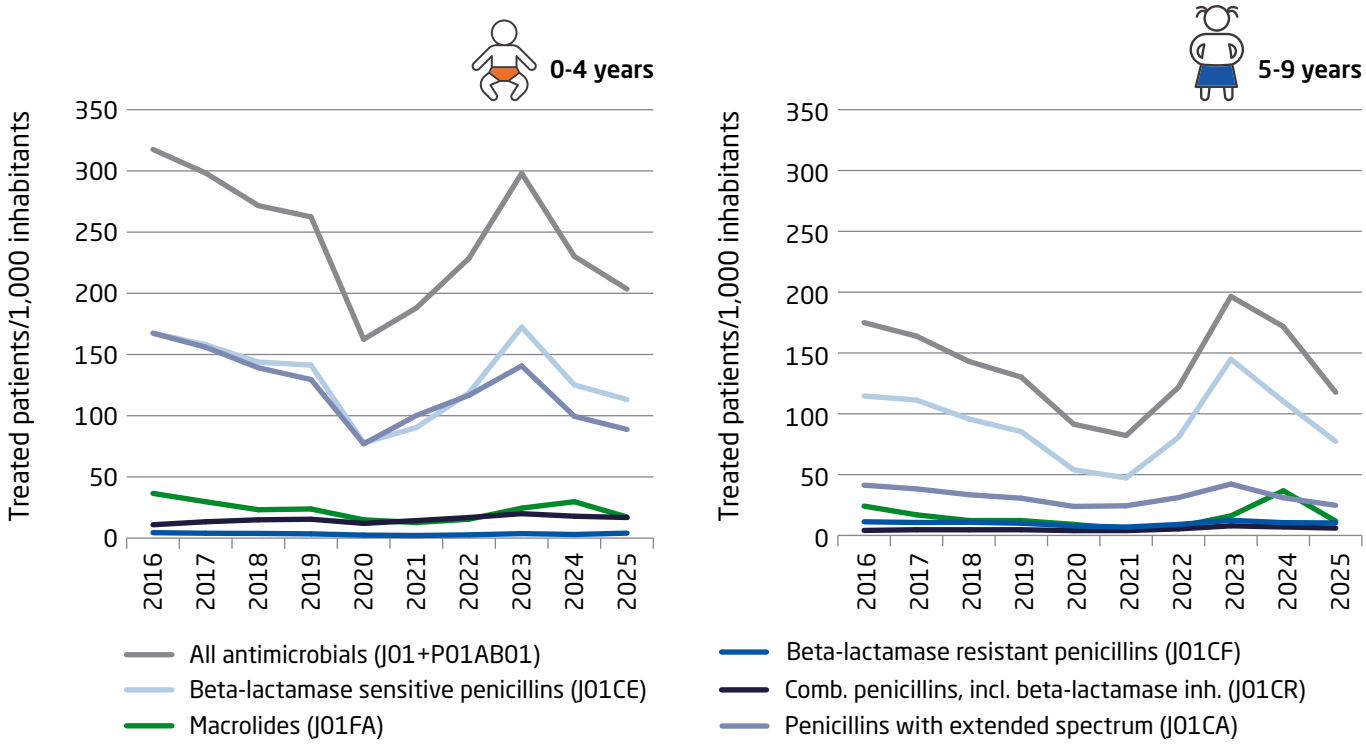
Hospital care



- Comb. of penicillins, incl. beta-lactamase inhib. (J01CR)
- Beta-lactamase resistant penicillins (J01CF)
- Sulfonamides and trimethoprim (J01E)
- Cephalosporins (J01DB, J01DC, J01DD)
- Fluoroquinolones (J01MA)
- Aminoglycosides (J01GB)
- Penicillins with extended spectrum (J01CA)
- Beta-lactamase sensitive penicillins (J01CE)
- Other antimicrobials (J01X, J01DF, A07AA09, P01AB01)
- Macrolides, lincosamides and streptogramins (J01F)
- Tetracyclines (J01AA)
- Carbapenems (J01DH)

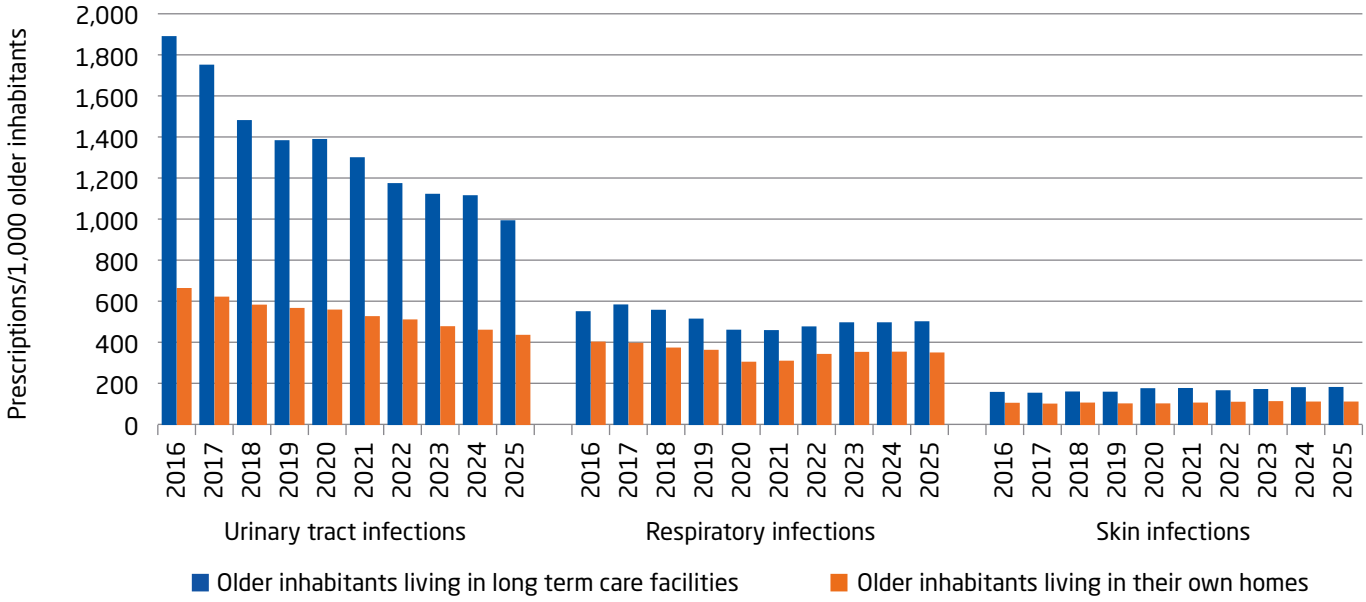
Among children, the consumption of beta-lactamase sensitive penicillins decreased by up to 30% in 2025, Figure 3.3. The COVID-19 related increase in consumption of beta-lactamase sensitive penicillins discontinued in already 2024 (-11.6% from 2023 to 2024) probably due to renormalized occurence of airway infections. On the other hand, consumption of macrolides increased by 21% from 2023 to 2024, probably due to the Group A streptococcal pandemic in 2023 and 2024, mainly among children and their parents. The increase in macrolide consumption was reversed in 2025 (up to 68% decrease).

Figure 3.3 Consumption of main antimicrobial agents among children, treated patients/1,000 inhabitants, Denmark, 2016-2025



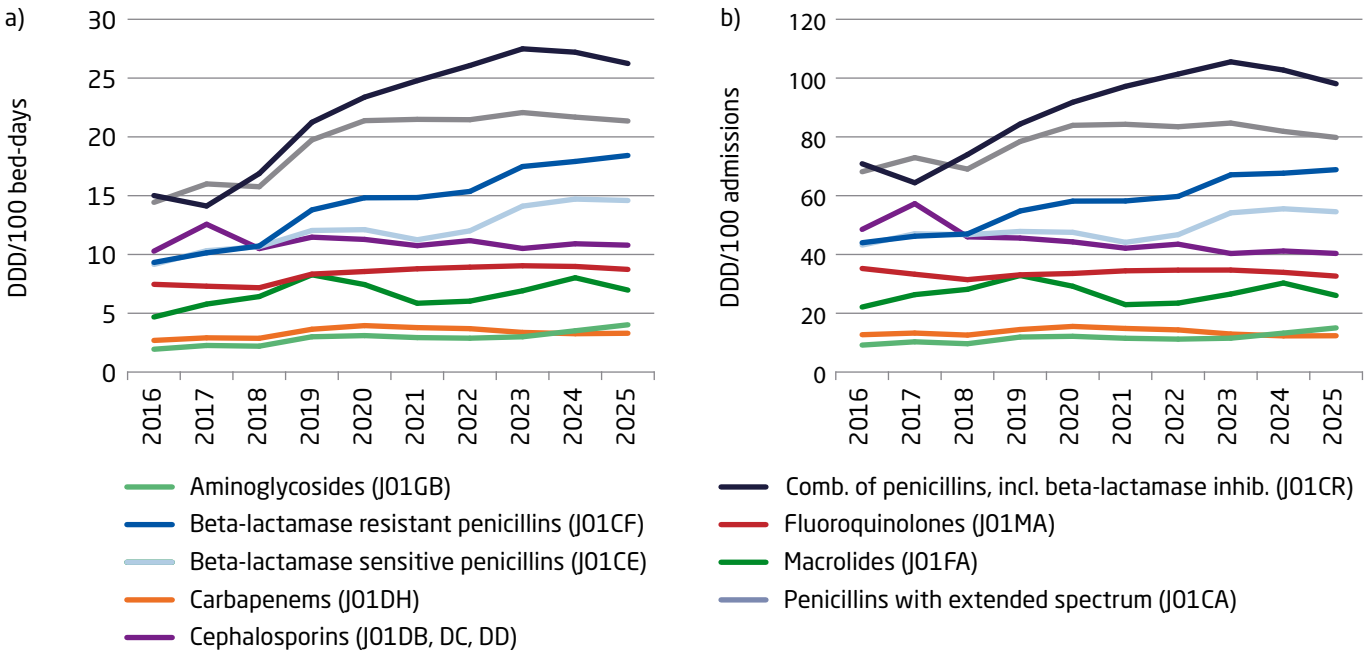
For older inhabitants, the antimicrobial consumption has been decreasing since 2016, with steeper decreases observed among older inhabitants living at care homes. However, older inhabitants living at care homes continue to receive notably more antimicrobials than older inhabitants living in their own homes (Figure 3.4). Urinary tract infections were the main driver of the high treatment frequency at care homes (991 versus 433 prescriptions for urinary tract infections per 1,000 older inhabitants, respectively in 2025).

Figure 3.4 Treatment of infections in primary health care for inhabitants ≥65 years, Denmark, 2016-2025



In hospital care, antimicrobial consumption in 2025 was similar to 2023-2024 after several years with increasing trends when measuring in DDD per 100 bed-days or per 100 admissions (Figure 3.5). In particular, combinations of penicillins, including beta-lactamase inhibitors have shown decreasing trends since 2024 (4-5% in 2025) after years of increasing consumption. Simultaneously, consumption of beta-lactamase sensitive penicillins has increased.

Figure 3.5 Antimicrobial consumption at somatic hospitals by antimicrobial group, a) DDD per 100 bed-days and b) DDD per 100 admissions, Denmark, 2016-2025



Over the last decade, consumption of critically important antimicrobials (cephalosporins, carbapenems and fluoroquinolones) has decreased continuously and by 13% in 2025 (DDD/100 admissions). This reflects the long-standing efforts in everyday clinical practice to keep the consumption low. Also, the national action plans on antimicrobial resistance in human health care published in 2017 and renewed in 2025 emphasize the importance of continued efforts to keep the consumption of critically important antimicrobials at a low level.

Highlights of antimicrobial resistance

Resistance in invasive infections with *E. coli* has fluctuated with increasing trends since 2016. Particularly, piperacillin-tazobactam-resistance has increased during this period. Resistance to 3rd generation cephalosporins, ciprofloxacin and cefuroxim has increased over the past five years after reaching a low-point in 2021 (Figure 3.6a). Carbapenem-resistance remained low at 0.1%. Table 3.1 presents resistance to selected antimicrobials in invasive *E. coli* for the last 10 years and also compared with 20 years ago.

Table 3.1 Invasive *Escherichia coli* isolates from humans, resistance (%) and annual number of individual cases, Denmark, 2006 and 2016-2025

Substance	Percent resistant invasive *E. coli* isolates												
	2006	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Trend 20 yr	Trend 10 yr
Piperacillin-tazobactam	NA	4.2	4.5	3.8	5.5	5.4	6.0	6.3	6.3	6.5	6.5	NA	55% ↑
Gentamicin	2.5	6.1	6.0	5.7	5.3	5.4	4.3	4.5	4.4	4.4	4.8	92% ↑	21% ↓
Ciprofloxacin	7.1	11.1	12.8	13.0	11.3	11.1	10.3	10.8	10.6	10.8	11.9	67% ↑	7% ↑
Cefuroxime	3.5	8.6	9.7	9.8	10.2	9.2	8.7	9.9	9.6	9.9	11.0	214% ↑	28% ↑
3rd gen.cephalosporins	NA	6.7	6.7	7.3	6.9	6.2	5.4	6.2	5.8	6.5	7.8	NA	16% ↑
Carbapenem	NA	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	NA	0% ↑
Combined resistance Amp/Genta	NA	5.8	5.8	5.5	5.2	5.1	4.0	4.1	4.1	4.0	4.3	NA	26% ↓
Total number of isolates	3,505	4,841	5,114	5,398	5,613	5,870	5,981	5,905	5,835	5,957	6,056	73% ↑	25% ↑

Invasive infections with ESBL *E. coli* have increased from 312 in 2016 to 387 in 2025, but with large variations from year to year with the lowest being 254 in 2021. ST131 remained the most frequent MLST and CTX-M-15 (59%) and CTX-M-27 (21%) the most common ESBL enzymes.

Piperacillin-tazobactam-resistance has also increased substantially in invasive infections with *K. pneumoniae* complex from 5.8% to 10.0% over the last decade (Figure 3.6b). This is of continued concern. As for *E. coli*, a slow increase in resistance to ciprofloxacin, 3rd generation cephalosporins and cefuroxim has also been observed. Resistance to carbapenems has remained below 1% with fluctuations due to outbreaks. Table 3.2 presents resistance to selected antimicrobials in invasive *K.pneumoniae* complex for the last 10 years and also compared with 20 years ago.

Figure 3.6 a) Antimicrobial resistance in *Escherichia coli isolates* from invasive infections and b) antimicrobial resistance in *Klebsiella pneumoniae* complex isolates from invasive infections, Denmark, 2016-2025

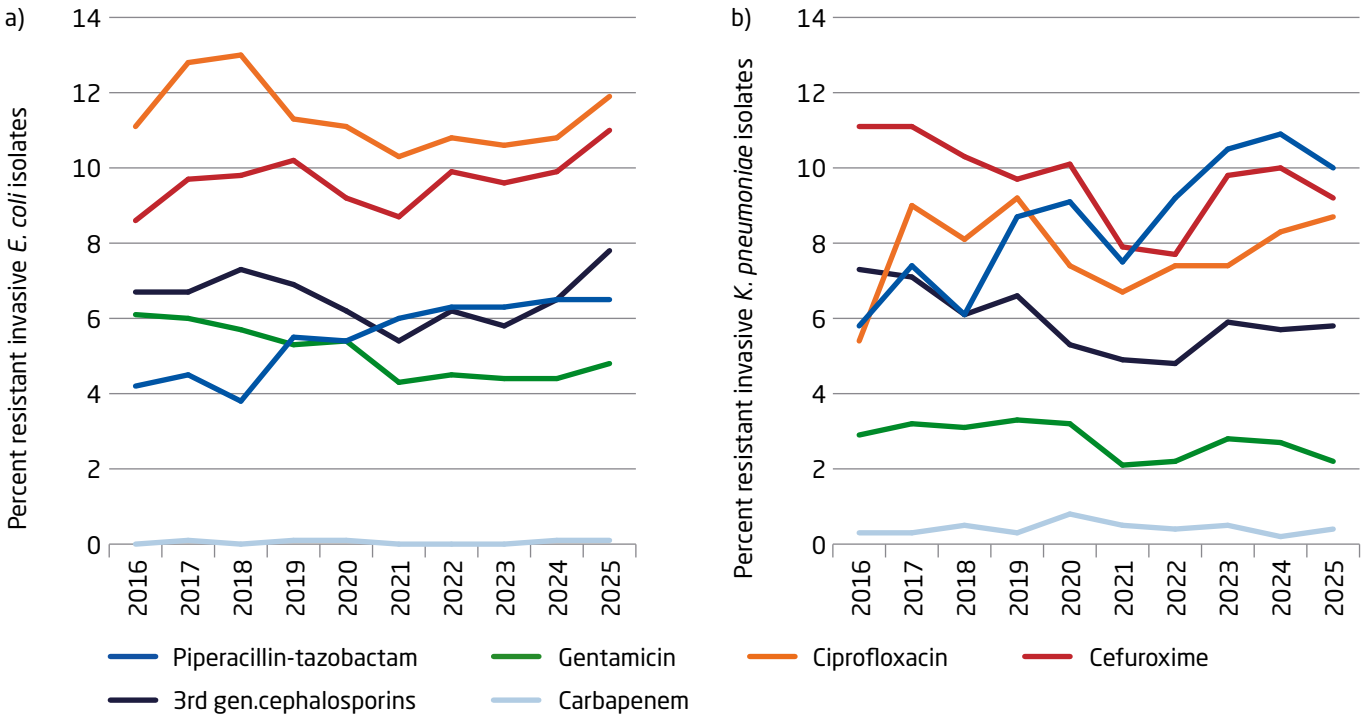


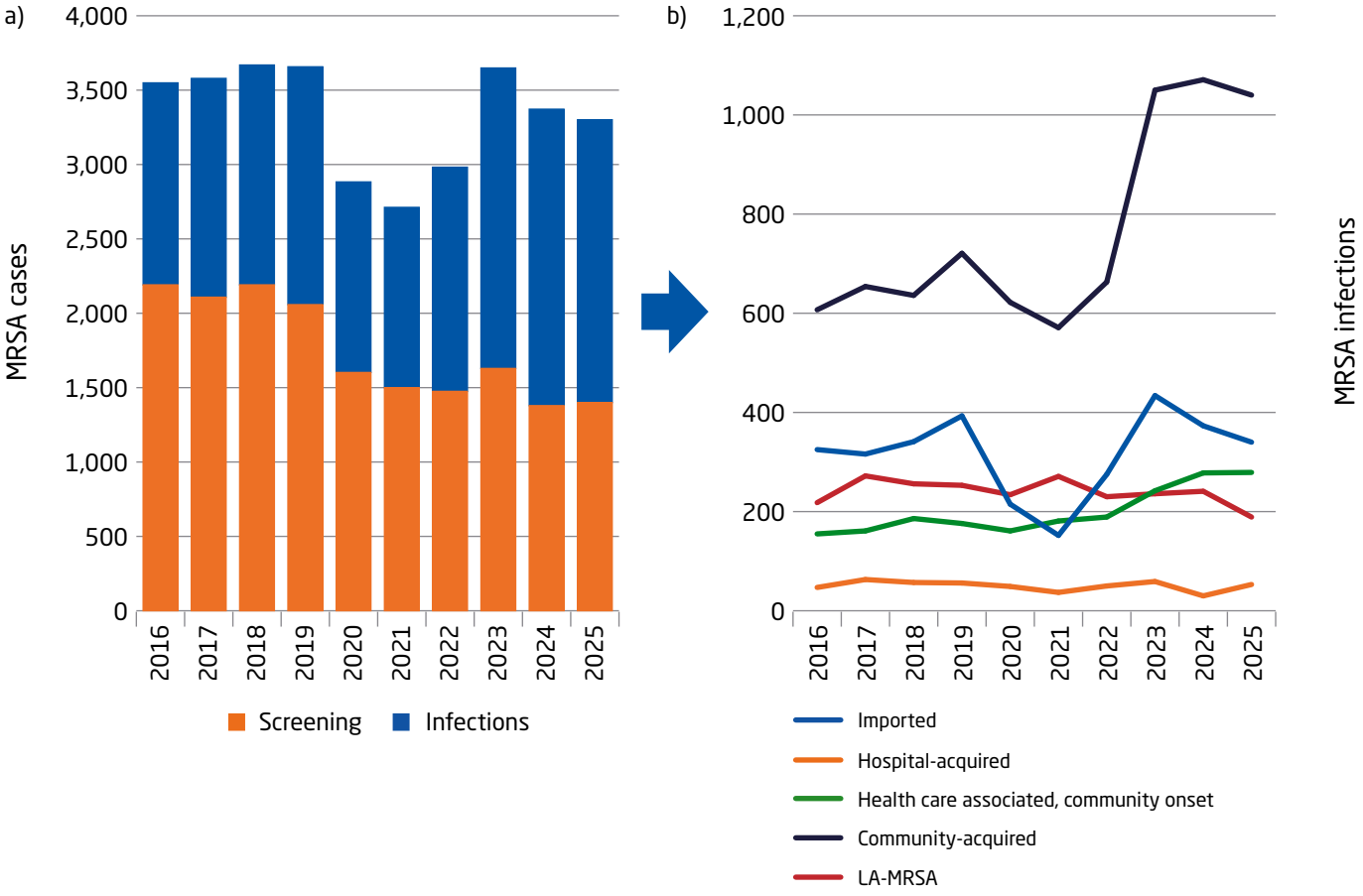
Table 3.2 Invasive *Klebsiella pneumoniae* complex isolates, resistance (%) and annual number of individual cases, Denmark, 2011 and 2016-2025

Substance	Percent resistant invasive *K. pneumoniae* complex isolates												
	2011**	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Trend 15 yr	Trend 10 yr
Piperacillin/ tazobactam	5.4	5.8	7.4	6.1	8.7	9.1	7.5	9.2	10.5	10.9	10	85% ↑	72% ↑
Gentamicin	5.8	2.9	3.2	3.1	3.3	3.2	2.1	2.2	2.7	2.7	2.2	62% ↓	24% ↓
Ciprofloxacin	11.7	5.4	9	8.1	9.2	7.4	6.7	7.4	7.2	8.1	8.7	26% ↓	61% ↑
Cefuroxime	14	11.1	11.1	10.3	9.7	10.1	7.9	7.7	9.6	9.8	9.2	34% ↓	17% ↓
3rd gen. cephalosporins	9.6	7.3	7.1	6.1	6.6	5.3	4.9	4.8	5.7	5.5	5.8	40% ↓	21% ↓
Carbapenem	0	0.3	0.3	0.5	0.3	0.8	0.5	0.4	0.5	0.2	0.4	NA	33% ↑
Combined resistance*	NA	1.6	2.4	1.7	2.4	1.5	1.0	1.0	1.8	1.4	0.9	NA	44% ↓
Total number of isolates	908	1,156	1,183	1,280	1,361	1,413	1,336	1,346	1,466	1,506	1,718	89% ↑	49% ↑

* Resistance to 3rd generation cephalosporins, ciprofloxacin, and gentamicin (multiresistance)
** Data from 2006 not available, surveillance of *K. pneumoniae* began in 2008.

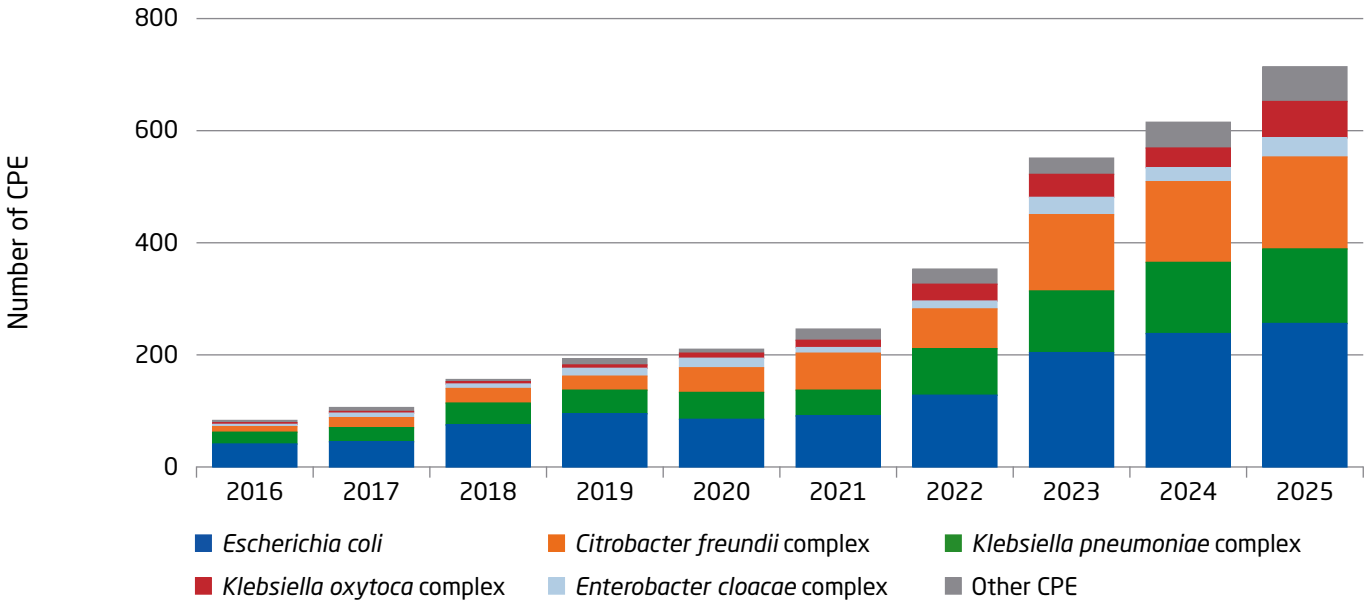
Sixty-six cases of bacteraemia with MRSA were identified in 2025 with the highest prevalence (2.8% of all *S. aureus* cases) since 2014 and nearly a 50% increase from 2024. Seven of these were caused by LA-MRSA. The number of new cases of MRSA was 3,301 with infections constituting 58%, which is a decrease compared to first post-COVID-19 years, but still higher both relatively and in absolute numbers than before the pandemic (Figure 3.7a). The majority of cases are classified as community-acquired (Figure 3.7b). Thirty-six MRSA outbreaks were registered at hospitals, nursing homes or other institutions with a total of 127 cases whereof 60 were infections.

Figure 3.7 a) Number of MRSA cases per year by screening/infection b) Epidemiological classification of MRSA infections, Denmark, 2016-2025



The number of carbapenemase-producing organism (CPO) isolates detected in Denmark has increased dramatically over the past ten years from 115 isolates in 2016 to 760 isolates in 2025. Additionally, the epidemiology of the cases has likely changed from being primarily travel-related cases to spread from domestic outbreaks or cases with no known epidemiological link. However, a large proportion of cases have no reported information on travel. Carbapenemase-producing Enterobacterales (CPE) constituted 714 of the new CPO isolates. The majority of new CPE cases are caused by *Escherichia coli, Citrobacter freundii* complex and *Klebsiella pneumoniae* complex demonstrating the complex epidemiological transmission routes (Figure 3.8). A total of 34 CPO-outbreaks were registered in 2025 involving 176 new patients of which six patients were involved in more than one outbreak.

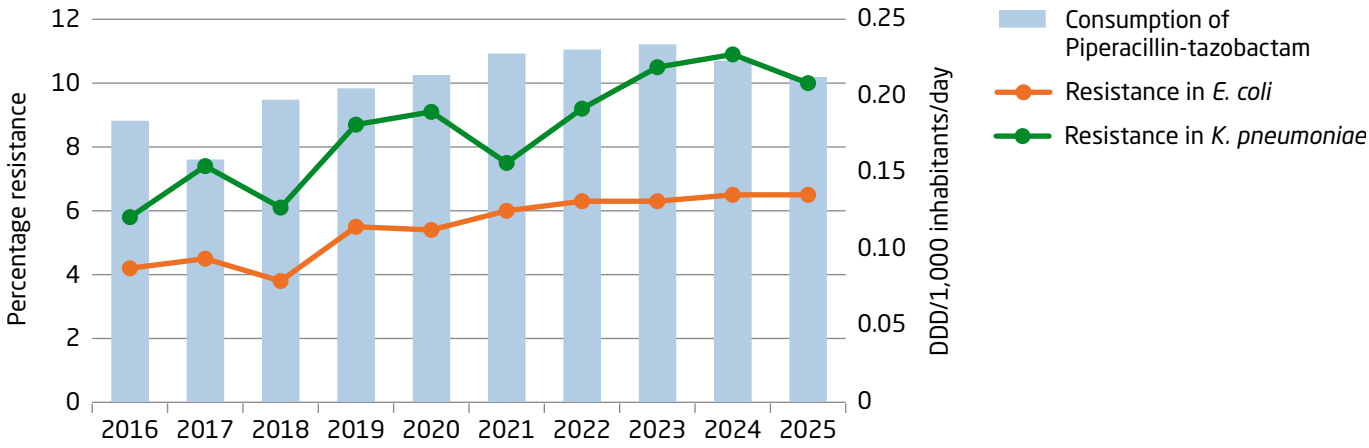
Figure 3.8 Number of new carbapenemase-producing Enterobacterales cases by bacterial species, Denmark, 2016-2025



Integrated perspectives of antimicrobial consumption and resistance

Over the last decade, there has been several changes in consumption of antimicrobials for humans, followed by changes in resistance trends. A steep increase was observed for consumption of combinations of penicillins and beta-lactamase inhibitors in hospital care. This was followed by an increase in the occurrence of resistance towards piperacillin-tazobactam in invasive *Escherichia coli* and especially *Klebsiella pneumoniae* from human cases, which has exceeded 10% for the past three years (Figure 3.9).

Figure 3.9 Piperacillin-tazobactam resistance (%) in invasive *Escherichia coli* and *Klebsiella pneumoniae* combined with piperacillin-tazobactam consumption (DID), Denmark, 2016-2025



On the other hand, reduced consumption of cephalosporins and fluoroquinolones (ciprofloxacin) was followed by reduced trends in resistance towards these antibiotics also in invasive *E. coli* and *K. pneumoniae* (Figure 3.10 and Figure 3.11).

Figure 3.10 3rd generation cephalosporin resistance (%) in invasive *Escherichia coli* and *Klebsiella pneumoniae* combined with cephalosporin consumption (DID), Denmark, 2016-2025

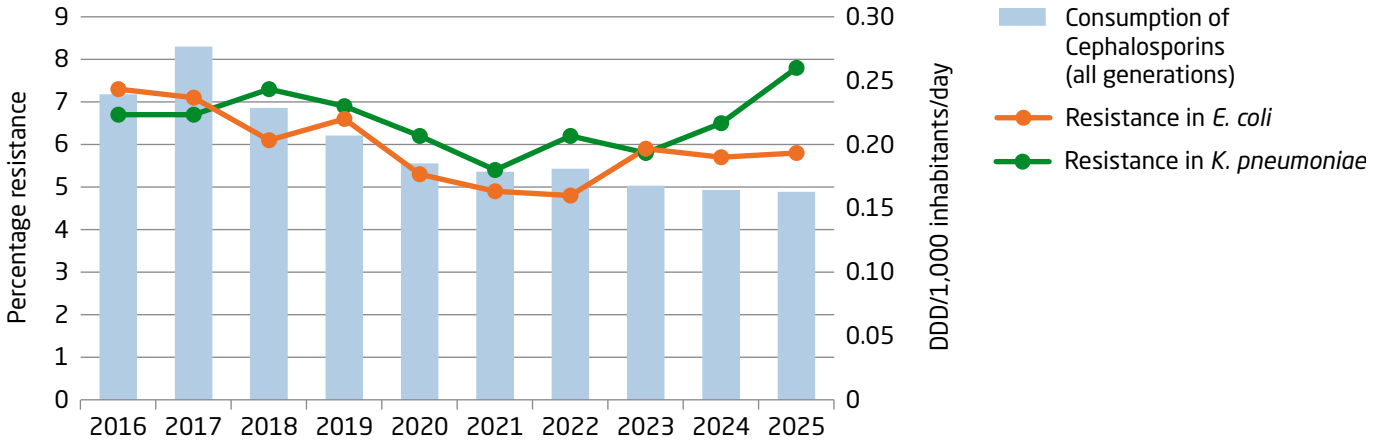
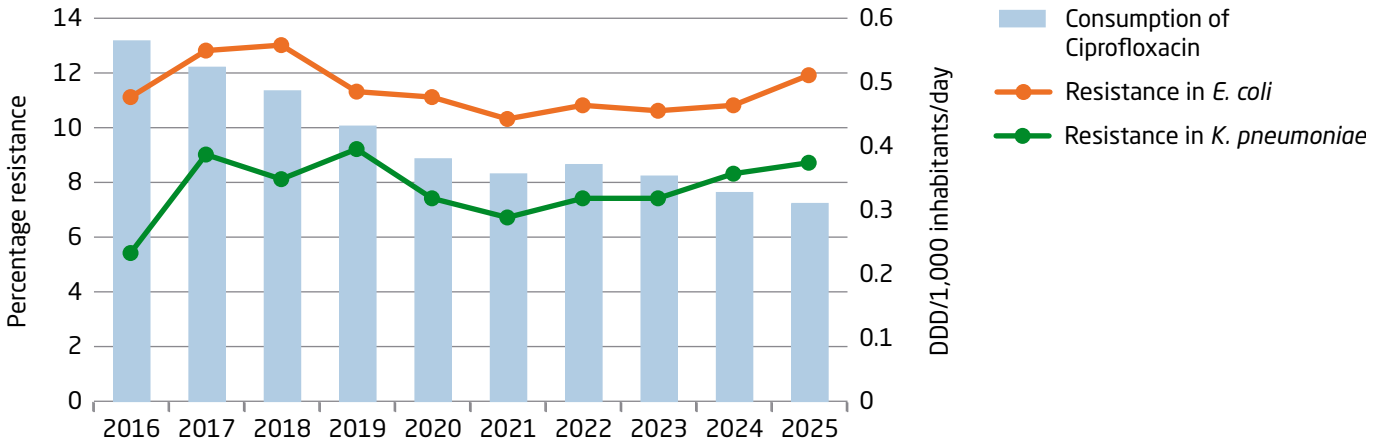


Figure 3.11 Ciprofloxacin resistance (%) in invasive *Escherichia coli* and *Klebsiella pneumoniae* combined with Ciprofloxacin consumption (DID), Denmark, 2016-2025



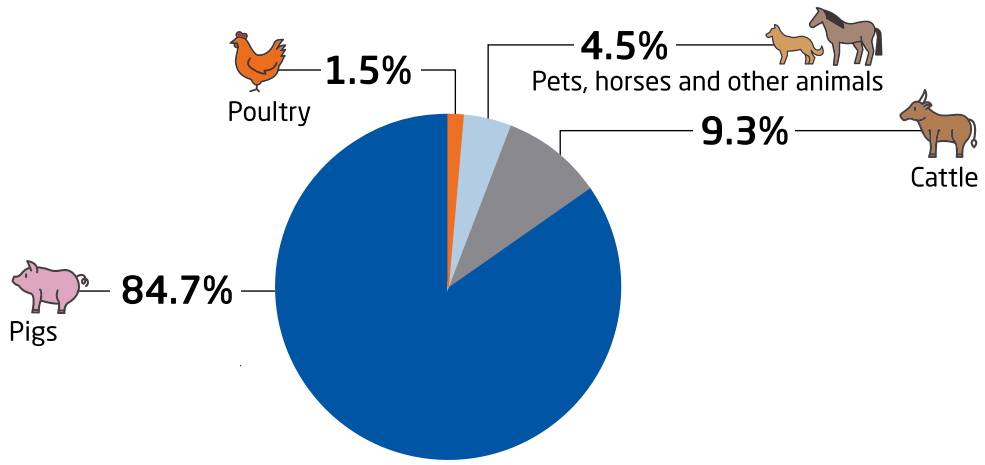
Curiously, the trend has since reversed with increasing resistance to 3rd generation cephalosporins and ciprofloxacin in both *E. coli* and *K. pneumoniae* over the past five years despite of continued decrease in the consumption of these antimicrobials.

4. Animal sector

Highlights of antimicrobial consumption

In 2025, **total antimicrobial consumption** in animals amounted to 88.44 tonnes of active compounds, representing a 1.14% increase compared with 2024. Pigs accounted for 84.7% of total consumption, followed by cattle (9.3%) (Figure 4.1). Pig production remained the principal driver of antimicrobial consumption in Danish livestock, despite cattle representing the largest share of estimated live biomass.

Figure 4.1 Distribution (%) of overall antimicrobial consumption by main animal species, Denmark, 2025



Antimicrobial consumption in **pigs** totaled 74.88 tonnes, corresponding to an increase of 2.03% compared with 2024. During the same period, the estimated live biomass increased by 0.38%, primarily due to increased exports of pigs. Taken together, these changes resulted in a 2.41% increase in the treatment proportion (DAPD). On any given day, an estimated 1.80% of sows and piglets, 11.57% of weaners, and 1.89% of finishers received antimicrobial treatment.

Table 4.1 presents an overview of the upward and downward changes in the DAPD in 2025 compared to 2024, by antimicrobial class and age group, in the pig production sector. Interestingly, in 2025, the use of lincosamides was higher across all age groups, and the use of macrolides was higher among weaners and finishers. Also notably, the use of aminoglycosides was lower in 2025 among weaners and finishers.

Table 4.1 Increase and decrease in the DAPD in pigs in 2025 compared to 2024, by antimicrobial class and age group, Denmark

Age class	Increase	Decrease
Sows and piglets	lincosamides (165%)	amphenicols (18%) macrolides (6%) other penicillins (11%) pleuromutilins (17%)
Weaners	amphenicols (19%) macrolides (10%) lincosamides (11%)	aminoglycosides (4%) β-lactamase-sensitive penicillins (5%) pleuromutilins (8%)
Finishers	macrolides (15%) pleuromutilins (9%) lincosamides (537%)	aminoglycosides (12%) amphenicols (59%) sulfonamides-trimethoprim (37%)

In **cattle**, antimicrobial consumption decreased to 8.20 tonnes, corresponding to a reduction of 0.72% compared with 2024, while the estimated live biomass declined by 1.05%. Daily systemic antimicrobial treatment affected approximately 0.26% of adult cattle and 0.85% of young cattle. Table 4.2 presents an overview of the upward and downward changes in the DAPD in 2025 compared to 2024, by antimicrobial class and age group, in the cattle production sector. The intramammary use of beta-lactamase-sensitive penicillins continued to dominate despite the decrease observed in 2025.

Table 4.2 Increase and decrease in the DAPD in cattle in 2025 compared to 2024, by antimicrobial class and age group

Age class	Increase	Decrease
Adult cattle	lincosamides (57%) aminoglycosides (8%) macrolides (4%) other penicillins (4%) cephalosporins (334%)	amphenicols (18%) β-lactamase-sensitive penicillins (5%) tetracyclines (2%)
Young cattle (<1 year)	macrolides (21%) other penicillins (8%) amphenicols (5%)	lincosamides (28%) tetracyclines (23%) β-lactamase-sensitive penicillins (5%) aminoglycosides (4%)

Antimicrobial consumption in **poultry** increased by 17.95% compared with 2024. Despite this increase, overall use remained very low and continued to be strongly influenced by disease outbreaks affecting a limited number of flocks.

In **horses** and **pets**, fluoroquinolone consumption was 12.75 kg in 2025 and was prescribed almost exclusively for these species. Cephalosporin consumption remained low at 42.03 kg, with pets accounting for 42% of total cephalosporin use.

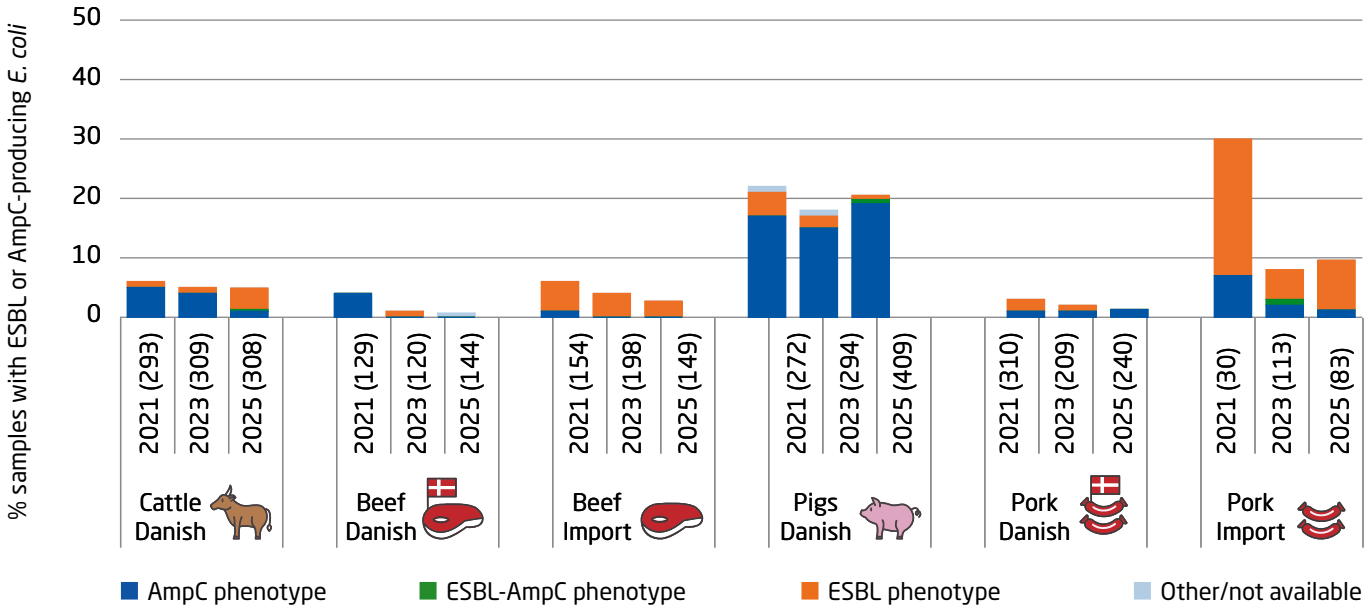
Highlights of antimicrobial resistance

Resistance in bacteria from healthy animals and meat

In 2025, fully susceptible **indicator *E. coli*** increased in broilers (66%), remained stable in pigs (41%), and decreased in cattle (88%, down from 93% in 2024). Multidrug-resistance occurrence was unchanged in broilers (13%) and pigs (34%), but increased in cattle to 11%, returning to pre-2024 levels (Figure 2.6). Resistance patterns in broilers and pigs changed only marginally (1 to 3 percentage points), whereas cattle showed increased resistance to several antimicrobials, reaching levels similar to 2021-2022. Ciprofloxacin resistance in broiler *E. coli* continued to decline, reaching 9% in 2025. No resistance to colistin, meropenem, or third-generation cephalosporins was detected.

The specific monitoring of **ESBL/AmpC-producing *E. coli*** showed an increase in Danish pigs from 18% in 2023 to 22% in 2025, while the occurrence in cattle, beef, and pork remained largely stable (±1 to 2 percentage points). ESBL/AmpC-producing *E. coli* remained more common in imported pork (10%) than in Danish pork (1%) (Figure 4.2). The frequency of ESBL and AmpC genetic determinants among the recovered isolates remained comparable to previous years. No carbapenemase-producing *E. coli* were detected.

Figure 4.2 Occurrence (%) of samples with ESBL- and/or AmpC-producing *E. coli* from animals and meat recovered by selective enrichment, 2021-2025



Number of samples tested per year is presented in parentheses. Classification of ESBL and/or AmpC phenotypes based on antimicrobial susceptibility testing.

Among enterococci from pigs, the proportion of fully susceptible isolates was 18% for ***E. faecalis*** and 10% for ***E. faecium*** in 2025. Compared with previous monitoring years, resistance increased for several antimicrobials in both species. Notably, resistance to linezolid or tigecycline was detected among a few enterococci. No vancomycin resistance was detected.

In 2025, the levels of resistance in ***Campylobacter jejuni*** and ***C. coli*** were consistent with the overall pattern observed in previous years, with high levels of resistance to ciprofloxacin and tetracycline, and low levels of resistance to chloramphenicol, erythromycin, and gentamicin. Among *C. jejuni* isolates from broilers and cattle, ciprofloxacin resistance was observed in 45% and 32% of the isolates, while tetracycline resistance was observed in 25% and 6% of the isolates, respectively. Combined resistance to both ciprofloxacin and tetracycline (CIP-TET) was detected in 24% and 6% of *C. jejuni* isolates from broilers and cattle (Figure 5.5). Macrolide resistance remained rare, with erythromycin resistance being absent among broiler and cattle *C. jejuni* isolates and detected in 3% of *C. coli* isolates from pigs.

Resistance to critically important antimicrobials, namely quinolones, third-generation cephalosporins, colistin, or carbapenems, remained uncommon in ***Salmonella* Typhimurium, monophasic *S.* Typhimurium and *S.* Derby** from healthy Danish pigs and pork (carcases) and was not detected among those isolates in 2025, with a single exception. One *S.* Derby isolate from a pig displayed an unusual ceftazidime-resistant phenotype, although no genetic ESBL and AmpC resistance genetic determinants could be identified. Increased levels of gentamicin resistance were observed among *S.* Derby and *S.* Typhimurium isolates from domestic pigs and pork, in line with a sporadic occurrence of genes conferring resistance to aminoglycosides (gentamicin and apramycin).

Resistance in pathogenic bacteria from acute mastitis in dairy cows

In dairy cows, 441 milk samples from acute mastitis cases were analysed, yielding 491 bacterial isolates of which 80.9% belonged to well-known mastitis pathogens. The most frequently identified species were ***Streptococcus uberis*** (25.1%), ***Escherichia coli*** (16.9%), ***Staphylococcus aureus*** (12.0%) and ***Streptococcus dysgalactiae*** (11.2%). Overall, there were no significant changes in phenotypic resistance compared with 2024.

Notably, 27.6% of *S. uberis* isolates were resistant to penicillin, although most isolates at a borderline level. Together with the absence of a clinical breakpoint for interpretation, the clinical significance of this resistance remains thus uncertain. Tetracycline resistance was observed in 16.3% of *S. uberis*, 16.4% of *S. dysgalactiae* and 70.6% of *S. agalactiae*. Among *E. coli*, resistance to ampicillin, sulfamethoxazole and trimethoprim ranged from 12.7–15.2%, while tetracycline resistance was 5.1%. As in 2024, one ESBL-producing *E. coli* isolate carrying $bla_{\text{CTX-M-15}}$ was identified. Resistance among the remaining mastitis pathogens was generally low.

Resistance in pathogenic bacteria from pigs

Most pathogenic bacteria from pigs displayed resistance levels similar to those observed in 2024 and 2020. However, ten pathogen–antimicrobial combinations showed significantly increased resistance, whereas none showed a significant decrease.

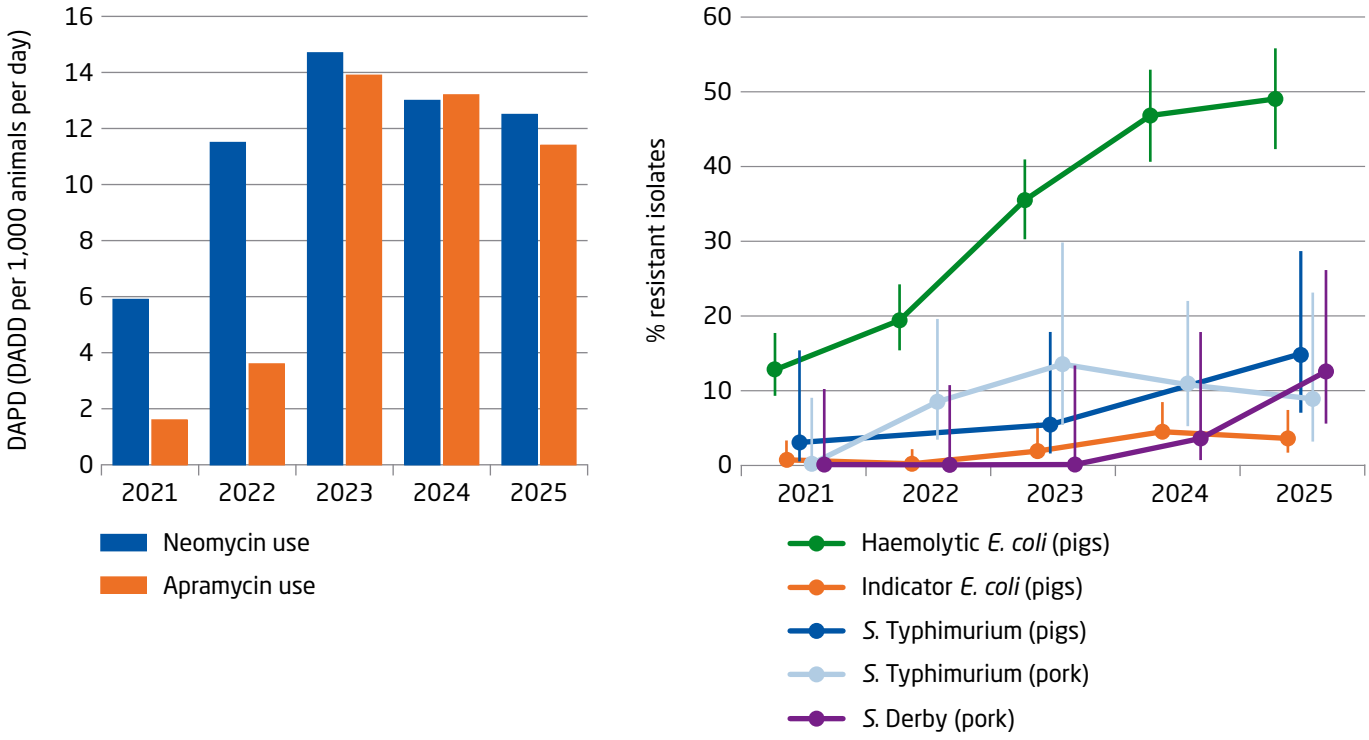
Haemolytic *E. coli* showed increased resistance to seven antimicrobials. Resistance to amoxicillin-clavulanic acid, neomycin, spectinomycin, and trimethoprim-sulfamethoxazole used for treatment of post-weaning diarrhoea remained high (38.6%–87.9%). Gentamicin resistance also remained high (48.8%). The continued high levels of resistance to neomycin and gentamicin are of particular concern, given the importance of neomycin as a first-choice treatment and the classification of gentamicin as critically important for human medicine. Resistance to third-generation cephalosporins (cefpodoxime) was 6.8%. **Non-haemolytic *E. coli*** also showed significantly increased resistance to amoxicillin-clavulanic acid and trimethoprim-sulfamethoxazole, while ***Actinobacillus pleuropneumoniae*** showed increased resistance to trimethoprim-sulfamethoxazole.

Integrated perspectives of antimicrobial consumption and resistance

Pigs

While overall **aminoglycoside** use in weaners decreased slightly in 2025 compared to the previous year, the use of both neomycin and apramycin has increased substantially since 2021 (Figure 4.3, left panel). In the same timeframe, gentamicin resistance in several cohorts of *Salmonella* and *E. coli* isolated from Danish pigs and pork has increased (Figure 4.3, right panel). The most notable increase occurred in haemolytic *E. coli* found in pigs, where gentamicin resistance has increased from 12.8% in 2021 to 48.8% in 2025. The increasing gentamicin resistance is likely related to increased use of apramycin, as resistance genes commonly confer resistance to both drugs.

Figure 4.3 Use of aminoglycosides (DAPD) in weaners and resistance to gentamicin (%) among several bacteria isolated from pigs and pork, Denmark, 2021-2025

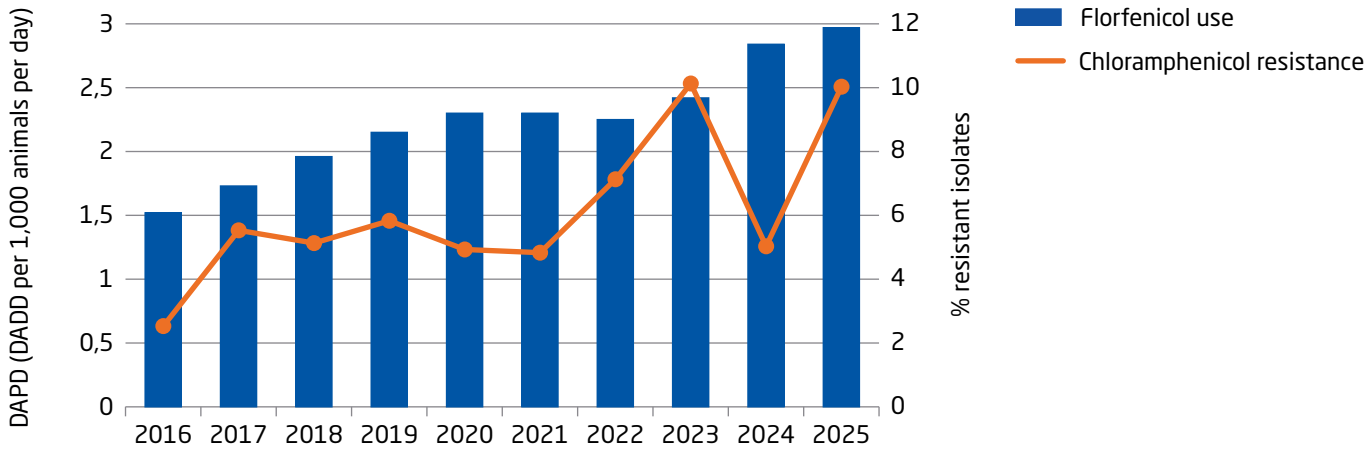


S. Typhimurium includes isolates verified as its monophasic variant. Error bars show the 95% Wilson confidence intervals.

Cattle

In 2025, the decade-long increase in the use of the **amphenicol**, florfenicol**,** in calves continued. Despite the sudden drop observed in 2024 in the occurrence of resistance to chloramphenicol among indicator *E. coli* recovered from calves at slaughter, the resistance level observed in 2025 returned to the level of 2023 (10%). This suggests a continued increase in chloramphenicol resistance levels within the same period. Figure 4.4 shows the florfenicol use and the chloramphenicol resistance levels in *E. coli* in the last ten monitoring years.

Figure 4.4 Use of florfenicol (DAPD) in calves and resistance to chloramphenicol (%) among indicator *E. coli* isolated from calves at slaughter, Denmark, 2016-2025

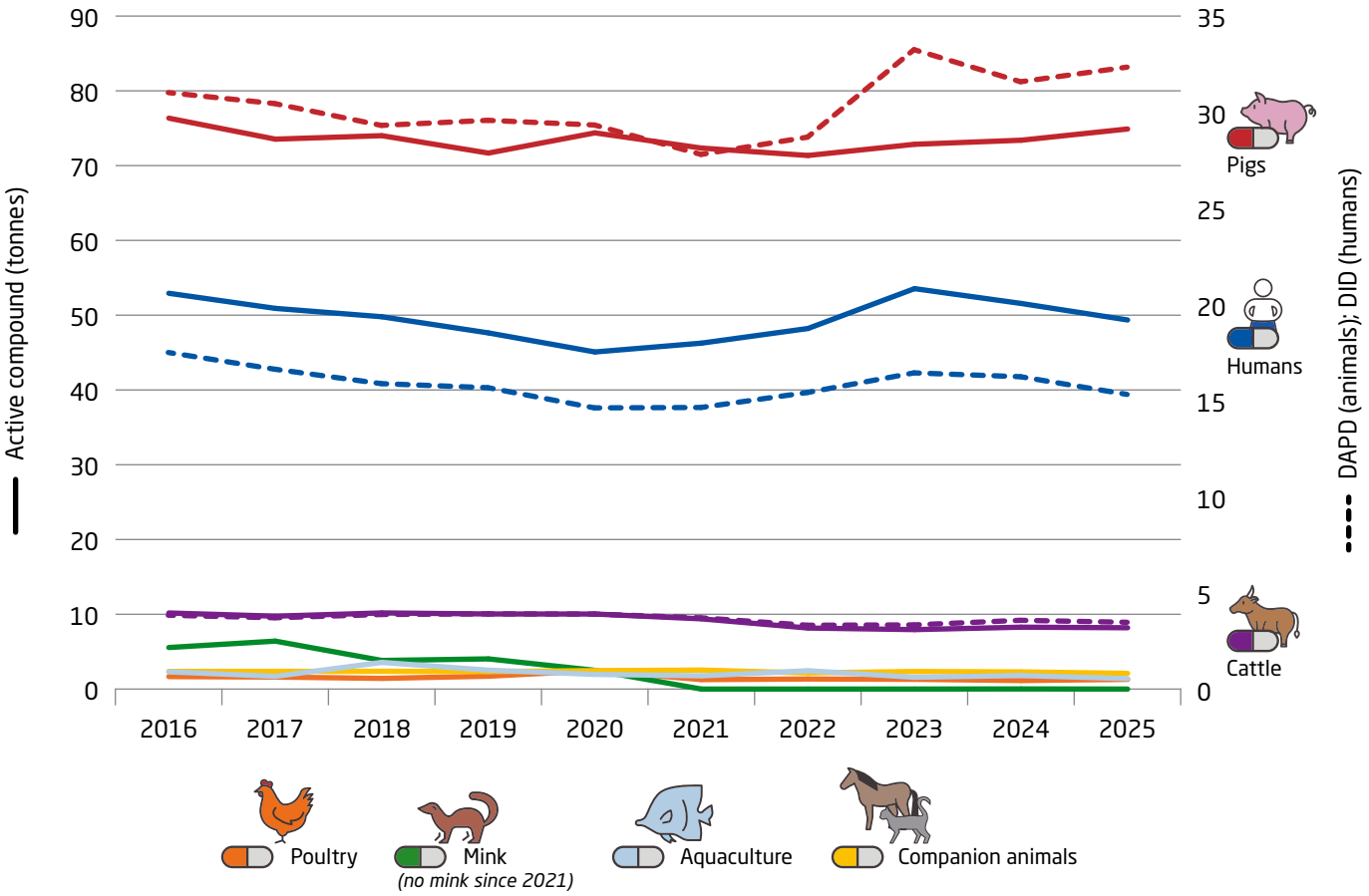


5. One health perspectives

Antimicrobial consumption across human and animal sectors

Comparing and analyzing antimicrobial consumption across human health and the animal sector is challenging due to differences in the applied surveillance methodology and in treatment dosages. However, calculating the consumption in DDD per 1,000 inhabitants per day (DID) for human consumption and Defined Animal Daily Dose per 1,000 animals per day (DAPD) for animal use is probably the closest approximation to a direct comparison.

Figure 5.1 Total antimicrobial consumption of active compounds in tonnes by animal species and humans, Denmark, 2016-2025



Small amounts of kg active (522.6 kg) compound were used by unspecified animal species in 2024.

In 2025, the human health care sector accounted for 49.36 tonnes of antimicrobials corresponding to 15.35 DID. In the animal sector, the corresponding numbers were 88.44 tonnes, with pigs accounting for 84.68% of the consumption (74.9 tonnes, corresponding to 32.4 DAPD) (Figure 5.1).

The Danish Veterinary Consortium, a partnership between the University of Copenhagen and Statens Serum Institut that handles veterinary diagnostics, disease surveillance, and research consultancy in Denmark, has recently published a risk ranking of antimicrobials used in Danish pig and cattle production based on the risk of increased resistance in humans and the subsequent health consequences (https://dkvet.dk/rapporter/). Fluoroquinolones and 3rd and 4th generation cephalosporins were ranked highest, followed by aminopenicillins with beta-lactamase inhibitors and apramycin (due to cross-resistance concerns with gentamycin used in human health care). Table 5.1 shows the consumption of the highest risk ranked antimicrobials in the human health care sector as well as in the pig and cattle production sectors.

Table 5.1 Consumption of antimicrobials ranked highest for the risk of increased resistance in humans, 2025, Danish human health care, pig production and cattle production

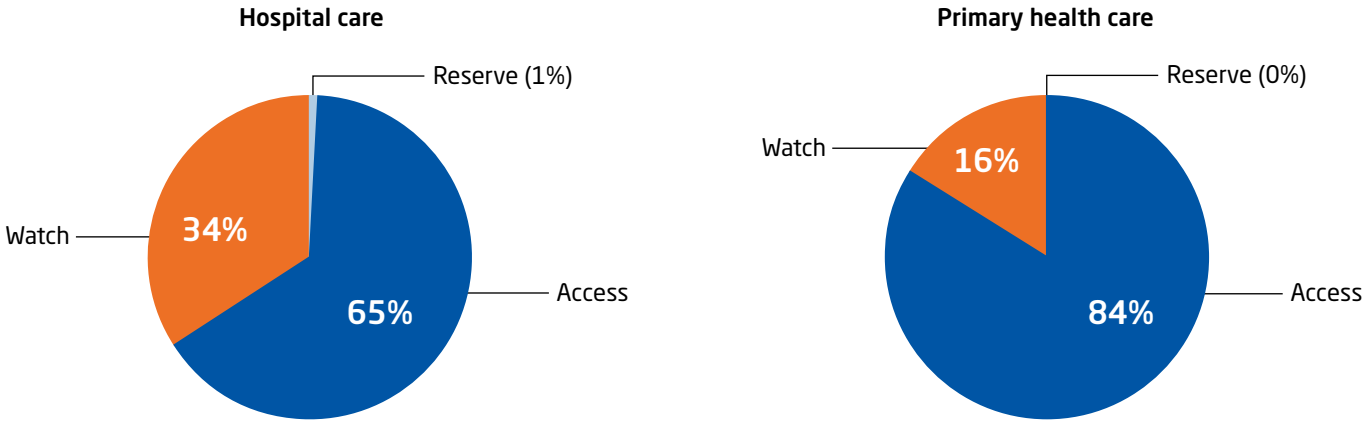
Antimicrobial class	Consumption (tonnes; DID)	Consumption (tonnes/kg; DAPD)	
	Human health	Pigs	Cattle
Fluoroquinolones	0.76 tonnes; 0.45 DID	0 tonnes; 0 DAPD	0 kg; 0 DAPD
3rd and 4th generation cephalosporins	0.13 tonnes; 0.03 DID	0 tonnes; 0 DAPD	0.03 kg; 0.00015 DAPD
Aminopenicillins/beta-lactamase inhibitors	2.58 tonnes; 0.78 DID	8.34 tonnes; 1.19 DAPD	4.49 kg; 0.00098 DAPD
Gentamicin/Apramycin	0.02 tonnes; 0.05 DID	3.58 tonnes; 0.85 DAPD	8.73 kg; 0.00127 DAPD

The World Health Organization (WHO) also ranks antibiotics to assist antibiotic stewardship and to reduce antimicrobial resistance. Antibiotics are classified into three groups by the AWaRe classification system tool to emphasize the importance of their appropriate use in human health care:

- **Access:** Antibiotics used to treat common susceptible pathogens with lower resistance potential than antibiotics in the other groups. 60% of total antimicrobial consumption should consist of Access agents.
- **Watch:** Antibiotics that have higher resistance potential, including most of the highest priority agents. These antibiotics should be prioritised as key targets of stewardship programs and monitoring.
- **Reserve:** Antibiotics reserved for treatment of confirmed or suspected infections due to multidrug resistant organisms. These antibiotics should be considered as "last-resort" options.

Figure 5.2 shows the distribution of the AWaRe groups in human health care by health care sector; primary health care and hospital care. According to WHO, the Access group antimicrobials should account for at least 65% of total consumption in human health care.

Figure 5.2 AWaRe classification of antimicrobials used in Danish human health care by health care sector, 2025

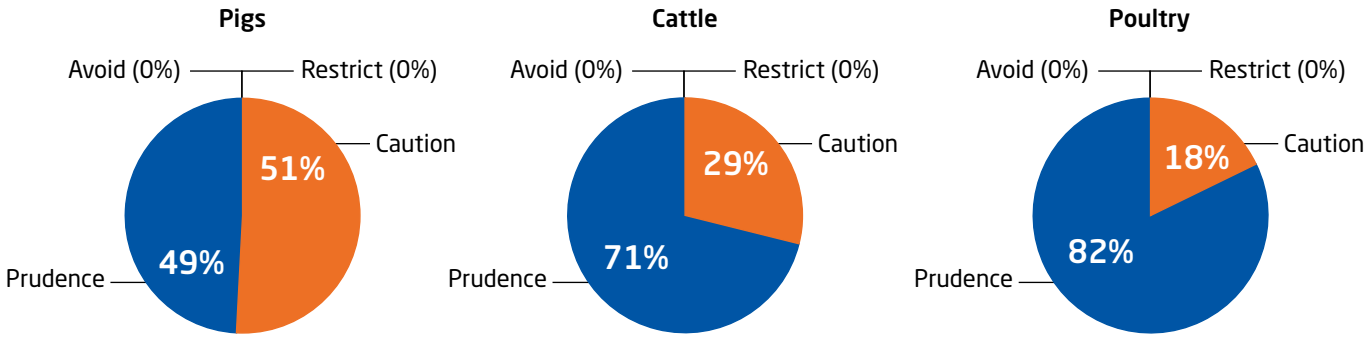


The European Medicines Agency's Antimicrobial Advice Ad Hoc Expert Group (AMEG) also classifies antibiotics used in veterinary treatment into four categories based on their importance to human medicine and the risk of antimicrobial resistance:

- **Category A (Avoid):** Antibiotics not authorised for use in veterinary medicine in the EU and generally not to be used in animals.
- **Category B (Restrict):** Antibiotics critically important to human medicine, whose use in animals should be restricted.
- **Category C (Caution):** Antibiotics that should be used when no suitable alternatives from Category D are clinically effective.
- **Category D (Prudence):** Antibiotics that can be used as first-line treatments when medically justified, following prudent-use principles.

For the animal sector, the EU has established a target to reduce overall sales of antimicrobials for farmed animals and aquaculture by 50% by 2030, compared with 2018. This is a reduction target, not a target for the distribution of antimicrobial classes. Figure 5.3 shows the relative distribution of antimicrobial use in 2025 by AMEG class and by animal species; pigs, cattle and poultry. In 2025, there was no use of antimicrobials from the category Avoid, and absent or negligible (corresponding to near 0%) use of antimicrobials from the category Restrict in the three animal species. The relative distribution among the categories Caution and Prudence varied among the species, with nearly 50-50% use of both categories in pigs, and a dominant use of Prudence antimicrobials in the cattle- and poultry production sectors.

Figure 5.3 AMEG classification of antimicrobials used in the Danish animal sector by farmed animal species, 2025



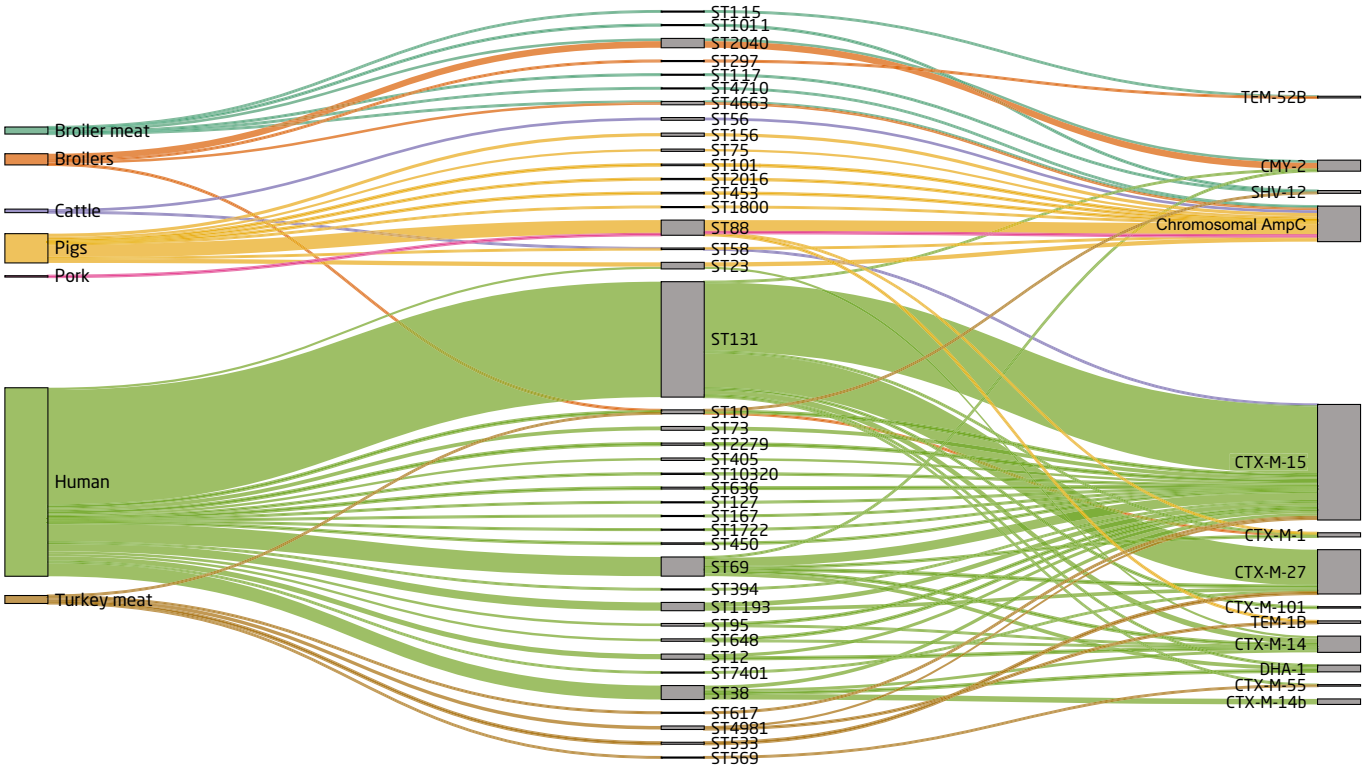
Antimicrobial resistance across human and animal sectors

Extended spectrum beta-lactamase/ AmpC-producing *E. coli*

The zoonotic transmission of extended spectrum beta-lactamase-producing *E. coli* (here abbreviated to ESBL Ec), has been indicated as a possibility in many countries, including Denmark (see DANMAP 2024, Chapter 3, Textbox 3.1), underlining the importance of monitoring the occurrence of these bacteria in animals and humans through an integrated approach.

Here, we map the frequency of multi-locus sequence types (MLST) and resistance genes and mutations in ESBL Ec recovered from livestock animals and meat and from humans. The analysis involved ESBL/AmpC-producing *E. coli* isolates from human bloodstream infections, food-producing animals and meat. A total of 2,579 isolates from 2018 through 2025 were included with 1,639 from humans, 426 from meat and 424 from animals.

Figure 5.4 Source of extended spectrum beta-lactamase/AmpC-producing *E. coli* and their MLSTs and ESBL/AmpC genotypes, Denmark, 2018-2025



Sequence types (ST) and ESBL/AmpC genes and mutations were compared using a Sankey diagram (Figure 5.4). As in the previous years, limited overlap was found in the combination of STs and resistance genotype in isolates from humans vs. animals and meat. Only two STs (ST10: humans, turkey meat and broilers; and ST23: humans and pigs) were found in appreciable numbers in both humans and food and/or animals.

The AmpC plasmid-mediated gene CMY-2, and the ESBL genes CTX-M-1, CTX-M-15, CTX-M-27 and CTX-M-55 were found in both humans and food-producing animals or meat. Interestingly, the ESBL genes found in turkey meat were primarily of the CTX-M-15 and CTX-M27-kind, the two most common ESBL genes among human isolates. The CMY-2 AmpC gene was almost exclusively found among isolates from broilers and broiler meat, and in few isolates from humans and turkey meat. The CTX-M-1 gene was mostly found among human isolates, but also in pig and broiler isolates. Most isolates from cattle harboured a C-42T mutation, which was not detected among the selected human isolates. However, a few cattle isolates had the CTX-M-15 gene, but with a different ST than the human isolates.

Many genes encoding for ESBL-producing phenotypes can be harboured by plasmids, and hence be horizontally transmitted between different, reservoir-specific *E. coli* sequence types. The analysis performed here does not allow us to investigate the occurrence of plasmid transmission across reservoirs, and further research into slow transmission over longer time spans, as well as more in-depth genomic analyses are of continued interest and on-going.

Campylobacter

Campylobacter spp. are commonly associated with intestinal disease in humans. In Denmark, *C. jejuni* is the dominating pathogenic species, accounting for approximately 90% of the human cases, followed by *C. coli*. Both species are ubiquitous in food producing animals. However, *C. jejuni* is most commonly found in broilers and cattle, while *C. coli* is more widespread in pigs.

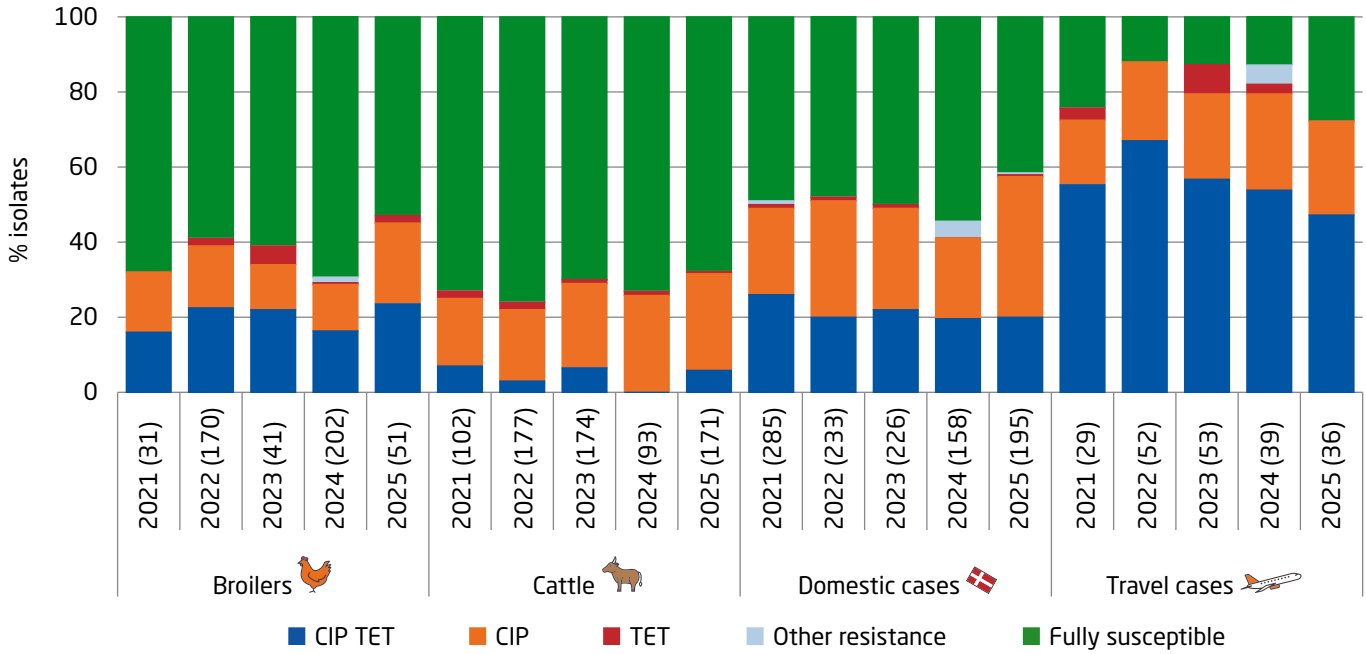
In Denmark, antimicrobials are generally not recommended for treating human patients with diarrhea apart from prolonged or severe cases. When necessary, macrolides (azithromycin) may be used for *Campylobacter* infections.

Increased ciprofloxacin resistance in domestic *C. jejuni* isolates

Ciprofloxacin resistance in domestic human and broiler isolates of *C. jejuni* was higher than in previous years (Figure 5.5). The increase was prompted by two major human domestic outbreaks caused by two distinct ciprofloxacin-resistant clones, which were traced to Danish broiler meat. This illustrates how the emergence of individual clones can influence resistance levels in both human and broiler isolates.

Combined tetracycline and ciprofloxacin resistance (CIP-TET) in 2025 increased in *C. jejuni* isolates from domestic broilers (24% of isolates) and cattle (6% of isolates, Figure 5.5). CIP-TET resistance levels have been high in travel-related *C. jejuni* cases, which was also the case in 2025 (47% of cases).

Figure 5.5 Distribution (%) of AMR profiles among *Campylobacter jejuni* from broilers, cattle and human cases, Denmark, 2021-2025



A human isolate is categorised as domestically acquired if the patient did not travel outside Denmark one week prior to the onset of disease. The bars show the percentage of isolates classified as CIP TET (with combined tetracycline and ciprofloxacin resistance), CIP (resistant to ciprofloxacin but not tetracycline), TET (resistant to tetracycline but not ciprofloxacin), other resistance (resistance to other antimicrobials but not CIP and TET), or fully susceptible (sensitive to all antimicrobial substances tested).

Macrolide resistance remained rare in *C. jejuni* and *C. coli*

In 2025, erythromycin resistance was detected in 1% of all 234 human *C. jejuni* isolates and was not observed among broiler or cattle isolates. Among 44 human *C. coli* isolates, three were resistant to erythromycin. This is similar to the low erythromycin resistance rate of 3% detected in 165 *C. coli* isolates from domestic pigs. The continued low prevalence of macrolide resistance supports the use of macrolides as first-line treatment for severe human campylobacteriosis.

Salmonella

Salmonella spp. are also commonly associated with intestinal disease in humans and include many different serotypes. There is often a correlation between *Salmonella* serotypes and resistance levels, making it difficult to compare these across serotypes. DANMAP focuses on *S.* Typhimurium and monophasic *S.* Typhimurium as these serotypes are present in clinical human isolates and isolates from food-producing animals, especially pigs.

In cases of prolonged or recurrent *Salmonella* infection, treatment with ciprofloxacin or trimethoprim-sulfamethoxazole may be considered, based on antimicrobial susceptibility testing. Information regarding antimicrobial usage for diarrhea at the patient level is currently not available.

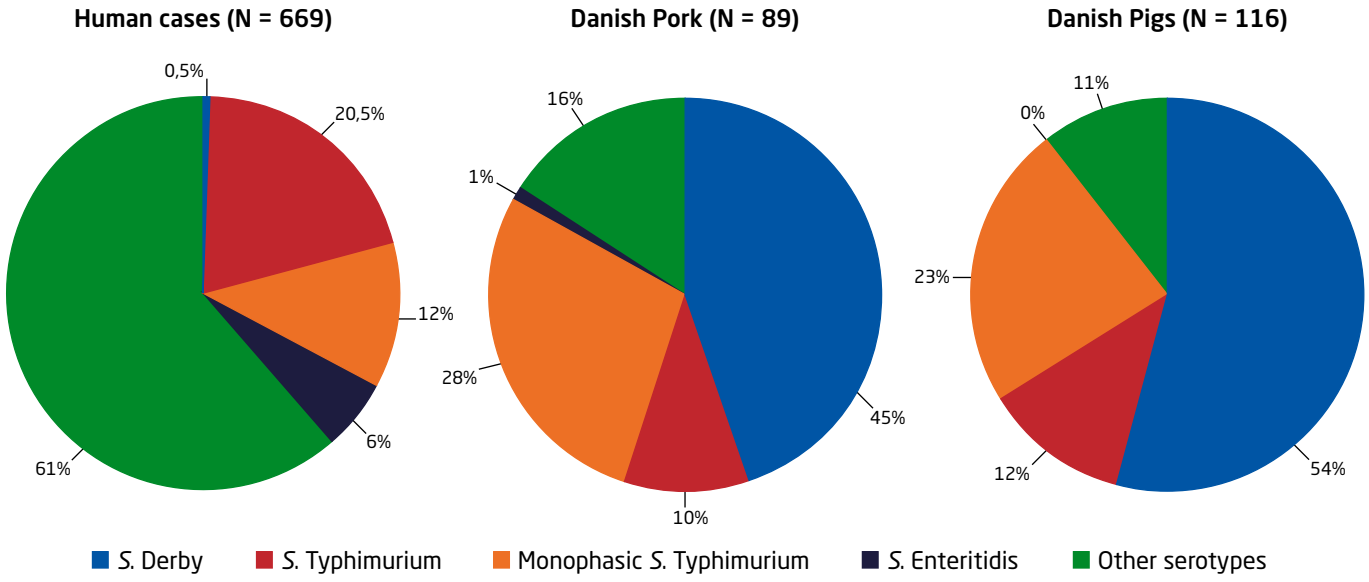
DANMAP only presents *Salmonella* AMR data based on human clinical isolates and isolates collected from healthy pigs as well as pig carcases (referred to as "pork"). The lack of AMR results from isolates originating from a wider variety of food and animal sources limits comparisons of resistance levels between human cases and relevant sources other than pork. It is well established that Danish pork is only one of several sources of human salmonellosis. To gain a better understanding of the clonal dissemination contributing to the spread of AMR, particularly among *S.* Typhimurium and its monophasic variant, *Salmonella* sources other than Danish pork could be monitored.

Different *Salmonella* serotype distributions in humans and pigs

In 2025, a total of 669 human isolates of *Salmonella* spp., including 337 domestic and 250 travel-related cases, were tested for antimicrobial susceptibility. The isolates represented 93 different serotypes and Figure 5.6 shows the most common serotypes. The predominant serotypes were *S.* Typhimurium (137 isolates), monophasic *S.* Typhimurium with the antigenic formula 4,[5],12:i:- (79 isolates), and *S.* Enteritidis (39 isolates). Except for *S.* Enteritidis, the tested isolates represented all clinical Danish isolates and included outbreak isolates. These included 49 outbreak isolates of fully susceptible *S.* Typhimurium, 12 outbreak isolates of monophasic *S.* Typhimurium, and 29 outbreak isolates of fully susceptible *S.* Strathcona, as well as isolates from a few other smaller outbreaks.

A total of 205 *Salmonella* spp. isolates from pigs (116 isolates) and pork (89 isolates) were tested for antimicrobial susceptibility in 2025. The most prevalent serotypes reported in domestic pigs and pork were *S.* Derby (103 isolates), monophasic *S.* Typhimurium (52 isolates), and *S.* Typhimurium (23 isolates).

Figure 5.6 Distribution (%) of *Salmonella* serotypes from human cases, Danish pigs and Danish pork included in DANMAP, Denmark, 2025



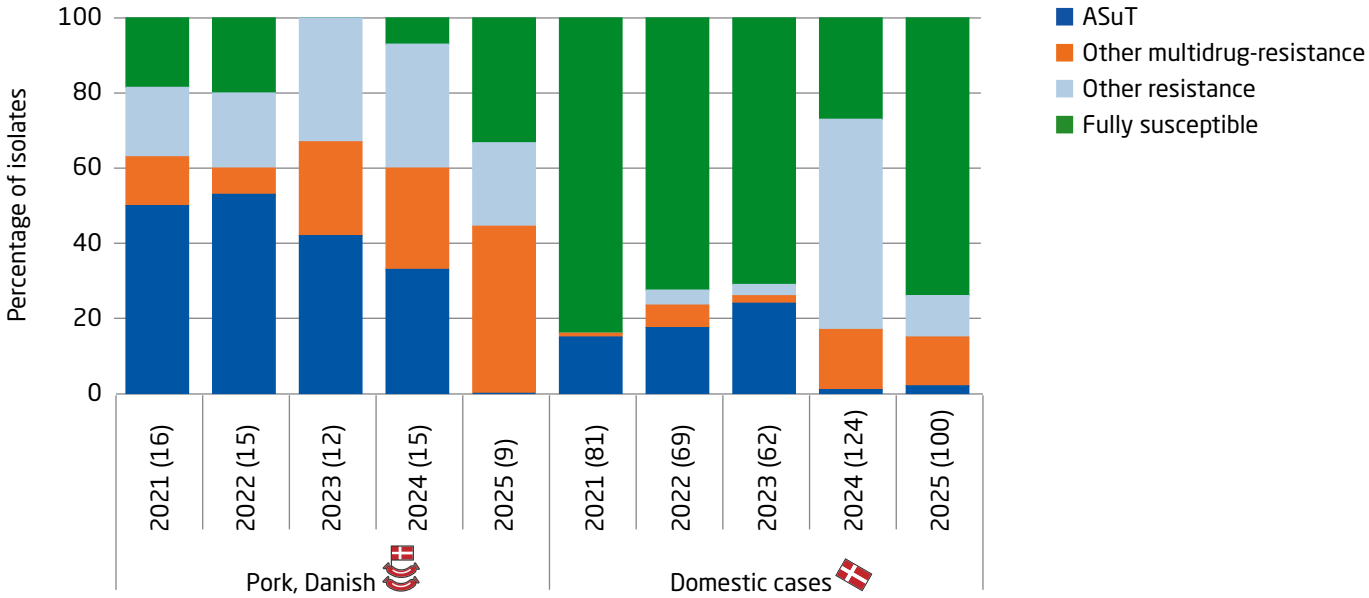
Salmonella serotypes and clones shape antimicrobial resistance

Clonal dissemination plays an important role in the occurrence of antimicrobial resistance, in particular among *S.* Typhimurium and its monophasic variant. These two serotypes are a focus of DANMAP, as they are prevalent in both human isolates and isolates from food-producing animals and derived products.

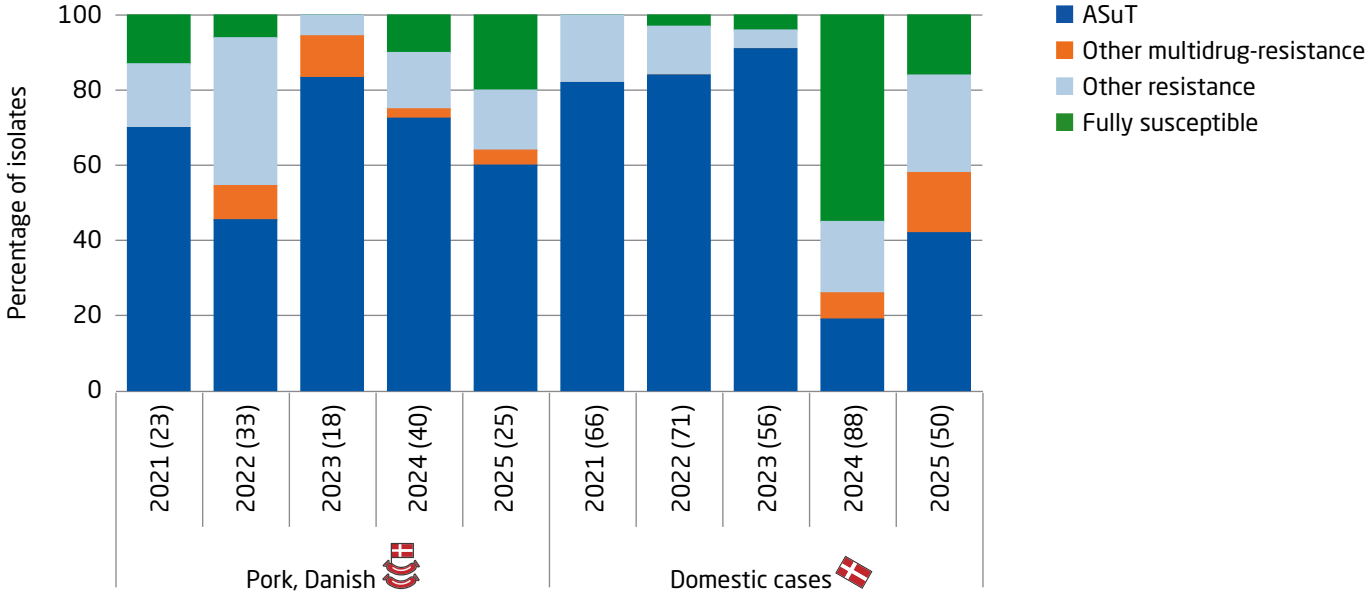
The relative distribution (%) of AMR profiles from 2021 to 2025 for *S.* Typhimurium and monophasic *S.* Typhimurium in Danish pork and human domestic cases is shown in Figure 5.7. Resistance levels in human domestic cases of *S.* Typhimurium are similar to the years 2021 to 2023, with over 70% of cases being fully susceptible to all 15 tested antimicrobial agents (Figure 5.7a). This was different in 2024, when a large outbreak of *S.* Typhimurium cases resistant to aminoglycosides, sulfamethoxazole and tetracycline (resistance gene profile *aph(3")-Ib/aph(6)-Id/sul2/tet(A)*) shaped the overall resistance picture.

Figure 5.7 Relative distributions (%) of AMR profiles among *Salmonella* Typhimurium (a) and monophasic *S.* Typhimurium (b) from Danish pork and human domestic cases, Denmark, 2021-2025

a) *S.* Typhimurium



b) Monophasic *S.* Typhimurium



The bars show the percentage of isolates classified as ASuT (resistant to at least ampicillin, sulfamethoxazole and tetracycline), other MDR (other multidrug resistance profiles than ASuT), other resistance (resistance to one or two antimicrobial classes), or fully susceptible (sensitivity to all antimicrobial substances tested).

A similar situation occurred in domestic human cases of monophasic *S.* Typhimurium, where a fully susceptible outbreak in 2024 crowded out the usual landscape of multidrug-resistant lineages, such as the epidemic monophasic *S.* Typhimurium ST34 lineage common in Europe. The resistance levels in domestic human monophasic *S.* Typhimurium cases in 2025 are similar to what was observed in the years before 2024, with only 16% of cases being fully susceptible (Figure 5.7b). It should be noted that the number of ASuT-resistant cases (combined resistance to ampicillin, sulfamethoxazole and tetracycline) was still much lower in 2025 than in the years 2021 to 2023.

Continued sporadic resistance to gentamicin and azithromycin in *Salmonella*

In *Salmonella* spp., azithromycin resistance was observed in 1% of human isolates, with no resistance detected among domestically acquired cases. Resistance to third-generation cephalosporins was observed in 2% of isolates, while no resistance to meropenem was detected. Ciprofloxacin resistance was observed in 16% of isolates, with resistance levels of 9% in domestic cases (up from 5% in 2024) and 23% among travel-related cases. Gentamicin resistance was seen in 3% of *Salmonella* spp. isolates and in 9% of human monophasic *S.* Typhimurium cases, the highest level recorded in the last five years.

Resistance to critically important antimicrobials, namely quinolones, third-generation cephalosporins, colistin or carbapenems, remained uncommon in *Salmonella* spp. from Danish pigs and pork and no resistance to colistin, meropenem or quinolones was observed. One *S.* Derby isolate from a pig displayed an unusual ceftazidime-resistant phenotype, although no genetic ESBL or AmpC resistance determinants were identified. Increased levels of gentamicin resistance were also observed among *S.* Derby and *S.* Typhimurium isolates from domestic pigs and pork. The increasing occurrence of gentamicin resistance in *Salmonella* warrants continued attention.

Towards a future of environmental AMR surveillance

Antimicrobial resistance is a recognized One Health challenge that extends beyond humans and animals to the environment. Surface water, wastewater, soils, sediments, and wildlife can act as reservoirs and transmission pathways for resistant bacteria, resistance genes, and antimicrobial residues. Although environmental AMR surveillance is still under development, international efforts are rapidly advancing monitoring approaches, indicators, and methodologies.

Recent studies highlight the value of wildlife, for example migratory birds and hedgehogs, as sentinels of environmental AMR. Evidence suggests that resistant bacteria circulate between wildlife, livestock, and human-impacted environments, emphasizing the need for integrated surveillance.

Surface water monitoring initiatives in Europe and beyond are evaluating sampling and detection methods and developing harmonized protocols for routine AMR surveillance. At the same time, wastewater is emerging as a key surveillance matrix because it reflects resistance patterns across large human populations. Large-scale wastewater studies have demonstrated the potential of metagenomics to track both clinically important resistance genes and broader environmental resistomes that may contribute to future resistance threats. The revised EU Urban Wastewater Treatment Directive now requires AMR monitoring in wastewater from major urban areas, marking a shift toward routine, harmonized environmental surveillance across Europe.

Together, research efforts and regulatory initiatives are laying the foundation for future One Health AMR surveillance systems that integrate environmental monitoring alongside human and animal sectors. DANMAP, like other AMR monitoring programs, is committed to exploring how environmental compartments can be incorporated into the national AMR surveillance framework.

6. National Action Plan monitoring

The **Danish National action plan on antimicrobial resistance in humans**[1] was launched in June 2025 by The Ministry of the Interior and Health. The action plan builds on experiences from the previous action plan published in 2017[2], as well as on the Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach[3].

The action plan differs from the previous by setting a broad framework for the Danish efforts to promote rationale use of antimicrobials and to prevent antimicrobial resistance in humans within four focus areas:

1. antimicrobial stewardship
2. access to antimicrobials
3. infection prevention and control
4. international engagement

For each area, overarching political objectives and monitoring indicators are set to track progress towards the objectives. In total, 21 initiatives are suggested as concrete steps to work with the action plan in practice. Additionally, four objectives and twelve indicators are defined to track progress. Table 6.1 presents and overview and status on the indicators in 2025 along with status on the EU Council Recommendation goals where available.

1) https://www.ism.dk/Media/638918721595453894/National-action-plan-on-antimicrobial-resistance-in-humans-UK-TILG.pdf
2) https://www.ism.dk/Media/6/2/National-handlingsplan-for-antibiotika-til-mennesker-UK%20version.pdf
3) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023H0622(01)

Table 6.1 Status on The Danish National action plan on antimicrobial resistance in humans and on the EU Council Recommendation on AMR, 2025

National objective	Indicator	Status, 2025	EU Council Recommendation baseline, 2019	EU Council Recommendation goal, 2030
We must reduce the use of antimicrobials and prioritise the use of antimicrobials that carry a lower risk of resistance development	Number of dispensed antibiotic prescriptions in primary care	2,209,910	-	-
	Use of Penicillin V and Mecillinam as a share of total antibiotic use in primary care, measured in prescriptions per 1,000 inhabitants	49.2	-	-
	Use of critically important antibiotics measured in DDDs per 100 hospital admissions	85.3	-	-
	Share of total antibiotic consumption represented by the Access group	82%	79.1%	>65%
	Total antibiotic consumption in both primary care and the hospital sector, including care facilities (DDD per 1,000 inhabitants per day)	15.35	15.3	Reduction by 9%
We must combat any increase and work towards a of infections requiring treatment	Bacteraemias per 100,000 inhabitants	216	-	-
	Incidence of bloodstream infections with carbapenem-resistant *Klebsiella pneumoniae* (per 100,000 inhabitants)	0.10	0.07	Reduction by 2%
	Incidence of bloodstream infections with methicillin-resistant *Staphylococcus aureus* (MRSA) (per 100,000 inhabitants)	1.1	0.8	Reduction by 3%
	Incidence of bloodstream infections with third-generation cephalosporin-resistant *Escherichia coli* (per 100,000 inhabitants)	7.3	6.6	Reduction by 5%
National objective	**Indicator**	**Status, 2025**		
We must work towards a more stable and improved supply of antimicrobials	Number of market withdrawals of antimicrobials	Between August 2025 and August 2026, a total of 40 AMR-relevant medicines were authorised and 42 were withdrawn from the market. Looking specifically at systemic antibiotics, 28 medicines were authorised and 21 were withdrawn. It is not meaningful to draw conclusions based on the difference between the number of medicines authorised and withdrawn over a single year, as there are natural fluctuations from year to year.		
	Number of new market registrations of antimicrobials			
We must strengthen Denmark's international involvement and contribution to global efforts to combat antimicrobial resistance	Denmark supports and collaborates with the authorities of other countries and international organisations in the fight against AMR	- The Government of Denmark renewed its funding for the International Centre for Antimicrobial Resistance Solutions (ICARS) until 2030. ICARS is a non-governmental organisation, that works to "advance implementation of innovative and evidence-informed AMR solutions aligned with national strategic priorities in low-and middle-income countries through research, partnerships and capacity strengthening" (mission). ICARS´ projects can be sector specific or sector spanning. In 2025, two of the first major projects supported by ICARS were finished: a four year project on surgical antibiotics prophylaxis in selected Georgian hospitals and a three year project on AMS in the Zambian healthcare system (https://icars-global.org/projects/). - Statens Serum Institut and the Danish Technical University were appointed as EU-reference laboratory for AMR for the ECDC and EG Sante (https://en.ssi.dk/surveillance-and-preparedness/international-coorporation/eurl-ph-amr). - Statens Serum Institut continued its partnership with India (2024), and started out with establishing two more partnerships with Ukraine (2025) and Tanzania (official start October 2026) via the Sector Specific Collaboration (link til UMs hjemmeside om SSC). - Statens Serum Institut and the Danish Health Authority continued its engagement in EU JAMRAI II, with contributions to all work packages (https://eu-jamrai.eu/).		

In the veterinary sector, the Danish Veterinary and Food Administration's third **Action Plan against antimicrobial resistance in animals and food**[4] was launched in September 2024, under the most recent national Food and Veterinary Agreement. The action plan reaffirms its commitment to reduce, regulate, and monitor antimicrobial use and resistance and is structured around four strategic pillars:

1. strengthening surveillance by integrating whole genome sequencing and improving data granularity across species and production systems

2. promoting responsible antibiotic use in livestock

3. advancing targeted communication strategies to support informed choices among veterinarians, producers, and consumers

4. prioritizing national and international collaboration and fostering cross-sectoral coordination and knowledge exchange, ensuring Denmark's active role in shaping global AMR policy and research

The current action plan maintains the aim to reduce the total use of antimicrobials in pigs, building on previous antimicrobial use reduction efforts, with a key target set to achieve an 8% reduction in the use of antimicrobials in pigs by the end of 2027 (2018 as baseline level).

Table 6.2 presents an overview on the status of indicators for the different goals of the action plan in 2024 and 2025, the first two years of the plan's period.

4) https://cdn2.gopublic.dk/fvst/Media/638610430209006066/AMR-handlingsplan%202024%20web.pdf

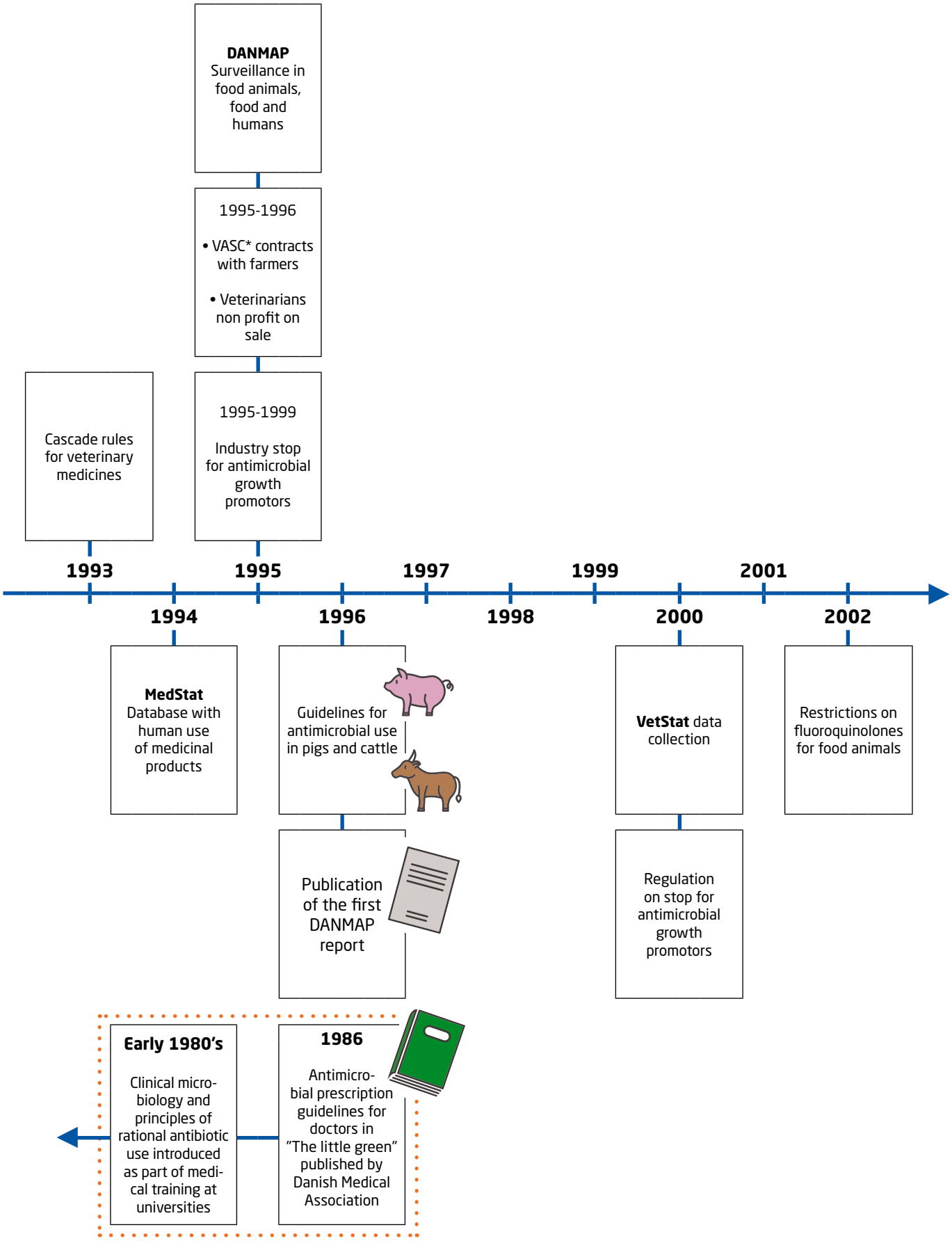
Table 6.2 Status on The Danish National action plan on antimicrobial resistance in animals and food, 2024-2025

National Goal	Indicator	Status 2024	Status 2025
Focus Area: Strengthening One Health Surveillance			
Increased focus on WGS-based monitoring	DANMAP reporting of WGS results for animal and meat isolates	202 ***Salmonella*** isolates from pork carcases (period 2020-2024)	179 ***Salmonella*** isolates from pork carcases (period 2021-2025)
		87 **ESBL/AmpC- producing *E. coli*** from broilers, broiler meat and turkey meat	117 **ESBL/AmpC- producing *E. coli*** from pigs, cattle, beef and pork meat
		768 **ESBL/AmpC- producing *E. coli*** from animals and meat (period 2018-2024)	885 **ESBL/AmpC- producing *E. coli*** from animals and meat (period 2018-2025)
Keep the low occurrence in food of bacteria resistant to antimicrobials critically important to human treatment	DANMAP reporting on bacteria resistant to critical antimicrobials in animals and domestic meat	**ESBL/AmpC-producing *E. coli:*** - **3%** in broilers - **2%** in Danish broiler meat - **34%** in imported broiler meat - **35%** in imported turkey meat	**ESBL/AmpC-producing *E. coli:*** - **5%** in cattle - **1%** in Danish beef - **3%** in imported beef - **22%** in pigs - **1%** in Danish pork - **10%** in imported pork
		Carbapenemase-producing *E. coli*: - **not observed** in animals and meat	**Carbapenemase-producing *E. coli***: - **not observed** in animals and meat
		Resistance to AWaRe **Reserve** substances: **- ertapenem:** **7%** in *C. jejuni* from broilers **37%** in *C. coli* from broilers - resistance to Reserve substances **not observed** in *E. coli* and *Salmonella* from animals and meat	Resistance to AWaRe **Reserve** substances: **- ertapenem:** **2%** in **C. jejuni** from broilers **1%** in *C. coli* from pigs **- tigecycline:** **7%** in *S.* Typhimurium from pigs **11%** in *S.* Typhimurium from pork **4%** in monophasic *S.* Typhimurium from pigs - resistance to Reserve substances **not observed** in *E. coli* from animals
		Resistance to AWaRe **Watch** substances: **- ciprofloxacin:** **29%** in *C. jejuni* from broilers **54%** in *C. coli* from broilers **26%** in *C. jejuni* from cattle **11%** in *E. coli* from broilers **- erythromycin:** **17%** in *C. coli* from broilers **- azithromycin:** **5%** in monophasic *S.* Typhimurium from pork **4%** in *E. coli* from pigs	Resistance to AWaRe **Watch** substances: **- ciprofloxacin:** **45%** in *C. jejuni* from broilers **13%** in *C. coli* from pigs **32%** in *C. jejuni* from cattle **9%** in *E. coli* from broilers **2%** in *E. coli* from pigs **- erythromycin:** **3%** in *C. coli* from pigs; **- azithromycin:** **14%** in *S.* Typhimurium from pigs **11%** in *S.* Typhimurium from pork **5%** in *S.* Derby from pork **1.6%** in *S.* Derby from pigs **6%** in *E. coli* from pigs
Increase the knowledge on resistance in animal pathogens	DANMAP reporting on AMR in animal pathogens (dedicated chapter implemented since DANMAP 2022)	**Mastitis pathogens:** AST reported for 376 isolates from 7 different pathogens	**Mastitis pathogens:** AST reported for 375 isolates from 7 different pathogens
		Pathogens from pigs: AST reported for 699 isolates from 8 different pathogens	**Pathogens from pigs:** AST reported for 571 isolates from 8 different pathogens
Optimize antimicrobial use data quality and accessibility for research	DANMAP reporting of AMU at substance level (implemented since DANMAP 2024)	Reporting of antimicrobial use in animals at **individual substance level**, by age group for pigs and cattle (period 2015-2024)	Reporting of antimicrobial use in animals at **individual substance level**, by age group for pigs and cattle (period 2016-2025)
	Initiatives to improve VetStat	The Danish Veterinary and Food Authority continues to develop VetStat and correct data to increase data quality.	The Danish Veterinary and Food Authority continues to develop VetStat and correct data to increase data quality.

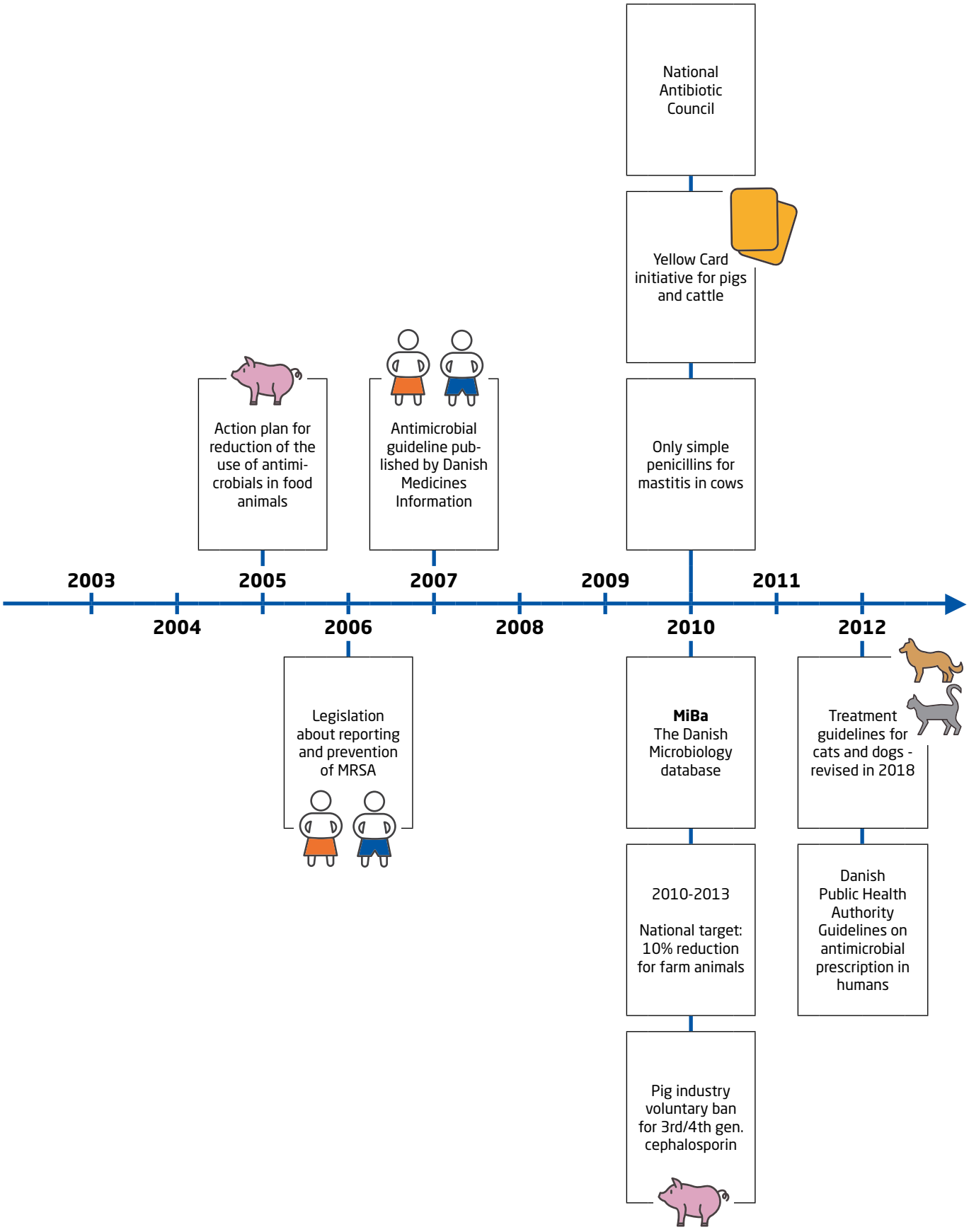
continued ... Table 6.2 Status on The Danish National action plan on antimicrobial resistance in animals and food, 2024-2025

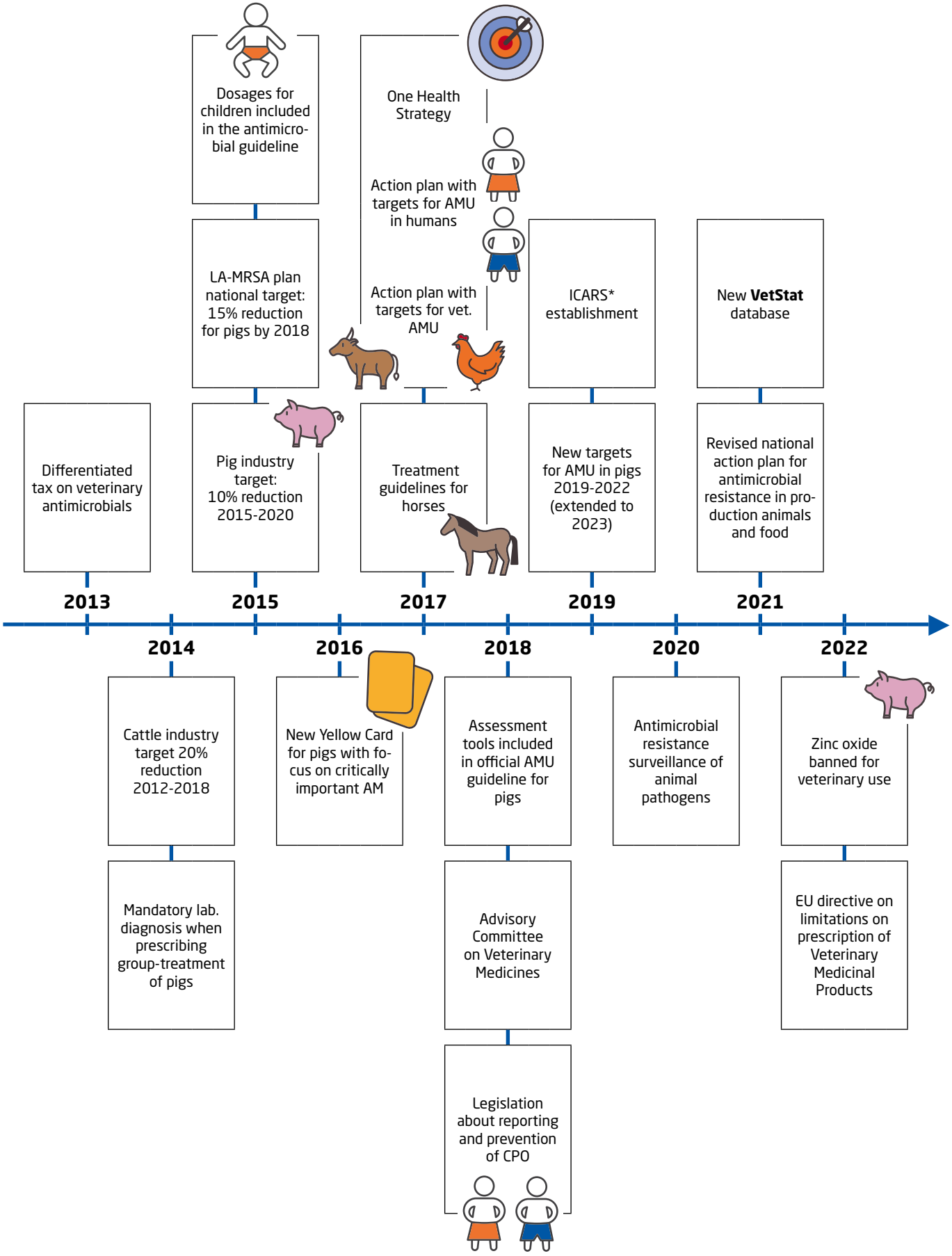
National Goal	Indicator		Status 2024	Status 2025
Focus Area: Healthy Animals and Low Use of Antimicrobials				
Continue the reduction in antimicrobial consumption in animals (2018 as baseline)	8% reduction on total antimicrobial consumption in pigs by 2027, compared to 2018 (baseline 74.04 tonnes)		decrease by 0.8% compared to 2018 (73.4 tonnes)	increase by 1.2% compared to 2018 (74.89 tonnes)
Keep the low consumption of antimicrobials critically important to human treatment (2023 as baseline)	DANMAP reporting of total consumption of antibiotics by AWaRe and AMEG classes, by animal species		Reporting of antimicrobial resistance in bacteria from animals by AMEG and AWaRe classes at DANMAP Seminar (period 2024 and 2025)	
			Reporting of antimicrobial consumption by **AMEG class** (period 2025): **Caution** - Pigs - 51%; Cattle - 29%; Poultry - 18% **Prudence** - Pigs - 49%; Cattle - 71%; Poultry - 82%	
Focus Area: Targeted Communication				
Increase the knowledge level about AMU and AMR	DANMAP integrated reporting of AMU-AMR by animal species		Comparison of trends in AMU and AMR (period 2020-2024) in indicator *E. coli* for: -**amphenicols** in **calves** -**aminoglycosides** in **weaners** -**macrolides** in **finishers**	Comparison of trends in AMU and AMR for: -**florfenicol use and chloramphenicol resistance** in *E. coli* (calves, period 2016-2025) - **aminoglycoside use in weaners and resistance to gentamicin** in *Salmonella* and *E. coli* (pigs and pork, period 2021-2025)
Support informed treatment choices and conscious choice by the consumers	Risk-ranking of antimicrobials for treatment of pigs and cattle (https://dkvet.dk/rapporter/)		Danish Veterinary Consortium (DK-VET) has completed risk ranking of antimicrobials used in Danish pig and cattle production based on the risk of increased resistance in humans and the subsequent health consequences.	
Focus Area: Prioritize National and International Collaboration				
Expand the Danish expertise and secure Danish influence in global-level decision making	Strategic Sector Collaboration missions focused on AMR/AMU surveillance led by the Danish Veterinary and Food Authority (DVFA)	South Africa		September 2025 (DTU) Incoming study visit at DTU on AMR/AMU surveillance
		Mexico	June 2024 (DTU/SSI) Incoming delegation/study tour with visits to both DTU and SSI. Partly related to AMR surveillance.	March 2025 (DTU) One week Mission in Mexico focusing on bridging the gap between collecting data and utilizing it for political action
				June 2025 (DTU) Incoming training at both DVFA LAB and DTU on AMR detection and reporting

7. Timeline



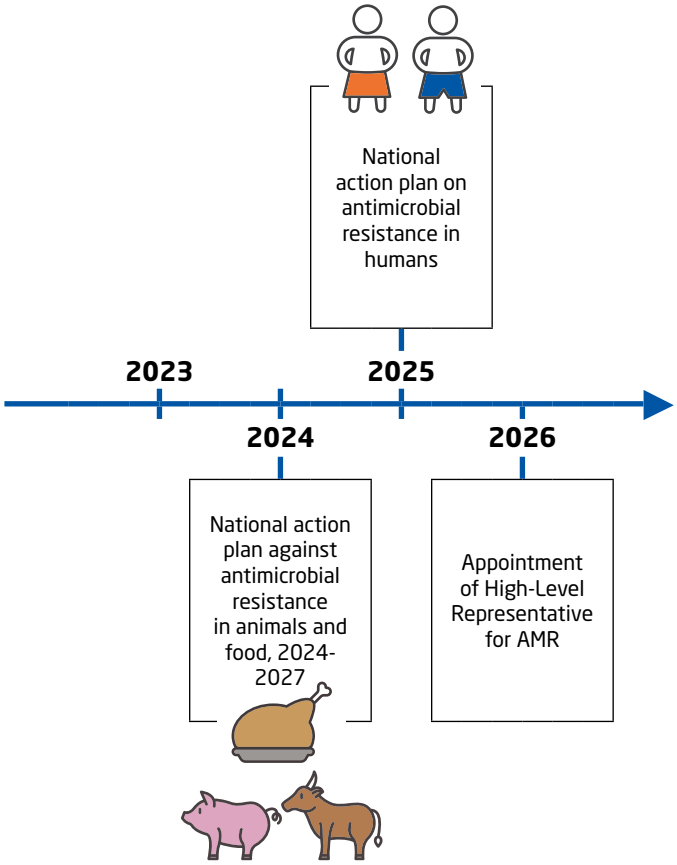
* Veterinary Advisory Service contracts.


National Antibiotic Council
Yellow Card initiative for pigs and cattle
Only simple penicillins for mastitis in cows
Action plan for reduction of the use of antimicrobials in food animals
Antimicrobial guideline published by Danish Medicines Information
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Legislation about reporting and prevention of MRSA
MiBa The Danish Microbiology database
2010-2013 National target: 10% reduction for farm animals
Pig industry voluntary ban for 3rd/4th gen. cephalosporin
Treatment guidelines for cats and dogs - revised in 2018
Danish Public Health Authority Guidelines on antimicrobial prescription in humans



* The International Centre for Antimicrobial Resistance Solutions.

continued ... Timeline of DANMAP



8. List of abbreviations

AMU	Antimicrobial use
AMR	Antimicrobial resistance
CA	Community-acquired
CPE	Carbapenemase-producing Enterobacterales/Enterobacteriaceae
CPO	Carbapenemase-producing organisms
DAD	Defined Daily Doses per 100 admissions
DADD	Defined Animal Daily Dose
DAPD	Defined Animal Daily Dose per 1,000 animals per day
DCM	Department of clinical microbiology
DDD	Defined Daily Dose
DID	Defined Daily Doses per 1,000 inhabitants per day (DDD/1,000 inhabitants/day)
DTU	Technical University of Denmark
DVFA	Danish Veterinary and Food Administration
LA-MRSA	Livestock-associated methicillin-resistant *Staphylococcus aureus*
MiBa	The Danish Microbiology Database
MDR	Multidrug-resistant
MRSA	Methicillin-resistant *Staphylococcus aureus*
SSI	Statens Serum Institut
VASC	Veterinary advisory service contracts
VMPs	Veterinary medicinal products
VetStat	Danish Register of Veterinary Medicines
WGS	Whole-genome sequencing
WHO	World Health Organization



Perspectives of DANMAP 2025

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